TENNESSEE'S NUTRIENT REDUCTION TOOLKIT

A Resource for Public Awareness, Outreach and Pollution Prevention to Improve Stream Water Quality

Tennessee Nutrient Reduction Task Force

Improving Stream Water Quality

More Information at: **www.tnnutrientreduction.org**

ACKNOWLEDGEMENTS

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- **Tennessee Dept. of Agriculture (TDA**), Land and Water Stewardship Section, (Admin. John McClurkan)
- **Tennessee Nutrient Reduction Strategy Taskforce** and **Communication, Education and Outreach Workgroup,** (Co-Chairs Cynthia Allen, Adam Reynolds)
- **Middle Tennessee State University (MTSU) Grant Committee:**
- **Center for Health and Human Services** (Director, Cindy Chafin, Christina Tayler Byrd).
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PREFACE

The U.S. Environmental Protection Agency (EPA) states that excessive nutrients such as nitrogen and phosphorus from community sources such as stormwater, fertilizers, leaves and grass clippings, detergents, sewage and manure contribute to one of America's most widespread, costly, and challenging environmental problems. Since pollution comes from all aspects of our communities, everyone's daily actions can become part of the solution to reduce nutrients in our waterways.

In 2015 the Tennessee Department of Environment and Conservation (TDEC) developed a strategy to reduce nutrient pollution from excess nitrogen and phosphorus runoff in streams and lakes. This toolkit is part of the ongoing effort to increase public awareness and offer resources and practical solutions for our communities.

The toolkit is structured to use in its entirety or as individual sections based on the needs of each end user. We've structured this toolkit based on topics the EPA lists as sources for nutrient runoff in our communities (Stormwater, Agriculture, Wastewater) and useful public outreach materials that teachers and community leaders (Educators) can use including resources and interactive lessons.

This Toolkit **Overview** is provided to explain the sections and how they can help the user:

- **Introduction** to 'nutrient pollution' provides an explanation of nutrients and impacts to water quality.
- **Background** highlights the extent of the pollution problem in the Gulf of Mexico and national efforts.
- **Reducing Nutrients in the Waterways of Tennessee shares** a broad view of nutrient pollution in our state including community sources from daily actions and stormwater runoff, farms and agriculture practices and wastewater contributions from sewer and septic failures. It details community impacts in our waterways and some simple solutions for pollution prevention methods. This section directs the user to the supplemental materials in the Appendix for more detailed information and resources.
- **Appendix** includes several sections with more details based on topic and supplemental outreach materials and resources and that community leaders can use to further education and awareness.
  - **Infographics** – this includes a series of 11 posters explaining the problems caused by nutrient pollution, some of the sources, and helpful actions to prevent pollution. These can be used in a variety of formats (printable or for web or social media).
  - **Stormwater** explains runoff and the way pollution travels through our farms, neighborhoods and communities. This section encompasses a wide range of general information and tips for pollution prevention for municipalities, homeowners and even classrooms or civic organizations to share and use.
  - **Agriculture** explains common farm pollutants and offers good farm practices such as the use of no-till, cover crops, soil testing, equipment calibration other applications for farm operations.
  - **Wastewater** provides an understanding of sewer and water treatment operations and explains how 'what goes down the drain' (don't bold this) can affect operations and contribute to pollution. It also highlights treatment plant optimization efforts and case studies that reflect improvements statewide. Septic information and materials for citizens are also included.
  - **Educators** includes 10 interactive curriculum-based activities and the current standards for formal (K-12) and non-formal teachers (scouts, 4-H, Homeowner Associations, stormwater professionals, FFA teachers, etc.) to use for teaching or in a classroom setting.
  - **Key Terms** for vocabulary and pollutant information is also included.
  - **Social Media** guidance and content is also provided to assist with online community outreach.

Working together and using pollutant reduction strategies helps us all enjoy safer and cleaner water statewide.

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OVERVIEW

GOALS AND INTENT

All Tennesseans can make a difference in the fight to keep our streams healthy. This toolkit was developed to increase public awareness of nutrient pollution sources and offer resources and solutions.

The **intent** of the toolkit is to equip community leaders and citizens with outreach resources to increase Tennessean awareness about how nutrients end up in our streams, where those pollutants come from, and what actions can be done to protect our waterways and reduce nutrient pollution.

The **goal** of this toolkit is to provide a resource to the different community sectors Tennessee communities to address nutrient pollution that is contributing to the environmental health and degradation of our waterways. It can be used in its entirety or by the individual sections that can standalone depending on what is most useful to the reader.

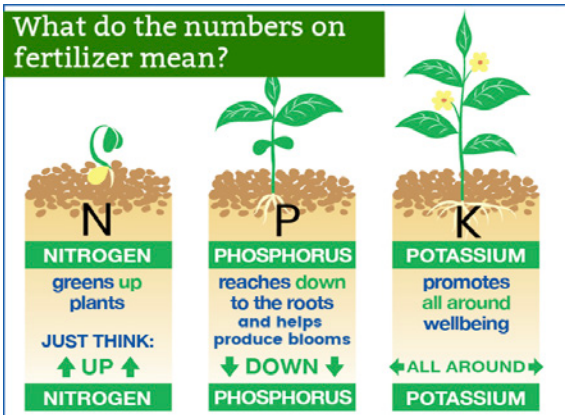
The **target audiences** for this toolkit are the general public including:

- formal and non-formal educators,
- businesses,
- landscapers, gardeners,
- agriculture and farm workers,
- municipal workers in wastewater treatment and stormwater management,
- homeowners and residents,
- industry, and
- government and civic leaders.

OVERVIEW (continued)

INTRODUCTION TO NUTRIENTS

Primary nutrients (N, P and K) are essential for daily living and growing plants, but they can be beneficial or detrimental depending on their



Source: https://elitechdrip.com/npk-fertilizer/

Two nutrients of focus include ***nitrogen*** and ***phosphorus*** which are often found in excess in America's rivers and waterways and contribute to water pollution in our streams, lakes and rivers. Excess nutrients can reduce oxygen levels harming aquatic animals and fish. In some instances, the excessive nutrients can produce harmful algal blooms that emit toxins that can be detrimental to wildlife, pets, and people.

BACKGROUND

National Waterways

The U.S. Environmental Protection Agency (EPA) states that **nutrient pollution** is one of America's most widespread, costly, and challenging environmental problems. This runoff and pollution pose a problem around the nation.

One of the regions of particular concern is the Mississippi River and the drainage area into the Gulf of Mexico. This is due largely to the large watershed drainage.

The Mississippi River Watershed is the world's third largest. It is the drainage basin for 41% of the continental United States.

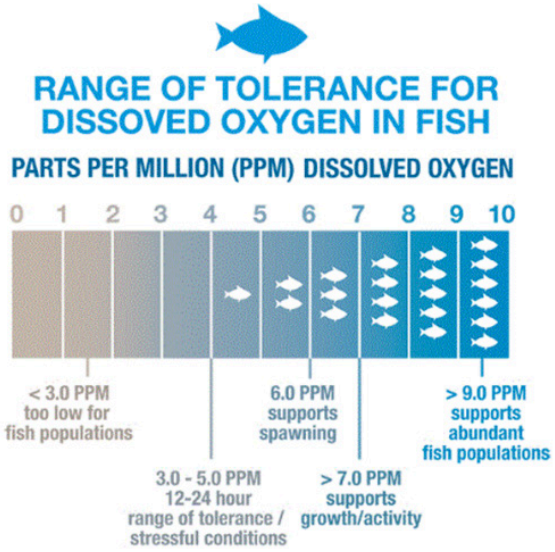
Source: https://www.iwr.usace.army.mil/Media/News-Stories/ rticle/481010/2011-floods-discussed-at-usace-usgs-quarterly-meeting/

EPA defines hypoxia levels that are l***ess than 2-3 mg/L of dissolved oxygen)*** and cannot adequately support aquatic life. Life cannot thrive without oxygen!

Algae Blooms and Low Oxygen

Because nitrogen and phosphorus encourage plant growth, when too much enters streams from overapplication or runoff during rain events, the outcome is an overgrowth of algae which consume oxygen levels in the water and blocks sunlight from underwater plants. Eventually the algae die leaving the oxygen levels in the water to become depleted. The lack of oxygen makes it impossible for aquatic life to survive. These areas now become'dead zones' because life can't survive without oxygen. In addition, some types of algae blooms produce chemicals, or toxins, thus becoming a 'harmful algal bloom' (HAB).

OVERVIEW (continued)



These can occur in any surface water including lakes, reservoirs, rivers, ponds, bays and coastal waters. The toxins cause harm and illness to pets, wildlife,and humans. There are different kinds of algae that produce HABs but the common one is from blue-green algae (cyanobacteria).

EPA states that "DO (dissolved oxygen) levels below 3 milligrams per liter (mg/L) are of concern and waters with levels below 1 mg/L are considered hypoxic and usually devoid of life."

The Gulf Dead Zone

Dead zones generally occur in the summer and are caused by significant and concentrated nutrient pollution from upstream sources. The largest dead zone in the United States is in the Gulf of Mexico from runoff in the Mississippi River Basin.

The National Oceanic and Atmospheric Administration (NOAA) monitors the size and pollution status of this zone:

- In 2021, estimated at 6,334 square miles, or equivalent to more than 4 million acres.
- **That's twice the size of the state of Delaware** (**Landwatch.com**)
- The range has been 5,380 to 8,776 square miles.

The hypoxia ('dead zone') is the result from decades of pollution runoff that drains into the sea. To combat this growing problem, EPA developed the Gulf Hypoxia Program, and a National Task Force to strive for progress toward reducing nutrient loads and improving water quality.

EPA resources can be found at *www.epa.gov/nutrientpollution*. *www.epa.gov/national-aquatic-resource-surveys/indicators-dissolved-oxygen*

Reducing Nutrients In TN Waterways

Federal Regulations (add this sub header, bold EPA) The Environmental Protection Agency (EPA) is the federal government agency responsible for determining and establishing guidelines for water quality. There are standards and regulations in place for more than 90 contaminants, including metals, disinfection byproducts, and microorganisms. Although infrequent, contamination may occur from sources such as sewage from overflowing waste treatment or septic systems, naturally occurring chemicals and minerals such as arsenic or radon, manufacturing processes releasing heavy metals like cyanide, livestock feeding operations releasing wastes, and agricultural applications of pesticides and fertilizers.

State Regulations & Waterways

The Tennessee Department of Environment and Conservation (TDEC) is the state agency responsible for administering water quality regulations.

- **According to TDEC, there are:**
- **over 3,000 miles of streams and**
- **over 15,000 acres of lake in the state of Tennessee (TDEC, 2021).**

For those of us in Tennessee that get our tap water from surface water, these contaminants must be treated by our water and wastewater treatment facilities. Something most of us don't want to think about is that we are all downstream from another town's wastewater (return flow)!

REDUCING NUTRIENTS IN TENNESSEE WATERWAYS

TENNESSEE WATER POLLUTION

Tennessee is 1 of 12 states that flows into the Mississippi River and contributes to the cumulative pollutant load that flows to the Mississippi River and into the sea.

This pollution has resulted in a large area of water that cannot sustain life and is causing devastating results to the region.

It is estimated by the U.S. Geological Survey (USGS) that Tennessee's source contribution flowing into the Mississippi River and on into the Gulf of Mexico is estimated at:

- 5% for the total nitrogen
- 5% of the total phosphorus.

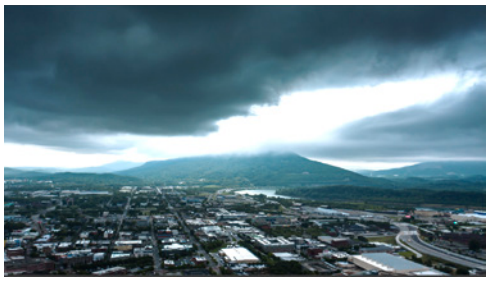
It's important to know where sources of nutrients originate to combat the problem.

REDUCING NUTRIENTS IN TN WATERWAYS (continued)

TN Pollution Sources

Where does all that pollution come from? The pollution comes from runoff as rain flows in our communities statewide. While we cannot manage to reduce all pollution, it does help to know where it comes from to help in identifying solutions to lower levels.

Stormwater- When rain flows in our state, the water picks up pollutant particles along the way. Rainwater on natural surfaces gets soaked into the ground.



Rainwater which does not infiltrate into the ground is considered '**stormwater**' which flows over and 'runs off' surfaces carrying pollutants to surface waters and streams by way of stormwater drains in our roadways, neighborhoods and small streams and ditches. Stormwater is not treated at any facility. It flows directly to the nearest stream carrying pollution that can accumulate and travel downstream.

The following are some other **pollutant sources** that comes from multiple other areas in communities across the state.

Cities- municipal impacts come from pollutants on roads, rooftops, streets, parking lots, neighborhood lawns, gardens, golf courses, landscaped areas, businesses parking lots, sewer lines, food wastes, construction sites and industrial facilities are pollution sources. Urban and rural areas both contribute to pollution.

In and Around the Home- Pollution in our city can include sediments and fertilizers to make lawns green. Yard debris contains nitrogen in grass clippings and phosphorus in leaves. Sewer and septic contain high amounts of nutrients as do areas where pets stay outdoors. Food scraps contain nutrients too that contribute to wastewater loads. Damage to septic fields as well as septic and sewer leaks and clogs can contribute if not maintained properly. Improper disposal of fats, oils, greases and hygiene products may also contribute to clogs and leaks.

Stream banks -Mowing to the stream bank also contributes to nutrient pollution. Trees and shrubs near the bank provide beneficial protection to hold the soil in place, cool water temperatures and filter pollutants.

Transportation -Roadways and vehicles can impact from fossil fuel use which often have high nitrogen pollution.

Wastewater- Sewer and septic systems are vital for community health by treating large quantities of wastewater from daily use. This includes unprocessed nutrients frow sewage, food scraps from garbage disposals and wash water, as well as toilets, showers etc. Often these municipal systems may not operate properly or may need upgrades causing them to not always be able to remove enough nitrogen and phosphorus before discharging into waterways.

Agriculture- farming and livestock impacts contribute from animal manure and bedding. Fields often are with chemical fertilizers that contain nitrogen and phosphorus. These nutrients are necessary to grow crops, but if plants and soil don't fully absorb these nutrients, they can runoff farm fields into nearby streams to harm water quality. Sediment runoff from loose soil also contains pollution particles.

REDUCING NUTRIENTS IN TN WATERWAYS (continued)

Tennessee Solution Strategies

Municipal leaders are working to preventing stormwater pollution by:

- **Stormwater regulations-**
  - including public education campaigns to help raise awareness in the community and in schools.
  - public participation events including streamside plantings to protect stream banks and reduce runoff
- **Community collection events** for pollutant reduction including pharmaceutical and household hazardous waste collection events. These help protect the wastewater treatment process in addition to other community benefits.
- **Construction regulations** to address and prevent sediment runoff during construction and encourage the use of various permanent devices and practices that help to treat stormwater runoff to reduce pollution. Some of these include detention ponds, wetlands, and rain gardens, and grass filter strips. These low impact development measures are designed to utilize natural processes versus solid surfaces which encourage infiltration and filtering capabilities. State and municipalities have a utilize Best Management Practices and devices for this type of stormwater pollution prevention during development.
  - **Other practices municipalities** do that encourage reductions in nutrient levels include:
    - ♦ Street Sweeping
    - ♦ Vacuuming out sediment, grass, leaves that flow into storm drains.
    - ♦ Yard debris pickup for residents
- **Wastewater regulations** are in place to treat nutrients before discharging into waterways, but the state also has programs in place to incentivize plant improvements and optimize operations.

Agriculture practices that reduce nutrients include crop rotations, cover crops and no-till practices. In fact, Tennessee is a leader in the amount of acreage that is no-till. Soil testing and precision agriculture are also very helpful in identifying which nutrients are needed and proper application rate to ensure plant uptake to reduce over application.

Citizens are needed to help in this effort. Residents of Tennessee can help prevent pollution with a few easy solutions at home.

Yard Practices

Mowing-

- longer grass length encourages healthy roots and less need for nutrients
- don't mow to a stream bank, plant trees/ shrubs for a healthy riparian area
- plant bare spots to reduce erosion

Fertilizers-

- Don't Guess, Soil Test soil to determine diciencies. Use only required amount.
- Calculate the area for proper amount
- Calibrate equipment to ensure proper application
- Read and follow label instructions for proper application
- Compost or bag leaves and grass clippings to reduce runoff when they get wet

Wash Water-

- **many detergents are high in phosphates. Select detergents that may have more environmental ingredients.**
- **Wash your car on the grass or at a car was facility for proper treatment of wastewater.**

Protect the Drain-

- Only rain down the outside storm drain. Protect it from improper disposal or nutrient rich runoff.
- Compost food scraps to reduce nutrient overloads to wastewater treatment plants and increase soil health
- Don't Treat your Toilet like a Trashcan- no flushable wipes, hygiene products, floss, litter or other items that contribute to leaks and clogs.
- Fat Free Drains- collect Fats, Oils and Grease and place in the trash.
- Chemical and Drug Free Drain- No pharmaceuticals or chemicals down the drain for disposal. Instead, take unused medications and chemicals for proper disposal to local Drug and Household Hazardous Waste collection events.

Septic-

Protect your septic fields, and have the septic system maintained regularly and pumped when needed.

REDUCING NUTRIENTS IN TN WATERWAYS (continued)

Tennessee Taskforce

In 2019, TDEC and TDA (TN Department of Agriculture) organized the **Tennessee Nutrient Strategy Taskforce** (the Taskforce) to include stakeholders in the effort to reduce water pollution both throughout the state, and to help reduce what flows downstream to the Gulf of Mexico.

The Taskforce was, in part, a response to the **2011 EPA "Stoner Memo,"** which encourages collaboration between state agencies and stakeholders, in the development of state framework for nutrient reductions and builds upon TDEC's and TDA's Nutrient Reduction Framework as part of comprehensive efforts to accomplish long-term nutrient reduction in Tennessee.

(www.acwa-us.org/documents/the-nancy-stoner-memo/)

The images reflect a greater detail of the nitrogen and phosphorus sources in the Southeast. Tennessee's geology has naturally occurring phosphorus in the underlying limestone which is also a contributing factor.

The Taskforce is working in a coordinated effort to understand, monitor and address nutrient pollution.

During the last few years, over 50 stakeholders from the community have come together including academia, state and local government, the private sector, non-governmental organizations, agricultural technical assistance agencies, municipal wastewater, environmental regulatory agency, stormwater utilities, watershed management agency, transportation agency, environmental non-profits, chamber of commerce, academic research and others.

Organizations Represented in the Taskforce			
Clean Water Professionals of Kentucky and Tennessee	Tennessee Chamber of Commerce and Industry	Tennessee Municipal League	United States Department of Agriculture
Middle Tennessee State University	Tennessee Department of Agriculture	Tennessee Stormwater Association	United States Geological Survey
Municipal Technical Advisory Service	Tennessee Department of Environment and Conservation	Tennessee Technological University	University of Tennessee Knoxville
Natural Resource Conversation Service	Tennessee Department of Transportation	Tennessee Valley Authority	University of Tennessee Extension Services
Tennessee Association of Utility Districts	Tennessee Farm Bureau	The Nature Conservancy	Oak Ridge National Laboratory

REDUCING NUTRIENTS IN TN WATERWAYS (continued)

Tennessee Taskforce continued

Together, the **Taskforce** and its workgroups are working to:

- Prioritize **watersheds** for taking actions to address nutrients
- **Set goals** for watershed nutrient load reduction
- **Ensure effectiveness** of point source permits
- **Develop watershed plans** that maximize the effectiveness of BMPs
- **Encourage nutrient reductions** from urban runoff
- **Establish watershed-based monitoring programs** to evaluate effectiveness
- **Document and report i**mplementation activities

In addition, TDEC further is working to reduce pollutants with:

- **The Tennessee Nutrient Reduction Framework** includes strategies for point and nonpoint sources.
- **Tennessee Plant Optimization Program (TNPOP),** a voluntary program for resources to operators in water and wastewater sectors to facilitate plant improvements to optimize nutrient removal and energy use within their plants and accomplish through low to no cost measures.
- communities with programs regulated under the **National Pollutant Discharge Elimination System (NPDES)** including construction, industrial, and Municipal Separate Storm Sewer System (MS4) stormwater pollutants.

Details of Tennessee's efforts including the Taskforce reports, goals and strategies are found online www.

ADDITIONAL RESOURCES can be found in the APPENDIX of this toolkit by topic for learning more and to use for community outreach.

APPENDIX

Supplemental outreach materials in the Appendix

APPENDIX (continued)

Supplemental outreach materials in the Appendix include targeted resources and handouts that community leaders and educators can use as to further public education and awareness.

Infographics – includes a series of 11 visual aids to educate citizens on common sources and solutions of nutrient pollution, and what can be done in all aspects of the community. Each flyer explains the problems caused by nutrient pollution and helpful actions to prevent pollution. These can be used in a variety of formats (printable, for web or social media).

1. Stormwater sources -protect the storm drain
2. Benefits of Riparian Stream Buffers
3. Benefits of Cover Crops
4. Good Farm Practices
5. Proper Application of Fertilizers on the Farm
6. Proper Yard Care at Home
7. Proper Application of Fertilizers when Landscaping
8. Good Landscape Practices
9. Septic Maintenance
10. Kitchen Drains and Garbage Disposals
11. Toilets are not Trash Cans

Stormwater explains runoff and the way pollution travels through our farms, neighborhoods and communities. This section encompasses a wide range of general information and tips for pollution prevention for municipalities, homeowners and even classrooms or civic organizations to share and use.

Agriculture explains common farm pollutants and offers good farm practices such as the use of no-till, cover crops, soil testing, equipment calibration other applications for farm operations.

Wastewater provides an understanding of sewer and water treatment operations and explains how 'what goes down the drain' can affect operations and contribute to pollution. It also highlights treatment plant optimization efforts and case studies that reflect improvements statewide. Septic information and materials for citizens are also included.

Educator Resources includes 10 interactive curriculum-based activities and the current standards for formal (K-12) and non-formal teachers (scouts, 4-H, Homeowner Associations, stormwater professionals, FFA teachers, etc.) to use in a classroom setting.

1. Water Wandering in TN and Beyond
2. A TN Water Molecules Journey
3. Too Much of a Good Thing
4. When is Enough, Enough
   |Lesson Supplement: Nutrient Loading in Lagoon Creek
5. Riparian Roaming
6. Green Ribbons of Life
7. Who Polluted the Tennessee River
8. What Flows There? A Pollution Puzzle
9. Water Down the Drain
10. Nature's Water Treatment Facility (Wetlands)
    Lesson Supplement: Personal Actions at Home
11. Curriculum Standards: Nutrient Reduction Topics and Associated Educator Activities

Key Terms for vocabulary and pollutant information is also included.

Social Media guidance and content is also provided to assist with online community.

INFOGRAPHICS

The Infographics section in the Appendix includes: 11 full-size, printable visual aids to educate citizens on common sources and solutions of nutrient pollution, and what can be done in all aspects of the community. Electronic files with various formats will be listed on www.tnnutrientreduction.org

1. **Stormwater sources -protect the storm drain**
2. **Benefits of Riparian Stream Buffers**
3. **Benefits of Cover Crops**
4. **Good Farm Practices**
5. **Proper Application of Fertilizers on the Farm**
6. **Proper Yard Care at Home**
7. **Proper Application of Fertilizers when Landscaping**
8. **Good Landscape Practices**
9. **Septic Maintenance**
10. **Kitchen Drains and Garbage Disposals**
11. **Toilets are not Trash Cans**

Rain carries pollutants directly to our rivers.

Excess nutrients in storm water can cause **harmful algae blooms** in rivers and in waterways.

Pollutants include:

- **Litter** that decomposes into microplastics
- **Sediment** from bare soil and stream erosion
- **Detergents/wash water** containing particles and phosphorous
- **Oils/grease/metals** from automobiles
- **Nutrients (nitrogen and phosphorous)** found in yard waste, lawns, fertilizers, sewage leaks, and animal waste

Rain flows over rooftops, sidewalks, and roads, carrying pollutants into storm drains that empty directly into our streams, rivers, and lakes, without being cleaned.

Tennessee Nutrient Reduction Task Force

Improving Stream Water Quality

Developed for public outreach under a grant agreement with Middle Tennessee State University's Center for Health and Human Services in partnership with the Tennessee Nutrient Reduction Task Force and the Tennessee Department of Environment and Conservation with funding from the U.S. Environmental Protection Agency (EPA).

Learn more at **tnnutrientreduction.org**

MIDDLE TENNESSEE STATE UNIVERSITY. CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true*BLUE.

Protect the drain!

Storm drains flow into the nearest waterway.

Plants protect waterways and reduce pollution.

Planting trees and shrubs beside waterways forms a healthy "riparian buffer."

Riparian buffer benefits:

- **Slows runoff** from storms to reduce erosion/soak up rain
- **Holds soil** in place to prevent stream bank loss
- **Filters pollution** before it enters rivers and streams
- **Offers shade** to lower stream temperatures/increase oxygen
- **Provides habitat** critical for wildlife and recreation

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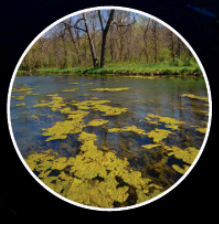
I AM *true*BLUE.

During rain events, nutrient rich pollutants including sewage, detergents, and fertilizers flow into nearby waterways and could cause **harmful algae blooms**. Trees may not prevent this but can offer a defense.



Cover crops in fields retain nitrogen, improve soil, and protect waterways.

Cover crops provide organic matter and retain soil nutrients such as nitrogen to reduce field runoff into waterways.

Benefits of cover crops:

- Slow erosion
- Improve soil health
- Enhance water availability
- Smother weeds
- Help control pests and diseases
- Increase biodiversity
- Retain nitrogen

Tennessee Nutrient Reduction Task Force

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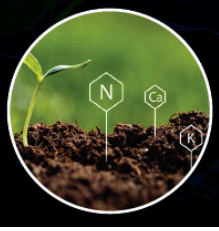
MIDDLE TENNESSEE STATE UNIVERSITY CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true* BLUE.

Don't guess. Soil test to determine nutrient needs.



Developed for public outreach under a grant agreement with Middle Tennessee State University's Center for Health and Human Services in partnership with the Tennessee Nutrient Reduction Task Force and the Tennessee Department of Environment and Conservation with funding from the U.S. Environmental Protection Agency (EPA).

Good farm practices retain field nutrients, save money, improve soil, and protect waterways.

On the farm:

- **Test soil** to determine existing nutrients and needs.
- **Calibrate equipment** for proper application rate.
- **Use precision agriculture** options as able for management.
- **No-till practices** minimize soil loss and disturbance.
- **Protect ditches/streams**—plant trees and shrubs to filter storm and water runoff.
- **Manage manure**—prevent runoff, use as able for fertilizer.

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MIDDLE TENNESSEE STATE UNIVERSITY CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true* BLUE.

Don't guess. Soil test to determine nutrient needs.

Developed for public outreach under a grant agreement with Middle Tennessee State University's Center for Health and Human Services in partnership with the Tennessee Nutrient Reduction Task Force and the Tennessee Department of Environment and Conservation with funding from the U.S. Environmental Protection Agency (EPA).

Proper application of fertilizers saves money, improves crop yield, and protects rivers.

During rain events, excess nutrients like **nitrogen and phosphorous** found in fertilizers can flow into waterways and could cause **harmful algae blooms**.

Before applying any chemical, **always calibrate equipment** and **use this checklist**:

1. Is it **really needed**?
2. Is it the **right use**?
3. Is it the **right product**?
4. Is it the **right method**?
5. Is it the **right practice**?
6. Is it the **right time**?
7. Always **read the label and follow the instructions**.

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I AM *true*BLUE.

Don't guess. Soil test to determine nutrient needs.

Proper yard care retains nutrients and prevents runoff in drains and waterways.

Fertilizers are beneficial for gardens and lawns, but **excessive nutrients** (nitrogen and phosphorous) are carried from yards during rain events and could cause **harmful algae blooms**.

Nutrient sources include:

- **Detergents**—prevent wash water runoff to pavement or storm drains.
- **Pet waste**—pick up and dispose of it in trash.
- **Yard waste**—compost or bag for trash pickup.
- **Fertilizers**—use sparingly, test soil for nutrient needs, follow label for use.
- **Septic and sewer**—maintain and protect septic field to prevent clogs and leaks.

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MIDDLE TENNESSEE STATE UNIVERSITY. CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true*BLUE.

Protect the drain!

Is more really better?

Proper application of fertilizer saves money, prevents pollution, and protects waterways.

During rain events, excess nutrients like **nitrogen and phosphorous** found in fertilizers can flow into waterways and could cause **harmful algae blooms**.

Before applying any chemical, **use this checklist**:

1. Is it **really needed**?
2. Is it the **right use**?
3. Is it the **right product**?
4. Is it the **right method**?
5. Is it the **right practice**?
6. Is it the **right time**?
7. Always **read the label and follow the instructions**.

Tennessee Nutrient Reduction Task Force

Improving Stream Water Quality

Developed for public outreach under a grant agreement with Middle Tennessee State University's Center for Health and Human Services in partnership with the Tennessee Nutrient Reduction Task Force and the Tennessee Department of Environment and Conservation with funding from the U.S. Environmental Protection Agency (EPA). Use is encouraged, but content cannot be modified without permission.

Learn more at **tnnutrientreduction.org**

MIDDLE TENNESSEE STATE UNIVERSITY. CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true*BLUE.

Don't guess. Soil test to determine nutrient needs.

Good landscaping practices keep nutrients in the yard to protect waterways.

During rain events, excess nutrients in grass clippings, yard waste, and fertilizers can flow into nearby waterways and could cause **harmful algae blooms**.

When landscaping:

- **Don't guess. Soil test** to determine nutrient needs.
- **Calibrate equipment** before applying chemicals.
- **Clean pavement** of grass, leaves, and fertilizer. Bag yard waste when able.
- **Minimize use of fertilizers**—overapplication pollutes rivers and wastes money.
- **Follow label instructions** for best application practices.
- **Preserve a "no-mow" buffer** of vegetation around waterways and ditches to prevent algae.

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MIDDLE TENNESSEE STATE UNIVERSITY. CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true*BLUE.

Protect the drain!

Maintain your drain.

Besides causing costly repairs, sewer leaks and septic failures can pollute water sources with bacteria, pathogens, and excessive nutrients.

Do your part.
Be septic smart!

- **Prevent** leaks and clogged pipes.
- **Dispose** of chemicals, wipes, trash, and grease appropriately.
- **Maintain** septic tanks routinely.
- **Protect** septic field lines from root and structural damage.

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MIDDLE TENNESSEE STATE UNIVERSITY CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true* BLUE.

Protect the drain. Protect local streams.

Excess nutrients in food, chemicals, and medications drain to sewer plants. Minimize sewer system loads so they operate effectively to reduce pollutant discharges into streams.

Prevent clogs.
Drains impact waterways when sewer overloads and clogs cause overflows.

Tennessee Nutrient Reduction Task Force
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tnnutrientreduction.org

MIDDLE TENNESSEE STATE UNIVERSITY CENTER FOR HEALTH AND HUMAN SERVICES

I AM *true* BLUE.

Discard all fats, oils, and grease into the trash.

Compost food to reduce nutrients.


Toilets are NOT trash cans.
Proper disposal prevents clogs and allows sewer systems to operate effectively and reduce pollutant discharges in waterways.
Tennessee Nutrient Reduction Task Force
Improving Stream Water Quality
Developed for public outreach under a grant agreement with Middle Tennessee State University's Center for Health and Human Services in partnership with the Tennessee Nutrient Reduction Task Force and the Tennessee Department of Environment and Conservation with funding from the U.S. Environmental Protection Agency (EPA). Use is encouraged, but content cannot be modified without permission.
Learn more at
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MIDDLE TENNESSEE STATE UNIVERSITY
CENTER FOR HEALTH AND HUMAN SERVICES
I AM trueBLUE.
Discard all wipes, floss, and sanitary products in trash can.
Dispose of all unused medicines/ chemicals at collection sites.

Runoff from rain during storm events often carries pollutants directly into nearby rivers

STORMWATER

Tennessee receives an average of 50 inches (130 cm) of precipitation annually, making stormwater an important topic for us to consider when we discuss pollutants and pollution prevention. (Wikipedia)

STORMWATER (continued)

What is Stormwater?

During storm events, any precipitation such as rain and snow flows over land and surfaces as it is pulled by gravity to discharge at the lowest point in the watershed.

The water which does not infiltrate into the ground is considered 'stormwater'.

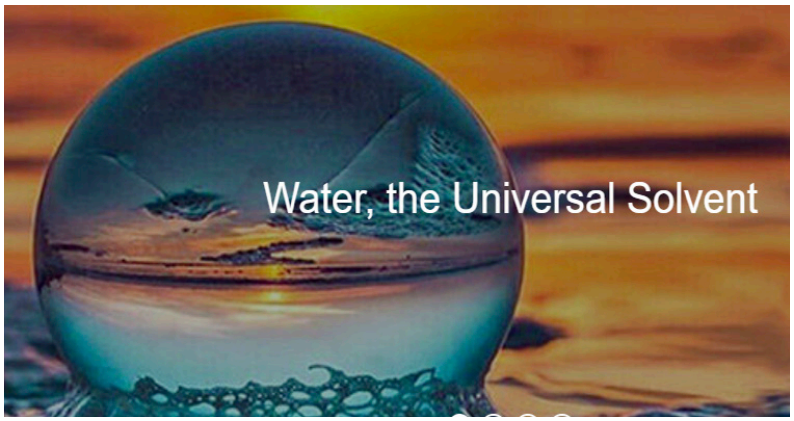
This stormwater 'runs off' solid surfaces such as rooftops, streets, parking lots, lawns, farms, construction and industrial sites, and through neighborhoods and businesses where the runoff flows untreated carrying pollutants to surface waters and streams.

Stormwater vs Sanitary Sewer

In communities, the stormwater usually flows into ditches, culverts and storm drain catch basins which may discharge into a combined sewer system (CSS) in older cities, or more often a municipalities separate storm sewer system (MS4) which is not combined and flows and discharges into the nearest water body without being treated to remove the pollution it carries. **Combined sewer systems are at risk of discharging the sewage into nearby surface waters during flood events**. This sewage is high in nutrients from organic matter, bacteria as wastes, and is a substantial cause of nutrient pollution in surface waters.

Image Source: https://reduceflooding.com

STORMWATER (continued)



Why Stormwater Matters

Water has a unique chemistry. It is known as the 'universal solvent' because it's unique chemical makeup and physical traits make it capable of dissolving and attracting more substances than any other liquid.

This unique trait is what makes it necessary and important to every living organism, but it also means that wherever it goes, it attracts and carries other substances along with it—sometimes in a good way such as in our cells, and water transport, but sometimes causing problems too like carrying pollutants. (USGS)

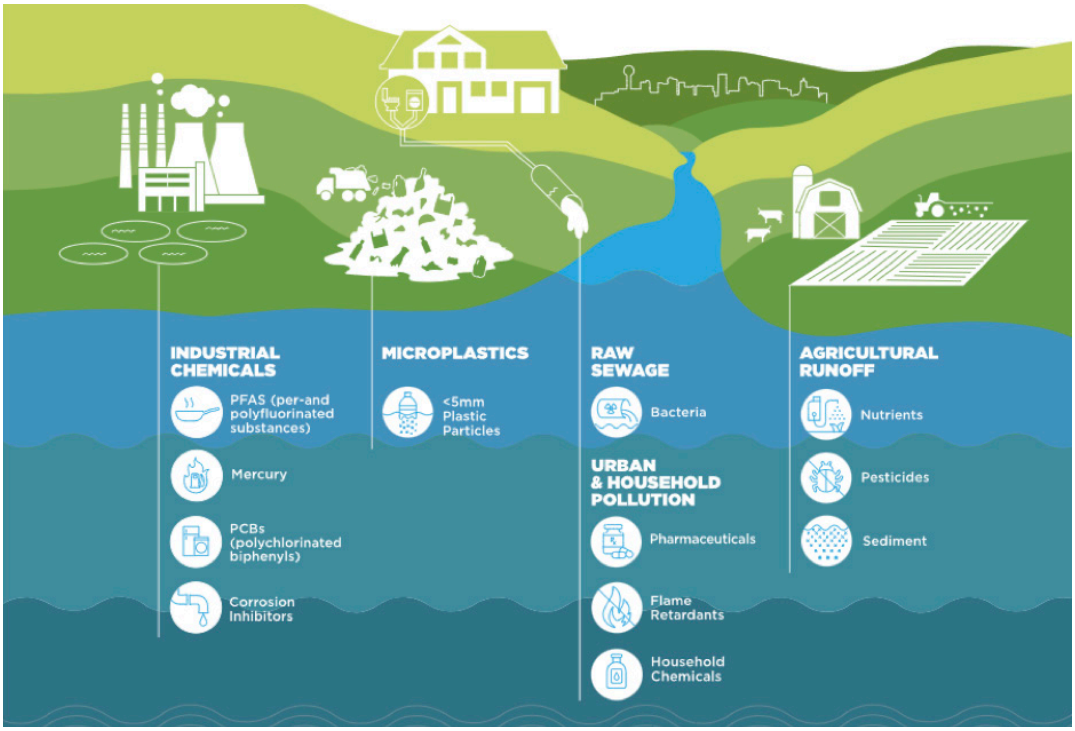
As precipitation falls and water flows in our communities, water's unique traits allow it to pick up a variety of pollutants from the surfaces it contacts. This storm runoff attracts pollution such as chemicals, metals, oils and grease, and dirt or particulate matter that it contacts on its way. Pollution that comes from multiple undetermined sources and combines into a concoction in nature that can cause detrimental harm.

The first inch of a storm event carries the most pollutants, so capturing and filtering this 'first flush' of stormwater is beneficial.

How Pollution is Categorized

The effects of pollutants on specific waters vary, are expensive to manage and have lasting and harmful effects on drinking water supplies, recreation, fisheries and wildlife. Pollution is categories in 2 ways:

- **Point source pollution** has an identifiable source you can 'point' to such as permitted discharges from industrial, landfills and sewage treatment plants. (Image Source: Sierra Club/ TVA plant)
- **Nonpoint source pollution** is caused by 'no easily identifiable source'; instead from storm events moving over and through community with numerous sources of the pollutants that are carried into nearby surface waters.



(Image Source: Chattanooga Free Times Press)

Image Source: Kellie Ward Story Map

Unlike pollution from industry or sewage treatment facilities, which is permitted and can be identifed, stormwater pollution is varied and magnified as it is caused by the everyday activities of people everywhere.

For this reason, public awareness and participation plays a huge part of preventing this type of pollution.

The EPA reports that nonpoint source pollution is a leading cause of water quality problems and emerging pollutants are raising new areas of concern.

Nonpoint source pollution can include examples such as:

- Excess yard waste, fertilizers, herbicides and insecticides from property maintenance, agricultural lands, golf courses, ballfields and residential lawncare
- Oil, grease, detergents and toxic chemicals from automobiles, businesses and urban runoff
- Litter and particulates from parking lots and community areas
- Food wastes and dumpster leaks and seepage
- Atmospheric deposition and chemicals from landfills, water treatment plants and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks
- Salt from roadways and irrigation practices
- Acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, faulty septic systems or leaks in sewer pipes

Federal Regulations for Stormwater Management

In order to reduce the impact of stormwater pollution, there are Federal mandates under the Clean Water Act and which are regulated by the Environmental Protection Agency (EPA) under a National Pollutant Discharge Elimination System (NPDES) permitting program. The Federal program is often administered by States who regulate local jurisdictions under a Municipal Separate Storm Sewer System (MS4) permit based on population.

The EPA requires NPDES programs to follow 6 elements to be included to combat pollution by using a strategy of Best Management Practices (BMPs):

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination (IDDE)
- Construction Site Stormwater Runoff Control
- Post Construction Stormwater Management for New and Redevelopment
- Good Housekeeping and Pollution Prevention

The term '*pollutant*' is defined in CWA section 502(6) and defines pollutant very broadly and includes any type of industrial, municipal, or agricultural waste (including heat) discharged into water. For regulatory purposes, pollutants are grouped into three categories: conventional, toxic, and nonconventional.

- **Conventional pollutants** are those defined in CWA section 304(a)(4) and include Biological Oxygen Demand, Total Suspended Solids, fecal coliform, pH, and oil and grease.
- **Toxic** (priority) pollutants are those defined in CWA section 307(a)(1) and include 126 metals and manmade organic compounds.
- **Nonconventional** pollutants are those that do not fall under either of the above categories (conventional or toxic pollutants) and include parameters such as chlorine, ammonia, nitrogen, phosphorus, chemical oxygen demand (COD), and whole effluent toxicity (WET). (EPA)

The Clean Water Act also requires all states to submit a Section 303(d) list to EPA every two years.

States must determine and identify waters that do not meet water quality standards and where pollution controls are insufficient. The 303(d) listing identifies the impaired and threatened water bodies and the specific pollutant or pollutants of concern for that

water body. Each state's 303(d) list helps establish priorities for the development of TMDLs or other measures to clean up waterways. EPA policy allows states to remove water bodies from the 303(d) list after they have developed a Total Maximum Daily Load (TMDL) or after other measures have been taken to meet water quality standards

Tennessee Protective Measures

In our state, the water quality protection efforts including oversight of the NPDES permits for pollution prevention are administered by the Tennessee Department of Environment and Conservation (TDEC). State regulations, permit guidelines, reports and publications can be found at the Division of Water Resources online at: https://www.tn.gov/environment/program-areas/wr-water-resources-home.html

Municipalities, construction companies, industries, and others that have been identifies are permitted or monitored and must use stormwater management and best management practices (BMPs) to identify, reduce and/or prevent pollution by controlling it at its source. (3. EPA)

Emerging Concerns: Nutrients in Stormwater

Stormwater runoff is often worsened by human activities, and of particular growing importance has been nutrients including nitrogen and phosphorus compounds which are nonconventional pollutants.

Nitrogen and phosphorus occur naturally and are vital to life on our planet. However excessive nutrients and an overabundance is detrimental and causes eutrophication and algal blooms in water bodies such as streams, lakes, rivers, bays, and the ocean.

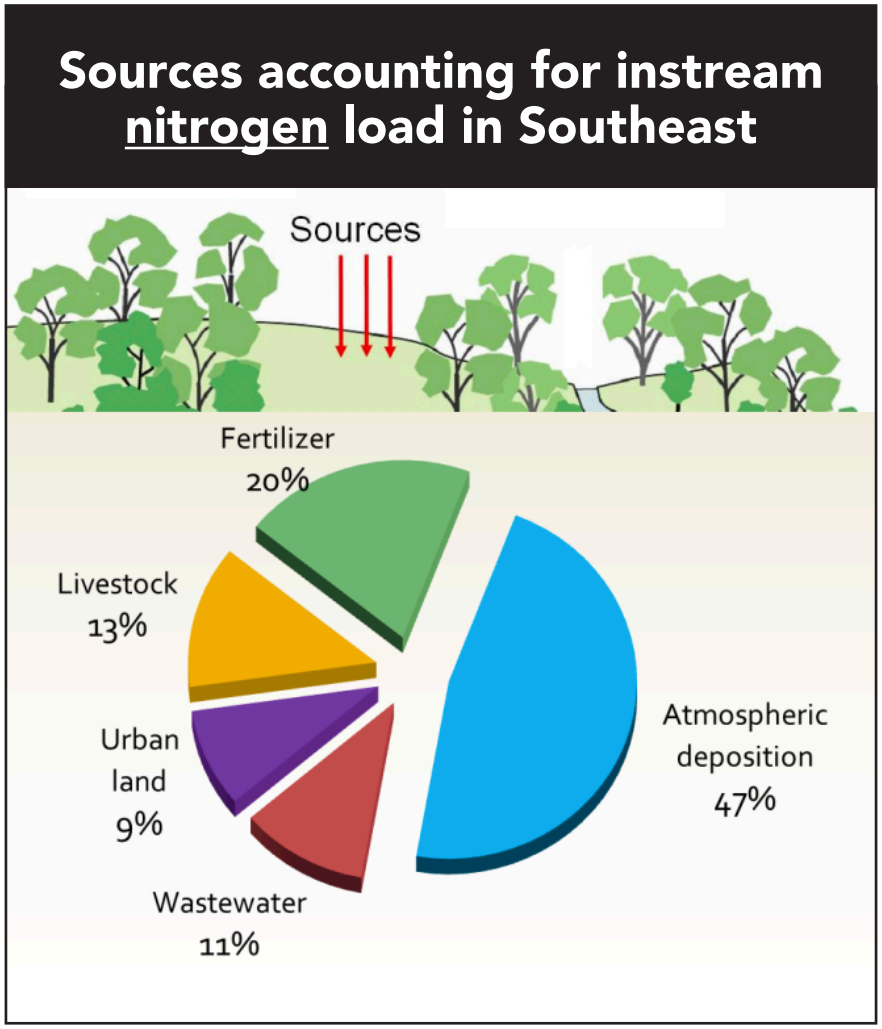


Image Source: USGS Victor Roland/ Anne Hoos

STORMWATER (continued)

Nitrogen in Stormwater

Sources of nitrogen in stormwater can be comprised of nitrite (NO2) and nitrate (NO3).

The primary sources of nutrient pollution in storm water runoff include fertilizer, animal manure, human waste from sewage treatment plant d ischarge, sewer leaks, failing septic tanks, detergents, yard waste, air deposits from automobile exhaust and power plant emissions.

When development occurs and an area becomes more urban, solid surfaces move quickly to the stream with much larger quantities causing flooding and erosion.

When the stream channel erodes, it causes cloudy (turbid) water that negatively affects the habitat and wildlife, as well as carrying particulates with pollutants attached which degrade the water quality. Pollutants such as nutrients have the tendency to bind to soil particles and be transported during runoff. Therefore, it is important to prevent runoff at the source wherever possible and slow water down, spread it out and allow it to soak into the natural ground.

Phosphorus in Stormwater

Sources of phosphorus in urban runoff include decomposition of organic plant material and leaf litter, soil particles, pet waste, road salt, fertilizer, mining activities and wastewater discharges.

IIn addition the geology is often naturally high in phosphorus such as in Tennessee with the underlying limestone.

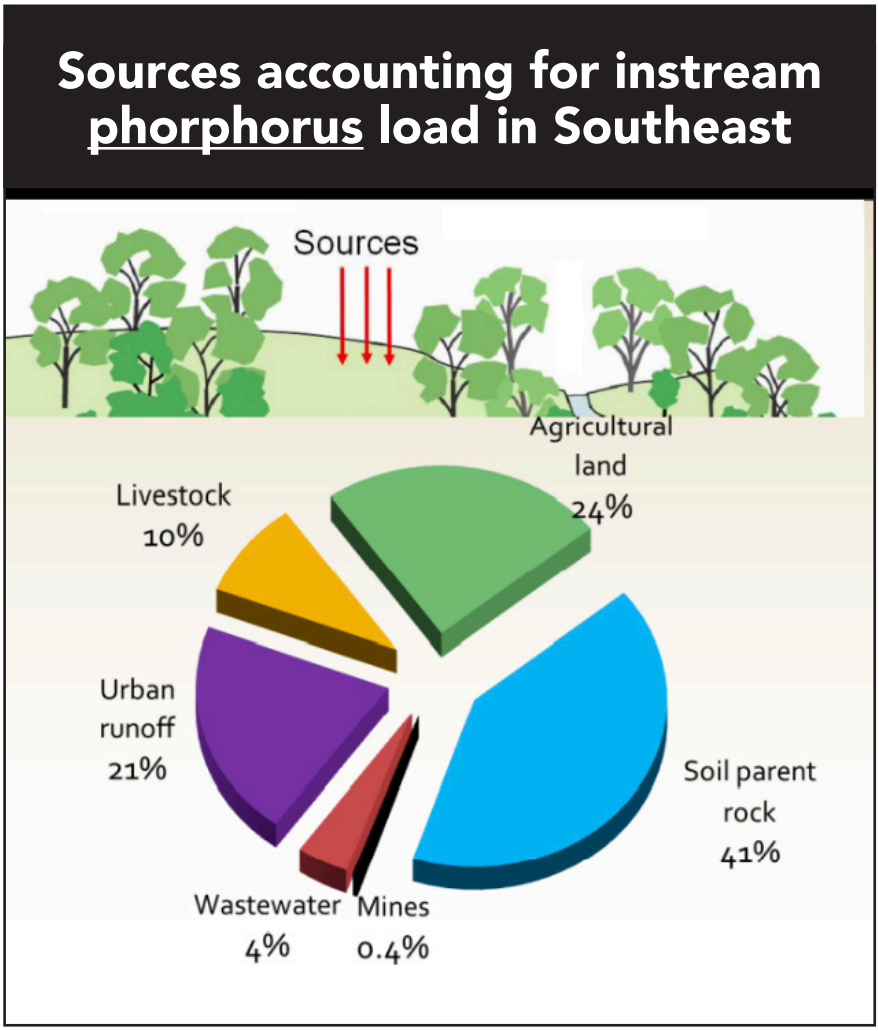


Image Source: USGS Victor Roland/ Anne Hoos

AGRICULTURE

NUTRIENTS IN WATER BODIES

Tennessee water bodies serve domestic, agricultural, recreational and transportation needs, not just for Tennesseans, but for the other neighboring states. Therefore, the quality of our water bodies is important for our socio-economic prosperity. The following subsections provide more information on what nutrients are and why we may need to worry about them.

What are they?

Nutrients are elements/compounds within the environment that are essential for life and stimulate growth. Most nutrients, in the right amount and place, are very healthy for the environment. They stimulate biological activity and plant growth, which in turn supports humans. Most of these nutrients are found in the soil and they include nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, carbon, hydrogen, iron, zinc, manganese, copper, molybdenum, and chlorine. These nutrients provide various functions to plants and animals. For a more detailed description on the various functions of these nutrients, please see;

https://www.taylorfrancis.com/chapters/edit/10.1201/9780429445552-34/soil-fertility-nutrient-management-john-havlin.

https://www.dpi.nsw.gov.au/agriculture/soils/improvement/plant-nutrients.

Why worry?

If nutrients are important, why do we need to worry about them? Remember, nutrients are important if they are in the right place at the right time, in the right form and amount. Some of the nutrients are easily dissolved in soil water. Others attach themselves to individual soil particles. If the nutrients that are meant for the plants, they become a nuisance if they find their way out of the soil. This usually occurs through excessive surface runoff caused by water and/or wind. Runoff water can transport dissolved nutrients and soil particles laced with nutrients to surface waters (streams, lakes, ponds, rivers). This can in-turn increase the amount of nutrients in water bodies. Increased nutrients in water bodies can be detrimental to marine organisms. For example, since nitrogen is an important component of live, excessive nitrogen in streams usually leads to an increase in algae population. As the population of algae in water bodies increase, they deplete the water of oxygen which can lead to death of fishes, plants and other marine organisms. Furthermore, elevated nitrogen levels in drinking water can lead to several health issues in newborns, like the 'blue baby syndrome'. For more information on nutrient problems in water bodies, please see Heathwaite et al. (1996), Badruzzaman et al. (2012) Meena et al. (2017), https://www.usgs.gov/mission-areas/water-resources/science/nutrients-and-eutrophication?qt-science_center_objects=0#qt-science_center_objects,

https://www.pca.state.mn.us/sites/default/files/wq-iw3-22.pdf, and

https://extension.missouri.edu/publications/g9221.

https://extension.okstate.edu/fact-sheets/nutrient-loss-and-water-quality.html.

What nutrients are of concern?

All the nutrients mentioned above can be a source for concern. What determines if they are a cause for concern is their concentration in water bodies. The Environmental Protection Agency (EPA) has produced several documents to assist states and Tribes in developing specific nutrient criteria for rivers and streams. A copy of this document is included in this toolkit. Further, The Tennessee Department of Environment and Conservation (TDEC) has a plan for nutrient criteria development which is also included in this toolkit.

Where Do They Come From?

The nutrients discussed above can come from various sources. However, there are two broad sources of nutrient; point and non-point sources (fig. 1). The following subsections briefly discuss how these sources can contribute nutrients to our water bodies.

- **Point sources**

  According to the EPA, point source pollution is any single identifiable source of pollution from which pollutants are discharged, such as a ditch, pipe, ship or factory smokestack. In agriculture, an important point source of pollutants are large farms that raise livestock, otherwise known as Concentrated Animal Feeding Operations (CAFOs). These animal wastes usually contain some amount of nutrients. If the wastes are not treated, runoff water can transport these nutrients to our water bodies. When these nutrients get to our streams, they can increase the growth of algae and other marine plants. An

increase in the population of algae will increase oxygen consumption in the water. This can lead to a drastic reduction in oxygen levels, resulting in the death of fishes, and other marine life. Further, an increase in algal population on the surface of water bodies can reduce the amount of sunlight reaching the marine plants, which reduces their photosynthetic activity and can also lead to their death. This process is known as eutrophication. Besides causing an eyesore environmentally, this pollutes the drinking water for humans and livestock. The good news is that the 1972 amendments to the Clean Water Act created the National Pollutant Discharge Elimination System (NPDES), which requires that relevant state and federal agencies authorize the discharge of pollutants from a point source into navigable waters. The following link provides information on the NPDES; https://www.epa.gov/npdes.

- **Non-point sources**

  Non-point source (NPS) pollution usually results from land surface runoff, precipitation, atmospheric deposition, drainage and seepage. Non-point source pollutants can include excess fertilizers, herbicides and insecticides from agricultural fields. Some salts can also runoff from irrigation practices and abandoned mines. Non-point sources can contribute significant amounts of nitrogen and phosphorus to surface water (see Carpenter et al., 1998) which can further exacerbate the problem of eutrophication. Since NPS nutrients do not have a single inlet into water bodies, the easiest way to reduce this form of pollutant is to target the known sources. This toolkit includes, and will further discuss, how to protect our water bodies from point sources.

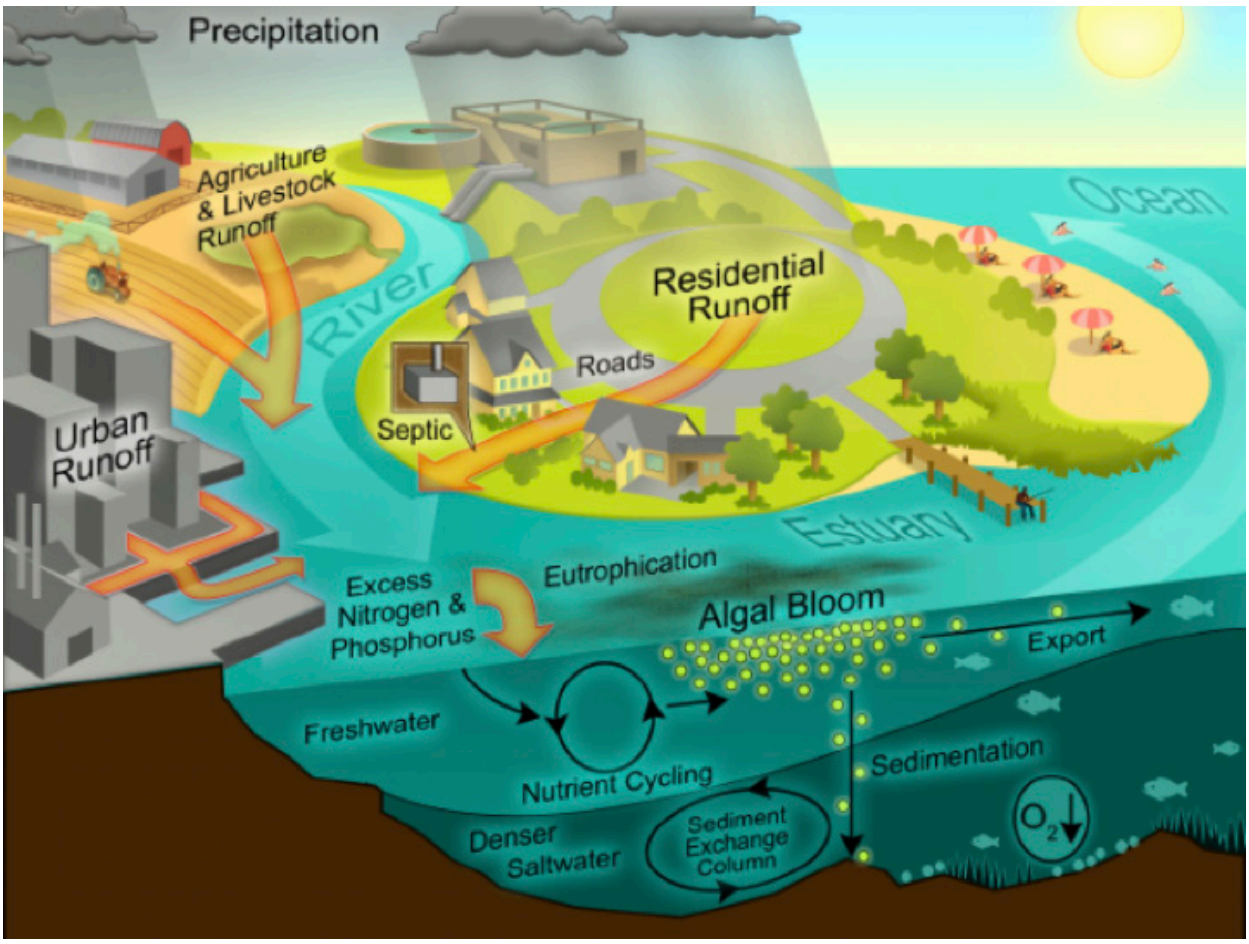


Fig. 1. Sources of pollutants and the resultant effects on our water bodies.

What Tennessee Is Doing to Prevent Water Pollution

The state of Tennessee and Tennesseans are doing a good job in reducing and preventing water pollution. One of the ways in which Tennessee is reducing water pollution is by adopting no-till agriculture. Ridge tillage with urea has been shown to lose 11 times more ammonium nitrogen compared to no-till (Zhao et al., 2001). Further, DeLaune and Sij (2012) reported 2.8 times more sediment runoff from moldboard tillage compared with no-till. These authors also reported significantly higher total phosphorus and ammonium nitrogen from tillage. In fact, Tiessen et al. (2010) reported that a conversion from no-till to conservation tillage, phosphorus loss increased by 12%. These studies show that no-till management helps to significantly reduce nutrient runoff. Nationally, Tennessee ranks as number 1 in no-till adoption (about 79% of all farmlands in Tennessee are under no-till management). This is so laudable that our state experts have provided advice to other states on how to improve no-till adoption in their states.

Besides no-till management, the use of cover crops (crops that are grown on the field during periods when the soil is usually left bare, such as winter period) can also reduce water pollution. Non-legume cover crops like cereal rye, winter wheat, barley, oats, ryegrass, brassicas and mustards can help by scavenging excess nutrients, especially nitrogen, left over from a previous crop (Haruna and Nkongolo, 2020), their roots can hold the soils in place which can reduce erosion (Kasper et al., 2001), and their roots can increase water infiltration (Haruna et al., 2018) thereby reducing water runoff. Nationally, about 12% of farmers use cover crops. In Tennessee, about 30% of farmers use cover crops. This is an encouraging statistic and the adoption rate of cover crops in the state is increasing annually. This would not be possible without the hardwork of various extension agents in the state and most importantly, the farmers who are willing to adopt these management practices.

How to Reduce Nutrient Runoff to Protect Our Waterways

Although Tennessee is doing a good job in adopting practices that can benefit our water bodies, there is still room for improvement. Included in this toolkit is a study by Shortle et al. (2019) on a systems approach for nutrient control in water bodies. Below is a brief summary of what individuals and farmers can do to further protect our water bodies;

- Regular Soil Testing: residents, especially farmers, are encouraged to regularly test their soils for available nutrients. These soil test results usually include recommendations on the amount and rate of each nutrient application and these recommendations are based on yield goals. Several soil testing laboratories are available in TN. A quick web search will provide information on the closest laboratory to your location.
- Nutrient Management Strategies: producers can improve crop productivity and reduce nutrient runoff by ensuring that the apply fertilizers at the right time, in the right place, at the right amount and in the right form. The soil test lab can usually provide help with this activity.
- Ensuring Year-Round Ground Cover: since most runoffs occur during periods when the fields are left bare, Tennesseans are encouraged to plant cover crops or perennial species on their fields. This will reduce the ability of the raindrops to cause detachment of soil particles. This is usually the first step of soil erosion. Additionally, these plant roots can reduce the transportation of soil and nutrient residues during periods of heavy rainfall, further helping to keep our water bodies clean.
- Planting Field Buffers: producers can plant trees, shrubs, and grasses along the edges of fields, especially those that borders water bodies. These buffers can protect water bodies by reducing the velocity of runoff water, allowing the sediments to settle out of suspension. They can also help by absorbing/filtering nutrients out of runoff water before they reach our water bodies.
- Manage Livestock Access to Established Buffers: farmers and ranchers can install fences along streams, rivers, and lakes to reduce animal traffic on streambank buffers. Reduced animal traffic on these buffers will enhance their growth and their ability to protect the water bodies from runoff.

- Planting Across Slopes: for fields located on >10% slopes, land owners are encouraged to farm across, rather than along, the slopes. By using this technique, any sediment from the interrow region is caught by the growing plants.
- Implementing No-Till: producers are encouraged to gradually transition for conventional tillage to no-till, not just for the protection of water bodies, but for improved crop yields. There are several government incentives that can help alleviate the economic strain of this transition.
- Engaging in Educating Peers: research has shown that humans are more receptive of information provided by peers. As such, Tennesseans are encouraged to collaborate with individuals, stakeholders, and organizations in educating peers on the need to improve water quality. Farmers can play an important leadership role in these efforts by getting involved with the Tennessee Department of Agriculture, Tennessee Department of Environment and Conservation, farm organizations, educational institutions, and non-profit organizations.

The link below provides some important information on protecting water quality from agricultural runoff.

*https://*nepis.epa.gov/Exe/ZyPDF.cgi/P10039OH.PDF?Dockey=P10039OH.PDF

Benefits of Implementing Nutrient Management Practices

Although the implementation of optimal plant nutrient use requires technical know-how, extra time, equipment, and resources, their benefits are far reaching. These benefits could include financial and human and environmental health benefits. The following subsections provide some details of these expected benefits.

- Financial Benefits: From reduction in the amount of nutrients added to the soil, to improvement in crop yields, adoption of nutrient management practices (conservation practices) provide economic benefits to the producers. For example, in the Northern Great Plains, producers have reported a 5% profit increase of more than 5% with the use of cover crops over 10 years (Wang et al., 2021). These producers also reported that these increases will likely spur further adoption of cover crops in the future by more reluctant producers. Another financial benefit of cover crop usage is an indirect one: the recycling of nutrients. A significant part of a farm operator's budget is devoted to purchasing plant nutrients. For example, during June 2021, the national average cost of urea was $0.59/lb.N, and that of UAN28 was $0.65/lb.N. At a hypothetical recommended application rate of 100 lbs./ac of urea, a producer who owns 1,000 acres will spend about $59,000 on N fertilizer alone (please note that this rate of application is hypothetical since fertilizer application rate is dependent on the amount of N currently in the soil, type of crop to be grown, and yield goal). Cereal rye (Secale cereale L.) cover crop has been reported to collect between 20 to 100 pounds of N per acre that can be utilized by the following crop (Gaskin et al., 2014). This means that if our hypothetical producer above planted cereal rye cover crop, the savings on N fertilizer alone will amount to about $29,500 for their 1,000-acre field (assuming cereal rye is able to recycle 50 lbs N/ac). Other cover crops like crimson clover (Trifolium incarnatum) and hairy vetch (Vicia villosa) can fix about 50 – 100 lbs N/acre and 80 – 150 lbs N/acre, respectively (these cover crops perform very well in the state of Tennessee). This is a significant amount of savings that can be redirected into other costs of production. Similarly, a switch from conventional tillage to no-till can have financial benefits for the producer by reducing or eliminating the cost of tillage equipment.
- When conservation practices reduce nutrient runoff, it leads to less algal bloom in Tennessee lakes, streams, and rivers. This improves the quality of our water bodies, improve the health of fishes and other marine life, preserve the value of homes and other properties around water bodies, and can potentially reduce the cost of water purification/treatment.

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WASTEWATER

According to the Tennessee Department of Environment and Conservation, Tennessee is reported to have over 3000 miles of streams and over 15,000 acres of lake in Tennessee that are impaired due to nutrients. (Director Jenny Dodd 2/13/2019, Division of Water Resources letter regarding the TPOP.

WASTEWATER (continued)

Prior to the Clean Water Act in 1972, treatment by chemical and filtering methods was not as widely used and water pollution from household, business, community, and industry wastes resulted in heavy pollution in rivers and streams across the nation. Modern practices in sanitation, including treating sewage and wash water, significantly improve human health by reducing exposure to chemicals, infection from pathogens, and harmful water borne illnesses. Although these advances have reduced health impacts, not all pollutants including nutrients can be completely removed from the wastewater when it empties back into rivers and streams. This is how wastewater can impact and contributes to water pollution.

What is Wastewater?

Wastewater comes from the water we use in everyday activities our homes, businesses, and industries. Wastewater is the used water that contains various waste products generated from hygiene, sanitation, and commercial activities. Some of these activities include showering, washing hands, brushing teeth, dishwashing, disposing of food wastes, cleaning practices, laundry, flushing toilets and various commercial and industry practices. Wastewater contains nutrients such as nitrogen and phosphorus found in human and animal waste, food scraps, wash water soaps and detergents.

The wastewater drains into a pipe system and travels often to a septic system or wastewater treatment plant (WWTP) where the dirty water goes through a mechanism of cleaning / treatment. Bio-solids screened during the process are especially high nutrient-rich organic materials produced by wastewater treatment facilities. Often these materials are landfilled and the liquid at the end of the treatment process is discharged as effluent. The 'effluent' from wastewater treatment plants is water that has been treated for pollution. It is regulated and monitored by state and federal officials for allowable limits of list of monitored parameters including nutrients and is most often discharged (returned) to flow into a local water body.

According to the Environmental Protection Agency, wastewater treatment facilities in the United States process approximately **34 billion gallons of wastewater every day.**

Types of Wastewater Treatment Facilities

The types and sizes of these wastewater treatment facilities vary across the nation. The level of treatment and pollutant removal depends on the regulations that exist, the type of facility and treatment system, and the age and physical state of the system components. Plant systems are generally categorized by centralized and decentralized systems.

Centralized –

Pipes convey the wastewater to a central location for treatment.

Combined sewer –

these are older first-generation style single-pipe systems designed to collect and transport raw sewage which has high levels of nutrients. Excessive water infiltrates during rain and wet seasonal events causing sanitary sewer overflows (SSOs) and the release of nutrient pollution into the environment and water bodies. Combined sewers are no longer approved for new construction.

Separate sanitary sewer system –

these conveyance pipes in communities are designed to collect only the wastewater but are not watertight. Inspections and maintenance are needed to correct any leaks, cracks, blockages, equipment failures, broken pipes, or vandalism and can also infiltrate water during excessive wet storm and events causing sanitary sewer overflows (SSOs) as well.

WASTEWATER (continued)

Current Issues in Wastewater treatment

The 2021 Report Card for America's Infrastructure reports that the United States has more than 16,000 wastewater treatment plants with almost 4,700 miles of pipeline across the nation which are estimated to be functioning at 81% of their design capacities, with 15% believed to have reached or exceeded capacity and in need of upgrades.

How Wastewater Contributes to Nutrient Pollution

Pass through Treatment Facilities

While nitrogen and phosphorus are nutrients that are naturally occurring elements, they are also found in abundance in human and animal waste, food scraps, and certain soaps and detergents. Often these nutrients are not completely removed during the wastewater treatment and some levels discharge into surface waters which can accumulate and become a source of nutrient pollution in our waterways.

Clogged/ Leaking Pipes

The wastewater system of pipes itself are also susceptible to clogs (from fats, oils, grease, and trash down drains) which can create leaks and release raw sewage into the environment.

Stormwater Intrusion

Many times, leaking pipes can also allow for water intrusion which can cause unexpected releases. In older combined sewer systems, water intrusion into pipes during wet seasonal weather events and cause sewage overflows from manholes.

Septic Systems

Septic systems can easily become a source of nutrient pollution to surface water and ground water if not properly maintained, emptied or if tanks and field lines become damaged.

Decentralized –

Onsite- septic or STEP (septic tank effluent pumping) systems- Approximately 20% of Americans rely on septic tanks.(3) 2021 Report Card for America's Infrastructure https://infrastructurereportcard.org/cat-item/wastewater/

Federal and State Efforts TN ARP funds for Infrastructure

In 2021-2022, part of the monies allocated to Tennessee under the American Rescue Plan (ARP) Act will help address water, wastewater, and stormwater issues. Nearly $1 billion dollars will be awarded to communities across the state via non-competitive grants. Some of these monies may help to address the wastewater nutrient and infrastructure issues These grants will be administered by the Tennessee Department of Environment and Conservation (TDEC) for eligible infrastructure projects as part of the Tennessee Water Infrastructure Investment Program. To learn more about this initiative, visit:

- **Federal/State ARP** https://youtu.be/p_A3eBUAIbk
- **Tennessee ARP** www.tn.gov/environment/arp.html

Tennessee's Plant Optimization Program (TPOP)

Funding resources for solutions exist from state and federal programs for municipalities to upgrade systems optimize plant improvements and conserve electricity.

Tennessee's Plant Optimization Program (TPOP) is an example of this type of program for our state.

The program is administered through the Tennessee Department of Environment Division of Water Resources (DWR) and is a free service to provide resources that support water and wastewater operators in achieving optimization in energy use and nutrient removal for their facilities.

Examples of support and low-and-no-cost measures include:

- Technical assistance,
- Cost-savings opportunities,
- Nutrient reduction of effluent,
- Flexible and informed regulatory oversight

WASTEWATER (continued)

TPOP Partnering Agencies

In 2011, TDEC, working with DOE and TVA, developed and implemented the Energy Efficiency Partnership with water and wastewater facilities. (Director Jenny Dodd 2/13/2019, Division of Water Resources letter regarding the TPOP)

In 2016, TDEC, working with TAUD and MTAS, piloted the Nutrient Optimization Program with the following program findings:

Facilities consistently achieved

- Roughly 20% ongoing reduction in energy usage and
- Nearly 40% reduction in nutrients through low-to-no-cost measures.

Efficient use of existing resources allowed facilities to avoid rate increases and capital improvements; some facilities leveraged cost-savings to support needed infrastructure and capital investment improvements through SRF and other funding sources.

Through the TN POP, TDEC is working with partners – TAUD, MTAS, and the Tennessee Industrial Assessment Center (TIAC) - to support you in achieving cost-savings and improved facility performance, including cleaner effluent, through low-and-no-cost measures.

Training videos, implementation and audit resources, case studies, technical assistance partners, and potential funding sources. (Director Jenny Dodd 2/13/2019, Division of Water Resources letter regarding the TPOP)

Case Studies: https://www.tn.gov/environment/program-areas/wr-water-resources/tn-plant-optimization-programs/tnpop/case-studies.html

Optimizing nutrient removal at municipal wastewater facilities: https://www.tn.gov/content/dam/tn/environment/water/tnpop/wr_tnpop-cleanwater-ops-report_tennessee_2017.pdf

To learn more about the TN Plant Optimization Programs (TPOP), visit: www.tn.gov/environment/program-areas/wr-water-resources/tn-plant-optimization-programs/tnpop.html

Municipal Efforts

Municipal Water Treatment Facility - O&M and Upgrades

Operation and maintenance for the wastewater system is a priority, from incoming pipes to the facility, to the pump station and the discharge points. Much of the functioning system components are underground and susceptible to damage and wear which can present a challenge. Some examples of problem areas and common prevention of sewage leaks include:

- Perform routine condition assessments of the system and underground pipes.
- Perform a manhole inventory and make essential repairs.
- Upgrade older components that are susceptible to failure rates with reliable construction materials.
- Conduct prevention measures during extreme weather events to prevent freezing as well as to reduce or eliminate the opportunity for water intrusion.
- Sewer line cleaning: vacuum and clean out sediment and sewer debris
- Identify sewer trouble spots; example smoke test for pipe leaks if needed

Citizen Efforts

Sewer and Septic System Care and Maintenance -

Onsite systems such as septic or STEP systems operate independently and are not connected to the municipal public system. Proper and consistent maintenance and care for both is critical to optimize performance and prevent overflows and failures. Preventing clogs and leaks are essential, as well as routine maintenance and prevention. Also, remember wastewater treatment is a biological function and to function properly needs living organisms which are susceptible to pharmaceuticals, cleaners, fats, oils, grease and other chemicals. This is true for municipal or private septic systems.

WASTEWATER (continued)

Here are some easy actions citizens can do to reduce wastewater nutrient problems:

- Prevent clogs and leakswhich lead to sewage spills and nutrient pollution.
- Do not dispose of grease, chemicals, pharmaceuticals or chemicals such as household hazardous waste down the toilet, sink or drains. Check for local programs and opportunities. Most local jurisdictions have the following local programs with educational resources for proper disposal:
  - household hazardous waste and
  - pharmaceutical collection events, and
  - Fats, Oils, and Grease (FOG) program- food such as meat fats, lard, shortening, cooking oil, sauces, gravy, mayonnaise, butter, ice cream and soups can clog sink, dishwasher, hood and floor drains. Also cleaning/ mop waters, wastewaters and food scraps may also be sources of FOG.
- **Think before you flush- Limit disposal of paper products to toilet paper only and do not use the toilet as a trash can.** Sanitary products, floss, kitty litter, baby/wet wipes and other items should go in the trash, NOT the toilet to prevent sewer and septic problems.
- Educational video: Murfreesboro Plant Expansion/ Wet Wipes **https://ia-petabox.archive.org/details/Wastewater_Treatment_Plant_Wet_Wipes_Newsbreak**
- Do not use tank additives– they are not a replacement for proper maintenance. Some chemicals damage seals.
- **Conduct annual inspections**– protect sewer clean out drains. Check to see if the septic system should be pumped or other maintenance is needed. Septic systems should be visually inspected annually and may only need to be inspectedand pumped by a professional every 3 to 5 years.

Sludge Depth Rule

Have your tank pumped when the Sludge + Scum Layer maks up 25-33% of tank water depth

- **Conserve water use and limit use of garbage disposal and compost when possible.**
- **Protect the sewer pipes and septic field lines. Avoid driving vehicles, digging, planting or placing heavy objects in their pipelines and drain field.**
- **Three Warning Signs the septic needs repair: wet spots, foul odors, and slow drains. Have your septic and sewer inspected by professionals.**
- **Use good practices during recreation as well. Here are some tips for RV, Boat and Mobile Home practices.**

SOURCES

- **EPA https://www.epa.gov/nutrientpollution/sources-and-solutions-wastewater**
- **2021 Report Card for America's Infrastructure https://infrastructurereportcard.org/cat-item/wastewater/**

ADDITIONAL RESOURCES

- **How Modern Wastewater Treatment Changed our World https://interestingengineering.com/innovation/how-modern-wastewater-treatment-changed-our-world**
- **Flood resiliency for water and wastewater utilities**
- **https://www.epa.gov/waterutilityresponse/flood-resilience-basic-guide-water-and-wastewater-utilitiesEPA Primer for Municipal Wastewater Treatment - Overview of municipal processes used to treat domestic wastewater before discharge to the nation's waters.**
- **https://mehaonline.org/wp-content/uploads/2020/04/Primer-for-Municipal-Waste-Water-Treatment-EPA-2004.pdf**
- **EPA Centralized Wastewater Collection System Toolbox https://www3.epa.gov/region1/sso/toolbox.html**
  - Pipe condition assessment
  - https://www3.epa.gov/region1/sso/pdfscondition-assessment-underground-pipes.pdf
  - EPA's Decentralized wastewater (septic) systems https://www.epa.gov/septic Septic Education- Variety of Outreach Resources (English and Spanish) https://www.epa.gov/septic/septicsmart-education-materials
  - EPA Septic Guidance for Homeowners https://www.epa.gov/septic/septicsmart-homeowners
  - EPA has an annual 'SepticSmart Week' every September
  - EPA 'SepticSmart Week' Guidance and Reminders for Homeowners https://www.epa.gov/septic/septicsmart-week
  - EPA 'SepticSmart Week' Social Media Guide- https://www.acwa-us.org/wp-content/uploads/2021/08/2021-SSW-Social-Media-Guide.pdf
  - Septic: When to Empty- https://angelikaschultheiss.blogspot.com/2021/06/how-do-i-know-when-to-empty-my-septic.html
- **Issues with Wet Wipes- Educational video: https://ia-petabox.archive.org/details/Wastewater_Treatment_Plant_Wet_Wipes_NewsbreakEPA Sources/ Solutions wastewater https://www.epa.gov/nutrientpollution/sources-and-solutions-wastewater**
- **Recreational vehicle safe wastewater disposal guide: https://www.epa.gov/septic/alert-recreational-vehicle-boat-and-mobile-home-owners-and-park-operators-about-safe**
- **EPA's Guide on Maintaining Septic Systems – https://www.epa.gov/septic/long-homeowners-guide**
  - https://www.epa.gov/septic/technical-information-about-septic-systems
- **Tips for choosing right septic tank maintenance https://www.termofservices.com/customer-service/tips-for-choosing-the-right-septic-tank-repair-company.html**

CASE STUDIES

TNPOP Case Studies- https://www.tn.gov/environment/program-areas/wr-water-resources/tn-plant-optimization-programs/tnpop/case-studies.html

- Case Study: Fayetteville, TN 2011-2015-Effluent Nitrogen Reduction by 50% of Total Nitrogen **https://www.tn.gov/content/dam/tn/environment/water/tnpop/wr_tnpop-casestudy-fayetteville.pdf**
- Case Study: Church Hill, TN 2016-2021- Reduced nitrogen loading to the Holston River by 35,800 tons/year with total nitrogen effluent concentrations ranging below 5 mg/L. **https://www.tn.gov/content/dam/tn/environment/water/tnpop/wr_tnpop-casestudy-church-hill.pdf**
- Case Study: Norris, TN 2014-2019- Norris reduced production of sludge and decreased their total phosphorus in the effluent by 25%, and total nitrogen by 84% to maintain effluent nitrogen below 5 mg/L prior to discharge to surface waters of Buffalo Creek, which also led to a Governor's Environmental Stewardship Award in 2019. **https://www.tn.gov/content/dam/tn/environment/water/tnpop/wr_tnpop-casestudy-norris.pdf**

SUCCESS STORIES

- Norris Water Commission received a Governor's Environmental Stewardship Award in 2019 for their work on reducing nutrient loading to Tennessee streams, specifically Buffalo Creek which in 2018 showed the receiving stream improved and met regional goals for biological integrity through improvements made at the wastewater treatment plant. **https://www.tn.gov/content/dam/tn/environment/water/tnpop/wr_tnpop-casestudy-norris.pdf**
- Cookeville Wastewater Treatment Plant-nutrient removal improvements at the Cookeville (Tennessee) Wastewater Treatment Plant, where operational changes to the oxidation ditches have enabled the plant to meet more stringent permit requirements. The changes involved dividing each of four ditches into separate vertical zones and turning them on and off to create anoxic conditions to facilitate nitrification-denitrification. See Article: Divide and Conquer Describes This Facility's Approach to Reducing Nitrogen and Phosphorus, **https://www.tpomag.com/editorial/2020/12/divide-and-conquer-describes-this-facilitys-approach-to-reducing-nitrogen-and-phosphorus**
- Murfreesboro Water Resources Recovery Facility-Awards (4 Peak Performance Gold Awards from the National Association of Clean Water Agencies; 2 Excellence in Beneficial Reuse Water Awards; and 8 consecutive Operational Excellence Awards from the Clean Water Professionals of KY and TN; 2014 Plant of the Year award from the TN Water and Wastewater Association; and achieved 2014 STAR Operations Designation from the TDEC; recognized as a National Utility of the Future Today).Effluent:The plant team had tripled nitrate-removal efficiency and increased phosphorus-removal efficiency by 100%. See Article: Through a Decade of Effort, Murfreesboro Wins Dramatic Effluent Nitrogen and Phosphorus Reductions
- **https://www.tpomag.com/editorial/2021/01/through-a-decade-of-effort-murfreesboro-wins-dramatic-effluent-nitrogen-and-phosphorus-reductions?fbclid=IwAR3v-Ke2Vtg**

Operation and maintenance for the wastewater system is a priority, from incoming pipes to the facility, to the pump station and the discharge points

EDUCATORS RESOURSES

As educators we must constantly balance the timing of our teaching against required concepts based upon system-mandated scope and sequence of the state standards and standardized exams. However, we want students to feel like our partners in their learning and have ownership over their knowledge. Most importantly, we want them to care about their learning. One way to get students to care is to get them involved in something that matters to everyone. Clean water is one of those topics, especially if students have studied about places in the world where it is a rare commodity. We are fortunate to live in a country with some of the safest tap water in the world. For that reason, clean water is something easy to take for granted in this country. Because we have regulations that govern water quality, you can travel from New York to California by car and along the way drink tap water at every place you stop. It may taste and smell different, but it is still safe to drink…. until it isn't.

EDUCATORS RESOURSES

It is all of our responsibility to protect a necessary resource for all life, beginning with educating our children who will continue to deal with water issues as part of their future. Ten activities were selected and adapted from multiple environmental education activity guides that would assist educators in their teaching about reducing nutrients in water systems. The five topic areas:

- Water Cycle
- Nutrient Reduction
- Streambank Erosion
- Storm Water Runoff
- Maintaining Clean Drinking Water

To assist in lesson planning, Tennessee Science Standards have been identified for each activity, K – 8, plus high school Biology 1 & 2, Ecology, and Environmental Science. Grade levels have not been specifically listed for each activity to provide an educator with the liberty to decide or adapt components of the activity accordingly. The activities have been selected to address a topic, not necessarily be taught sequentially. See Nutrient Reduction Topics and Associate Lessons on the following page.

There are many excellent environmental education resources available that can be adapted to classroom topics. The four resources that were used for this collection of activities are nationally known. Full credit goes to each respective organization, with the name of the original activity included with each activity we developed should you want to pursue more information. If you are interested in obtaining copies of the activity guides from Population Connection, Project Aquatic WILD, Project Learning Tree Activity Guide Grades 7 to 12, and Project WET, contact information is provided below. You can also contact the national office for more information.

Resources

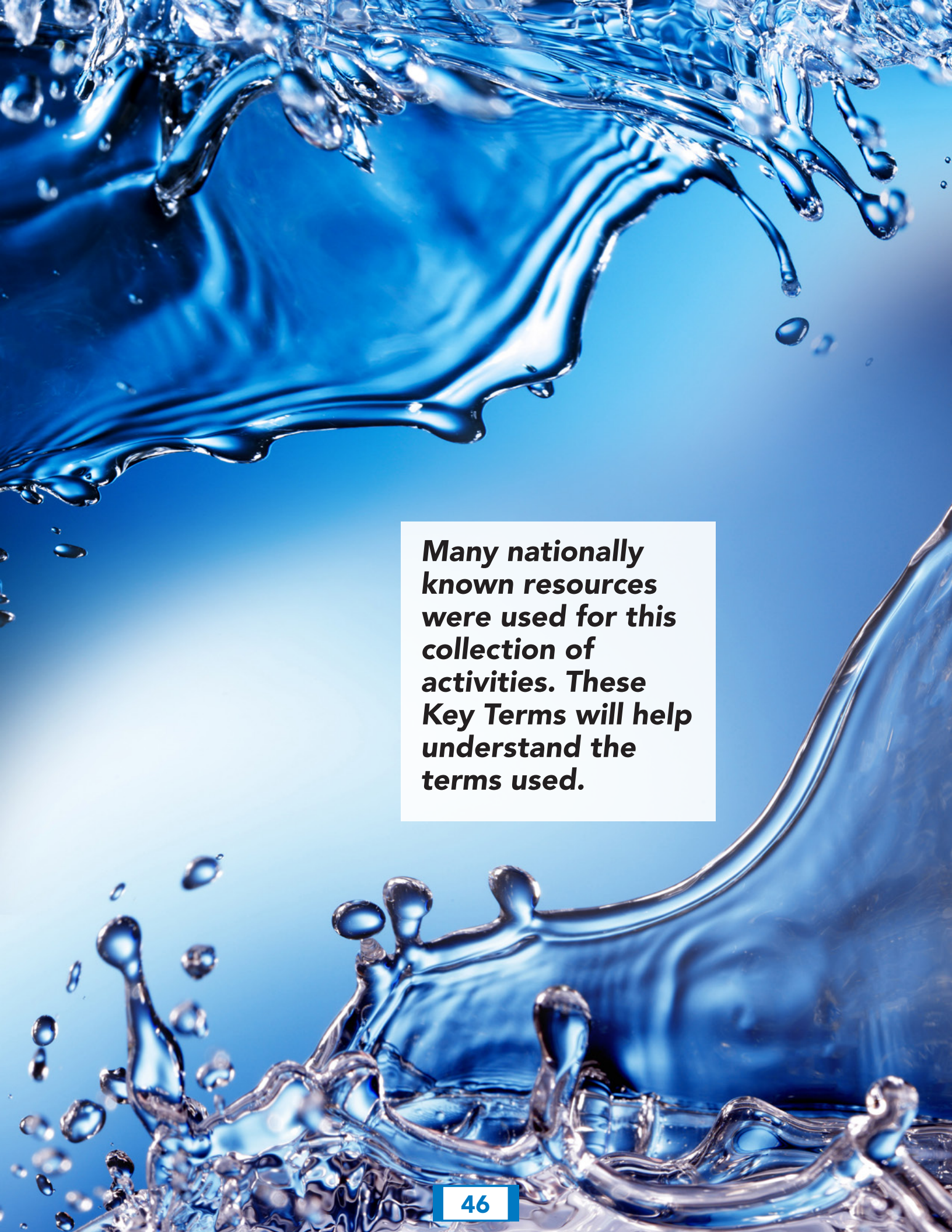
Population Connection

Contact: https://www.populationconnection.org/
Project Aquatic WILD

Contact: Tennessee Wildlife Resource Agency, David H. Lowrie <David.H.Lowrie@tn.gov>
Project Learning Tree

Contact: Tennessee Forestry Association, Teri Frye <terikfrye@gmail.com>
Project WET (Water Education Today)

Contact: Austin Peay State University, Rogers, Michelle <rogersm@apsu.edu>



Many nationally known resources were used for this collection of activities. These Key Terms will help understand the terms used.

KEY TERMS

Sediments

Particles of soils, sand, silt, clay and minerals wash from land and paved areas into creeks and tributaries. In abundance, these natural materials can be considered a pollutant. Construction projects often contribute large amounts of sediment. Certain lumbering practices affect sediments in runoff. Sediments may fill stream channels that later require dredging. Sediments suffocate fish and shellfish populations by covering fish nests and clogging the gills of bottom fish and shellfish.

Petroleum Products

Oil and other petroleum products like gasoline and kerosene can find their way into water from ships, oil refineries, automobile service stations and streets. Oils spills kill aquatic life (vegetation, shellfish, fish, and birds). Birds are unable to fly when oil loads their feathers. Shellfish and small fish are poisoned. If washed up on a shoreline, the oil requires much labor to clean up. Fuel oil, gasoline, and kerosene may leak into ground water through damaged underground storage tanks.

Animal Waste

Human wastes that are not properly treated at a waste treatment plant and then released to water may contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery (diarrhea), hepatitis, flu and common cold germs are examples of disease caused by microbes in contaminated water. When raw sewage enters water systems, people can come into contact with these microorganisms by drinking the polluted water or through swimming, fishing, or eating shellfish in polluted waters. Often unexpected flooding of barnyards or stock pens can increase the toxics effects of animal wastes in water. Animal waste can also act as a fertilizer and create damage by increasing nutrients (see Fertilizers).

Organic Wastes

Domestic sewage treatment plants, food processing plants, paper mill plants and leather tanning factories release organic wastes that bacteria consume. If too much waste is released, the bacterial populations increase and use up the oxygen in the water. Fish die if oxygen levels are depleted by bacteria decomposing organic matter.

Inorganic Chemicals

Inorganic chemicals and mineral substances, solid matter and metal salts commonly dissolve into water. They often come from mining and manufacturing industries, oil field operations, agriculture, and natural sources. For example, a huge coal ash spill occurred in Kingston, Tennessee. These chemicals interfere with natural stream purification, they destroy fish and other aquatic life. They also corrode expensive water treatment equipment, and increase the cost of boat maintenance.

Fertilizers And Detergents

Many of these substances are toxic to fish and harmful to humans. They cause taste and odor problems and often cannot be treated effectively. Some are very poisonous at low concentrations. The major course of pollution from agriculture comes from surplus fertilizers in the runoff. Fertilizers contain nitrogen and phosphorus that can cause large amounts of algae to grow. The large algae blooms cover the water's surface. The algae die after they have used all the nutrients. Once dead, they sink to the bottom where bacteria feed on them. The bacterial population increase and use up most of the oxygen in the water. Once the free oxygen is gone, many aquatic animals die. This process is called eutrophication.

Heated or cooled water

Heat reduces the ability of water to dissolve oxygen. Electric power plants use large quantities of water in their steam turbines. The heated water is often returned to streams, lakes, or reservoirs. With less oxygen in the water, fish and other aquatic life can be harmed. Water temperatures that are much lower than normal can also cause habitat damage. Deep dams often let extra water flow downstream. When the water comes from the bottom of the dam, it is much colder than normal.

Acid Precipitation

Aquatic animals and plants are adjusted to a rather narrow range of pH levels. The measure of the acidity or alkalinity of a solution is determined by pH. When water becomes too acid, due to inorganic chemical pollution or from acid rain, fish and other organisms die.

Pesticides, Herbicides, Fungicides

Agricultural chemicals designed to kill or limit the growth of life forms are a common form of pollution. This pollution results from attempts to limit the negative effects of undesirable species on agricultural crop production. Irrigation, groundwater flow and natural runoff brings these toxic substances to rivers, streams, lakes and oceans.

EDUCATORS RESOURSES

ACTIVITY 1

WATER WANDERING IN TENNESSEE AND BEYOND

Adapted from *The Incredible Journey* from **Project WET Curriculum and Activity Guide** 2016 ©The Watercourse and Council for Environmental Education

How can water from Tennessee end up in the Pacific Ocean in the Gulf of Mexico?

Concept

Water is an essential nutrient that cycles in the environment through living and non-living sources; it occurs as three states of matter: liquid, solid, and gas.

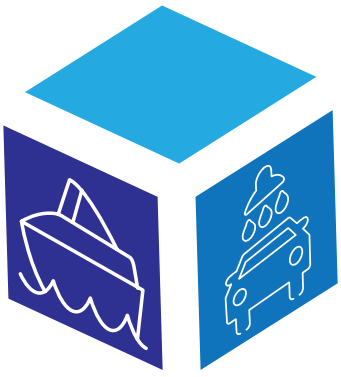
Activity Summary

Students roll a cube to simulate the journey of a water molecule. As students travel they will record each place the cube directed them to go and collect a bead to document their journey. We teach the water cycle in a simplistic manner and role-playing a water molecule helps students conceptualize the water cycle beyond a two-dimensional path.

Objective

Students will:

- describe the movement of water within the water cycle
- identify the states of water as it moves within the water cycle



Materials

- Water Molecule Stations. 8 large pieces of paper (11" x 14" or placemat size) to make locations where water molecules will travel. Label each paper and include a simple illustration: Ocean, Cloud, River & Lake, Groundwater, Wetland, Soil, Plant, and Animal.
- Water Molecule Cubes. 8 large cubes (6" square made from cardstock or purchased mug gift boxes). Label each according to the Cube Labels Table (see next page). Each cube is unique for each station, it is suggested to color-match the cube labels to the station labels. Example, use green marker, ink, or crayon to label the Plant cube and Plant station. For soil, use brown, then for the ocean use blue, etc…For younger children, include the simple illustration that also corresponds to the station illustration.
- Journey Documentation Beads. 8 different colors of 9mm craft beads (pony beads) for each station (purchase in large quantities, 500 or more). If you get these first you can color-code the beads to match the label color used for each station. Example, green beads will be placed at the Plant station, brown beads at the Soil station, dark blue beads at the ocean station, etc.…
- Each student needs 1 pipe cleaner/chenille-wired stem, long enough to go around the wrist to hold the beads collected on their water molecule journey
- Index card for each student to document the locations visited as a water molecule
- Copies of the Water Cycle (Optional)

CUBE LABELS TABLE

Station	Cube Side Labels	State of Water on Journey Explanation – do not include on the cube	
Ocean	Two sides CLOUDS	Gas	Evaporates
	Four sides STAY	Liquid	Remains in ocean
Clouds	One side SOIL	Liquid or Solid	Condenses to rain/snow
	One side WETLAND	Liquid or Solid	Condenses to rain/snow
	One side RIVER & LAKE	Liquid or Solid	Condenses to rain/snow
	Two sides OCEAN	Liquid or Solid	Condenses to rain/snow
	One side STAY	Gas	Remains as water vapor
River & Lake	One side WETLAND	Liquid	Flows
	One side GROUND WATER	Liquid	Pulled by gravity
	One side OCEAN	Liquid	Flows
	One side ANIMAL	Liquid	Consumed
	Two sides CLOUDS	Gas	Evaporates
	One side STAY	Liquid	Remains in River & Lake
Ground Water	One side RIVER & LAKE	Liquid	Filters into River & Lake
	Two sides WETLAND	Liquid	Filter in Wetland
	Three sides STAY	Liquid	Remains underground
Wetland	One side GROUND WATER	Liquid	Pulled by gravity
	One side ANIMAL	Liquid	Consumer
	One side RIVER & LAKE	Liquid	Flows
	One side CLOUDS	Gas	Evaporates
	Two sides STAY	Liquid	Remains
Soil	One side PLANT	Liquid	Absorbed by roots
	One side RIVER & LAKE	Liquid	Runs off after saturated
	One side GROUND WATER	Liquid	Pulled by gravity
	Two sides CLOUDS	Gas	Evaporates
	One side STAY	Liquid	Remains
Plant	Four sides CLOUDS	Gas	Transpiration
	Two sides STAY	Liquid	Metabolism/Photosynthesis
Animal	Two sides SOIL	Liquid	Excretion
	Three sides CLOUDS	Gas	Respiration/Evaporation
	One side STAY	Liquid	Metabolism

EDUCATORS RESOURSES

ACTIVITY 1

BACKGROUND INFORMATION

(transcribed the from Project WET Guide)

While water does circulate from one point or state to another in the water cycle, the paths it can take are variable. Heat energy directly influences the rate of motion of water molecules. An increase in heat energy can cause a change in state, and usually physical movement from one location to another. Gravity also influences the ability of water to travel over, under, and about Earth's surface. One of the most visible states in which water moves is the liquid form in oceans, rivers, lakes and seeping underground. Although unseen, water vapor surrounds us all the time; the condensation of it can be seen as water droplets on the outside of a glass of cold water. In clouds, water molecules collect on tiny dust particles, eventually becoming too heavy and the water droplets are pulled to t he Earth by gravity.

Living organisms also move water within their bodies by consuming directly or removing from food during digestion. Water can be excreted as a liquid during urination or perspiration, and as a gas during respiration. In plants, water that has been absorbed through the roots is excreted through the leaves during transpiration. Water is also essential for the metabolic processes of photosynthesis and cellular respiration. All these processes and more, work together to move water around, through, and over Earth.

Procedure

1. **Ask students to identify the different places water can go as it moves through and around the Earth. After this list has been generated, depending on grade level, ask students to identify words that describe or are related to the movement of water.** For example, humans take in and get rid of water through ingestion, digestion, excretion, urination, defecation, respiration, perspiration. You will find there are LOTS of words associated with this process for all the locations (not all of them end in –ation)!

2. **Explain to students they will take a journey as a water molecule, moving to other locations by tossing a cube that will direct them to where they will go next.** Water movement depends on energy from the sun and gravity. However, sometimes they will not go anywhere, but stay where they are if they roll 'Stay.' If they roll a 'Stay' they will go to the end of the line for that station and roll again on their turn.

3. **Hold up and share the location stations, one-by-one, reinforcing what students previously told you about the different places water can go. After you briefly discuss, place that station, the matching cube, and matching color beads in a designated place.** This activity is perfect for out-of-doors but the stations and cubes will blow away if windy. If this is in a class room, space the stations far enough apart for students to line up and toss cubes. The Ocean and Cloud stations tend to accumulate people, space those on opposite sides of the room.

4. **Students will keep track of their movements. Distribute a pipe cleaner and an index card to each student. Explain they will use the pipe cleaner to collect a single bead each time they roll a cube and travel to a location. The index card will be their record of the ten locations they visited. Students will number the card 1 – 10. For each location, they will also include the state of water they were in when they traveled (solid, liquid, gas) and the name of the process that got them to that location.** For example, if I went from Cloud to Wetland, I would have traveled as a liquid (rain) or solid (hail/snow) and the process would be through precipitation.

5. **To begin, assign an even number of students to each station, Cloud can have an odd number, if necessary. Students will return to their seats or designated area after they have traveled/ tossed the cubes ten times.** As mentioned previously, some of the stations have more movement within (Ocean and Ground Water) which is reflected by more 'Stay' sides. Remind students if they roll a 'Stay' to write that location down, take a bead, and move to the back of the line for that station. Some students get stuck in these locations but it makes for a good discussion.

6. **Students will share their travel stories with the class, using their notes on their index card and beads to tell their story. They will share the location, process, and state that water traveled.** Did any students find they cycled between stations? Does this help answer the question how water from Tennessee can end up in the Pacific Ocean in the Gulf of Mexico? How can water from the ocean end up in Tennessee? How many students were retained in the ocean or ground water? Students can also write their stories and exchange with each other to share or draw a picture to demonstrate their journey.

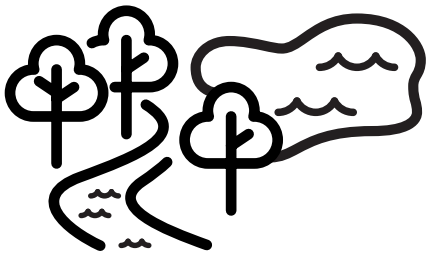
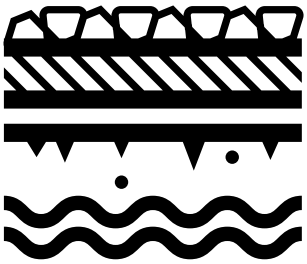
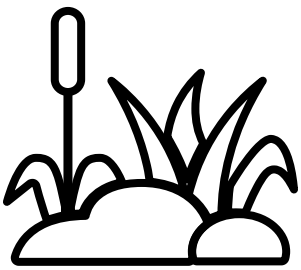
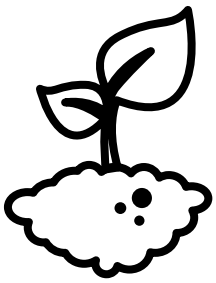
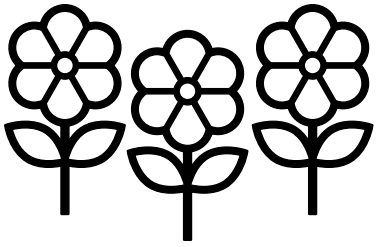
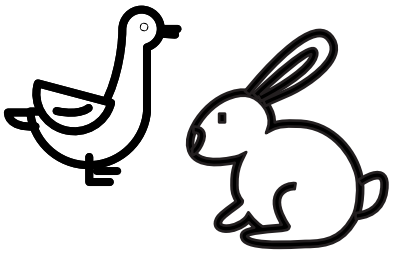
Extension

Students can investigate how water becomes polluted or laden with nutrients as it moves through the water cycle. For instance, as water moves through the soil, pollut ants are picked up. This can be demonstrated with stickers at the soil station that are stuck onto the student. For instance, if a student rolls river & lake, they will take several stickers with them. But if they roll clouds they will leave their stickers behind because as water evaporates it leaves the pollutants behind.

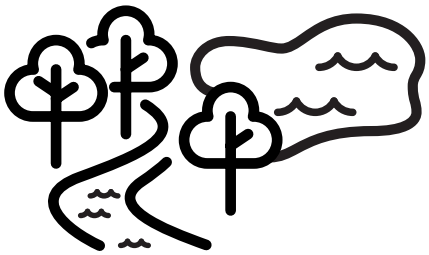
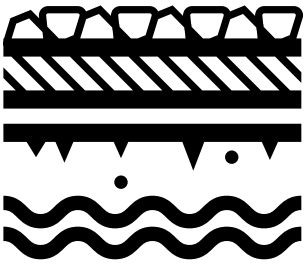
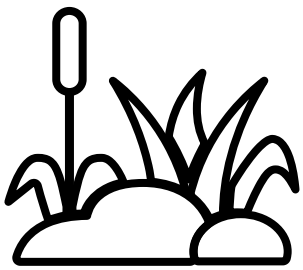
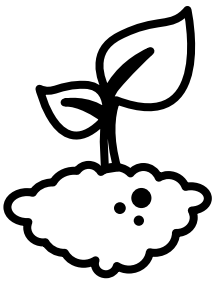
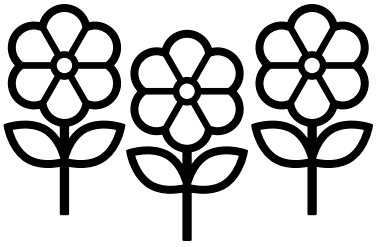
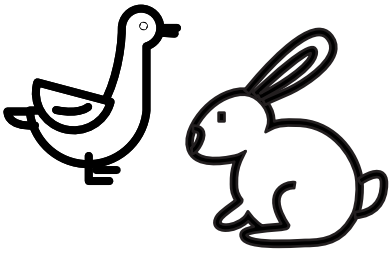
Students can also investigate the movement of water in different locations around the globe. They can change the cube labels, add alternate stations to represent different conditions. What would water journeys look like if a desert or the north and south poles were included?

ACTIVITY 1

IMAGES FOR CUBE SIDES

 OCEAN	 CLOUDS
 RIVER & LAKE	 GROUNDWATER
 WETLAND	 SOIL
 PLANT	 ANIMAL

PLACEMAT/WATER STATION IMAGES

 OCEAN	 CLOUDS
 RIVER & LAKE	 GROUNDWATER
 WETLAND	 SOIL
 PLANT	 ANIMAL

EDUCATORS RESOURSES

ACTIVITY 2

A TENNESSEE WATER MOLECULE'S JOURNEY

Adapted from *Imagine!* **Project WET Curriculum and Activity Guide** 2016 ©The Watercourse and Council for Environmental Education

What would it be like to take a journey as a water molecule in Tennessee?

Concept

Water is an essential nutrient that cycles in the environment through living and non-living sources; it occurs as three states of matter: liquid, solid, and gas.

Activity Summary

Students take an imaginary journey with water in its solid, liquid, and gaseous forms as it travels from Tennessee and around the world.

Objective

Students will:

- Identify changes in the state of water that enables water to move through the water cycle
- Describe the water cycle

Materials

- Copy of ***Tennessee Water Molecules' Journey***
- Audio recording of water sounds, optional but adds tremendously as far as setting the tone for the activity (water lapping the shore of a pond or lake, a storm with rain, waterfall, ocean waves crashing)

Background Information

(transcribed the from Project WET Guide)

Students learn about the water cycle usually throughdiagrams but using their imagination they can discover what happens to water as it move above, over, and under the Earth's surface. If you were able to travel with a water molecule, you would explore ocean depths, float through the atmosphere, plash down on a cedar glade, and weave among soil particle deep underground. How does water travel to all those places? The processes that drive the water cycle are evaporation, condensation, transpiration, and precipitation. They are powered by solar energy and gravity. When solar energy evaporates water from soil and bodies of water is causes water vapor to rise. When it cools and condenses in the atmosphere, gravity pulls it back down as rain, hail, sleet, or snow. The water we drink today could have dribbled down the back of a dinosaur, been locked inside a glacier during the ice age, spent 30,000 years in the ocean depths, or floated over the Great Smoky Mountains when they were just forming!

Procedure

1. **Ask students to diagram or write a description of the water cycle and describe that processes that occur as water moves from one location to another.**
2. **Ask students what t hey think it would be like to travel with water as it moves through the water cycle.**
3. **Tell students that you are going to take them on a journey through the water cycle with their imaginations. They should sit quietly and may wish to close their eyes.** You may want to distribute soft blindfolds made from stripes of cotton t-shirts. You will be relating ideas and events that will help them create pictures in their minds.
4. **Begin the audio recording of water sounds and start reading the script, Tennessee Water Molecules' Journey. Keep your voice even, level, and clear. Pause 3-5 seconds when you encounter the symbol "....." to let students have time to imagine what you are describing.**
5. **After reading, ask the students for their impressions. What were some major parts of the journey that resonated with them? Where did they go and how did they get there? In their daily life, what are some water movements that occur in the water cycle in their everyday lives (puddles, animal drinking water, fog, humidity in the air)?** As a southern state we experience high levels of humidity, relative humidity reports can be tracked to provide evidence that even if you can't see water, it is moving in the air around them. Why does a cold drink accumulate droplets of water on the outside of the container on a hot day? Students can keep class records to monitor throughout the seasons of the school year. Students can also create a comic strip of a water molecule traveling through the water cycle.

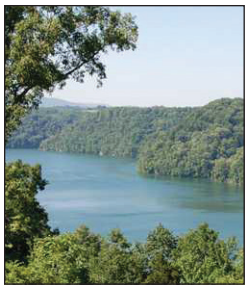
Extensions

Have students write a script for other parts of the water cycle? What happens when ground water is absorbed by a plant or consumed by a deer? What happens when wastewater is treated and deposited back to an aquatic system?

Instead of having students close their eyes, you can ask them to diagram or draw a picture of their journey as you read the narrative.

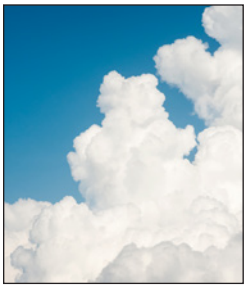
ACTIVITY 2

A TENNESSEE WATER MOLECULE'S JOURNEY



The Lake

It is a beautiful summer day…….the sky is blue……..white puffy clouds float overhead……. the sun is shining…….the ground is warm…….a mockingbird sings in a nearby tree…….Imagine a still pool of lake water in a cove…….it is surrounded by limestone rocks and tall trees…….you are a water molecule in the lake…….moving gently back and forth…….you can feel other water molecules around you…….you are all gently moving around each other…….touching then moving away…….a gentle wind ripples the surface…….tiny waves move along…….you are bounced into each other……. you are all rocking back and forth…….the sun warms the surface of the water…….you are close to the surface of the water…….now you are right at the surface of the water…….you begin to move more rapidly…….the warmth and energy of the sun continue to strike you…….you become more energized and move more quickly…….suddenly you burst from the surface……you are released in to the air…….you have moved away from the other and you gently float alone…….invisible to the human eye……apart from any other water molecules.



The Atmosphere

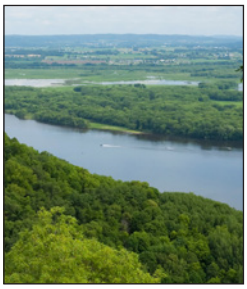
You float in the air and rise slowly…….there is great space around you…….you can see the lake below……. it grows more distant……. you continue to rise……. around you, you see other water molecules…….but they are on their own…….you cannot reach and touch them…….they, like you, continue to float and rise into the atmosphere……as you rise, it is getting cooler……your movement becomes slower…….a tiny particle floats by you…….you grab on to it…….another water molecule grabs on to the same particle…….then another and another…….you all begin to stick to each other making the particle larger and larger…….you see other particles with water molecules attached……..everything around you begins to form patterns…….the patterns are like giant diamonds…….light passes through these ice crystals and creates prisms and tiny rainbows…….. more and more water molecules come together…….you feel them surround you…….you are becoming heavier…….heavier……. heavier…….you begin to fall…….

Down The Smoky Mountains

As you tumble downward, you feel other water molecules push together around you…….suddenly you burst to the surface…… the sun is bright…….the air is fresh and dry…….it invigorates you……all around you there are water molecules…….traveling quickly…….all moving down a hill…….more groups of molecules join you…….more…….and more…….all travelling down quickly…….as you travel you see trees, grasses…….you come upon a large tree…….you bump against the roots and slow down…….

Into The Ground

Gravity begins to pull at you…….you seep into the ground, weaving among sand and soil particles……. flowing underground is like moving, slow motion, through a dark obstacle course……. you are now deep underground, surrounded by soil particles……. suddenly, your movement seems to be more horizontal, the pressure of other molecules behind you pushes you along…….it appears lighter up ahead……you and surrounding molecules spring out of the ground…….tumbling over ground, you continue your gradual descent to the foot of the mountain…….



The Tennessee River And Beyond To The Mississippi

Gradually you slow down…….you sense a gradual decrease in the slope of the land…….you now move gracefully in a large mass of water…….other streams contribute other molecules to your journey…….more and more water molecules collect together……..this is the big river……..along you travel…….other particles swirl around you……. you and other molecules work together to carry the particles…….there are so many particles…….. increasing as you move along…….you move more slowly now…….the slope is very slight…….the slower you go the less energy you have to carry the particles…….some of the particle slip from your grasp and sink but others are strongly attracted to you…….these are the salts…….they fill in the gaps between you and other water molecules…….. you and the other water molecules…….. you and the other water molecules continue to move about……..

What Next? The Vast Pacific Gulf Of Mexico

There are many options open to you……where will you go?.....the sun's energy may invigorate you, you could break away and float into the sky again……other water molecules may hold on to you, and you could swirl around the surface…….gravity may pull at you, you may explore darkness of the deep…….a fish swims by with its mouth open……now there's a possibility…….imagine where you will go next…….picture it in your mind…….you bump into a large mammal called a manatee as it swims by…….when will you know where you are or will go……..how far have you come……when you are ready open your eyes/remove the blindfold.

ACTIVITY 3

TOO MUCH OF A GOOD THING

Adapted from *Glass Menagerie* **Project WILD Aquatic 1992** ©Western Regional Environmental Education Council

What are the effects of too many nutrients in an aquatic system?

Concept

Nutrients are chemical substances essential to all living things. When aquatic habitats experience an excessive increase in nutrient levels, especially nitrogen and phosphorus, this can potentially have harmful health and environmental effects. An excessive increase in nutrients in water begins a process known as eutrophication.

Activity Summary

Students create, observe, and describe changes in physical characteristics of several different experimental aquatic habitats that vary in nutrient concentration.

Objective

Students will:

- Describe the characteristics of eutrophic aquatic habitats
- Explain the causes and results of excessive nutrients in aquatic systems

Materials

- **Seven 1-quart glass jars washed with hot, soapy water**
- **Masking tape or adhesive labels**
- **1 gallon of distilled water**
- **Tap water**
- **Small bottle of liquid plant fertilizer**
- **One roll of aluminum foil for jar covers** (mason/canning jar lids will seal too tightly)
- **1 gallon of fresh pond water with abundant organisms** (Note: Pond Mixture cultures can also be purchased from Carolina Biological Supply Company, if using pond cultures, 1 gallon of purchased spring water will be needed as well)
- **Microscopes, dissecting and compound light plus microscope slides/cover slips**
- **Eye dropper or soda straw for drawing samples**

Background Information

(transcribed from ***Project WILD Aquatic***)

The process of eutrophication, or an increase in nutrients, in streams, rivers and lakes is caused by runoff from surrounding watersheds, sediments present in that particular aquatic system, and organisms (living and dead) that occur there. These are natural sources of nutrients that are continually available and sustain a healthy and biologically diverse ecosystem. However, when nutrient loads increase rapidly, particularly nitrogen and phosphates, this triggers large-scale algae growth or blooms. The rapid algal growth depletes the excessive nutrients, which then triggers a sudden algal die-off. The algae that have died begin to decompose rapidly. Bacteria promoting the decomposition process use up much of the available oxygen in the water. Dissolved oxygen is needed by fish and other aquatic organisms; rapid eutrophication threatens their lives. Another negative effect from huge blooms is some species, blue-green bacteria in particular, produce toxins harmful to human and wildlife health.

Nutrient loading is eutrophication, a natural process, which is accelerated by human activities. Domestic sewage, industrial wastes, chemical fertilizers, and soil erosion are sources of human-caused nutrient enrichment. These "unnatural" nutrients, given their source and quantity, can be harmful to wildlife and humans.

Procedure

1. **Explain to students they will explore a process known as nutrient loading or eutrophication in aquatic systems through an observational study. Students will construct models of aquatic systems with varying levels of nutrients.** They will make observations, collect data, and formulate conclusions about the impact of excessive nutrients in aquatic systems.
2. **Collect a gallon of viable pond water, preferably with students. If viable pond water is not possible to obtain, then several cultures of mixed pond organisms can be purchased from a science supply store (such as Carolina Biological Supply Company).** Viable pond water is when the container is shaken and examined, there is an assortment of organisms floating or swimming about in the sample; a microscope will be needed to verify this.
3. **Students will learn to identify some of the different types of organisms in the pond water. A healthy pond water sample will have microscopic animals known as rotifers, assorted protozoa, and different types of algae. Some Tennessee ponds also have tiny floating plants called duckweed.**
   Using a microscope, students will examine the pond water and document the different types of organisms they find. They will record their observations through sketches or photographs and use various resources to identify their organisms. Some phones have the ability to take a photograph by placing the phone camera directly on the eyepiece of the microscope. The class will compile a list and sketches/photographs of the different types of organisms found, this list will be used for the next month.
4. **To set up the activity/experiment label 7 clean quart jars:**
   - **Jar 1 Control**
   - **Jar 2 Pond Water**
   - **Jar 3 Tap WaterJar 4 Distilled Water**
   - **Jar 5 Distilled Water with Fertilizer** (the recommended amount/proportion to add is indicated on the fertilizer label)
   - **Jar 6 Distilled Water with Fertilizer Overload x 10** (add 10 times the amount indicated on the fertilizer label)
   - **Jar 7 Distilled Water with Fertilizer Overload x 20** (add 20 times the amount indicated on the fertilizer label)
5. **Prepare the 'aquatic system' solutions as follows:**
   - Jar 1 Control – three cups distilled water
   - Jar 2 Pond Water – Three cups and one-half cups pond water (if using purchased culture from a science supply house, adjust this to 6 tablespoons of culture added to 3 cups of spring water)
   - Jar 3 Tap Water – Three cups tap water, one-half cup pond water, container of pond water shaken before removing sample (if using purchased culture from a science supply house, adjust this amount to one tablespoon of culture to three cups of tap water)
   - Jar 4 Distilled Water – Three cups distilled water, one-half cup pond water, container of pond water shaken before removing sample (if using purchased culture from a science supply house, adjust this amount to one tablespoon of culture added to three cups distilled water)
   - Jar 5 Distilled Water with Fertilizer – Three cups distilled water, normal amount of fertilizer as indicated on label, one-half cup pond water (if using purchased pond culture, add one tablespoon of pond culture)
   - Jar 6 Distilled Water with Fertilizer Overload x 10 – Three cups distilled water plus ten times the normal fertilizer, one-half cup of pond water (if using purchased pond culture, add one tablespoon of pond culture)
   - **Jar 7 Distilled Water with Fertilizer Overload x 20** – Three cups distilled water plus twenty times the normal fertilizer, one-half cup of pond water (if using purchased pond culture, add one tablespoon of pond culture)

ACTIVITY 3

TOO MUCH OF A GOOD THING (continued)

6. **Cap the jars loosely with the aluminum foil to prevent excessive evaporation. Do not use mason/canning jar lids because they seal too tightly. Place jars in a cool, visible, well –lighted place.** Direct sunlight should be avoided due to over-heating the samples. This will mark the beginning of week one of the experiment. Instruct students to generate hypotheses concerning the effects of nutrient loading on the contents of each of the jars. What do they predict will happen and why? Ask students to brainstorm about the type of data they will plan to collect to support their hypotheses. Will they compare clarity in the jars' solutions? Will they compare the smell? Will they estimate the number of organisms present? What differences do they expect to find?
7. **Ideally, the samples should be observed daily and at the very least, weekly. Students can be divided into teams, with members within each team assigned a specific jar to examine and report back to the group. Entries should be made on a data sheet specific to each jar.** By the second week, some changes will be visible to the eye without optical assistance. If time is a limiting factor, it is not necessary to use microscopes until the final week to examine changes in the numbers of pond organisms.
   If samples are being examined weekly microscopically, straws are useful because they are long enough to reach inside the jars (put finger over top of straw, dip in jar, release to draw in solution, then put finger back on top to withdraw). One straw will contain enough of the sample for several students' slides. You don't want to use up all the sample before the experiment ends, so sharing is a good idea.
   The class also needs to withdraw samples in the same way to compare results; prior to withdrawing a sample, the jar contents need to be stirred thoroughly.
8. **Throughout the observation period, discuss findings as changes begin to appear.** Sometimes just a few moments is all that is needed since some of the jars will not exhibit any changes.
9. **At the end of the four-week observation and data collecting timeframe, students will analyze their data.** Which jar exhibited the most change? Why do they think this change occurred? What conclusions can students make about their experiment? Did they support their hypotheses? Why or why not?
10. **Talk with students about the role of nutrients and how they occur in nature. Emphasize the role and impact of accelerated growth due to introduced nutrient loads. Discuss natural sources of nutrients and human-related sources. Compare the similarities and differences between these two.** Did they see a relationship between nutrient concentration and growth of organisms in their experiment? What is the cumulative effect of excessive nutrients on downstream rivers, such as the Tennessee River entering into the Mississippi which ultimately empties into the Gulf of Mexico? What kinds of effects might nutrient loading have on aquatic wildlife? On people? Why do we care, especially about places seemingly far away?

Extensions

This activity lends itself to many different iterations and requires very basic materials to conduct. Other factors related to nutrient loading such as temperature and dissolved oxygen can be explored if appropriate equipment is available. Students can also test the results from using different types of fertilizers. For example, is there a difference in the evidence of nutrient loading with a commercially prepared fertilizer and one labeled as organic? Students can observe a difference in the impact of nutrient loading on a single type of organism, pure cultures of organisms can be purchased and used instead of mixed pond cultures. For example, does spirogyra, a filamentous green algae proliferate or die when provided excessive nutrients?

EDUCATORS RESOURSES

ACTIVITY 4

WHEN IS ENOUGH, ENOUGH?

Adapted from *How Clean is Clean?* **Project Learning Tree Supplementary Guide For Grades 7-12**

What are the trade-offs when stricter water quality standards are proposed and enforced?

Concept

Solving environmental problems can be complex. Excessive nutrients in water impair water quality which can harm wildlife and harm human health. Excess nutrients can enter aquatic systems from point and non-point sources. Point source pollution can sometimes be traced and parties held responsible for violations, if there are regulations in place for that type of pollutant. Regulations governing water quality are updated and amendments voted upon by both Houses and the President of the US.

Activity Summary

Students explore a hypothetical situation in a Tennessee town with a creek that becomes polluted due to nutrient overloading. This creek has historically been identified by the state as having the "cleanest" water. Students are asked to explore the trade-offs of economic growth and environmental health through the lens of a congressman/woman that will travel to Washington D.C. to vote about pollution standards.

Objective

Students will:

- Describe the causes and effects of nutrient loading in an aquatic system
- Investigate solutions to issues caused by nutrient loading
- Identify agencies and regulations that determine clean water guidelines

Materials

- One copy per student of the hypothetical issue, Nutrient Loading in Lagoon Creek
- Students will need access to resources to research information related to clean water regulations and agencies responsible for enforcement of these regulations
- Slips of paper, post-it notes, index cards for Voting Ballots

Background Information

Excessive nutrients in aquatic systems causes an overgrowth of algae that impairs the health of wildlife and humans. The causes of nutrient loading in aquatic systems can be from point (discharge from a source) or nonpoint sources (run-off from fields, towns, factories). The federal government regulates water quality through the Environmental Protection Agency, which determines water quality standards. Amendments to the Clean Water Act (1972) must be approved by both houses (Congress and Senate) and the president of the United States. Environmental health and economic growth are important to nearly all citizens, we look to our district representatives to make decisions and vote for laws that will protect the health and prosperity of our community.

ACTIVITY 4

WHEN IS ENOUGH, ENOUGH? (continued)

Procedure

1. **Tell students they are going to respond to a hypothetical issue related to a type of pollution known as nutrient loading.** Explain that the federal government provides regulations to state agencies that are responsible for enforcing these regulations to protect human and environmental health. The Federal Water Pollution Control Act of 1948 was the first law in the US that addressed pollution. It was amended by the Clean Water Act of 1972 and is regulated by the Environmental Protection Agency. Any substantive changes to the regulations established by EPA must be introduced as a bill, and if approved by congress, the bill then moves on to the senate, and if approved by the senate, is then signed or vetoed by the President of the United States.
2. **Each student will play the role of the representative that will be responsible for going to Congress to vote for legislation to impose stricter pollution-control standards.** Pretending to be that representative, they will write out their thoughts while going through the process of making a decision as how to vote. These are the items they will address:
   - What issues are at stake? Identify the issues at stake.
   - What evidence or data is needed to understand the various issues and implications?
   - What is the validity of the evidence or data? Is it scientifically supported? Statistically valid? Anecdotal? Emotional? Self-serving for just a few individuals in the community?
   - What are the trade-offs involved in the representative's decision? What are the positive consequences? What are the negative consequences?
   - What are some possible, realistic alternatives to correct the issues related to nutrient loading?
3. **Students will take turns presenting their decision-making thoughts. A suggestion is to divide students into discussion teams of 3-4 students that will address one of the items.** A spokesperson will speak for the team. The next item will be shared by another team and so on.
4. **After discussion teams have shared, each student will cast their vote as though they are the representative; they must explain their reasoning behind their decision.**

Extensions

Students can research local news to find evidence of previous incidents of nutrient loading in their local water systems. They can attempt to determine what the polluting substance was and if the cause was from a point or non-point source. They can also try to determine if a clean-up effort was conducted. It may take some research but they can also try to find if the polluting entity received a fine. Are their local water quality regulations different than federal water quality regulations?

ACTIVITY 4 SUPPLEMENT

Nutrient Loading In Lagoon Creek

Nutbow is community located amid the beautiful rolling hills and agricultural fields of Tennessee. Lagoon Creek runs through the town and has historically been identified as one of the cleanest water systems in the state. Nutbow is one of the smaller towns in the state but recently sent a local person, to Washington, D.C. as a congressional representative from the district. Before their election, the representative was a lawyer in Nutbow and is very well acquainted with the people in the community and the problems.

Nutbow's economy depends primarily upon a vegetable canning factory which employs several hundred workers and indirectly supports the town's business establishments through its payroll. Because Nutbow is located next to Lagoon Creek, the second largest industry is related to year-round recreational water activities that limit the use of internal combustion engines: world-class fishing, swimming, canoeing, kayaking, inner-tubing down the creek, snorkeling, diving for pearls from native mussels, and camping with guides. The town of Nutbow was written up in National Geographic Travel Guide as a place to visit because of the ecologically sustainable recreational opportunities.

Recently, a bill was introduced in Congress to impose stricter pollution-control standards. To meet these standards, the canning factory would have to spend a substantial sum of money and thereby reduce its profit margin. The canning factory owners have asked the representative to oppose the bill because, they say, the profit loss will force them out of business, and hundreds of Nutbow workers will lose their jobs. The president of the cannery union opposes the bill and has threated to withdraw his support for that representative in the next election if they vote in favor of the stricter regulations.

However, the townspeople dependent upon the Nutbow water recreational industry are urging the representative to vote for the new bill. For a long time, they have opposed some of the practices of the cannery. They generate piles of vegetable waste for compost but sometimes place the piles too close to the creek. During heavy rains, the vegetable matter and nutrients from the compost piles washes into the creek, creating dense pockets of algae in slow-moving sections of the creek. Fish prefer the vegetable matter to eat and this interferes with sport fishing. Last year an old pipe that routed cannery waste to a holding pond broke and went unnoticed for hours while thousands of gallons of vegetable waste spilled into Lagoon Creek. The waste, high in nitrogen and phosphorus, triggered an algal bloom of green slime for 5 miles. To make matters even worse, the toxins produced by the algae made people ill that swam in the creek. Then fish and other aquatic wildlife began to die due to oxygen deprivation. It took months for the situation to resolve and people dependent upon the creek for their livelihood suffered, while the cannery did not. If control measures are not put into place, another accident from the cannery could force them out of business.

You, as the representative for this district, are under considerable pressure from constituents on both sides of the issue. What information do you need to make your decision? Here are questions you need to answer:

- What issues are at stake? Identify the i ssues at stake.
- What evidence or data is needed to understand the various issues and implications?
- What is the validity of the evidence or data? Is it scientifically supported? Statistically valid? Anecdotal? Emotional? Self-serving for just a few individuals in the community?
- What are the trade-offs involved in the representative's decision? What are the positive consequences? What are the negative consequences?
- What are some possible, realistic alternatives to correct the issues related to nutrient loading?

ACTIVITY 5

RIPARIAN ROAMING

Adapted from *Just Passing Through* from the **Project WET Curriculum and Activity Guide** 2016 ©The Watercourse and Council for Environmental Education

What benefit does vegetation serve in reducing nutrients and sediments from entering streams?

Concept

Understanding how vegetation affects water's movement through a site promotes student appreciation of the relationship between water quality and landscape. Vegetation areas growing next to streams/rivers/lakes are known as riparian zones.

Activity Summary

Students will explore through a role-playing activity how vegetation affects the process of erosion, which is the movement of water, nutrients, pollutants, and sediments over land surfaces. Students will collect data to make comparisons between a riparian area with vegetation and an area with rocks/no vegetation. This works best on a sloped area, out-of-doors, but can also be done on a flat area or even in a large inside area.

Objective

Students will:

- **Compare the rates at which water flows down slopes with and without plant cover**
- **Identify Best Management Practices that can be used to reduce erosion**

Materials

- Photographs or images of hillsides in Tennessee with and without plant cover – some areas of Tennessee with strip-mining or over development would be good examples of areas without plant cover
- 50' to 75' rope, sturdy yarn, or garden hose
- Tokens that will serve as "nutrients" and "sediment" – made from paper, biodegradable packing peanuts, or poker chips are a few examples, you will need enough for half the class to have 3 of each
- Timepiece plus a means to record time and number of tokens

Background Information

(transcribed the from ***Project WET Guide***)

As water flows over and through soil, it filters through spaces among particles and around plant roots and vegetative matter. This presence of vegetation slows the movement of water. Nutrients dissolved in the flowing water, as well as other sediments and materials, are removed from the water. When vegetation is removed due to human or natural causes, soil is more likely to be dislodged and carried away by water; the process is erosion. Although erosion has formed the Grand Canyon, gradually leveled the Appalachian Mountains, and enriched floodplain regions over thousands of years, the effects of erosion are not always desirable. Erosion of topsoil reduces the fertility of soil, causing build-up of nutrients and sediments in aquatic systems which is harmful to aquatic life. Ensuring that the land does not promote deleterious erosion and other and other water resource problems involves the use of Best Management Practices (BMPs). Watershed managers suggest these practices to prevent erosion: landscape

areas to prevent erosion; replant areas cleared by logging or mining; monitoring water that enters and leaves cut areas; building terraces, catch basins, and natural filters to mitigate sediment deposition; and leaving riparian zones intact.

Procedure

1. **Show students images of hillsides that are covered with vegetation. Ask them to imagine a gentle rain falling, what will have to the water? Then show them images of hillsides with barren slopes, how would rainfall affect these areas compared to the previous images?** Explain that all water in Tennessee either flows into a river, lake, or underground. Areas with vegetation next to rivers and lakes are known as riparian zones.
2. **Inform students they are going to take turns acting out the role of water as is flows through a site with vegetation and without vegetation.** If there is not a sloped area, ask them to use their imagination that the area is sloped. Lay the rope to indicate the stream, making large curves for the first half and then tight zig-zag curves for the last half to represent rapids, ending with a straight section to indicate a slow, flowing stream. See diagram Slope with Plant Cover and Slope without Plant Cover.

PART I –

Water Movement with Vegetation

3. **Divide the class in half, students will either be "raindrops" or "vegetation."**
   Raindrop instructions: Raindrops will loosely gather at the beginning of the rope/stream, holding several nutrient and sediment tokens; when instructed they will walk (not run) through the vegetative area. If they are tagged by vegetation (to simulate filtering into the soil) they will walk around the vegetation 5 times, dropping their nutrient and sediment tokens. Raindrops can only be tagged by vegetation once. After this they will crawl to the rope/stream to represent water moving underground and passing through small spaces (in reality, this could take months). When they reach the stream they will stand up and walk the length of the rope/stream. At the rapids, they will twirl or tumble to represent water spilling over the rocks. When they reach the end of the stream they will sit down and wait.
   Vegetation instructions: Vegetation will disperse themselves randomly 5 to 10 feet on either side of the rope/stream. Instructors may need to direct students where to go to avoid clumping or students being too close to the stream. Vegetation will try to tag the raindrops but can only pivot on one foot (did they ever see a tree walk?) and stretch their arms to represent roots seeking water and nutrients. Raindrops can only be tagged once and if they tag a raindrop, they will gather/absorb the nutrients left by the raindrop.

ACTIVITY 5

RIPARIAN ROAMING (continued)

4. **Begin the timer and announce the thunderstorm has begun. Raindrops will walk swiftly (not running) through the vegetative area, following the stream.** It helps to do a quick 'test run' with a few students as example, with everyone else watching to be sure students know their role and understand the purpose of their movements. When the last raindrop exits the stream, stop the timer. Record the time and the number of nutrient and sediment tokens that made it downstream. Collect more data, repeat with students switching roles.
5. **Discuss the results of the activity.** Ask students to describe water's movement. Help students understand how vegetation slows the rate of flow which allows time for water to percolate through the soil and reduces erosion.

PART II –

Water Movement without Vegetation

6. **Ask students how they think the results will compare when vegetation is removed.** For the second part of the simulation, divide the class again into "raindrops" and "small rocks." Rock instructions: Students representing rocks will disperse themselves 5 to 10 feet from the stream and will sit curled up into a ball. Raindrop instructions: When instructed, raindrops will walk around or hop over rocks as they encounter them, holding onto their nutrients and sediment tokens. If they drop a nutrient/sediment token, they may not pick it up. They will proceed toward the stream, walking downward. At the zig-zag spot (the rapids), they will twirl or do a somersault. When they reach the end of the stream they will sit down and wait for other raindrops.
7. **The same as for Part I, begin the timer and announce the thunderstorm has begun. When the last raindrop exits the stream, stop the timer. Record the time and add up the number of n**utrient and sediment tokens that were washed downstream. Have students switch roles and repeat.

8. **Compare the results from Part I and Part II. Do students see a difference in the time? Is there a difference in the number of nutrient and sediment tokens? Although erosion is a natural process, discuss the problem of unchecked erosion.** Have them brainstorm ways that erosion could be controlled. Share the list of Best Management Practices and compare that with the ideas they developed. Do they know of any riparian areas where they live that would benefit from BMPs? Explain that the Tennessee River ultimately flows into the Gulf of Mexico, one of twelve states that directly connects to the Mississippi River. What do they think are the consequences of all these states not using BMPs to control erosion? What impact will this have on the aquatic life in the Gulf of Mexico?

Extensions

To demonstrate the movement of other materials, besides sediment and nutrients, raindrops can pick up other materials as they travel down the slope to the stream (biodegradable packing peanuts, twigs, small stones, multi-colored pasta, or strips of colored paper). These items can be collected and the impact of them on downstream habitat discussed.

ACTIVITY 6

GREEN RIBBONS OF LIFE

Adapted from *Blue Ribbon Niche* **Project WILD Aquatic** 1992 ©Western Regional Environmental Education Council

What are the ecological roles of organisms that live in riparian zones?

Concept

Riparian zones are comprised of a distinctive plant community living at the edges of flowing water. The name riparian is derived from the Latin word, ripa, which mean riverbank. This zone also includes animals that cannot survive without the special conditions the riparian zone provides.

Activity Summary

Students create a model of a riparian zone with a variety of representations of organisms that live in riparian habitats in the part of Tennessee in which they live. Students research and become an expert about their selected organisms as they design and construct a diorama riparian habitat.

Objective

Students will:

- Identify different organisms that live in riparian ecosystems
- Describe the ecological role of some riparian organism
- Describe basic characteristics of riparian habitats
- Evaluate possible positive and negative effects from changes in riparian habitats

Materials

- Images of streams and riparian zones in Tennessee can be used or a simulation can be set up in the classroom with butcher paper
- Variety of art materials: markers, crayons, paints, clay, glue, paint brushes, plain and construction paper, cardstock, scissors, cardboard/shoe boxes
- List of Tennessee riparian organisms, collected from sources

Background Information

(transcribed the from ***Project WILD Aquatic Guide)***

Riparian habitats are the "green ribbons of life" found on the edges *of* water courses. Characterized with both aquatic and terrestrial habitat they often provide different and more abundant vegetation than surrounding areas, higher shade and higher humidity, as well as unique plant and animal diversity. The width of the riparian zone depends on many factors related to type of water system, soil types, minerals, weather patterns, and geologic structures. Riparian areas are affected by natural and human-caused changes, for example, spring flooding and flash floods. Excessive use of riparian areas by humans, livestock and wildlife can result in destabilization of stream banks causing increased rates of erosion. Riparian zones protect aquatic systems from excessive run-off that occurs from surrounding landscapes that contains nutrients, pollutants and all types of solid waste. Learning about the riparian zone will introduce people to the aesthetic, economic, ecological, and intrinsic value of these areas and perhaps foster appreciation and protection.

Procedure

1. **Ask the students to think about a local Tennessee stream, river, or lake and identify as many organisms as possible.** Did they include any organisms that are found in the intersection between water and land? Explain that the water in the area next to the bank, the bank itself, and some of the land within a given distance from the water is known as a riparian ecosystem.

2. **Students will research five organisms that are found in the riparian zone.** They will:
   - provide the Common And Scientific Name For Each Organism
   - Describe The Organisms Physical And Morphological Features (Size, Shape, Color, And Other Adaptations That Permit Survival)
   - Describe The Habitat (Where Found In The Riparian Zone)
   - Describe The Niche (The Ecological Role Or 'Job'), This Includes:
     - ♦ Life History Or Life Cycle (How Long It Lives, How It Reproduces)
     - ♦ What It Eats (Is It A Predator, Carnivore, Herbivore, Omnivore, Detritivore, Decomposer)
     - ♦ When It Eats (Is It Nocturnal, Diurnal, Both)
     - ♦ What Eats It
   - The Selection Criteria For The Five Organisms: Two Must Be Plants And Three Must Be Animals, One Must Only Occur In The Water, One Must Only Occur On The Land Of The Riparian Zone
3. **Once students have completed their research they will construct a diorama of their riparian zone to demonstrate the interrelationship of the five species they researched.** Water, banks, and associated riparian land will be represented. Students will print from the web or draw a sketch of their organisms and place their species in the correct riparian zone.
4. **Students will present their dioramas to each other, discussing similarities and differences in selected species.** A suggested strategy is for half the class present at their desks or designated stations while the other half of the class rotates to each one individually, taking notes and discussing unique features. Students swap after the first rotation is completed. To avoid information overload, assign students to three other students, requiring they compile a table with the information from each organism the three other students researched.
5. **.Students have complied an extensive list of organisms that occur in the riparian zone.** Now ask students to consider things that might change the riparian zone. Some examples of potential changes (positive and negative) are:
   - Removing shade-producing trees or shrubs along the bank
   - Introducing an invasive species, plant or animal
   - Clearcutting a slope above a stream producing siltation from increased runoff
   - Disturbing breeding or spawning beds by livestock moving through or people wading in streams
   - Planting vegetative cover on a previously bare slope above a riparian area
   - Regulating uses of an area where soil is being compacted and creating erosion problems
   - Educating homeowners that live on rivers and lakes to leave vegetation on the bank

Extensions

To demonstrate the negative impact on riparian zones, students can construct their diorama in a manner that shows a negative effect in one area. For example, cows standing on the streambank lacking any vegetation an area cleared out and devoid of vegetation, or trash on the bank and in the stream.

Contact the local agency responsible for managing riparian zones and invite them to come and speak with the class, admire the dioramas, answer questions, and provide helpful suggestions.

ACTIVITY 7

WHO POLLUTED THE TENNESSEE RIVER?

Adapted from Who Polluted the River? **Counting on People: K-5 Activities for Global Citizenship**

Who is responsible for pollution of streams, rivers, and lakes in Tennessee?

Concept

Through time, individ*ual* and collective actions have impacted our rivers in many ways. These impacts have changed biodiversity of the river, plus human use.

Activity Summary

Through an interactive story, students experience the pollution of a local river over time and propose methods to protect the river from current and future pollution. Each student will receive a container of a substance that is added to a large bowl of water as the story is narrated. The large container of water becomes visibly changed, which helps students conceptualize the issue.

Objective

Students will:

- Discuss ways people can pollute a water source
- Propose methods for preventing and cleaning up water pollution
- Explain why it is more effective to prevent pollution than to clean it up after the fact

Materials

- **1 clear gallon jar or a large clear bowl of water**
- **Each child needs 1 small plastic condiment container & lid (or film canisters if you can find)**
- **Container ingredients (leaves, soil, baking soda, litter, fishing line, coffee, red & green food coloring, soapy water, vegetable oil)**
- **Labels for small containers (provided)**
- **Character nametags (provided)**
- **Story: Who Polluted the Tennessee River? (provided)**
- **Plastic fish for river (optional)**

Background Information

(transcribed from ***Counting on People: K-5 Activities for Global Citizenship***)

Rivers have always been an important resource. They provide water for drinking, a means of transportation, a home for wildlife in and out of the water, and more. As human populations have increased, so has our impact on the water system and many rivers have changed as a result. In this activity, students actively participate in a story about the changes humans have made to a river over time and learn how many of our rivers have become polluted. This example demonstrates that just as we each contribute to the problem, we can also each be part of the solution.

Procedure

1. **Prepare and label the containers using the container labels provided and the items in the chart, Story Characters and Container Ingredients.** Prepare enough containers for each student to have at least one. There are 10 pollutants that will be added to the water, double up on any of these EXCEPT the barnyard (coffee) container; it will make the water too dark to notice the progression afterwards.

Container	
Story Characters	**Container Ingredients**
Trees	Dry Leaves
Building Sites	Dry Soil
Farmers	Baking Soda
Family Picnics	Litter, Assorted shreds of paper and plastic
Person Fishing	Tangle of Fishing Line or Dental Floss
Barnyards (only do one)	Water + Instant Coffee or Strong perked Coffee
Factories	Water + One drop Red Food Coloring
Drivers	Vegetable Oil + One drop of Red and Green Food Coloring
Washing the Car	Soapy Water
Motorboats	Vegetable Oil + one drop Red and Green Food Coloring

2. **Cut out the character Nametags. Make sure there is a Character Nametag for each canister you've made.** For example, if there are two "Washing the Car" containers, then there needs to be two Character Nametags.
3. **Fill a LARGE clear jar or bowl (1 gallon size) with water. Place the bowl in a location that can be seen and accessed by students.** If you are also using a plastic fish, place in the bowl now and refer to the fish throughout the story, include the question "How do you think the fish feels?"
4. **Give each student a Character Nametag, asking them one thing they know are the Character they have been given.**
5. **Set up the labeled containers with easy reach of where you will be facilitating the activity, in the order they will go in the water.**
6. **Explain that you will tell a story about the Tennessee River and each student will have a part in the story.** The jar of water represents the river. When they hear the name of the item pictured on the Character Nametag you've given them, they will come up to and you will give them the matching containing. They will remove the top and empty its contents into the water. To avoid spills, you can open for them or have the tops loose to easily remove and hand to the student.
7. **Read the story aloud, Who Polluted the Tennessee River?** Add emphasis as you read each bolded character name and remember to pause at least 5 seconds after each question to give students time to think and respond.
8. **8. Discussion questions can help students see the point of the story and role we all play in pollution.** A good first question is who pollutedthe Tennessee River? What effect did the increasing population have on the health of the river? Thinking about your containers' pollutant, what could have been done to prevent that pollutant from entering the river in the first place? Challenge students to clean up the bowl of water, what could they do to restore the cleanliness of the water in the bowl right now? Ask them if it's easier to prevent pollution or clean it up later?

Extensions

Arrange a class field trip to your local waste water treatment plant. Prior to your visit, have each student write down one question they have about polluted water or the cleaning process for the tour guide. Things they may want to know would be related to how much water gets treated, where does it enter back into the river, who is downstream drinking our treated waste water?

Why is the treatment of the water important to us and also to that community, too?

ACTIVITY 7

STORY: WHO POLLUTED THE TENNESSEE RIVER?

There was a time many years ago when our land was very wild. This was a time before roads and cars. Only a small number of people lived in Tennessee then. These native people depended on nature for many things they needed to survive, but lived simple and didn't change the natural surroundings too much. The people hunted in the forest, found food in the swamps, and caught fish in the river that came to be known as the Tennessee River. The beautiful and sparkling river was home to fish and o her wildlife. Image that the bowl of water in front of you was taken from the river long, long ago.

- Describe how the water looks to you. Would you drink this water? Eat fish that came from it? Swim in it?

  Eventually more people traveled to this land from across the ocean. They found rich soil for farming, forests full of wildlife, and a river that provided plenty of food and water. It was a perfect place to live.
- How do you think the new people used the river?
- Do we use the river in the same way today?

  The river has changed a lot since that time long ago. This is the story of those changes. Listen for the name of what's pictured on your Character Nametag. When you hear your picture names, walk up to the teacher, get the matching container, and dump what's inside into the river. Be sure to stand to the side so the whole class can see the bowl.

Years went by and once in a while there were big storms. Strong winds whipped through the **TREES** and blew leaves in the water. More and more people moved to the area. Gradually a city grew up around the river. People drained the wetlands and cut down the forest to build houses, schools, churches, stores, roads, hospitals, and many other buildings. Rains washed loose soil and nutrients in the soil from these **BUILDING SITES** into the river.

- Is this water safe to drink? (if the answer is "no" ask if leaves and soil were blown into the river long ago)
- Would you swim in it? Is it safe for animals to drink and fish to swim in?

At first, the city was small. Upstream, **FARMERS** planted crops to feed all the people as the city grew. They used chemicals called fertilizers to make the crops grow faster. Some farmers kept pigs and other animals in the **BARNYARDS**. As rainwater drained out of the fields and barnyard, it carried some of the fertilizers and manure into a little creek behind the barn. This creek flows into the river.

- Would you drink this water now? Would you swim in it? Go boating in it?
- Is it safe for fish and animals?

Many, many years later the city along the river has grown to be one of the largest cities in Tennessee. Many people live and work in and around the city. Many Businesses provide services for the people. Several **FACTORIES** make thanks that people want, like cars, furniture, guitars, Goo-Goo cluster candy. But the factories leak paint and other chemicals into the river. These pollutants cause the fish to become sick. As more people move about their busy days they often drive from place to place instead of walking. Traffic jams are a big problem for DRIVERS who take their cars to and from work. If a car is not taken good care of, it might also leak oil or other fluids, along with tiny rubber particles for the tires that will be washed off the road and into the river with each rain.

A boy in the city is **WASHING THE CAR**. The water rushes down the driveway into the storm drain that leads directly to the river. Along with the soapy water also goes the grease, grime, tar, rust, and tiny bits of rubber. If the boy had gone to a local carwash, the water would have been cleaned or recycled before going into the river. The soapy water is high in phosphate which acts like a fertilizer for aquatic plants and algae. This causes them to grow prolifically and then die. Some produce substances toxic to aquatic life and humans. The dead aquatic plants and algae are then consumed

by bacteria that in the process remove the oxygen from the water, causing other aquatic organisms like mussels and fish to suffocate and die, too.

On nice days many people head down to the river. Some zoom up and down the river in jet skis and **MOTORBOATS** and don't notice a little engine oil leaks into the water. The oil will not mix with the river water, but will float on the surface. It will coat the feathers of ducks or other birds that paddle on the water looking for food, making it harder for them to stay afloat or fly. Lots of people are having **FAMILY PICNICS** in the parks along the river, too. Some of the people have left trash on shore. With the next storm or wind, that trash will wash into river. On the shore a **PERSON FISHING** snags a hook on a log. Instead of untangling it, the person fishing simple breaks off the snagged piece of the nylon fishing line and lets it fall into the river. What will happen to the organism that gets tangled in that line? The land is no longer wild and the river has changed a lot over the years.

The Tennessee River's waters, along with the excessive nutrients and pollutants within it, eventually end up in the Mississippi River, which drains to the Gulf of Mexico and the Pacific Ocean. The Gulf of Mexico is the largest gulf in the world, supporting a huge biodiversity of organisms. It's incredible to think that our actions in Tennessee could have any impact on wildlife so far from us
but they do!

ACTIVITY 8

WHAT FLOWS THERE? A POLLUTION PUZZLE

Adapted from ***Deadly Waters Project WILD Aquatic*** 1992 ©Western Regional Environmental Education Council

What are the types and sources of pollution of streams, rivers, and lakes in Tennessee?

Concept

In its many journeys, water may be contaminated by thousands of different substances. For the most part, these substances alter water in such ways that it becomes a hazard to wildlife, wildlife habitat and humans as well. Some effects are direct; others are indirect.

Activity Summary

Through a simulation activity students take samples from different rivers in Tennessee. Student research teams scoop a given volume of tokens (take a water sample) from a container (the river) and analyze the contents for various types of pollutants. Student teams graph their data and discuss pollutant impacts and possible solutions

Objective

Younger Students will:

- Name and describe different kinds of pollution that can be found in waterways
- Describe how some animals and plants are affected by pollutants

Older Students will:

- **Identify major sources of aquatic pollution**
- **Make inferences about the potential effects of a variety of aquatic pollutants on wildlife and wildlife habitats.**

Materials

- **Ten different colors of construction paper, two sheets of each to make pollution tokens**
- **Writing or graph paper**
- **Tape or glue to adhere tokens to paper**
- **Paper punch for making pollution tokens** –OR– **scissors for making ½" square tokens**
- **Pollutant Information Sheet** (one per student)
- **¼ teaspoon measure for paper punch tokens** –OR– **1 tablespoon measure for ½" square tokens**

Background Information

(transcribed from ***Project WILD Aquatic***)

The purpose of this activity is for students to increase their understanding of water pollution and its potential effect on human and wildlife habitats. The way we feel about pollution has to do with the attitudes and values we hold regarding the quality of life. Issues of economic importance often affect the human reaction to pollution. In the case of DDT, it took years before we could see the effects and ban the use of DDT in this country. Some pollutants enter water from a localized source, like a chemical discharge from a factory. This is called **point source pollution**. Other pollutants enter from a variety of less easily identified sources. For example, when rain washes motor oil left from dripping cars in store parking lots in city drains to re-enter the water supply. This is called **non-point source pollution**.

There are four categories of pollutants:

Chemical Pollution. The introduction of toxic substances into an ecosystem (acid rain, pesticides, herbicides, DDT).

Thermal Pollution. Varying temperatures above or below the normal condition (power plant turbine heated water)

Organic Pollution. Oversupplying an ecosystem with nutrients (sewage, fertilizers)

Ecological Pollution. Stresses ordinarily created by natural processes (extreme tides bring saltwater to habitats normally protected from sea water; abnormal increase in runoff sediments; bird droppings introducing aquatic plants to a different ecosystem)

Procedure

1. **1. Prepare the pollution tokens by making 100 of each color. To speed up the process, fold the construction paper in quarters. For younger students, make ½" squares with a paper cutter; for older students, use a paper hole-punch to make circles. Place in a container and stir thoroughly to mix the colors. Make one copy of the Pollution Information Sheet for each student.** Some teachers prefer to copy the Pollution Information Sheet, cut the descriptions apart, and paste the appropriate paragraphs on each of the colored sheet of construction paper that corresponds to the token color.
2. **2. List the four major categories of pollution on the board and discuss each.** Refer to the background section for a description of each. The first three are predominantly caused by humans: Chemical, Thermal, and Organic. However, in rare cases natural processes can cause them; for example, volcanic ash causes acid rain. The fourth category is Ecological Pollution, is caused by natural processes, although there are cases where it is caused by human activity.
3. **3. Distribute the Pollution Information Sheets. Review each kind of pollution with the students. Talk about how some of these can fit into more than one of the four kinds of pollution categories. Explain that for this activity, each type of pollutant is represented by a color and a number.** Post each sheet of construction paper with the number and label of the corresponding type of pollutant in a prominent and convenient place.
4. **4. Tell students they will divide into research teams of three. Each team will analyze the pollution content of a river in Tennessee. Each team will take a "water sample" (the tokens) from a Tennessee river (the container with the tokens).** When they receive the container with the tokens, instruct them to take one, ¼ teaspoon scoop if using punch-out tokens and one, 1 tablespoon if using ½" squares. Each team will also be given one sheet of graph paper.
5. **Teams will separate the colored tokens into piles, using the number/color key, they should identify each type of pollutant. Once this is done, they should count the number of each kind of pollutant they have identified and then use graph paper to construct a simple bar graph showing the array of pollutants in their sample.** They will arrange the pollutants in numerical order to make it easier and logical to compare their findings with others.
6. **When the bar graphs are completed and compared to other teams' results, explain that any quantity above two units of any kind of pollutant is considered damaging to wildlife habitat.** In their river, what pollutants would be likely to cause the most damage to wildlife and wildlife habitats? Give examples and discuss the kinds of damage that could be caused.
7. **Instruct teams to come up with at least one solution for each of their pollutants considered damaging to wildlife.** Solutions need to be somewhat feasible and logical, for example, saying, "Stop polluting or stop driving cars" is not a feasible solution.

Extensions

Invite students to match the pollutants with the four categories of pollution listed at the beginning of the activity. Some seem to fit rather easily; others could fit in more than one category, depending on the source of the pollution. For example, is thermal pollution human or naturally caused (thermal hot springs or power plant water discharge)?

Students can reflect on the own lives and identify five things they personally can to reduce the number of pollutants they introduce into the environment.

Getting information about national and state laws protecting water quality, research if DDT is still being used in the U.S. and if not, where is it being used and why.

EDUCATORS RESOURSES

ACTIVITY 9

WATER DOWN THE DRAIN

Adapted from Sparkling Water from the P**roject WET Curriculum and Activity Guide** 2016 ©The Watercourse and Council for Environmental Education

How do we clean wastewater in Tennessee to remove wastes and some nutrients?

Concept

It is the law in the United States that towns and cities have some type of wastewater treatment facility. It is easy to take for granted the processes that ensure water we have used is returned in the same condition before we used it. The process used in wastewater treatment plants is similar to the natural process by which water is cleaned while moving through the water cycle.

Activity Summary

Students are challenged to devise strategies to clean contaminants and nutrients harmful to aquatic system. In this activity students will produce "wastewater" and then determine methods to clean the water using basic materials. Student teams will apply their devised methods and clean the "wastewater" samples to classroom standards.

Objective

Students will:

- **Compare how water is cleaned in the water cycle to how it is cleaned in water treatment systems**
- **Describe the processes for treating wastewater**

Materials

- **Water**
- **Safety Goggles and Gloves**
- **A gallon-sized container**
- **Several small containers, 3 –ounce capacity**
- **Wastewater materials:**
- **Coffee grounds**
- **Salt**
- **Vegetable oil**
- **Soil**
- **Yeast**
- **Soap**
- **Food scraps**
- **Vinegar**
- **Possible Water Cleaning Materials:**
- **Assorted sizes of screens to use as filters**
- **Diluted bleach**
- **Alum (available in grocery stores in the food section, used for making pickles)**
- **Bowls and cups**
- **Straws, pipettes**
- **Spoons**
- **Baking soda**
- **Charcoal**
- **Rocks and sand**
- **Possible Testing Materials:**
- **pH test strip/paper**
- **Brown paper bag to test for fats**
- **Wax paper**

Background Information

(transcribed the from ***Project WET Guide***)

As hard as it is to imagine, some streams and rivers have been so polluted they caught on fire from the oil and chemical waste. Our rivers, lakes, and even oceans were thought to mysteriously be capable of carrying off and treating our liquid waste. Cities pumped raw sewage and factories dumped used water full of chemical waste, untreated, into aquatic systems. As populations expanded and these practices continued, the contaminated water supply began to pose a public health issue. It wasn't until this moment in time that the country collectively and systematically tackled this problem. This change was not without controversy because the expense of treating wastewater meant building costly treatment plants that required increases in taxes.

The simplest form of wastewater treatment (primary treatment) involves filtering and settling procedures, including skimming any floating materials from on top the water. Nearly 50% of pollutants are removed utilizing primary techniques. Secondary treatment is primary biological and removes 85 to 90% of remaining pollutants. Microorganisms consume most of the waste material in aerator tanks and then are separated from the water in settling tanks before discharge. The water is also disinfected to remove any disease-producing organisms before being released. Despite all of this, some undesirable materials still remain like nitrates, phosphates, pesticides, herbicides, other chemicals, and heavy metals. Some advanced plants have a third treatment that passes the water through activated carbon to remove organic waste, distillation to remove salts, and flocculation by adding alum which clumps suspended particles causing them to settle out. The solids produced from wastewater treatment are known as sludge and can sometimes be used as fertilizer for crops, burned or buried. Environmental consulting agencies are promoting engineered wetlands as a means of using natural processes to treat wastewater. The best treatment is for the collective public to not put substances harmful to the water supply down the drain, in the yard, or in the storm drains in the first place.

EDUCATORS RESOURSES

ACTIVITY 10

NATURE'S WATER TREATMENT FACILITY

Adapted from *Wetland Metaphors* **Project WILD Aquatic** 1992 ©Western Regional Environmental Education Council

What role do wetlands play in providing clean drinking water for citizens of Tennessee?

Concept

All wetlands, whether a freshwater or saltwater marsh, wet meadow, swamp, bog, or lagoon provide special habitat that serve areas far beyond their boundaries. Wetlands are uniquely important because of the abundance of food, vegetative cover (shelter), and water found there. Most wetlands are rich with diverse wildlife species but imperiled due to human activities.

Activity Summary

Students are presented with a selection of objects for investigation as metaphors that describe the natural functions of wetlands.

Objective

Students will:

- Describe the characteristics of wetlands
- Explain the importance of wetlands to wildlife and humans

Materials

- **Images of Tennessee Wetlands**
- **A container to hold objects – pillowcase, bag, or box**
- **Suggested items: sponge, small pillow, soap, egg beater/mixer; small doll cradle; sieve of strainer; paper coffee filter; anti-acid tablets; small box of cereal; 3 x 5 cards to show images of other wetland metaphors (a zoo could represent the idea of wildlife diversity; a lush vegetable garden would represent the idea of a productive wetland with plenty of food; a resort could represent the idea of resting or wintering place for migrating waterfowl).**

Background Information

(transcribed from ***Project WILD Aquatic)***

The many activities that take place in wetlands make them the most productive ecosystems in the world. Coastal and inland marshes provide breeding resting and wintering habitats for thousands of migratory birds, including ducks geese, swans, cranes and shore birds. Many species of fish that are important for commercial and person use by humans reproduce and spend part, or all of the life cycle in fertile wetlands adjacent to larger bodies of water. These fish species include bass, salmon, walleye, perch and pickerel. A wide variety of reptiles, amphibians, insects and crustaceans also breed and live in wetlands. Frogs and toads, turtles of all kinds, salamanders, snakes, dragonflies, water striders, clams and crayfish flourish in wetland habitats. Many mammals, from muskrats and beaver to whitetail deer and moose, also depend on wetland areas. Wetlands are often referred to as nurseries because they provide critical breeding and rearing habitats for countless numbers and kinds of wildlife.

The importance of vegetation associated with wetlands significant. Plants absorb nutrients and help cycle them through food webs. Plants also help keep nutrient concentrations from reaching toxic levels. Plants slow down water flow causing silt to settle. Through photosynthesis, plants add oxygen to the system and provide food to other life forms. Of great importance to humans are the flood control characteristics of wetlands. When runoff from rains and spring thaws is high, wetland areas absorb excess water until it gradually drains away down streams and rivers and through the soils. Acting as buffers, healthy wetlands prevent flooding and erosion. In dryer periods, wetlands hold precious moisture after open bodies of water have disappeared.

Wetlands also have the unique ability to purify the environment. They act as natural filtering systems and have been shown to be extremely effective. Wetlands can remove excessive nutrients such as nitrogen and phosphorus through chemical, physical, and biological processes. Wetlands can trap and neutralize sewage waste, allow silt to settle, and promote the decomposition of many toxic substances.

Wetland habitats are being converted to other uses (agriculture, roadways, housing developments) or otherwise being destroyed (drained for pest control or polluted) at the rate of more than half a million acres per year. The Fish and Wildlife Service estimates that Tennessee has lost more than 50% of its wetlands in the last 200 years. Although many wetlands are protected by federal and state laws, there still appears to be significant need to create a greater understanding of the importance of wetlands as ecosystems and wildlife habitat.

Many of the major attributes of wetlands can be explored through the use of metaphors. To use a metaphor is to apply a word or phrase to an object or concept which it does not literally denote in order to suggest a comparison between the two. A metaphor represents a concept or idea through another concept or idea. "A tree is a home" and Books are windows of thought" are two examples. In this activity a variety of everyday objects are used to represent the natural functions of wetlands. See the following chart for metaphors related to the activity.

OBJECT	METAPHORIC FUNCTION
Sponge	Absorbs excess water caused by runoff; retains moisture for a given time even if standing water dries up (a sponge placed in a small puddle of water absorbs water until saturated, ten stays wet after the standing water has evaporated)
Pillow or Bed	Is a resting place for migratory birds and other animals
Mixer or Egg Beater	Mixes nutrients and oxygen into the water
Cradle	Provides a nursery that shelters, protects, and feeds young wildlife
Sieve of Strainer	Filters impurities from the water
Filter	Filters small impurities from the water
Antacid	Neutralizes toxic substances
Cereal	Provides nutrient-rich food
Soap	Helps cleanse the environment, as wetlands do

ACTIVITY 10

NATURE'S WATER TREATMENT FACILITY (continued)

Procedure

1. **Prepare a "Mystery Metaphor Container" where it is possible for a student to reach in and pull out an object without seeing the other objects.** Have at least one object for teams of four students and to individually involve each student, have as many as one metaphoric object per student.
2. **Discuss the variety of wetlands found in Tennessee, sharing images of as many as you kind find. If using student teams, an effective strategy is to have several sets for each table team to view.** Ask students to write down things they observe: what is the same and what things appear to be different in each of the wetland image sets. List these on the board.
3. **Students will research some of the organisms that live in wetlands in Tennessee. Have them identify the type of wetland in which the organisms they researched can be found.** Explain some organisms are uniquely adapted to live in wetlands. Some trees that occur in wetlands have what were thought to be 'air roots' or 'knees' that are roots that project out of the water but it appears these structures store carbohydrates. Another structure wetland trees have are buttresses, which is where the base of the trunk fans outward, stabilizing the tree as it grows upward. Some other species of plants in wetlands are carnivorous, not which chewing mouthparts, but possessing structures that have evolved to trap and dissolve insects, extracting nitrogen.
4. **Now that students understand about the types of wetlands and some organisms associated with wetlands, provide the students with background information to serve as an overview of the basic ecological activities that characterize the wetland habitat.** For example, wetlands have a sponge effect that slows runoff.
5. **Now bring out the "Mystery Metaphor Containers." Tell the students that everything in the container has something to do with a wetland. Student teams will pick a representative to select an object from the container.** Then, the team must figure out how the object could represent what a wetland is or does.
6. **When each group has an object, ask them to work as a team to describe the relationships their metaphoric object and the wetland.** Encourage the students to build on each other's ideas. You can also assist by strengthening their connections. Students will report out to the class.
7. **List student ideas and discuss, reviewing the functions represented by each metaphor. Encourage the students' understanding of how the wetlands' condition depends on each of us.** Not only wildlife, but our own well-being requires wetland ecosystems. Recreation, aesthetics, and environmental quality are but a few of the connections we have with wetlands.

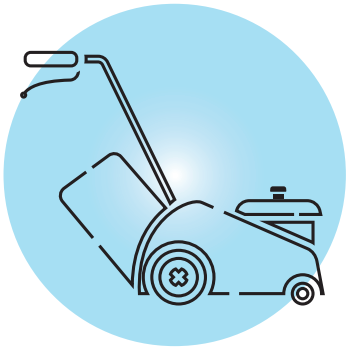
Extensions

Arrange a class trip to a wetland. Identify and discuss any limitations to the appropriateness of the metaphors they explored in class. Ask them to identify what seem to be the most compelling attributes of the metaphors in helping them understand the characteristics and nature of the wetland. Explain to students that there are negative attributes humans associate with wetlands, breeding ground for mosquitos, snakes, other animals considered to be a nuisance, land that can't be built or farmed and other complaints. How do they feel after experiencing and learning about wetlands?

PERSONAL ACTIONS AT HOME TO REDUCE NUTRIENTS INTO TENNESSEE WATER SYSTEMS

1. Use phosphate-free cleaning products to avoid adding phosphates to aquatic systems, look for the phosphate free symbol

2. Compost or dispose of food waste, do not put in garbage disposal which then contributes extra nutrients into aquatic systems
3. Lawn care:
   - recycle grass clippings or mulch back into the lawn, do not blow into the street
   - sharpen mower blades and cut grass no shorter than 3 inches
   - follow instructions on fertilizer application amount (less is more)
   - wait to fertilize the lawn or garden until after a rain to prevent wasting fertilizer and to keep it from washing nto aquatic systems
   - have lawn and garden soil tested at local Extension Service Agency to avoid spending money on fertilizer you may not need



4. Nothing in the toilet except bodily wastes and toilet paper…all other things dispose of in the trash.
5. Wash your car at a car wash and not your driveway, car wash facilities treat the water or recycle the car wash water to avoid excess soap/contaminants going into aquatic systems

6. Septic systems:
   - maintain an annual septic tank pumping schedule to avoid leakage into aquatic systems
   - avoid planting trees and shrubs over septic system field lines, these can become blocked with roots and fail to drain septic tank properly causing leakage into aquatic systems
7. Use less water in your daily routine
   - when brushing your teeth, turn the water off until it is time to rinse
   - when washing your hands, turn the water off after soaping up and while rubbing your hands to the tune of "Happy Birthday"
   - think of ways that you use water being mindful of the long term cost to the environment

CURRICULUM GUIDANCE: NUTRIENT REDUCTION TOPICS AND ASSOCIATED EDUCATOR LESSONS

Nutrient Overload

TN K-12 Standards: 1.LS1.3, 3.LS4.1, 4.LS2.5, 4.ESS3.2, 6.ESS2.4, 6.ESS3.3, 6.ETS1.1, 6.LS2.6, BIO1.LS4.3, ECO.LS2.9, ECO.LS2.19, ECO.LS4.7, EVSC.LS2.2, EVSC.LS2.6, EVSC.ESS3.13, EVSC.ESS3.14

1. Too Much of a Good Thing Adapted from Glass Menagerie Project Aquatic WILD (1992) – page 130
   - Explore the differences as nutrients are introduced to several model aquatic habitats
2. When is Enough, Enough? Adapted from How Clean is Clean? Project Learning Tree Activity Guide Grade 7 to 12 (1992) – page 101
   - Explore the trade-offs when stricter pollution standards are imposed

Streambank Erosion

TN K-12 Standards: K.ESS3.3, 2.ESS2.2, 2.ESS2.1, 3. LS4.1, 4.LS2.5, 4.ESS3.2, 6.LS2.4, 6.LS2.6, 7.LS1.6, BIO1.LS4.3, BIO2.LS2.1, BIOL2.LS4.19, ECO.LS2.3, ECO.LS2.10, ECO.LS4.7, EVSC.LS2.2, EVSC.ESS3.5, EVSC.ESS3.6, EVSC.ESS3.13, EVSC.ESS3.14

1. What Flows There? Adapted from Just Passing Through Project WET (2016) – page 167
   - Describe the impact of vegetation on the movement of water
2. Green Ribbons of Life Adapted from Blue Ribbon Niche Project Aquatic WILD (1992) – page 72
   - Explore riparian zones and importance to organisms explored

Storm Water Run-Off,

TN K-12 Standards: K.ESS3.3, 3.LS4.1, 4.ESS3.2, 7. ESS3.2, ECO.ETS2.1, ESS.ESS3.3, EVSC.ESS3.5

1. Who Polluted the Tennessee River? Adapted from Who Polluted the Potomac? Population Connection – Unit 7 (2016) <**https://populationeducation.org/resource/who-polluted-potomac/**>
   - Discover how individual actions have impacted rivers in multiple ways
2. What Flows There? A Pollution Puzzle Adapted from ***Deadly Waters Project Aquatic WILD*** (1992) – page 147
   - Analyze types of pollutants and make recommendations about actions to take

Maintaining Clean Drinking Water

TN K-12 Standards: K.LS1.3, K.ESS3.3, 3.ESS3.2, 6.ETS1.1, BIO2.ETS2.3, ECO.LS4.7, EVSC.ESS3.5, EVSC.ETS2.1

1. *Water Down the Drain* Adapted from ***Sparkling Water Project WET*** (2016) – page 347
   - Strategies to remove contaminants from water are explored
2. *Nature's* Water Treatment Facility Adapted from ***Wetland Metaphors Project Aquatic WILD*** (1992) – page 54
   - Explore natural functions of wetlands through metaphors using everyday objects

The Water Cycle

TN K-12 Standards: 2.ESS1.1, 4.ESS2.1, 6.ESS2.4, 7.LS2.1, BIO1.LS2.2, BIO1.LS2.3, ECO.LS2.7

1. *Water* Wandering in Tennessee and Beyond Adapted from ***Incredible Journey Project WET*** (2016) – page 161
   - Become a water molecule and interactively journey through the water cycle
2. *A Tennessee Water Molecules' Journey* Adapted from ***Imagine Project WET*** (2016) – page 157
   - Take an imaginary journey as a water molecule travels to the Gulf of Mexico

Grade Level Curriculum Standard	Nutrient Reduction TOPICS
K.ESS3.3	Streambank Erosion, Stormwater Runoff, Maintaining Clean Drinking Water
K.LS1.3	Maintaining Clean Drinking Water
1.LS1.3	Nutrient Overload
2.ESS1.1	The Water Cycle
2.ESS2.1	Streambank Erosion
2.ESS2.3	Streambank Erosion
3.LS4.1	Nutrient Overload, Streambank Erosion
3.ESS3.2	Maintaining Clean Drinking Water
4.LS2.5	Nutrient Overload, Streambank Erosion
4.ESS2.1	The Water Cycle
4.ESS3.2	Nutrient Overload, Streambank Erosion, Stormwater Runoff
6.LS2.4	Streambank Erosion
6.LS2.6	Nutrient Overload, Streambank Erosion
6.ESS2.4	The Water Cycle, Nutrient Overload
6.ESS3.3	Nutrient Overload
6.ETS1.1	Nutrient Overload, Maintaining Clean Drinking Water
7.ESS3.2	Stormwater Runoff
7.LS2.1	The Water Cycle
7.LS1.6	Streambank Erosion
BIO1.LS2.2, BIO1.LS2.3	The Water Cycle
BIO1.LS2.3	Nutrient Overload
BIO1.LS4.3	Streambank Erosion
BIO2.LS2.1	Streambank Erosion
BIOL2.LS4.19	Streambank Erosion
BIO2.ETS2.3	Maintaining Clean Drinking Water
ESS.ESS3.3	Stormwater Runoff
ECO.LS2.7	The Water Cycle
ECO.LS2.9	Nutrient Overload
ECO.LS2.10	Streambank Erosion
ECO.LS2.19	Nutrient Overload
ECO.LS4.7	Nutrient Overload, Streambank Erosion, Maintaining Clean Drinking Water
ECO.ETS2.1	Stormwater Runoff, Maintaining Clean Drinking Water
EVSC.LS2.2	Nutrient Overload, Streambank Erosion
EVSC.LS2.6	The Water Cycle
EVSC.ESS3.5	Nutrient Overload, Streambank Erosion, Maintaining Clean Drinking Water
EVSC.ESS3.6	Streambank Erosion
EVSC.ESS3.13, EVSC.ESS3.14	Nutrient Overload, Streambank Erosion
EVSC.ETS2.1	Maintaining Clean Drinking Water

SOCIAL MEDIA GUIDANCE

The Center for Health and Human Services partnered with the Tennessee Department of Environment and Conservation to create an educational toolkit focusing on water quality and environmental health.

A social media calendar has been created for weekly postings of information relevant to the target audience

SOCIAL MEDIA GUIDANCE

The Center for Health and Human Services partnered with the Tennessee Department of Environment and Conservation to create an educational toolkit focusing on water quality and environmental health. This toolkit is comprised of multiple media components such as images, videos, and PSAs. The target audiences for the water quality campaign will include general public/storm water, wastewater treatment facilities, K-12 students, and agriculture. The campaign will address issues with water pollution in Tennessee waterways, how to prevent water pollution, and ways to improve. All educational material will be converted into a digital toolkit which will be available to download from MTSU's website.

A social media calendar has been created for weekly postings of information relevant to the target audience; Five posts will be made per week with a specific audience. Health observances such as Earth Day, World Waters Day, and World Oceans Day are featured in the social media calendar, following programs that allows individuals to organize a local community event related to water pollution. The purpose of the social media postings is to inform all target audiences on how to improve water quality inside and outside of their homes, in schools, and within their community. Also, K-12 students can engage in a few activities that will help them better understand the different process water goes through such as the water cycle. All information provided has been collected from a variety of websites such as the Environmental Protection Agency, Center for Disease Control and Prevention, and TN.gov; Links are provided with the social media posts for those who would like to learn more information about a specific topic of interest.

Best Practices

When posting for a social media campaign it is important to assess each platform's requirements and abilities individually. Each platform has different restrictions, different audiences, and a difference in character limit. There are ways to make the most out of every social media post. Effective messages will have a fairly simple foundation. These fundamental steps are:

- State the issue (e.g., secondhand smoke exposure is dangerous to nonsmokers)
- Include credible supporting facts (e.g., secondhand smoke contains nearly 70 chemicals that cause cancer)
- Evoke a shared value (e.g., everyone has the right to breathe clean air)
- Include a call to action (e.g., protect loved ones from secondhand smoke)

(Best Practices User Guide,2018)

Facebook

Character limit: 63,206

- Best Posting times (vary depending on the target audience): Best times to post to Facebook: Wednesday at 11 a.m. and 1 p.m.
- Best day: Wednesday is the best day to post on Facebook.
- Most consistent engagement: Weekdays from 9 a.m–3 p.m.
- Worst day: Sunday has the least amount of engagement for Facebook during the week.
- Lowest engagement: Early mornings and evenings, before 7 a.m. and after 5 p.m. have the least amount of engagement per day.

Although the statistics vary, the best times for posting on this social media platform is known to be later in the week as a general staple. You can choose either Wednesdays, Thursdays, or Fridays 11am–1pm seem to generate the most traffic. Thursdays are the most popular with the most engagement.

The best times to post on social media. American Marketing Association. Retrieved September 29, 2021, from https://www.ama.org/marketing-news/the-best-times-to-post-on-social-media/.

Instagram

Character Limit: 2,200

Best Posting times (vary depending on the target audience):

- Best times to post on Instagram: Wednesday at 11 a.m. and Friday at 10–11 a.m.
- Best day: Wednesday is the overall best day to post to Instagram
- Most consistent engagement: Tuesday through Friday, 10 a.m–3 p.m.
- Worst day: Sunday receives the least amount of engagement on Instagram
- Lowest engagement: Occurs during late night and early morning from 11 p.m.–3 a.m.

This is a more video-based platform. Interaction and promotion depend on audience, and more importantly video content. Instagram reels are great attention grabbers and can boost account traffic. This is a good platform for infographics, and interactive posts.

The best times to post on social media in 2021. Sprout Social. Retrieved September 29, 2021, from https://sproutsocial.com/insights/best-times-to-post-on-social-media/#FB-times.

Twitter

Character limit: 280

Best Posting times (vary depending on the target audience):

- Best times to post on Twitter: Wednesday at 9 a.m. and Friday at 9 a.m.
- Best days: Tuesday and Wednesday are the best days to post on Twitter.
- Most consistent engagement: Monday through Friday from 8 a.m–4 p.m.
- Worst day: Saturday gets the least engagement.
- Lowest engagement: Occurs every day from 10 p.m–4 a.m.

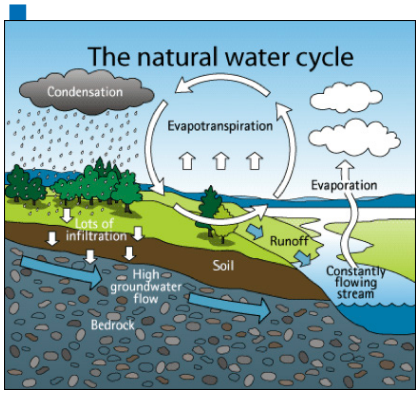
The engagement for this platform is rather consistent throughout all the weekdays. Define your objectives before posting. Know your target audience, and keep your content sort and simple.

The best times to post on social media in 2021. Sprout Social. Retrieved September 29, 2021, from https://sproutsocial.com/insights/best-times-to-post-on-social-media/#FB-times.

SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

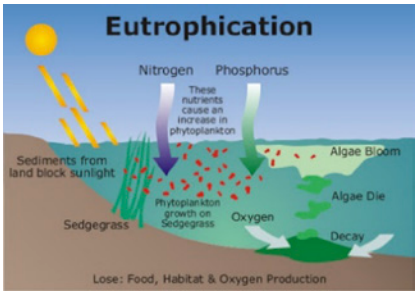
Recommendations for use: The intent of this social media calendar is to give various groups and organizations content to post on social media throughout the week. Each day is geared at a different population and contains an image and hastags to include. Please see document "Guidelines and Best Practices for Social Media Campaign" for more information and helpful tips on how to use on various social media platforms. For easy accessibility and implementation, please see the "Social Media" word document.

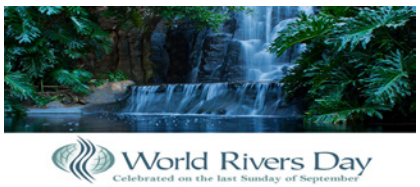
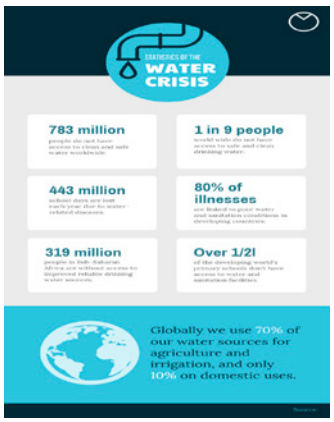
	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	One of the best ways to protect the water quality of a community is to minimize the disruption of the natural water cycle also known as the hydrologic cycle- the continuous movement of water on, above, and below the surface of the Earth. This requires city planners to consider the impact of their land use decisions of the community's water quality and on human health. To find more information, you can visit https://www.cdc.gov/healthyplaces/healthtopics/water.htm	The United States has one of the safest water supplies in the world. Over 90 percent of Americans get their tap water from community water systems, which are subject to safe drinking water standards. Even though U.S. tap water supplies are considered to be among the safest in the world, water contamination can occur among sewage release, naturally occurring chemicals, mineral, and local land use practices. Please visit https://www.cdc.gov/healthywater/drinking/public/water_quality.html
Source	Healthy Places-Water Quality (September, 2021) retrieved from https://www.cdc.gov/healthyplaces/healthtopics/water.htm	The Importance of water quality and testing (September, 2021) retrievevd from https://www.cdc.gov/healthywater/drinking/public/water_quality.html
Suggested Image		
Hashtag	#tnnutrientreduction	#tnnutrientreduction

	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	The first **Earth Day** took place on April 22, 1970. More than 20 million Americans participated in one of the largest grassroots community service movements in our history. Earth Day is now celebrated every year by almost 1 billion people world-wide. For more information about Earth Day, please visit https://www.history.com/this-day-in-history/the-first-earth-day	Runoff can be directly associated with erosion, sediment transport and sedimentary rock formation, flooding, loss of biodiversity, aquifer depletion, and water quality degradation. Water that does percolate into the ground after a precipitation event can carry contaminants from different waste sources like septic tanks, landfills, and road runoff, to areas that may pose a risk to the health of people exposed to it. To learn more information, you can visit https://www.cdc.gov/healthyplaces/healthtopics/water.htm	Water is essential for life and plays a vital role in the proper functioning of the Earth's ecosystem. Water pollution has a serious impact on all living creatures and can negatively affect the use of water for drinking, household needs, recreation, etc. The quality of water we drink and bathe in is important for our bodies to stay healthy, for us to be hydrated, regulate our body temperature, remove toxins from our body and to lubricate our body's digestive tract and other body processes.
	Today in history (September, 2021) retrieved from https://www.loc.gov/item/today-in-history/april-22	Healthy Places-Water Quality (September ,2021) retrieved from https://www.cdc.gov/healthyplaces/healthtopics/water.htm	Retrieved from www.tn.gov
			
	#tnnutrientreduction	#tnnutrientreduction	#tnnutrientreduction

SOCIAL MEDIA GUIDANCE

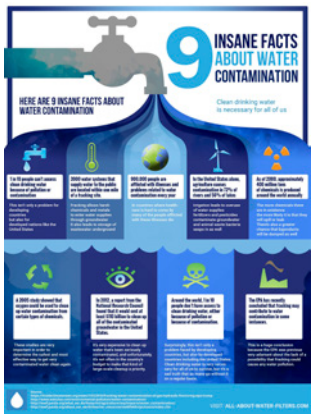
TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***	
Topic	***General Public***	***Waste Water Treatmant***	
Caption	The presence of certain contaminants in our water can lead to health issues, including gastrointes.nal illness, reproductive problems, and neurological disorders. Infants, young children, pregnant women, the elderly, and people with weakened immune systems may be especially at risk for illness.	Excessive nutrients, such as phosphorus and nitrogen (including ammonia) can cause eutrophication, or over-fertalization of receiving waters, which can be toxic to aqua.c organisms, promote excessive plant growth, reduce available oxygen, harm spawning grounds, alter habitat, and lead to a decline in certain species.	
Source	water quality and testing (September, 2021) retrieved from hbps://www.cdc.gov/healthywater/drinking/public	Water & Wastewater Treatment (September, 2021) retrieved from https://celina-tx.gov/1431/Water-Wastewater-Treatment	
Suggested Image			
Hashtag	#tnnutrientreduction	#tnnutrientreduction	

	Wenesday	Thursday	Friday
	K-12 Schools	Agriculture	General Public
	World Rivers Day is a celebration of the world's waterways. It highlights the many values of our rivers, strives to increase public awareness, and encourages the improved stewardship of all rivers around the world.	A clean and plen.ful water supply is essential for productive agriculture to supply the public with adequate food and fiber. Common causes of poor water quality include soil erosion, manure runoff, over-application of nitrogen fer.lizer, pollutants, and Drinking water quality varies from place to place excess phosphorus.	Drinking water quality varies from place to place excess phosphorus. depending on the condition of the source water from which it is drawn and the treatment it receives. Community water systems follow the rules set forth by the Safe Drinking Water Act. Many states enforce their own drinking water standards that are at least as protective as EPA's na.onal standards.
	www.worldriversday.com	www.worldriversday.com	Drinking water: The Imprtance of Water Quaity and Testing (September, 2021) retrieved from https://www.cdc.gov/healthywater/drinking/public/water_quality.html
			
	#tnnutrientreduction	#tnnutrientreduction	#tnnutrientreduction

SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***	
Topic	***General Public***	***Waste Water Treatmant***	
Caption	The U.S. Environmental Protection Agency regulates drinking water quality in public water systems and set maximum concentration levels for water chemicals and pollutants. Sources of drinking water are subject to contamination and require appropriate treatment to remove disease-causing contaminants. Contamination of drinking water supplies can occur in the source water as in the distribution system after water treatment has already occurred.	Public drinking water systems use various methods of water treatment to provide safe drinking water for their communities. Today, the most common steps in water treatment used by community water systems include coagulation, flocculation, sedimentation, filtration, and disinfection. In the U.S. drinking water sources can become contaminated causing sickness and disease from waterborne germs.	
Source	Drinking water: Drinking Water Standards and Regulations (September,2021) retrieved from https://www.cdc.gov/healthywater/drinking/public/regulations.html	Drinking water: water treatment (September,2021) retrieved from https://www.cdc.gov/healthywater/drinking/public/water_treatment.html	
Suggested Image			
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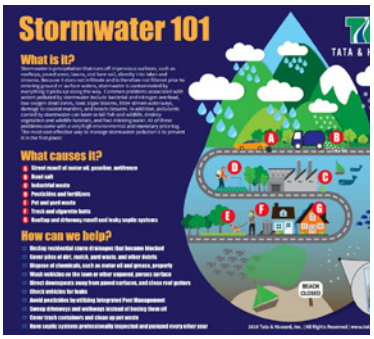
	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Project WET water festivals are held globally to educate students about water in fun, interactive environments and offer alternative learning opportunities including structured learning stations and hands-on water activities and investigations. The festivals also promote multidisciplinary approaches to learning by integrating social studies, geography, math, language arts, art and journaling.	Agricultural contaminants can impair the quality of surface water and groundwater. Fertilizers and pesticides don't remain stationary on the landscapes where they are applied; Runoff and infiltration transport these contaminants into local streams, rivers, and groundwater.	Anything dumped or dropped on the ground or in the gutter can end up in the nearest body of water. Stormwater pollution results from materials and chemicals washed into the storm drains from streets, gutters, neighborhoods, industrial sites, parking lots and construction sites. This type of pollution is significant because, unlike the water that goes down a sink or toilet in your home, stormwater is untreated and flows directly to a lake, river, or the ocean.
	Water festivals Sseptember, 2021) retrieved from www.projectwet.org	Agricultural contaminants (September,2021) retrieved from https://www.usgs.gov/mission-areas/water-resources/science/agricultural-contaminants?qt-science_center_objects=0#qt-science_center_objects	Featured story: Stormwater Runoff (September, 2021) retrieved from https://www3.epa.gov/region9/water/npdes/stormwater-feature.html
			
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SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	Tuesday	
Topic	**General Public**	**Waste Water Treatmant**	
Caption	Water pollution from runoff subsequently pose concerns of eutrophication in the Tennessee River due to the nutrients that are loaded from the runoff. Eutrophication is described as "the loading of waterways with nutrients, leading to explosive algal blooms, and ultimately resulting in starvation of dissolved oxygen.	The major aim of waste water treatment is to remove as much of the suspended solids as possible before the remaining water, called effluent, is discharged back into the environment. As solid material decays, it uses up oxygen, which is needed by the plants and animals living in the water.	
Source	Water Pollution (September 17,2021) retrieved from https://www.pmfias.com/water-pollution-biological-oxygen-demand/#Eutrophication_and_Algal_Bloom	WasteWater Treatment (September 17, 2021) retrieved from https://halifaxwater.ca/wastewater- service#:~:text=Wastewater%20Treatment%20The%20major%20aim%20of%20wastewater%20treatment,the%20plants%20and%20animals%20living%20in%20the%20water.	
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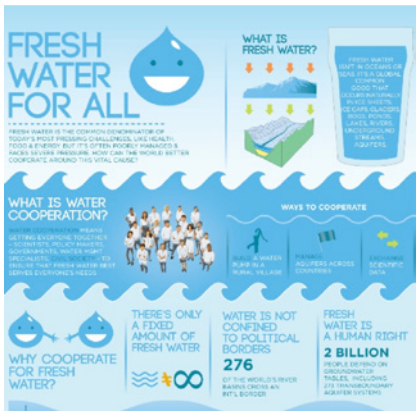
	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Water.org is a global nonprofit organization working to bring water and sanitation to the world. Today, 785 million people lack access to safe water at home. The water crisis negatively impacts the health and livelihood of more than one third of our global population.	Water quality can be affected by poor planning of industrial sites, animal farms, and barnyard and feedlots. Poor water quality can affect the quality of food crops and lead to illness in those who consume them. Management strategies are the most important way to improve agricultural water use and maintain optimal production and yield.	Clean fresh water is vital to our lives and many of the plants and animals we depend on. Types of nonpoint pollution that ultimately end up in our waterways include used oil poured into storm drains, soil washed from construction sites, and grease from restaurants.
	www.water.org	Other Uses of Water: Agricultural (September 17,2021) retrieved from https://www.cdc.gov/healthywater/other/agricultural/index.html	Water Quality (September 17, 2021) retrieved from https://www.watereducation.org/general-information/water-quality
			
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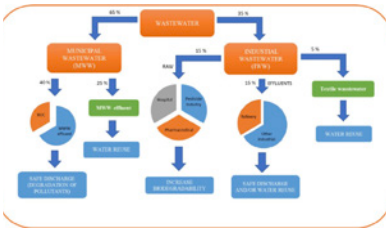
SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Point source pollution can be critical to the health of the waterway as it occurs independently of flow conditions and can therefore impact a waterway when it has the least ability to accommodate the pollution, especially in any condition.	There are three types of wastewater, or sewage: domestic, industrial, and storm. Domestic sewage carries used water from houses and apartments; it is also called sanitary sewage. Industrial sewage is water used from manufacturing or chemical processes. Storm sewage, or storm water is runoff from precipitation that is collected in a system of pipes or open channels.
Source	Your environment: Water (September 17, 2021) retrieved from https://www.epa.nsw.gov.au/your-environment/water	Wastewater Treatment (September 17,2021) retrieved from https://www.britannica.com/technology/wastewater-treatment/Sources-of-water-pollution
Suggested Image		
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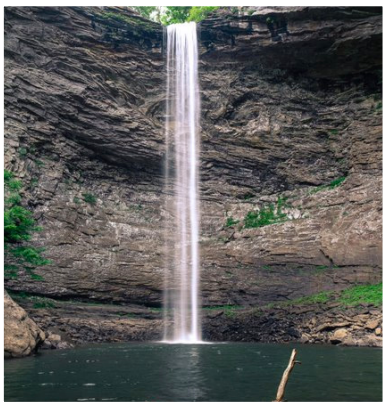
	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	World Wetlands Day is celebrated on February 2 each year to raise global awareness about the vital role of wetlands for people and our planet. The theme for 2021 focused on wetlands as a source of freshwater and encourages actions to restore them and stop their loss.	Agricultural subsurface drainage water presents the single greatest threat to water quality. The need for drainage is often quoted as a mechanism to eliminate the hazards from waterlogging and salinity in irrigate land. A drainage scheme can be implemented for engineering or economic reasons, but in either case the drainage water created by the scheme will contain a high concentration of salts.	Although a person can live without food for more than a month, a person can only live without water for approximately one week. The human body is more than 60 percent water. Dirty water kills more children than war, malaria, HIV/AIDS, and traffic accidents combined. U.S. drinking water contains more than 2100 toxic chemicals that can cause cancer.
	World Wetlands day (September 17, 2021) retrieved from https://sdg.iisd.org/events/world-wetlands-day-2021/	Irrigation Water Quality and Wastewater Re-use (September 17,2021) retrieved from http://www.fao.org/3/T0234E/T0234E08.htm	Water facts (September 27 2021) retrieved from https://savethewater.org/water-facts/
			
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SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Water intoxication occurs when water dilutes the sodium level in the bloodstream and causes an imbalance of water in the brain. More than 45 million Americans drank water supplied by systems where the unregulated and potentially deadly contaminant Cryptospordium was found in their raw or untreated water.	Dissolved oxygen is an important water quality factor for lakes and rivers. The higher the concentration of dissolved oxygen, the better the water quality. When the dissolved oxygen levels drop too low, trout and other aquatic species soon perish. Decomposition of organic compounds without oxygen causes the undesirable odors usually associated with septic or putrid conditions.
Source	Water Facts (September 17 2021) retrieved from https://savethewater.org/water-facts/	WasteWater Treatment (September 17, 2021) retrieved from https://www.britannica.com/technology/wastewater-treatment/Sources-of-water-pollution
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	Wenesday	Thursday	Friday
	K-12 Schools	***Agriculture***	***General Public***
	World Oceans Day is a global event that is observed annually on the 8th of June for the conservation and protection of the oceans of the world. The global Oceans Day is celebrated in different ways such as beach and aquatic cleanups, launching of new initiatives and campaigns, outdoor exploration, etc. To learn more about World Oceans Day.	**World Soil Day** is held annually on December 5 as a means to focus attention on the importance of healthy soil and to advocate for the sustainable management of resources. An international day to celebrate soil was recommended by the International Union of Soil Sciences in 2002.	Nutrient pollution is a major threat to water quality. Excess nitrogen and phosphorus carried in runoff from city streets and farm fields or flowing out of wastewater treatment plants can fuel algae blooms that decrease oxygen needed by aquatic plants and animals. In the Gulf of Mexico, nutrients washed down by the Mississippi River have created a "dead zone" that stretches for thousands of square miles. At home, nutrient pollution can also lower property values, hinder recreation, and degrade drinking water quality.
	World Oceans Day (September 17 2021) retrieved from https://www.worldatlas.com/articles/when-and-why-is-the-world-oceans-day-celebrated.html	World Soil Day (September 17 2021) retrieved from https://www.un.org/en/observances/world-soil-day	Illinois Nutrient Loss Reduction Stratetegy Implementation (September 17 2021) retrieved from https://www2.illinois.gov/epa/topics/water-quality/watershed-management/excess-nutrients/Pages/nutrient-loss-reduction-strategy.aspx
			
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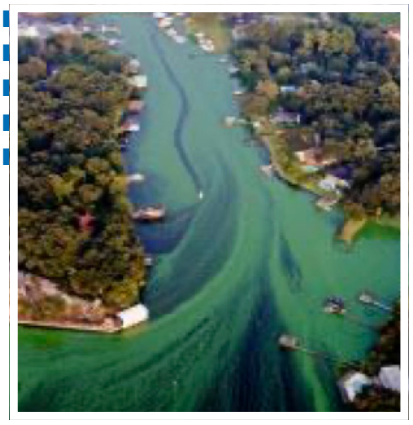
TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Nitrogen and phosphorus are nutrients that are natural parts of aquatic ecosystems. Nitrogen is also the most abundant element in the air we breathe. Nitrogen and phosphorus support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish and smaller organisms that live in water.	The US EPA reports that 53 percent o the miles in rivers and streams, 98 percent of shoreline miles on the Gre Lakes, 71 percent of acres in lakes, ar 79 percent of estuarine square miles not acceptable for at least one type o water use. Public treatment facilities must treat more than 8 million tons o dry-weight sludge per year, consumir one-third of all its electricity use.
Source	Nutrient Pollution:The issue (September 17, 2021) retrieved from https://www.epa.gov/nutrientpollution/issue	Water: Rivers & Streams (September 17,2021) retrieved from https://archiv epa.gov/water/archive/web/html/streams.html
Suggested Image		
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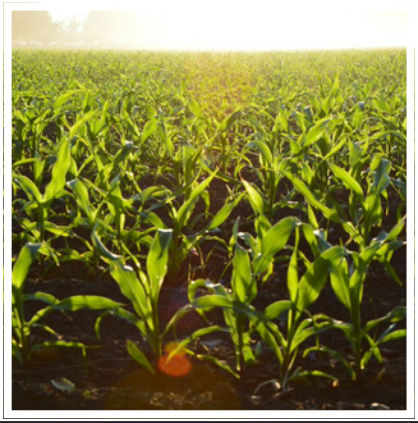
	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Did you know that less than 1% of all the water on Earth can be used by people? The rest is salt water (the kind you find in the ocean) or is permanently frozen and we can't drink it, wash with it, or use it to water plants. As our population grows, more and more people are using up this limited resource. Therefore, it is important that we use our water wisely and not waste it.	Farmers can improve nutrient management practices by applying nutrients (fertilizer and manure) in the right amount, at the right time of year, with the right method and with the right placement. Farmers can plant cover crops or perennial species to prevent periods of bare ground on farm fields when the soil (and the soil and nutrients it contains) are most susceptible to erosion and loss into waterways.	Fossil fuels are also a big cause of water pollution. Not just the burning of those fuels, which causes the formation of acidic particles in the air, creating acid rain, but also oil spills. Since oil does not dissolve in water, it sits on the top of the water. This prevents sunlight from reaching the lower regions of the water, as well as choking the fish and other animals. In addition, increase of water temperature, known as thermal pollution, also greatly affects the ecosystem and the various species that inhabit it.
	WaterSense For Kids (September 17, 2021) retreived from https://www.epa.gov/watersense/watersense-kids	The Sources and Solutions: Agiculture (September 17 2021) retreived from https://www.epa.gov/nutrientpollution/sources-and-solutions-agriculture	Water Pollution Facts (September 17 2021) retrieved from https://www.greenandgrowing.org/water-pollution-facts-causes-effects/
			
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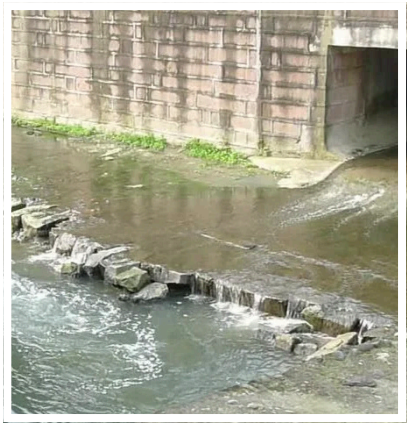
SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Recycling reduces the size of landfills and also reduces how much solid waste ends up in the waters. You can also start buying organic. This helps to lower funding for factory farms and other farms that actively use fertilizers and pesticides. Also, be mindful of how much water you are using. Reducing water is a good way to prevent further freshwater scarcity.	Domestic sewage contains compounds of nitrogen and phosphorus, two elements that are basic nutrients essential for the growth of plants. In lakes, excessive amounts of nitrates and phosphates can cause the rapid growth of algae. Algal blooms, often caused by sewage discharges, accelerate the natural aging of lakes in a process called eutrophication.
Source	Water Pollution Facts (September 17 2021) retrieved from https://www.greenandgrowing.org/water-pollution-facts-causes-effects/	Wastewater Treatment (September 17,2021) retreived from https://www.britannica.com/technology/wastewater-treatment/Sources-of-water-pollution
Suggested Image		
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	We use large amounts of water every day in our homes, for drinking, cooking, cleaning, washing, and gardening; It is estimated that we use approximately 250 liters (66 gallons) of water each day. About 30% of the total water, we use in our homes is for toilets. Modern dual toilets use approximately 4-6 liters per flush (1.6 gallons), older ones used up to 13 liters (3.4 gallons) of water. Water is the only substance that can be found in three states or forms: liquid, gas, and solid.	Industrial chemicals and agricultural pesticides that end up in the water are then consumed by the marine life, thus later eaten by humans. Mercury poisoning is a serious issue when eating fish. Fish are very vulnerable to heavy metals in the water. Mercury has been found to interfere with the development of the nervous system in fetuses and young children	Population growth and the development of urban/urbanized areas are major contributors to the amount of pollutants in the runoff as well as the volume and rate of runoff from impervious surfaces. Together, they can cause changes in hydrology and water quality that result in habitat modification and loss, increased flooding, decreased aquatic biological diversity, and increased sedimentation and erosion.
	What is the Water Cycle for Kids (September 17 2021) retrieved from https://howforkids.com/what-is-water-cycle-for-kids/	Water Pollution Facts (September 17, 2021) retrieved from https://www.greenandgrowing.org/water-pollution-facts-causes-effects/	NPDES Stormwater Program (September 17, 2021) retrieved from https://www.epa.gov/npdes/npdes-stormwater-program
			
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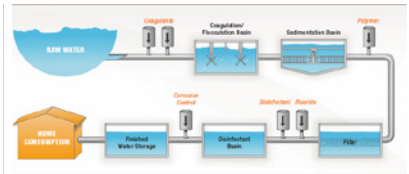
SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Stormwater harms local creeks, rivers and lakes in two major ways. It causes physical damage like flooding, streambank erosion and loss of fish habitat when too much water drains into a creek or river too quickly; and it causes water pollution because stormwater often contains harmful materials picked up when it washed across the land. Everyday compounds can poison stormwater when over used, or used improperly. Common toxic compounds include misapplied pesticides around the home and farm, excess winter salt applications around homes, public roads and commercial properties; and gas, oil and antifreeze leaks from cars and trucks.	In the U.S., chlorination is the most common mean of disinfection. Chlorination may be followed by dechlorination to avoid deteriorating ecological health of the receiving stream and the production of carcinogenic by-products. Ultraviolet (UV) disinfection is an alternative to chlorination and has comparable energy consumption.
Source	What are StormWater Pollutants? (September 17, 2021) retrieved from https://extension.psu.edu/what-are-stormwater-pollutants	U.S. Wastewater Fact Sheet (September 17.2021) retreived from https://css.umich.edu/factsheets/us-wastewater-treatment-factsheet
Suggested Image		
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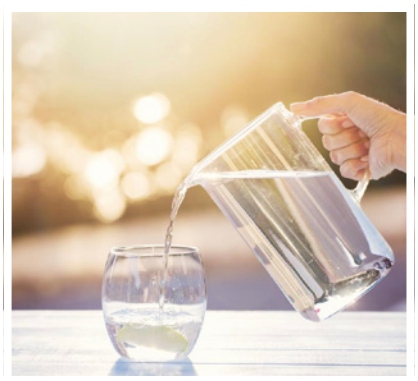
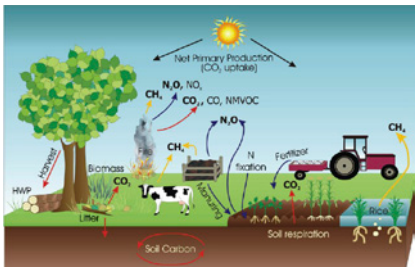
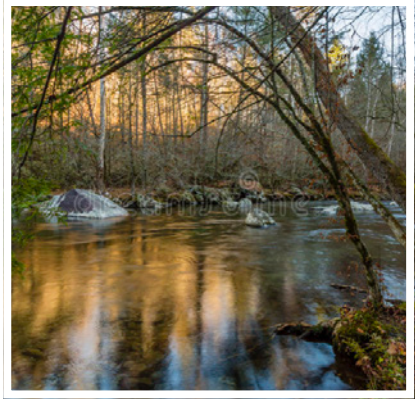
	Wenesday	Thursday	Friday
	K-12 Schools	Agriculture	General Public
	Drinking plain water is a healthy source of hydration. However, many people obtain their water from sugary beverages and unhealthy foods. While these sources can support your water intake needs, they can cause other problems, like obesity and diabetes.	Agriculture is responsible for a significant amount of greenhouse gases on a global scale, especially for the emission of methane. Agricultural pollution can lead to severe human health effects. This could be due to antibiotic resistance or also through the contamination of the groundwater which humans will eventually drink through the use of tap water.	Headwaters, seasonal streams and rain-dependent streams absorb significant amounts of rainwater, runoff and snowmelt before flooding. These streams have significant storage ability and play a critical role in protecting downstream communities by moderating flooding during heavy flow and by maintaining flow during dry weather. Over the last 30 years, freshwater flooding has cost an average of $7.8 billion in direct damage to property and crops each year.
	Water and Healthier Drinks. Retrieved from: https://www.cdc.gov/healthyweight/healthy_eating/water-and-healthier-drinks.html	17 Agricultural Pollution Facts & Stats You Need To Know (September 17,2021) retrieved from https://environmental-conscience.com/agricultural-pollution-stats-and-facts/	Section 404 of the Clean water Act (September 17,2021) retrieved from https://www.epa.gov/cwa-404/streams-under-cwa-section-404
			
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SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	The term Green Infrastructure (GI) currently has multiple interpretations and definitions depending on the context. For the purposes of the Green Infrastructure Integration Plan, Green Infrastructure refers to practices that provide social, economic, and environmental benefits through environmental site design that is intended to mimic the natural hydrologic condition and allow stormwater to infiltrate into the ground and evapotranspirate into the air.	Several water-related diseases, including cholera and schistosomiasis, remain widespread across many developing countries, where only a very small fraction (in some cases less than 5%) of domestic and urban wastewater is treated prior to its release into the environment.
Source	Retrieved from: www.cleanwaternashville.org	Water for All Means Leaving No One Behind. Retrieved from: https://sdg.iisd.org/commentary/guest-articles/water-for-all-means-leaving-no-one-behind/
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Storm Smart Schools is a guide that local governments, schools, and other community stakeholders can follow to identify grounds and integrate green infrastructure into projects and/or a program to achieve regulatory compliance, manage stormwater, and improve environmental literacy. Incorporating green infrastructure practices on school grounds helps improve local regional water quality by capturing, retaining, and/or infiltrating rain where it falls	Agricultural is the leading source of impairments in the nation's rivers and lakes. About a half million tons of pesticides, 12 million tons of nitrogen, and 4 million tons of phosphorus. Fertilizers are applied annually to crops in the continental United States. Pesticides are widespread in surface water and groundwater	There are two main ways of measuring the quality of water. One is to take samples of the water and measure the concentrations of different chemicals that it contains. If the chemicals are dangerous or the concentrations are too great, we can regard the water as polluted. Measurements like this are known as chemical indicators of water quality. Another way to measure water quality involves examining the fish, insects, and other invertebrates that the water will support.
	Storm Smart Schools: A Guide to Integrate Green Stormwater Infrastructure (september 17,2021) retrieved from https://www.epa.gov/sites/default/files/2017-10/documents/storm_smart_schools_print_final_071317.pdf	Agricultural contaminants (September 17,2021) retrieved from https://www.usgs.gov/mission-areas/water-resources/science/agricultural-contaminants?qt-science_center_objects=0#qt-science_center_objects	Water pollution: an introduction (September 17,2021) retrieved from https://www.academia.edu/8744180/Water_pollution_an_introduction
			
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SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Sometimes the causes of water pollution are quite surprising. Chemicals released by smokestacks (chimneys) can enter the atmosphere and then fall back to earth as rain, entering seas, rivers, and lakes and causing water pollution. That's called atmospheric deposition. Water pollution has many different causes and this is one of the reasons why it is such a difficult problem to solve.	Decaying organic matter and debris can use up the dissolved oxygen in a lake so fish and other aquatic biota cannot survive. Chlorine compounds and inorganic chloramines can be toxic to aquatic invertebrates, algae and fish. Metals, such as mercury, lead, cadmium, chromium and arsenic can have acute and chronic toxic effects on species.
Source	Retrieved from: www.explainthatstuff.com	Dissolved Oxygen and Water (September 17,2021) retreived from https://www.usgs.gov/special-topic/water-science-school/science/dissolved-oxygen-and-water
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Walk for Water: inspired by the burden that millions of women and children bear everyday walking an average of 3.5 miles to collect water that is not safe, raise awareness of the global crisis and funds that save lives. Interested in hosting a walk in your community? We have easy-to-use resources to guide you through each step, from creating your leadership team, to setting your walk date and route, to spreading the word about your event.	The **Global Soil Week** is a platform by TMG Think Tank bringing together a diverse range of actors to initiate and strengthen policies and actions on sustainable soil management and resposible land governance. Since its beginning in 2012, the focus and design of the GSW has continuously evolved in order to respond to and shape ongoing policy debates and land management programming. Multiple events and meetings are taken place every year to translate global goals into local realities and priorities, and a conference gathering the international network of partners together is organized every two years.	Each year, EPA holds **Septic SmartWeek** with outreach activities to encourage homeowners and communities to care for and maintain their septic systems. During Septic SmartWeek, EPA seeks to inform homeowners on proper septic system care and maintenance, assist local agencies in promoting homeowner education and awareness, and educate local decision makers about infrastructure options to improve and sustain their communities. Septic SmartWeek is held on September 20-24, 2021.
	Walk for water (September 17,2021) retrieved from https://watermission.org/get-involved/walk-for-water/	Retrieved from: www.globalsoilweek.org	Septic Systems:Septic Smart Week (September 17, 2021) retrieved from https://www.epa.gov/septic/septicsmart-week
			
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SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	Tuesday	
Topic	**General Public**	**Waste Water Treatmant**	
Caption	United for Infrastructure works to highlight the critical role infrastructure plays in all sectors of the economy and show policymakers at all levels of government the breadth and diversity of support for long term, sustainable infrastructure investment. This week of advocacy brings together organizations and individuals from across America- from local businesses, trade associations and chambers of commerce to mayors and individual citizens- to host events, tour new and innovative projects, and talk about infrastructure	Globally, 80% of wastewater flows back into the ecosystem with being treated or reused, contributing to a situation where around 1.8 billion people use a source of drinking water contaminated with feces, putting them at risk of contracting cholera, dysentery, typhoid, and polio	
Source	Retrieved from: www.unitedforinfrastructure.org	Water Quality and WasteWater (September 17,2021) retreived from https://www.unwater.org/water-facts/quality-and-wastewater/	
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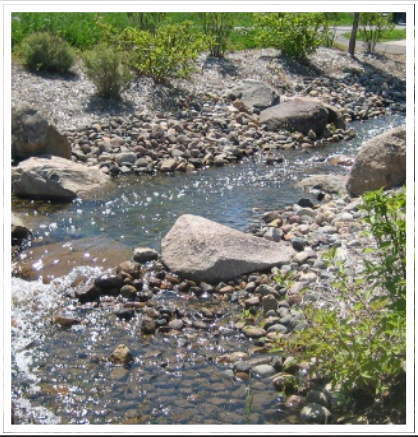
	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Charity: water is a non-profit organization bringing clean and safe drinking water to people in developing countries. This organization works with local partners to fund water, sanitation, and hygiene (WASH) programs for rural communities around the world.	Working with the Natural Resource Conservation Service, farmers apply a system of conservation strategies to keep valuable fertilizer on their land and out of nearby waterways. Filter strips move row crop operations away from streams and function as collection centers for nutrient runoff. Cover crops reduce soil erosion and hold nutrients in place. No-fill practices also reduce soil erosion and improve field-level water infiltration capacity	Stormwater control practices are installed on the landscape to delay, captur, and filter runoff before it reaches streams and rivers. The types of practices installed to manage runoff have shifted from large practices that focus on storing and delaying runoff to a wide variety of smaller, nature-based practices that use soil and vegetation to replicate natural functions, such as infiltration and evapotransportation. Bioretention gardens that soak up and filter runoff are one example of nature-based, green stormwater infrastructure practices.
	Retrieved from: www.charitywater.org	Farmers Keeping Nutrients on the Field, Out of Streams (September 17,2021) retreived from https://www.usda.gov/media/blog/2017/12/13/farmers-keeping-nutrients-field-out-streams	Stormwater Management Practices at EPA Facilities (September 17, 2021) retrieved from https://www.epa.gov/greeningepa/stormwater-management-practices-epa-facilities
	charity: water		
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SOCIAL MEDIA GUIDANCE

TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	During the Spring of 2011, the U.S. Environmental Protection Agency, Region4- Atlanta, and the Tennessee Department of Environment and Conservation assembled a team to conduct an Energy Management Initiative for Tennessee Water and Wastewater Utilities. The EMI process involved an initial energy assessment and benchmark stage, followed by a series of four workshops that were based on the 'Plan-Do-Clean-Act', PDCA is designed to help water/ wastewater utilities better understand their energy consumption, identify opportunities for improvement, prioritize projects for potential funding measure success, reduce or avoid energy costs, and reduce greenhouse gas emissions.	As indicated by U.S. EPA projects, around 1.2 trillion gallons of untreated wastewater is dumped into U.S. water sources each year. Not exclusively is that an issue for people, its an issue for the natural life living in certain territories. Advanced wastewater treatment techniques exist for a large number of reasons. Water can convey harmful illnesses and microscopic organisms, which implies it should be altogether cleaned before its utilized as a part of homes and organizations.
Source	Retrieved from: www.tn.gov	Everything you Need to KnowAabout WasteWater (September 17, 2021) retrieved from https://theberkey.com/pages/everything-you-need-to-know-about-wastewater
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Groundwater Foundation provides motivational and inspirational education and community based action programs that creatively involve individuals, communities, public and private entities in groundwater conservation and protection. The project connects people, businesses, and communities through local groundwater education and action, making all of us part of the solution for clean, sustainable groundwater.	The herbicide used in agricultural chemicals could be dissolved in irrigation and brought to near water body. This can affect the water ecosystem, especially for the plants. Several herbicides could be deadly to small water plants and bacteria that is important as a primary food source for another organism.	80% of the world's wastewater is dumped back into freshwater sources, a majority of our freshwater sources are rendered unsafe to use. This widespread problem is threatening our health as unsafe water is the number one killer of humankind each year, trumping that of all acts of war and violence combined. Furthermore, this results in less than 1 percent of the earth's freshwater actually being accessible to us, with global demands for freshwater only steadily increasing each year.
	Groundwater Foundation: Mission statement (September 17, 2021) retreived from https://www.groundwater.org/who/mission.html	8 Harmful Effects of Agricultural Chemicals on Water Quality (September 17,2021) retreived from https://azchemistry.com/effects-of-agricultural-chemicals-on-water-quality	Water Pollution Facts: What You Need to Know (September 17,2021) retreived from https://www.drinkheartwater.com/water-pollution-facts/
			
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TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	About 1 billion people become sick from drinking unsafe water each year, with low-income communities often taking the biggest hit as they are often closest to the most polluting industries. However, low-income communities aren't the only ones that become exposed to life-threatening water-related diseases or death. Even in wealthy nations, like the U.S., accidental or illegal dumps from sewage treatment facilities or runoffs from farms and urban areas contribute to contaminated water.	Wastewater production is rising and inadequate infrastructure and management systems for the increasing volume of wastewater produced are at the heart of the wastewater crisis. Globally, two million tons of sewage, industrial and agricultural waste is discharged into the world's waterways, and this is in addition to the unregulated or illegal discharge of contaminated water. This wastewater contaminates freshwater and coastal ecosystems, threatening food security, access to safe drinking and bathing water and being a major health and environmental management challenge.
Source	Drinking Water Facts. Retrieved from: https://www.who.int/news-room/fact-sheets/detail/drinking-water	WasteWater Management and sustainable Development (September 17, 2021) retreived from https://www.greenfacts.org/en/wastewater-management/index.htm
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	H20 for Life offers a service-learning opportunity designed to engage, educate, and inspire youth to take action to solve the global water crisis by raising awareness and funds to support implementation of water, sanitation, and hygiene education projects for global partner schools. Since 2007, nearly 1 million students from H20 for Life schools have supported water, sanitation, and hygiene education projects for partner schools in the developing world. This innovative school-to-approach helps young people develop a concern for others by taking a major global crisis and scaling it down to a manageable size – one water project in the developing world	Agriculture accounts for 70% of total water consumption worldwide and is the single- largest contributor of non-point source pollution to surface water and groundwater. Agriculture intensification is often accompanied by increased soil erosion, salinity, and sediment loads in water and by the excessive use (or misuse) or agricultural inputs to increase productivity. Pesticides and fertilizers used in agriculture can contaminate both groundwater and surface water, as can organic livestock wastes, antibiotics, silage effluents, and processing wastes from plantation crops.	80% of the water pollution is caused due to domestic sewage like throwing garbage on open ground and water bodies. According to the survey done by Food & Water Watch cities that approximately 3.5 billion people in 2025 will face water shortage issues. This will be mainly due to water pollution. This is likely to happen because the world pollution is increasing tremendously with more water sources getting contaminated as a result of water pollution.
	H20 for life: mission statement (September 17, 2021) retreived from www.h2oforlifeschools.org	Water pollution From and to Agriculture (Sepetmber 17, 2021) retreived from https://wateractiondecade.org/	Water Pollution and Lack of Drinking Water Access (September 17, 2021) retreived from https://www.asente.ch/environmental-issues/water-pollution/
			
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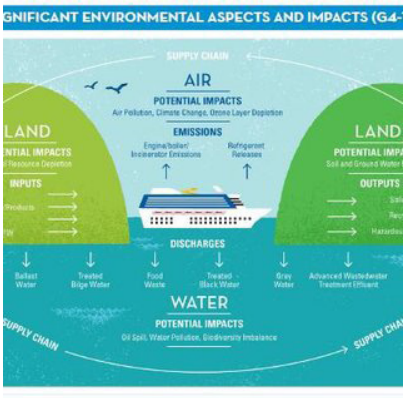
TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Cruise ships are also a major source of water pollution. They produce over 200,000 gallons of sewage, which is mostly released in the ocean. One big step that every human being can take to prevent water pollution is to minimize water contamination and wastage from their side at every level possible.	A critical component that influences the well-being of any community is its system for removing and treating wastewater for the protection of human and environmental health. Wastewater infrastructure includes a network of sewer pipers that collect and carry household, business, and industrial effluents to wastewater treatment systems. Within these treatment systems, wastewater undergoes processes to remove harmful constituents and reduce pollution to the Environmental Protection Agency (EPA) and/or state-regulated levels prior to being discharged into nearby waterbodies or, in some cases, recovered for water, energy, and nutrient reuse.
Source	Retrieved from: https://www.everycrsreport.com/reports/RL32450.html	WasteWater: Overview (September 17,2021) retreived from https://infrastructurereportcard.org/cat-item/wastewater/
Suggested Image		
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	In this hands-on activity, students investigate different methods—aeration and filtering—for removing pollutants from water. Working in teams, they design, build and test their own water filters—essentially conducting their own "dirty water projects." After this activity, students should be able to use sight and smell to identify pollutants in a water sample; explore what types of pollutants are removed from water by aeration and filtration; design, build and test a water filtration system; explain the role of engineers in water treatment systems.	Irrigated agriculture, which accounts for the largest share of the Nation's consumptive water use, makes a significant contribution to the value of U.S. agricultural production. In 2012, irrigated farms accounted for roughly half of the total value of crop sales on 28 percent of U.S. harvested cropland. Irrigated farms also support the livestock and poultry sectors through irrigated production of animal forage and feed crops. Roughly 56 million acres—or 7.6 percent of all U.S. cropland and pastureland—were irrigated in 2012.	Every day, 2 million tons of sewage and untreated waste are released into our water. The equivalent of the weight of the entire human population of 6.8 billion people. Contaminants such as chemicals, nutrients, and heavy metals are responsible for eight per cent of ocean pollution.
	Dirty Water Projects (September 17,2021) retreived from https://www.teachengineering.org/activities/view/cub_environ_lesson06_activity2	Understanding irrigated Agriculture (September 17,2021) retreived from https://www.ers.usda.gov/amber-waves/2017/june/understanding-irrigated-agriculture	Water Pollution facts & Statistics (September 17, 2021) retreived from https://www.trvst.world/environment/water-pollution-facts-statistics/
			
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TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Water quality reports indicate that 45% of U.S. streams, 47 percent of lakes, and 32 percent of bays are polluted. Forty percent of America's rivers are too polluted for fishing, swimming or aquatic life. The lakes are even worse -- over 46% are too polluted for fishing, swimming, or aquatic life. Every year almost 25% of U.S. beaches are closed at least once because of water pollution. Americans use over 2.2 billion pounds of pesticides every year, which eventually washes into our rivers and lakes.	Untreated wastewater is also a major source of methane, a deadly greenhouse gas. Methane gas is 84 times more potent than carbon dioxide and warms the atmosphere faster. This could cause high heat levels, leading to severe droughts and water shortages, especially in tropical areas. Wastewater treatment contributes an estimated 3% to 7% of global GreenHouse Gas (GHG) emissions.
Source	Retrieved from :www.waterbenefitshealth.com	Water Pollution facts & Statistics (September 17, 2021) retreived from https://www.trvst.world/environment/water-pollution-facts-statistics/
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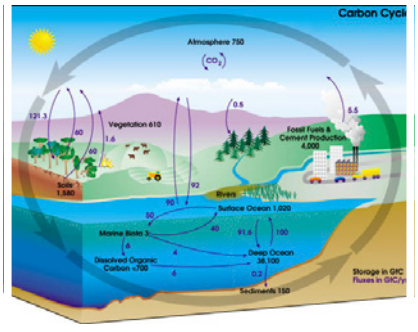
	Wenesday	Thursday	Friday
	K-12 Schools	Agriculture	General Public
	Elements within biogeochemical cycles flow in various forms from the nonliving (abiotic) components of the biosphere to the living (biotic) components and back. In order for the living components of a major ecosystem (e.g., a lake or a forest) to survive, all the chemical elements that make up living cells must be recycled continuously. Each biogeochemical cycle can be considered as having a reservoir (nutrient) pool—a larger, slow-moving, usually abiotic portion—and an exchange (cycling) pool—a smaller but more-active portion concerned with the rapid exchange between the biotic and abiotic aspects of an ecosystem.	The problem of pesticides, fertilizers, animal wastes, and sediments in runoff can be increased by livestock grazing along the stream. Vegetation that grows near streams acts as a buffer. This vegetation absorbs toxins and nutrients and traps sediments before they reach the stream. Livestock remove the vegetation. Without a vegetation buffer, pollutants can move freely from a field into a stream. In addition, livestock increase erosion of banks along streams, and thereby increase the occurrence of siltation.	Routine housekeeping is important. Catchments, inlets, oil-water separators, oil booms, waddles, tarps, and other pollutant collecting materials need to be maintained regularly or they can become ineffective. Clean out drain inlets periodically, especially before the wet season, during the wet season, and after the wet season ends.
	BioGeochemical cycle (September 17,2021) retreived from https://www.britannica.com/science/biogeochemical-cycle	Water Pollution:Agriculture (September 17, 2021) retrieved from http://www.cotf.edu/ete/modules/waterq3/WQpollution3.html	Stormwater Management (September 17,2021) retreived from https://www.slocounty.ca.gov/Departments/Public-Works/Forms-Documents/Water-Resources/Stormwater/Stormwater-Autorecylers-Flyer.pdf
			
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	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	If you live in a city or town that provides water to its citizens, the water utility distributing the water must ensure the water quality. Testing for microorganisms and biological or chemical contaminants is done by the water utility. The testing is done on the raw water before it is treated and distributed to the users. Treatment usually involves flocculation, filtration, chlorination, fluoridation and polishing using carbon for odor and taste.	Everything that you flush down your toilet or rinse down the drain is wastewater. Rainwater and runoff, along with various pollutants, go down street gutters and eventually end up at a wastewater treatment facility. Wastewater can also come from agricultural and industrial sources. Some wastewaters are more difficult to treat than others; for example, industrial wastewater can be difficult to treat, whereas domestic wastewater is relatively easy to treat (though it is increasingly difficult to treat domestic waste, due to increased amounts of pharmaceuticals and personal care products that are found in domestic wastewater.
Source	Retrieved from: www.tn.gov	Wastewater Treatment Plant (September 17, 2021) retreived https://www.ariseowatertech.com/wastewater-treatment-plant.html
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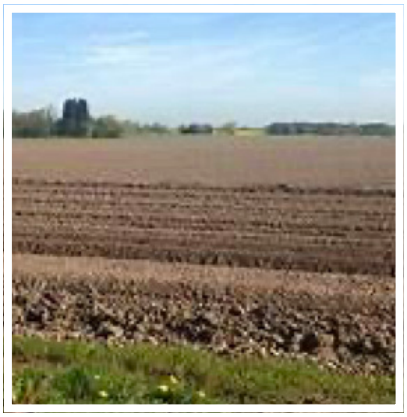
	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	The water cycle is the constant movement and storage of water throughout the Earth. The Earth's water supply never changes. It just travels. The Earth always has 332.5 million cubic miles of water. In addition to oceans, lakes, and rivers, the Earth stores and transports water in many ways. Water moves through condensation, evaporation, and precipitation (rain and snow). It's stored in ice, snow, and the ground.	The most prevalent source of agricultural water pollution is soil that is washed off fields. Rain water carries soil particles (sediment) and dumps them into nearby lakes or streams. Too much sediment can cloud the water, reducing the amount of sunlight that reaches aquatic plants. It can also clog the gills of fish or smother fish larvae.	The best way to prevent large-scale water pollution is to try and reduce its harmful effects. There are various small changes we can make to protect ourselves from a scary future where water is scarce. Conserving water is our first aim. Water wastage is a major problem globally and we are only now waking up to the issue. Simply small changes you can make domestically will make a huge difference. So treating waste products before disposing of it in a water body helps reduce water pollution on a large scale. Agriculture or other industries can reuse this wastewater by reducing its toxic contents.
	The Water Cycle (September 17,2021) retreived from https://kids.nationalgeographic.com/science/article/water-cycle	Protecting Water Quality from Agricultural Runoff (Sptember 17, 2021) Retrieved from: https://nepis.epa.gov/	Water and Water Pollution (September 17,2021) retrieved from https://www.toppr.com/guides/biology/natural-resources/water-and-water-pollution/
			
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TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Toxic rainfall can occur in areas where water and/or air is polluted with toxic chemicals and materials. Polluted water can lead to sickness, disease, infections, deformities, and even death among animals and plant life. Once water becomes polluted, it can affect people and animals either directly through consumption or indirectly through food sources, land degradation, and the overabundance of plants and algae, which can cover the surface of various bodies of water, making it undrinkable and affecting the animals that live in that body of water.	There are two different types of wastewater – when it has come from domestic baths, kitchens, and laundries it is called gray water, and when the wastewater contains animal, human, or food waste it is referred to as black water. There are generally two approaches, and two types of technologies, for disposing of these types of waste: the decentralized system and the centralized system. The decentralized system is where waste is simply deposited in nearby water sources (such as streams or rivers), or dumped into a cesspit. This system is archaic and not healthy for humans or the environment. The centralized system, which involves the use of self-cleansing sewers, is the safer and healthier option.
Source	Retrieved from: www.whalefacts.org	Facts about sanitation and wastewater management (September 17,2021) retreived from https://blog.oup.com/2017/03/sanitation-wastewater-management-facts/
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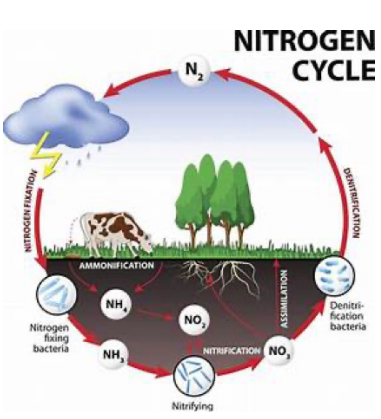
	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	The nitrogen cycle is a repeating cycle of processes during which nitrogen moves through both living and non-living things: the atmosphere, soil, water, plants, animals and bacteria. Microscopic living organisms that usually contain only one cell and are found everywhere. Bacteria can cause decomposition or breaking down, of organic material in soils. In order to move through the different parts of the cycle, nitrogen must change forms. In the atmosphere, nitrogen exists as a gas (N2), but in the soils it exists as nitrogen oxide, NO, and nitrogen dioxide, NO2, and when used as a fertilizer, can be found in other forms, such as ammonia, NH3, which can be processed even further into a different fertilizer, ammonium nitrate, or NH4NO3.	Nitrate from agriculture is now the most common chemical contaminant in the world's groundwater aquifers. Aquatic ecosystems are affected by agricultural pollution; for example, eutrophication caused by the accumulation of nutrients in lakes and coastal waters impacts biodiversity and fisheries. Despite data gaps, 415 coastal areas have been identified experiencing eutrophication. Meanwhile, about one-quarter of produced food is lost along the food-supply chain, accounting for 24 percent of the freshwater resources used in food-crop production, 23 percent of total global cropland area and 23 percent of total global fertilizer use.	The most important water contaminants created by human activities are microbial pathogens, nutrients, oxygen-consuming materials, heavy metals and persistent organic matter, as well as suspended sediments, nutrients, pesticides and oxygen-consuming substances, much of it from non-point sources. Heat, which raises the temperature of the receiving water, can also be a pollutant. Pollutants are typically the cause of major water quality degradation around the world.
	What Is the Nitrogen Cycle and Why Is It Key to Life (September 17,2021) rereived from https://kids.frontiersin.org/articles/10.3389/frym.2019.00041	Agriculture: cause and victim of water pollution, but change is possible (September 17,2021) retreivd from http://www.fao.org/land-water/news-archive/news-detail/en/c/1032702/	Water: Fact15-Water Pollution (September 17,2021) retrieved from: https://www.unesco.org/en
			
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	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	A healthy ecosystem is dependent on the complex web of organisms such as plants, animals, fungi, and bacteria, that interact with each other. This kind of interaction can be direct or indirect, but it creates a chain effect once one group is harmed. Such is the case in aquatic environments. Water pollution can cause the death of the animals found in the water. It can kill various types of animals such as whales, dolphins, fishes, and even birds. If an animal gets killed, all other animals will be affected, and the system will be disrupted.	Septic systems can affect the quality of surface water bodies as well as local drinking water wells. The extent of the septic system pollution depends on how well maintained the septic system is as well as how it is used. If a septic system that is located near a water well is not functioning properly, contaminates from the effluent can find their way into the drinking water and this can result in the breakout of serious diseases. The bacteria, viruses, and protozoa from the wastewater can cause diseases like typhoid, gastrointestinal illness, hepatitis A and cholera. When not properly treated, wastewater has lots of nitrogen from the urine, food waste, feces as well as cleaning compounds.
Source	9 Things that Cause Water Pollution, retrieved from: https://theberkey.com/blogs/water-filter/9-things-that-causes-water-pollution-and-its-possible-solution	How Your Septic System Can Impact Nearby Water sources (September 17,2021) retreived by https://www.epa.gov/septic/how-your-septic-system-can-impact-nearby-water-sources
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Water erosion happens when water moves the pieces of rock or soil downhill. Waves also carry away small pieces of material. A wave can wash up onto the surface of rock or soil and then carry away pieces of material as it flows back into the ocean or lake. The size of earth materials that can be moved by water depends on how fast the water is moving. A fast-flowing stream can carry large rocks while a slow-moving stream might only be able to carry very small things like clay. Canyons are among the most obvious features made by erosion. Where a river meets the sea, it drops the solids, sometimes making a river delta.	Agriculture is both a cause and a victim of pollution. In many developed countries agricultural pollution from use of nitrogen and phosphorous, insecticides, herbicides, fungicides and bactericides has overtaken contamination caused by settlements and industries as the main cause of inland and coastal eutrophication. This results in toxic algal blooms, loss of habitat and biodiversity, and long term reduction or loss of fish catches. The run-off of farm and agro-processing chemicals into surface streams and their seepage into aquifers introduces risks for both human health and the environment. In most developing countries, agriculture's contribution to water pollution is less important, mainly because of the greater significance of pollution from urban and industrial sources.	The lack of proper drainage can cause several concerns, depending on where the water goes. If the water gets into nearby water sources, it can impact water quality and wildlife. If water accumulates in one area of your home — such as the foundation of your home or business — it can cause soil erosion. Stormwater runoff can also overwhelm your septic system and cause damage.
	Erosion Facts, retrieved from: https://kids.kiddle.co/Erosion	Agricultural Contaminants (September 17,2021) retreived from https://www.usgs.gov/mission-areas/water-resources/science/agricultural-contaminants	What is StormWater Runoff (September 17, 2021) retreived by https://www.dirtconnections.com/what-is-stormwater-runoff/
			
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	Monday	Tuesday	
Topic	**General Public**	**Waste Water Treatmant**	
Caption	One of the main concerns of stormwater runoff is pollution. As stormwater runoff occurs, it picks up all of the dirty pollutants that exist on driveways, parking lots and roads, which is a considerable amount of dirt, bacteria, and other contaminants that come from tires, shoes, dirty cars, and much more. Stormwater pollution can cause a variety of other concerns as well. Much of the water runoff from a storm enters into nearby bodies of water. Since the stormwater runoff is dirty and polluted, it compromises the water quality. While water pollution can have an effect on drinking water, it has an even bigger impact on fish and wildlife	There are two types of technologies used to dispose of wastewater – the decentralized and centralized systems. When waste is deposited in nearby water sources like streams or rivers it is the decentralized approach or the unhealthy way of disposing wastewater and harmful for both humans as well as the environment. The safer option is the centralized system which uses self-cleansing sewers which is much healthier. This system places wastewater through several different processes: The first treatment separates the solids and liquids through screening and sedimentation. The second treatment introduces bacteria to consume any organic matter still in the water. The third treatment sees the water being placed through a treatment in which activated carbon removes even more organic matter through adsorption. The final water may contain oxygen to ensure that the environment and water bodies that receive it have the right levels of dissolved oxygen	
Source	Retrieved from: www.dirtconnections.com	Facts about Wastewater Management (September 17, 2021) retrieved from https://tabersolidscontrol.com/facts-about-wastewater-management/	
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	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	August is National Water Quality Month. National Water Quality Month is dedicated to making the most of the relatively small amount of fresh water we have, because having clean water is vital to our individual health, our collective agricultural needs, and the needs of our environment. National Water quality month reminds us to take a moment to consider how important these water sources are not just to humans, but also to the other inhabitants of these ecosystems—whether it be the fish that live in the waters or the plants and animals that rely on these lakes and rivers for water just like we do. There are easily thousands of factors that can have a negative impact on the quality of your local water sources ranging from industrial pollutants like metal particulate, oils, and other chemicals to the pesticides we use in our own backyards.	Soils can be used to filter and absorb the waste constituents of wastewater from septic systems. About half of North Carolina residents depend on septic systems (and hence on soil absorption) for the treatment and disposal of their household wastewater. More than 1 million housing units in the state use on-site septic systems to dispose of their wastewater. At least 30,000 additional septic tank systems are installed each year. Each day, septic systems in North Carolina discharge more than 100 million gallons of sewage into the soil.	In 2010, Tennessee researchers said 32.4% of the river miles they tested were impaired. A decade later, in the state's 2020 report, that number jumps to 55.4%, meaning more than half of the waterways that they sampled were too polluted to support their basic functions. The most common pollutant in impaired rivers is e.coli, a bacteria that is tied to human and animal waste.
	Retrieved from: www.nationalwaterqualitymonth.org	Soils and water facts (September 17, 2021) reteived from https://content.ces.ncsu.edu/soils-and-water-quality	Whats in the water? (September 17, 2021) retrieved from www.newschannel5.com
			
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TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Waterborne pathogens, in the form of disease-causing bacteria and viruses from human and animal waste, are a major cause of illness from contaminated drinking water. Diseases spread by unsafe water include cholera, giardia, and typhoid. Even in wealthy nations, accidental or illegal releases from sewage treatment facilities, as well as runoff from farms and urban areas, contribute harmful pathogens to waterways. You can learn more information by visiting https://www.nrdc.org/stories/water-pollution-everything-you-need-know	The average household's leaks can account for nearly 10,000 gallons of water wasted every year, according to the U.S. Environmental Protection Agency. Ten percent of homes have leaks that waste 90 gallons or more per day, according to the U.S. Environmental Protection Agency. Of the estimated 29 billion gallons of water used daily by households in the US, nearly 9 billion gallons, or 30 percent, is devoted to outdoor water use, according to EPA's WaterSense program. In the hot summer months, or in dry climates, a household's outdoor water use can be as high as 70 percent.
Source	Retrieved from: www.nrdc.org/	Retrieved from: www.pomperaug.org/
Suggested Image		EPA WaterSense
Hashtag	#tnnutrientreduction	#tnnutrientreduction

	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	The Stream Discovery program is an environmental education project that provides students in grades K-12 with the unique hands-on opportunity to learn about water quality in their community by monitoring a local stream. Students, schools, and youth groups can all develop a deeper connection with their natural environment by monitoring and protecting a special stream. Stream monitoring and related service activities such as stream clean up and plantings, inspire a lifelong stewardship of our environment.	The excessive use of fertilizers and pesticides combined with other agrochemicals control invasive pests, weeds, and diseases and produce large crop yields. However, the positive effects of these substances last for a certain time since the soil is likely to suffer in the long-term from the excessive use of these toxic chemical elements. Since they remain in the soil for years, in the long run, crop yields are reduced, and the soil loses the optimal characteristics to produce crops due to agricultural pollution. They have the potential of contaminating waters and plants and kills soil microorganisms as well as beneficial insects.	Many industries are located near rivers or fresh water streams. These are responsible for discharging their untreated effluents into rivers like highly toxic heavy metals such as chromium, arsenic, lead, mercury, etc. along with hazardous organic and inorganic wastes. Factories manufacturing plastic, caustic soda and some fungicides and pesticides release mercury (a heavy metal) along with other effluents in nearby water body.
	Retrieved from: www.ngrrec.org/	Retrieved from: www.conserve-energy-future.com/	Retrieved from: Contamination of Groundwater: https://www.usgs.gov/special-topics/water-science-school/science/contamination-groundwater
			
	#tnnutrientreduction	#tnnutrientreduction	#tnnutrientreduction

SOCIAL MEDIA GUIDANCE

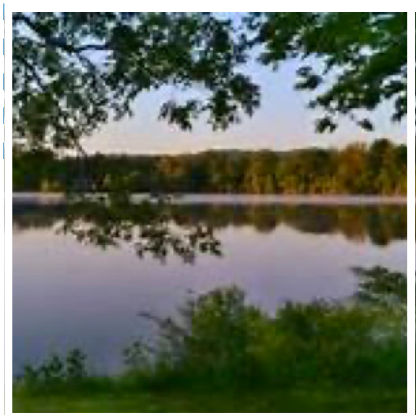
TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***
Topic	***General Public***	***Waste Water Treatmant***
Caption	Groundwater gets polluted in a number of ways. The dumping of raw sewage on soil, seepage pits and septic tanks cause pollution of groundwater. The porous layers of soil hold back solid particles while the liquid is allowed to pass through. The soluble pollutants are able to mix with the groundwater. In addition to these, the excessive use of nitrogenous fertilizers and unchecked release of toxic wastes and even carcionogenic substances by industrial units many result in slow trickling down through the earth's surface and mixing with the groundwater.	The sewage contains garbage, soaps, detergents, waste food and human excreta and is the single largest sources of water pollution. Pathogenic (disease causing) microogranisms (bacteria, fungi, protozoa, algae) enter the water system through sewage making it infected. Typhoid, cholera, gastroenteritis and dysentery are commonly caused by drinking infected water. Water polluted by sewage may carry certain other bacteria and viruses cannot grow by themselves but reproduce in the cells of host organisms. They cause a number of diseases, such as, polio, viral hepatitis and may be cancer which are resistant to like the organic matter are oxygen demanding substances. They are responsible for deoxygenation of water-bodies which is harmful for aquatic life.
Source	Retrieved from: Contamination of Groundwater: https://www.usgs.gov/special-topics/water-science-school/science/contamination-groundwater	Retrieved from: Contamination of Groundwater: https://www.usgs.gov/special-topics/water-science-school/science/contamination-groundwater
Suggested Image		
Hashtag	#tnnutrientreduction	#tnnutrientreduction

	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Where Did the Water Go? Science lesson by the Cumberland River Compact. In this lesson, students will investigate the phenomenon of water evaporation through an investigation. They will collect their own data, make observations, and interpret their results. This activity can help jump-start a more in-depth investigation of the conservation of matter in the water cycle.	Agriculture's stormwater runoff from fields is viewed as significant and pernicious cause of water pollution in the nation's waters. Many opponents of agriculture claim state efforts to improve water quality impacted by agriculture have met with little or no success. EPA and its supporters constantly argue that present day agricultural practices cause serious adverse impacts to surface water and ground water.	Nutrients can lead to a massive overgrowth of algae, known as an algae bloom. Certain types of algae emit toxins. Coming into contact with these toxins can cause stomach aches, rashes and more serious problems for humans. Excess nitrogen is a common drinking water contaminant in agricultural areas and can pose particular risk to infants younger than six months old. Chemicals used to treat nutrient polluted drinking water pose additional risks to human health.
	Retrieved from: www.cumberlandrivercompact.org/	Retrieved from: www.farmprogress.com/	Retrieved from: www.epa.gov/
			
	#tnnutrientreduction	#tnnutrientreduction	#tnnutrientreduction

SOCIAL MEDIA GUIDANCE

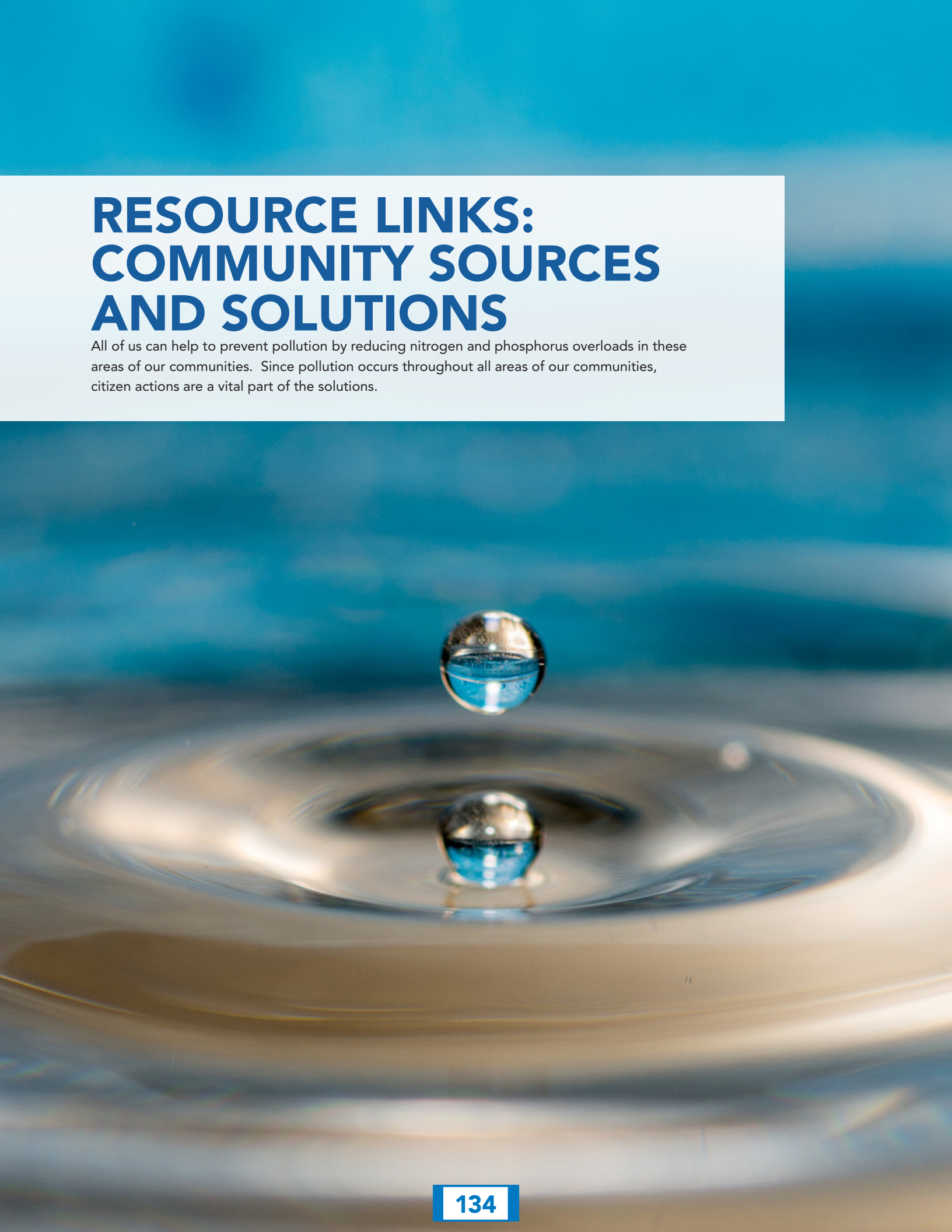
TENNESSEE NUTRIENT REDUCTION TASK FORCE SOCIAL MEDIA CAMPAIGN

	Monday	***Tuesday***	
Topic	***General Public***	***Waste Water Treatmant***	
Caption	Managing runoff helps improve its quality and reduce its volume over time. Unlike sanitary sewer water, runoff flowing into our storm drains doesn't receive any treatment before entering our waterways, thus delivering any pollutants that it picked up along the way. This negatively impacts the environment and atmosphere at our beaches. In addition, water that doesn't seep into the ground runs off to lower areas, which can cause local flooding and stream bank erosion.	Gravelless drainfields have been widely used for over 30 years in many states and have become a conventional technology replacing gravel systems. They take many forms, including open-bottom chambers, fabric-wrapped pipe, and synthetic materials such as expanded polystyrene media. The gravelless systems can be manufactured with recycled materials and offer a significant savings in carbon footprint.	
Source	Retrieved from: www.h2oc.org/	Retrieved from: www.beaglehill.com/	
Suggested Image			
Hashtag	#tnnutrientreduction	#tnnutrientreduction	

	Wenesday	Thursday	Friday
	K-12 Schools	**Agriculture**	**General Public**
	Knox County Stormwater Management is a member of the Water Quality Forum, and administers the Knox County arm of the Water Quality Forum's Adopt-A-Stream program. The Adopt-A-Stream program is a citizen-based monitoring and litter-prevention program intended to protect the health and serenity of our local waterways, and to educate our communities on the environmental concerns that impact them every day on a personal level.The mission of the Adopt-A-Stream Program is to educate and inspire local residents to care for the waterways in their community by engaging them in hands-on environmental action through stream clean-ups.	Coupled with these changes, farmers in many regions will face increasing competition from non-agricultural users due to rising urban population density and water demands from the energy and industry sectors. In addition, water quality is likely to deteriorate in many regions, due to the growth of polluting activities, salination caused by rising sea levels and the abovementioned water supply changes. These water challenges are expected to strongly impact agriculture – a highly water-dependent sector – undermining the productivity of rain-fed and irrigated crops and livestock activities particularly in certain countries and regions. These changes could in turn further impact markets, trade, and broader food security.	Water pollution kills about 10 thousand people every day, this is 3.6 million people a year. The United States faces a serious water problem too. Approximately 40% of all American rivers and 46% of lakes are too polluted for fishing and bathing. Each year, people throw more than 6 billion kilograms of garbage into the world ocean. Plastic takes one of the biggest or even the main part in the garbage, and for marine inhabitants it is toxic. At this rate, by 2025 three will be one ton of plastic for three tons of ocean inhabitants mostly in the surface water, and by 2050 the amount of plastic will exceed the number of fish.
	Retrieved from: https://knoxcounty.org/	Retrieved from: www.oecd.org	Retrieved from: www.findinterestingfacts.com/
			
	#tnnutrientreduction	#tnnutrientreduction	#tnnutrientreduction

RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS

All of us can help to prevent pollution by reducing nitrogen and phosphorus overloads in these areas of our communities. Since pollution occurs throughout all areas of our communities, citizen actions are a vital part of the solutions.



RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS (continued)

Below are categories that EPA lists for community sources of nutrient pollution and solutions (https://www.epa.gov/nutrientpollution/sources-and-solutions). Included are additional solutions for each topic:

- **Agriculture Sources: Animal manure and chemical fertilizers contain nitrogen and phosphorus which are necessary to grow crops. If plants and soil don't fully absorb these nutrients, they can runoff farm fields into nearby streams to harm water quality. Agriculture Solutions Include:**
  - **Farm Management**: There are many tools and publications, research and case studies to search by topic and use as a primary resource from state and federal agencies, visit:
  - **US Dept. of Agriculture (USDA) Extension and County assistance** https://utextension.tennessee.edu/
    - **Tennessee Department of Agriculture (TDA)** https://www.tn.gov/agriculture.html
      - Farm Guide Brochure https://www.mtsu.edu/stormwater/docs/WaterworksFarmerGuidetoCleanerWater07163107BPRINTBlankMailer.pdf
  - **USDA Natural Resources Conservation Service (NRCS**) https://www.nrcs.usda.gov/
    - UT Soil & Nutrient Management Resources https://utcrops.com/soil/
  - **TN Soil Conservation Districts** http://tnacd.org/
  - **USGS Nutrients** https://www.usgs.gov/mission-areas/water-resources/science/nutrients-and-eutrophication

- **Nutrient Management/ Planning: https://utcrops.com/soil/soil-fertility/nutrient-management/**
  - https://www/conservation/nutrient-management
  - https://www.farmers.gov/sites/default/files/2022-09/farmersgov-fact-sheet-smart-nutr-mgnt-9-2022.pdf
  - https://www.nrcs.usda.gov/conservation-basics/conservation-by-state/maryland/comprehensive-nutrient-management-planning
  - https://www.farmers.gov/blog/save-money-and-protect-water-quality-with-smart-nutrient-management
  - https://www.ers.usda.gov/topics/farm-practices-management/crop-livestock-practices/nutrient-management/

- **Models and Tools: https://www.tn.gov/environment/program-areas/wr-water-resources/nutrient-management-in-tennessee/resources/models-and-tools.html**

- **7 Rs recommended for Agriculture/ Nutrient Management:** http://past.infoag.org/abstract_papers/papers/paper_357.pdf#:~:text=If%20we%20are%20to%20increase%20conservation%20effectiveness%20and,the%207%20Rs%20of%20nutrient%20management%20and%20conservation%29

- **Calibration**
  - **Boom Sprayer** https://extension.tennessee.edu/publications/Documents/W315.pdf https://extension.tennessee.edu/publications/Documents/W236.pdf
  - **Video** https://www.youtube.com/watch?v=MPcC_T0GtkM

- **Fertilizer Use: https://soillab.tennessee.edu/soil-testing-and-fertilizer-recommendations/**
  - **Calculators** https://soillab.tennessee.edu/fertilizer-calculator/
    - https://extension.psu.edu/how-to-calculate-a-fertilizer-ratio
    - https://ag.umass.edu/vegetable/fact-sheets/calculating-fertilizer-applications
  - **Cotton** https://extension.tennessee.edu/publications/Documents/W783.pdf
  - **Corn** https://extension.tennessee.edu/publications/Documents/PB1905.pdf
  - **Row Crop** https://soillab.tennessee.edu/wp-content/uploads/sites/129/2021/06/D24-chapter-2-agro117-update-2017.pdf
  - **Pasture/ Hay/ Silage** https://soillab.tennessee.edu/wp-content/uploads/sites/129/2020/07/chap3-pasturehay_mar2009.pdf

RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS (continued)

- **Commercial Vegetable** https://soillab.tennessee.edu/wp-content/uploads/sites/129/2020/07/chap4-commvegrootcrops2007.pdf
- **Commercial Fruit/ Nut** https://soillab.tennessee.edu/wp-content/uploads/sites/129/2020/07/chap5-fruitandnut2008.pdf
- **Savings** https://www.farmers.gov/blog/save-money-and-protect-water-quality-with-smart-nutrient-management

■ **Field Runoff https://www.e-education.psu.edu/geog3/node/1114**

- **Phosphorus** https://extension.tennessee.edu/publications/Documents/pb1640.pdf
- **Nitrogen** https://extension.tennessee.edu/publications/Documents/W302.pdf

■ **Soil Health: https://extension.tennessee.edu/publications/Documents/W998.pdf**

- **Deficiencies** https://extension.tennessee.edu/publications/Documents/W976.pdf
- **Soil Test** https://soillab.tennessee.edu/
- **Test Results** https://extension.tennessee.edu/publications/documents/W229.pdft
- **Field** https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=44756.wba
- **Biochar** https://www.nrcs.usda.gov/conservation-basics/conservation-by-state/oregon/news/innovations-in-biochar
- **Cover Crops** https://utcrops.com/soil/nutrient-management/cover-crops/
- **Variety** https://extension.tennessee.edu/publications/Documents/W1022.pdf
- **Video** https://www.youtube.com/watch?v=3j5MRJeCoYs
- **Crop Rotation**: https://www.ers.usda.gov/topics/farm-practices-management/crop-livestock-practices/soil-tillage-and-crop-rotation/?mod=article_inline
- **No-Till**:
  - ♦ **The Milan No-Till Field Day is an annual educational event with demonstrations and training** https://milannotill.tennessee.edu/
  - ♦ **Grants** https://cumberlandrivercompact.org/portfolio/soil-health-for-tobacco-farms-in-the-red-river-watershed/

■ **Manure:**

- **CAFO** https://www.nrcs.usda.gov/confined-livestock-and-manure-nutrients
- **Poultry** https://extension.tennessee.edu/publications/Documents/W081.pdf
- **Dairy** https://extension.tennessee.edu/publications/Documents/W080.pdf
- **Swine** https://extension.tennessee.edu/publications/Documents/W082.pdf
- **Land Application**
  - ♦ https://extension.tennessee.edu/publications/Documents/W852.pdf
  - ♦ https://extension.tennessee.edu/publications/Documents/W796.pdf
  - ♦ https://extension.tennessee.edu/publications/Documents/W085.pdf
  - ♦ https://extension.tennessee.edu/publications/Documents/Info%20319.pdf

RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS (continued)

- **Streams/ Ditches/ Channels/**
  - **Riparian Buffers**
    - https://www.fs.usda.gov/nac/practices/riparian-forest-buffers.php
    - https://www.fs.usda.gov/nac/buffers/index.html
    - https://www.tn.gov/environment/program-areas/wr-water-resources/nutrient-management-in-tennessee/resources/riparian-buffers.html
    - https://resoilfoundation.org/en/environment/riparian-buffer-strips-water/
  - **Guide to Streambank Stabilization**
    - https://www.tn.gov/content/dam/tn/environment/water/natural-resources-unit/wr_nru_tdec-landowners-guide-streambank-stabilization.pdf
    - **Live staking** https://extension.tennessee.edu/publications/Documents/SP781-B.pdf
    - **Cattle** https://extension.tennessee.edu/publications/Documents/SP722.pdf
    - **Aquatic Life** https://www.nifa.usda.gov/farm-ditch-home-sweet-home-tiny-aquatic-species

- **Incentive Programs**
  - **River Friendly Farms** https://www.riverfriendlyfarm.org/get-certified https://cumberlandrivercompact.org/what-we-do/river-friendly-farms/
  - **Conservation** https://www.nrcs.usda.gov/programs-initiatives/acep-agricultural-conservation-easement-program
  - **Environmental Quality** https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives

- **Livestock Watering https://extension.tennessee.edu/publications/Documents/pb1640.pdf**
  - **Alternatives** https://extension.tennessee.edu/publications/Documents/PB1641.pdf

STORMWATER SOURCES: Rain flowing through our cities and towns flows across grass and hard surfaces - like roads, parking lots, rooftops, and sidewalks – carrying pollutants, from landscaping debris and chemicals, pet waste, and wash water. These contain nitrogen and phosphorus as well and flow into storm drains which empty into local streams and rivers without being cleaned and treated. Solutions include:

- **Community: https://www.epa.gov/nutrientpollution/what-you-can-do-your-community**
  - **Issue** https://www3.epa.gov/npdes/pubs/centralized_brochure.pdf https://www.epa.gov/nutrientpollution/issue
  - **Storm-SMART** https://extension.tennessee.edu/publications/Documents/W301.pdf

- **Management**
  - **Models and Tools** https://www.tn.gov/environment/program-areas/wr-water-resources/nutrient-management-in-tennessee/resources/models-and-tools.html
  - **National Study of Nutrient Removal - Fact Sheets** https://www.epa.gov/eg/national-study-nutrient-removal-fact-sheets
  - **MS4s** https://www.epa.gov/tx/municipal-separate-storm-sewer-system-ms4-storm-water-management-program-swmp
  - **EPA Community Outreach Toolkit** https://mostcenter.umd.edu/sites/default/files/2020-04/EPA_Community_Outreach_Toolkit.pdf
  - **USGS Nutrients** https://www.usgs.gov/mission-areas/water-resources/science/nutrients-and-eutrophication

RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS (continued)

- **Stormwater BMPs/ Practices** https://www.mtas.tennessee.edu/stormwater-bmp-toolkit
  - https://www.tn.gov/environment/program-areas/wr-water-resources/nutrient-management-in-tennessee/resources/best-management-practices.html
  - **Erosion** https://tnepsc.org/handbook.asp
  - **Riparian** https://www.fs.usda.gov/sites/default/files/fs_media/fs_document/Urban-Forest-Systems-GSI-FS-1146.pdf
- **Decentralized wastewater/ Septic**
  - **Handbook** https://www.epa.gov/sites/default/files/2015-06/documents/2005_12_20_septics_onsite_handbook_fs.pdf
  - **Guidebook** https://www.epa.gov/sites/default/files/2015-06/documents/2004_07_07_septics_septic_its_your_choice_0.pdf
  - Septic Smart Program https://www.epa.gov/septic/septicsmart
  - **Clean out** https://www.tn.gov/environment/permit-permits/water-permits1/septic-systems-permits/ssp/wr-sds-active-installers-pumpers.html
  - **Septic media campaign** https://www.acwa-us.org/documents/2021-septicsmart-week-social-media-guide/

Guides to Cleaner Water for Target Audiences

- **Homeowners** https://www.mtsu.edu/stormwater/docs/WWKS_TNSA_Homeowner_Guide.pdf
- **Construction** https://www.epa.gov/sites/default/files/documents/DryCreekRancheraCaseStudy.pdf
  - https://www.mtsu.edu/stormwater/docs/WaterworksConstructionGuidetoCleanerWater07163107CPRINTBlankMailer.pdf
  - https://www.epa.gov/greeningepa/stormwater-management-practices-epa-facilities
  - https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater-post-construction
- **Farmers**: https://www.mtsu.edu/stormwater/docs/WaterworksFarmerGuidetoCleanerWater07163107BPRINTBlankMailer.pdf
- **Golf courses** https://www.gcsaa.org/environment/bmp-planning-guide
  - https://www.gcsaa.org/media/news-release/2020-news-releases/2020/04/07/tennessee-latest-state-to-publish-bmp-guidelines-for-golf-courses
- **Fertilizer Use/ Spreader Calibration**: https://www.youtube.com/watch?v=Cmbqp-qy5XM
  - https://extension.psu.edu/calibrating-your-fertilizer-spreader
  - https://www.bing.com/videos/search?q=mitchell+mote+calibration+fertilizer+youtube&docid=608049648882487717&mid=7562F37A77528E36BC5F7562F37A77528E36BC5F&view=detail&FORM=VIRE

Landscaping https://www.epa.gov/nutrientpollution/what-you-can-do-your-yard

- **Leaf Removal**
  - **Quantify** https://www.usgs.gov/publications/evaluation-leaf-removal-a-means-reduce-nutrient-concentrations-and-loads-urban
  - **Schools** https://www.epa.gov/nutrientpollution/what-you-can-do-your-classroom
  - **School Streams** https://extension.tennessee.edu/publications/Documents/W1119.pdf
- **Activities - See Educator Section in Appendix for learning activities**
  - https://www.epa.gov/sites/default/files/2016-03/documents/activity_grades_4-8_nonpoint_pollution.pdf

RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS (continued)

Stream Protections/ Riparian Buffers

- https://resoilfoundation.org/en/environment/riparian-buffer-strips-water/
- https://www.tn.gov/environment/program-areas/wr-water-resources/nutrient-management-in-tennessee/resources/riparian-buffers.html
- https://www.tn.gov/agriculture/forests/urban/buffer.html
- https://www.tn.gov/environment/program-areas/wr-water-resources/znutrient-management-in-tennessee/resources/streambank-erosion-and-restoration.html

- **Riparian Handbook** https://www.tn.gov/content/dam/tn/agriculture/documents/forestry/2018/UrbanRiparianBufferHandbook.pdf
- **TWRA Riparian Grant** https://www.tn.gov/content/dam/tn/twra/documents/habitat/Tennessee-Riparian-Tree-Application.pdf
- **Guide to Streambank Stabilization** https://www.tn.gov/content/dam/tn/environment/water/natural-resources-unit/wr_nru_tdec-landowners-guide-streambank-stabilization.pdf

Wastewater Sources: Sewer and septic systems are vital for community health by treating large quantities of human waste and unprocessed nutrients frow sewage, food scraps from garbage disposals and wash water. Often these systems may not be maintained properly or have an overload causing them to not always operate properly or remove enough nitrogen and phosphorus before discharging into waterways. Solutions are:

Municipal Wastewater

- **EPA** https://www.epa.gov/npdes/municipal-wastewater
- **TDEC** -
  - **Resources** https://www.tn.gov/environment/program-areas/wr-water-resources/srfp/srf-home/resources-and-technical-assistance.html
  - **TN Plant Optimization Program** https://www.tn.gov/content/tn/environment/program-areas/wr-water-resources/tn-plant-optimization-programs/tnpop.html
  - **Area Wide Optimization Program** https://www.tn.gov/content/tn/environment/program-areas/wr-water-resources/tn-plant-optimization-programs/tn-area-wide-optimization-program--awop-.html
  - **State Revolving Fund Program** https://www.tn.gov/environment/program-areas/wr-water-resources/srfp.html
  - **TN Infrastructure Scorecard** https://www.tn.gov/environment/program-areas/wr-water-resources/srfp/srf-home/resources-and-technical-assistance/tn-infrastructure-scorecard.html
  - **Fats, Oils Grease (FOG) Guidance** https://www.tn.gov/content/dam/tn/environment/water/documents/GuidanceDoc.pdf
- **Management**
  - https://www.epa.gov/water-research/sanitary-sewer-overflow-analysis-and-planning-ssoap-toolbox
  - https://www.epa.gov/sites/default/files/2015-06/documents/wwrptb_intro-a.pdf
  - **Decentralized wastewater** https://www.epa.gov/septic/septic-systems-guidance
  - **Handbook** https://www.epa.gov/sites/default/files/2015-06/documents/2005_12_20_septics_onsite_handbook_fs.pdf
  - **Guidebook** https://www.epa.gov/sites/default/files/2015-06/documents/2004_07_07_septics_septic_its_your_choice_0.pdf
  - **Sewer/ Septic** https://www.epa.gov/septic
    - Clean out https://www.tn.gov/environment/permit-permits/water-permits1/septic-systems-permits/ssp/wr-sds-active-installers-pumpers.html
    - Education https://www.epa.gov/septic/septicsmart-education-materials
      Septic media campaign https://www.acwa-us.org/documents/2021-septicsmart-week-social-media-guide/
    - Septic Smart Program https://www.epa.gov/septic/septicsmart
    - Toilet https://thinkbeforeyouflush.org/

RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS (continued)

- **Industrial Wastewater https://www.epa.gov/npdes/industrial-wastewater**

Algae Sources - Algae is a common nonflowering, typically aquatic plant in many waterways. Under the right conditions and when excessive nutrients are present it can proliferate and become harmful.

- **Field Guide https://dec.vermont.gov/sites/dec/files/wsm/lakes/Ponds/lp_kentucky-algae-guide.pdf**

- **Harmful Algal Blooms**
  - **EPA** https://www.epa.gov/nutrientpollution/harmful-algal-blooms
  - **TDEC** https://www.tn.gov/environment/program-areas/wr-water-resources/nutrient-management-in-tennessee/resources/habs.html
  - **Re**sponse https://www.epa.gov/ground-water-and-drinking-water/drinking-water-cyanotoxin-risk-communication-toolbox
  - Fossil Fuels Sources: The amount of nitrogen in the atmosphere is also increased through generating electric power, industrial and agriculture processes, and vehicle transportation through use of fossil fuels.

Home Sources: lawn and garden chemicals and fertilizers, grass clippings and leaves from yard debris, pet waste and certain soaps and detergents contain nitrogen and phosphorus which can contribute to nutrient pollution if used or disposed of properly. Hard surfaces and certain types of landscaping can also increase the runoff of nitrogen and phosphorus during wet weather or irrigation. Solutions for activities around the home include:

- **Homeowners https://www.epa.gov/nutrientpollution/what-you-can-do-your-home**
  - https://www.mtsu.edu/stormwater/docs/WWKS_TNSA_Homeowner_Guide.pdf

- **Plumbing/ Drains**
  - **Fats, Oils, Grease** https://conserve.restaurant.org/Downloads/PDFs/FOG/FOG-ToolkitFinal3.aspx
  - **Pharmaceuticals** https://www.tn.gov/environment/program-areas/opsp-policy-and-sustainable-practices/community-programs-and-services/unwanted-household-pharmaceuticals-takeback-program.html
    - **Compost at home** https://www.tn.gov/content/dam/tn/environment/sustainable-practices/community-team/environmental-education/opsp_eei-composting-at-home-brochure.pdf
      - **Toilet** https://thinkbeforeyouflush.org/
      - **Septic** https://www.epa.gov/septic
      - **Septic Smart Program** https://www.epa.gov/septic/septicsmart
      - **Care** https://www.epa.gov/septic/how-care-your-septic-system
      - **Clean out** https://www.tn.gov/environment/permit-permits/water-permits1/septic-systems-permits/ssp/wr-sds-active-installers-pumpers.html
      - **Education materials** https://www.epa.gov/septic/septicsmart-education-materials

- **Soil Testing https://soillab.tennessee.edu/soil-fertility/**
  - **How to soil test**
    - https://soillab.tennessee.edu/wp-content/uploads/sites/129/2020/06/Soil-Testing-Guide-for-Lawns-and-Gardens-Flyer.pdf
    - https://extension.tennessee.edu/publications/Documents/PB1061.pdf
    - https://soillab.tennessee.edu/lawn-and-garden-soil-samples/
  - **Soil Test Video** https://www.youtube.com/watch?v=hEEtqYJmYEY

- **Fertilizer Use https://soillab.tennessee.edu/soil-testing-and-fertilizer-recommendations/**
  https://soillab.tennessee.edu/wp-content/uploads/sites/129/2020/07/SP645.pdf
  - Calculators https://soillab.tennessee.edu/fertilizer-calculator/

RESOURCE LINKS: COMMUNITY SOURCES AND SOLUTIONS (continued)

- **Equipment Calibration:**
  - https://www.youtube.com/watch?v=Cmbqp-qy5XM
  - https://extension.psu.edu/calibrating-your-fertilizer-spreader
  - https://www.bing.com/videos/search?q=mitchell+mote+calibration+fertilizer+youtube&docid=608049648882487717&mid=7562F37A77528E36BC5F7562F37A77528E36BC5F&view=detail&FORM=VIRE
  - **Calibrate Video** https://www.youtube.com/watch?v=7VMjh1Yia1U**Home Gardens:**
  - https://extension.tennessee.edu/publications/Documents/W346-D.pdf
  - https://rutherford.tennessee.edu/master-gardener-program/
  - https://soillab.tennessee.edu/wp-content/uploads/sites/129/2020/07/chap7-homelawngarden2008.pdf

- **Landscaping**
  - **Soil** https://www.youtube.com/watch?v=EUIxrYNWkFI
  - **Lawns** https://extension.tennessee.edu/publications/Documents/PB1038.pdf
  - **Less to Do Lawncare video** https://www.youtube.com/watch?v=9x3YTpuhj-Y
  - **Don't Over Do** https://www.youtube.com/watch?v=D3JSR4arVRY
  - **Irrigation** https://extension.tennessee.edu/publications/Documents/W871.pdf
  - **Rain Gardens** https://tnyards.utk.edu/
  - **Native Plants** https://www.tn.gov/content/dam/tn/twra/documents/habitat/landscaping-tennessee-native-plants.pdf
  - **Pesticide Use** https://www.youtube.com/watch?v=_Psl9nThYLI

- **Yards https://www.epa.gov/nutrientpollution/what-you-can-do-your-yard**
  - **Handbook:** https://extension.tennessee.edu/publications/Documents/W219.pdf
  - **Smart Yards** https://tnyards.utk.edu/
  - **Planning** https://extension.tennessee.edu/publications/Documents/W869.pdf
  - **Stream banks** https://resoilfoundation.org/en/environment/riparian-buffer-strips-water/

Tennessee Nutrient Reduction Task Force

Improving Stream Water Quality

More Information at
www.tnnutrientreducation.org

MIDDLE TENNESSEE STATE UNIVERSITY

CENTER FOR HEALTH AND HUMAN SERVICES

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