Recognizing that the waters of Tennessee are . . . held in public trust for the use of the people of the state, it is declared to be the public policy of Tennessee that the people of Tennessee . . . have a right to unpolluted waters.

– The Tennessee Water Quality Control Act, 1999

All citizens of the state can play a role in keeping the waters of Tennessee healthy for our economy, communities, and quality of life. This handbook is designed to help citizens understand the basics of watershed and stream health, how to assess both, and how to take action to restore, conserve and protect the state's water resources for our families, communities, and future generations. The handbook is divided into four parts the latter three with accompanying Appendices:

- **Part I** provides an introduction to water quality in Tennessee, stream use classification and identifies the leading causes of water pollution.
- **Part II** explains the basics of watershed science and the impacts of land use on water quality, as well as how maps can be used to identify watershed problems and help figure out possible solutions (Appendix 1). In addition Part II explains how to assess stream health using visual stream assessments (VSA), water sampling, and aquatic insect sampling (Appendix 2).
- **Part III** explains how to restore streams (Appendix 3). Direct restoration actions include litter cleanup, debris dam removal, and streamside reforestation and stream bank stabilization, including bank reshaping, bioengineering, and rock barbs and vanes. Off-stream or indirect restoration actions include water capture and detention systems, water infiltration systems, the proper use or disposal of lawn chemicals, elimination of pollution hot spots and how to handle household automotive fluids, chemicals and pet waste.
- **Part IV** explains the basic structure of the federal Clean Water Act (CWA) and identifies opportunities for citizen action under both federal (Appendix 7) and state laws (Appendix 5).

The Action Guide Appendices include much more detail on "how to" and a glossary (Appendix 8) that briefly explains watershed and water quality terms. While reading Parts I through IV, you may want to refer to the glossary for definitions of unfamiliar terms. Parts I through IV contain references to particular appendices that contain additional information. The appendices provide more in-depth guidance, resources, and information and should be consulted often.

Part I: An Introduction to Water Quality and Watershed Science: What You Need to Know About Water Quality in Tennessee

Part I explains how streams are classified based on their use (e.g. drinking water, fish and aquatic life, recreation), and that many streams in the state are too polluted to support those uses. Part I also identify some of the leading causes of water pollution in Tennessee and explain how land use impacts streams. Finally, this section provides a brief overview of watershed science, and explains how maps can be used to identify and solve problems in watersheds. Part I provides the basic information you need to know about watersheds and water quality before you can assess the health of streams in your watershed and begin to restore the polluted streams where you live.

Tennessee is a water-rich state, with over 60,000 miles of rivers and streams and about 572,063 acres of lakes and reservoirs. These water bodies are great resources for the state; for example, they provide drinking water, as well as recreational and economic opportunities. Unfortunately, however, many of these streams and lakes are polluted and need to be restored to better health to meet their designated uses, such as providing drinking water for people or habitat for animals. The Tennessee Department of Environment and Conservation (TDEC) is responsible for regulating water quality, but all Tennesseans can lend a hand in reducing pollution and cleaning up the state's waters.

A. What You Need to Know About Stream Designated Uses

Table 1:
Tennessee's Current Stream Use Classifications

1. Fish and aquatic life
2. Recreation
3. Irrigation
4. Livestock watering and wildlife
5. Drinking water supply
6. Navigation
7. Industrial water supply

Water has many uses. For some uses, like drinking, recreation (e.g., swimming) and fish and aquatic life, the water must be very clean. For other uses, like watering crops or cooling power plants, quality may be less important. The Tennessee Water Quality, Oil and Gas Board reviews and classifies water bodies in the state, depending on how the water will be used. All streams, rivers, lakes, and reservoirs in Tennessee are classified for at least two public uses: (1) protection of fish and aquatic life, and (2) recreation. The uses for which a water body is classified are known as its "designated uses." Table 1 lists the seven types of designated uses for Tennessee water bodies.

TDEC assesses rivers and streams to determine if they are clean enough to support their designated uses. However, TDEC has only assessed about 49% of the rivers and streams in the state. Tennessee citizens are needed to help assess the remaining 51% of streams. As TDEC and citizens assess more streams, we may find more streams too polluted to support their designated uses and need to be cleaned up.

Of the streams that have been assessed, only 58% are able to fully support their designated uses; the other 42% cannot because they are too polluted. Tennessee citizens deserve better and can improve this situation by helping clean up the remaining 42% of streams that do not fully support their designated uses.

Assessed Streams and Rivers in Tennessee:

- 58% fully support their designated uses
- 42% are polluted and do not support their designated uses

As discussed above, many of Tennessee's waters are polluted. To clean them up, we need to know how the waters became polluted. Only then can we prevent, or at least control, the pollution. This section identifies several leading causes of water pollution in Tennessee. It is important to keep in mind that specific causes of pollution vary based on location and the way in which the land is used. For example, a rural, agricultural area may have different pollution problems than an urban area. Even if you are familiar with the most common causes of water pollution in the state, you still need to learn about the leading causes of pollution in your watershed. A watershed is defined as an area that drains to a common point such as a river, stream or lake.

Water pollution occurs when pollutants are released directly or indirectly into the water. A direct release is sometimes called a point source because it can often be traced to a single point (i.e., pipe). This was once a common way for factories to get rid of liquid wastes. The factory would simply run a pipe to the nearest stream and discharge its wastes through the pipe. Most direct pollution discharges are now illegal unless they have been permitted (see Appendix 5). Today, point sources must meet standards that limit the amount of pollution that can be discharged into a receiving stream.

Nonpoint source pollution, on the other hand, cannot be traced to a single source and is harder to control. Most nonpoint source pollution comes from rainfall that runs over the ground and picks up pollutants that are ultimately deposited into streams and other water bodies. Heavy storms can produce large volumes of water that can cause streams to collapse, which adds sediment or dirt to the water. Urban areas generate more stormwater than forested areas, but both urban and agricultural runoff is major sources of nonpoint source pollution. As a result, stormwater is a major focus of watershed restoration efforts.

Some stormwater pollution is regulated under the federal CWA as a point source of pollution (see Part IV and Appendix 7) and is better controlled today than in the past, although it remains a problem. Agricultural runoff from crops is exempt from the CWA unless you can identify a point source, however, and remains a significant source of pollution.

The leading sources of pollution in Tennessee waters include the following:

i. Agriculture

Agriculture is the biggest contributor to water pollution in Tennessee. About half of the state's land area is dedicated to agriculture, which includes cropland and livestock production. When it rains, fertilizer, herbicides, pesticides, nutrients from animal waste, and soil run off the ground and into the water. Cropland and livestock production are responsible for about 43% of what are referred to by regulators as "impaired" stream miles in Tennessee.

ii. Mining

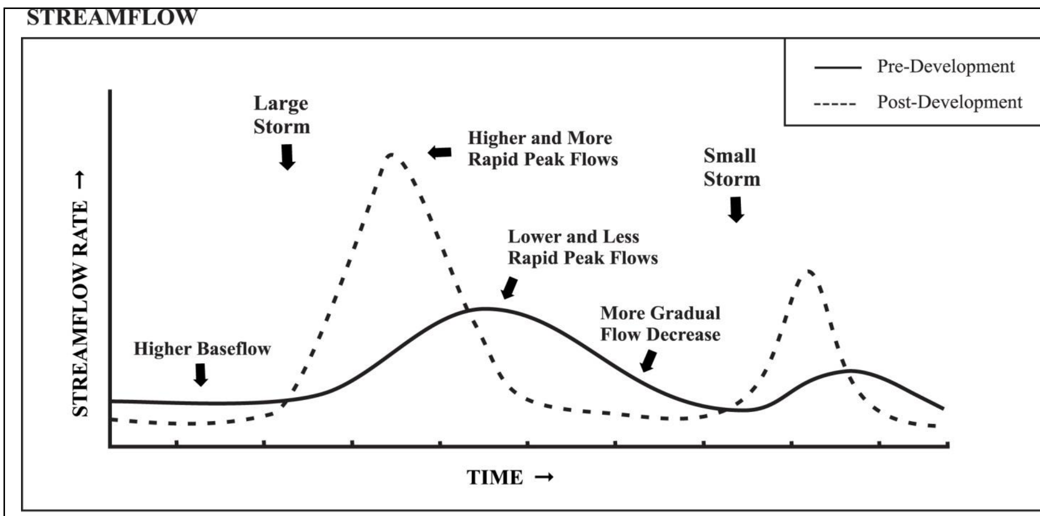
Mining is another source of water pollution in Tennessee. Both metals and acid- forming substances are associated with mining, although impacts vary depending on what is mined and the way it is mined. Mining sites typically are required to have permits and to treat polluted water before releasing it, but mining still causes pollution problems.

iii. *Urban Stormwater Runoff*

In towns and cities, much of the land is covered in hard, impervious surfaces, such as asphalt and rooftops, which cannot absorb water. When it rains, the water runs over the surface of the land, where it picks up many types of pollutants, such as motor oil, sediment, fertilizers, and pet waste. The polluted stormwater then flows into drainage pipes that take the stormwater to streams and lakes. This polluted water can lead to poor stream water quality.

Increased stormwater has two major impacts on streams. First, high flows lead to flooding and bank erosion. Stream bank erosion means that more sediment or dirt enters the stream. Too much sediment in the stream clouds the water, which smothers fish and aquatic life in the stream. Pollutants such as pesticides also stick to the sediment, entering streams along with the dirt. Second, land development, which typically includes surfaces such as pavement, causes more water to run off the ground quickly, rather than soaking into the ground as it would in a forest. Although some of this water is channeled into pipes and eventually enters streams (after picking up pollutants), streams are flashier, with higher floods and lower summer flows. This results in increased bank erosion and less suitable habitat for fish and other aquatic creatures. Figure 1 illustrates this relationship.

Fortunately, we have made progress in controlling stormwater over the last 10 to 20 years. For example, permits are now required for certain types of stormwater releases that are considered point source pollution, such as urban stormwater from cities and some construction and industrial activities. In addition, programs in Tennessee and nationwide have encouraged people to use innovative designs for buildings, parking lots, and streets to increase the amount of water that can soak into the ground rather than run off hard surfaces. This is known as Low Impact Development (LID) and is a big step in the right direction, but has not yet been adopted on a large scale in Tennessee. Unfortunately, LID does not address the problems associated with currently polluted urban streams. The Action Guide does!



Comparison of stream flows after a rain, showing the effect of development. (After Schueler, 1987)

Figure 1 The Effect of Development on Stormwater Flows

Despite the progress the nation and Tennessee have made in controlling stormwater, a lot of work still has to be done. Stormwater runoff remains a serious problem that must be addressed on an ongoing basis as humans continue altering the natural environment.

C. Why You Need to Help Assess Water Quality in Tennessee

Before we can clean up the waters of Tennessee, we need to find out which ones are polluted and need our help. All Tennesseans can help and work along with TDEC and local stormwater jurisdictions (see Table 3 for ways to find your local stormwater coordinator). TDEC has assessed water quality in 48% of the river and stream miles in Tennessee. This is a good start, but over half of the state's river and stream miles still need to be assessed. Citizens can help TDEC get the job done by assisting with stream monitoring and assessments. Because TDEC has limited resources, citizens can be a critical link by providing on-the-ground eyes and ears, carrying out simple assessments, and leading communities to cleaner streams and rivers in Tennessee.

There are three main reasons why citizen assessments are a good idea:

(1) TDEC has a limited staff and is not able to assess all Tennessee streams. Once TDEC assesses a stream, it must reassess the stream at least every three to five years to determine whether its quality has changed or remained the same. These stream assessments take a lot of TDEC staff's time and leave less time to monitor

new streams. Citizen assessments can address this problem by helping TDEC assess new streams in addition to the ones TDEC currently monitors.

(2) TDEC uses assessment methods that score streams based on limited water quality samples. Citizens can help TDEC assess stream health more fully and accurately by conducting assessments, such as visual stream assessments (see Part II and Appendix 2), that assess the entire stream.

(3) Citizen assessments support the development of watershed restoration plans (Appendix 6) and provide a structure for citizens to take action. Such plans identify (1) sources of water pollution, such as stormwater runoff, (2) valuable natural features in the watershed, such as parks and wetlands, and (3) restoration techniques necessary to clean up pollution.

Table 2: Citizens Stream Assessments

1. Provide data on streams that TDEC is unable to assess;
2. Supplement TDEC's water quality sampling for assessed streams to provide more comprehensive data to local media, stormwater coordinators, citizen groups and TDEC; and
3. Support development of watershed restoration plans and projects that can help drive citizen involvement in river and stream restoration.

D. Leading Causes of Pollution in Tennessee's Lakes and Reservoirs

Tennessee has 90 major lakes and reservoirs, totaling 572,063 lake acres. The biggest lake is the Tennessee portion of the Kentucky Reservoir (117,500 lake acres). TDEC has assessed 98% of these lakes and reservoirs for water quality, and found that 68% of the lakes support their designated uses. The remaining 32% have some kind of problem, including pollution from agriculture, sewage, heavy metals, nutrients from fertilizers, and/or chemicals such as PCBs, dioxins, or chlordane.

Agricultural runoff has polluted about 16,000 lake acres in Tennessee, including Reelfoot Lake, the only natural lake in Tennessee. Chemicals and metals are also a persistent lake and stream pollution problem because they attach to sediment particles in the water and build up in the fish tissue and other aquatic life. High levels of chemicals and metals can build up over years, making fish unsafe to eat and creating a public health risk.

In addition to these major lakes, Tennessee also has thousands of private lakes and ponds. These lakes and ponds are generally not assessed or only assessed for limited purposes. It is important for these water bodies to be fully assessed as well.

For a more detailed discussion of TDEC's water quality assessment process and listings of exceptional and polluted water bodies, see TDEC's 2012 305(b) Report: The Status of Water Quality in Tennessee, Final 2012 303(d) list, and The Known Exceptional Tennessee Waters list.[1]

[1] Tennessee Department of Environment & Conservation, Water Quality Reports and Publications, http://www.tn.gov/environment/water/water-quality_publications.shtml.

Part II How You Can Assess Watershed and Stream Health

Watershed science provides a way to understand the water cycle (Figure 2) and how human activities affect water quality. The following section and Appendix 1 explore how land use affects water quality and explains how you can use maps to understand what is going on in your watershed. This information is valuable because understanding how land use and human activities can affect your watershed will help you identify the causes of pollution and ways it can be reduced and/or eliminated.

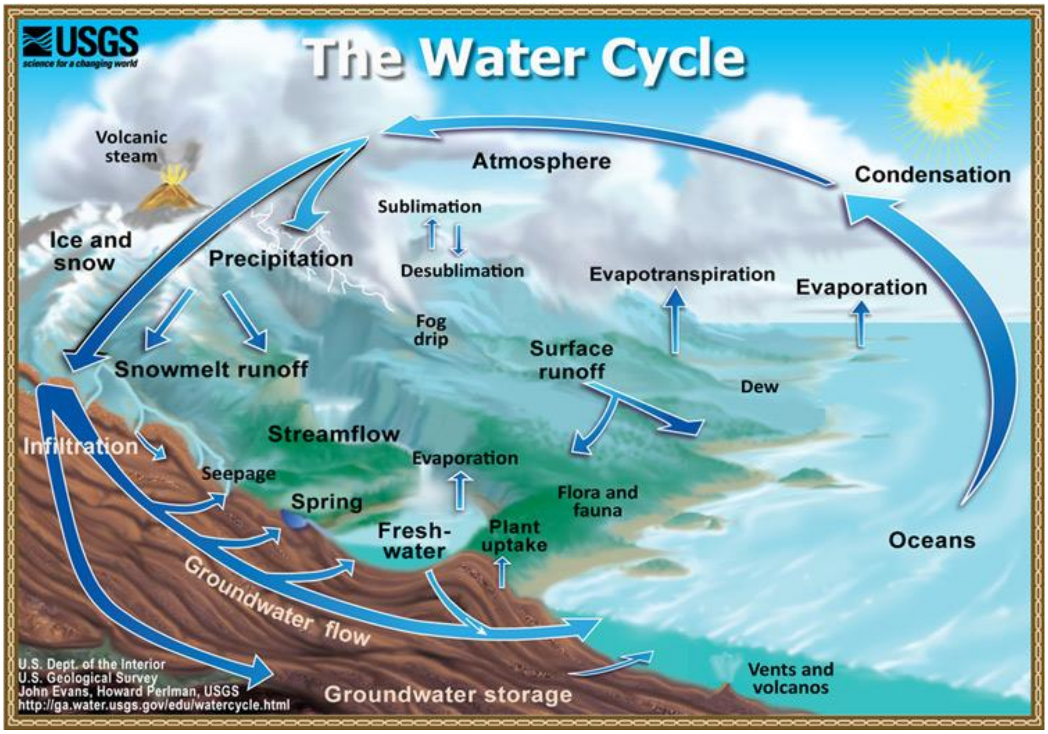


Figure 2 The Water Cycle

A. How to Use Maps To Find Your Watershed's Boundaries, Soil Types and Land Uses

Maps are a helpful way to get to know your watershed and investigate possible sources of pollution. To map your watershed, you must start by identifying the boundaries of the watershed. This can be done by hand using USGS quadrangle maps, or by employing online tools. These mapping methods are discussed in Appendix 1.

After you identify your watershed's boundaries, you can examine its characteristics in more detail. For example, rainwater/stormwater carries soil into streams, so it is a good idea to find out what types of soil exist in the watershed. Some types of soil erode more quickly and easily than others, and different soils contain different chemicals. Soil type also helps determine the restoration strategies that are best suited for the site. Appendix 1 includes a great online tool, the Web Soil Survey, to help you understand soils.

Land use is another important factor to consider. Accurate and up-to-date land use maps are available for some parts of Tennessee. These maps show different kinds of land use, including roads, and how they are distributed. You can employ land use maps to determine which types of land use are common in your watershed. Examples can be found in Appendix 1.

Aerial photography is also available in most local planning offices and on Google Earth. A list of mapping resources is included in Appendix 1. This technology allows a more detailed analysis than most land-use maps, which generally classify a piece of land based on a single use, even if the land is subject to multiple uses. For example, not all farms have active crops: many are partly forested or include pastureland. These different types of land use affect how much rainwater is absorbed and how much stormwater runs off the land.

Similarly, a residential area of five-acre lots would have a different impact than an apartment complex that does not have as much undeveloped land to absorb rainwater, although they are both residential land uses.

Detailed analysis of land use is particularly important in calculating the amount of impervious (i.e. asphalt) surface in a watershed. A watershed with over 20% impervious surfaces is likely to have trouble maintaining a healthy stream system, because of high runoff volumes carrying large amounts of pollution and eroding stream banks during and after storms. See Appendix 1 for a link to the Impervious Surface Analysis Tool, which you can use to calculate the percentage of impervious surface area in user-selected geographic areas.

In sum, local data sources for land use, aerial imagery, and other features are available for your area, just as water quality data is available for your watershed. Maps are an important tool that can help you organize your field work, pinpoint sources of pollution, pick assessment site and restoration opportunities.

B. How Healthy is Your Stream? A Guide to Assessment

If you want to know whether a stream is healthy, you will need to conduct a stream assessment. Visual Stream Assessments (VSA), aquatic insect sampling, and water physical/chemical sampling are generally accepted as the best ways to determine whether a stream is healthy. These options are discussed below and detailed information, methods, and protocols for stream health assessment are included in Appendix 2. Testing water samples in a laboratory to identify pollutants present in a stream is also an option, but it is not discussed here in detail because it can be difficult and costly.

As explained in Part I, citizen assessments are very helpful to local communities and TDEC. This Part explains how to share results with experts in the environmental community and TDEC. It is important to assess water bodies throughout the state because the assessments tell us which water bodies are polluted and perhaps what types of pollutants they contain. The more streams that are assessed, the better we can control pollution and restore streams.

Citizens who learn how to conduct stream assessments empower themselves and their communities to take action to protect and restore their local streams. Once you have collected stream data, you should share it with: (1) with the Tennessee Environmental Council (TEC) (www.tec.tn.org); 2) your local stormwater coordinator, and (3) TDEC (see Table 3 and Appendix 5 for contact information).

You should share your data with TEC and your local stormwater coordinator first because they have a wealth of knowledge and experience in dealing with water pollution problems and can help you submit your data in the most effective manner to TDEC.

A careful study of the general guidelines for conducting all stream assessment or restoration events (see Appendix 3) is recommended before starting on any stream activity or event, including stream assessments.

How to Determine Whether a Stream is Healthy:

- Visual stream assessment
- Aquatic Insect sampling
- Water Physical/Chemical Sampling

i. How to Do a Visual Stream Assessment (VSA)

VSAs are perhaps the most useful way to assess watershed and stream health, because: (1) stream and habitat conditions can be quickly documented at one sampling point or throughout the length of a stream; and (2) VSAs often give strong clues as to what may be happening to your stream. For example, excessive algae indicate nutrient pollution, which means that you should test for nitrogen, phosphorus, and possibly fecal coliform bacteria.

VSAs require little equipment other than a camera, clipboard, and basic training to gather the information correctly. A VSA should include at least two participants per field team to document stream conditions. If you assess the entire stream, collect habitat data at equal intervals along the stream (e.g., every quarter mile if conditions are similar, or more frequently if the conditions change notably at smaller intervals). Make sure to record data carefully and complete each section of the data sheets. In addition, record the location (use hand-held GPS, or mark the location on the field map and then get coordinates in Google Earth), and provide specific directions so others can find the site. Take photos at each sampling point and make sure to tag each photo and the data to a specific location. It is very important to clearly document the site location and the information gathered at the site. VSA methods are included in Appendix 2.

Once this initial work is completed, you may decide to conduct a more detailed assessment. A more detailed assessment may include monitoring aquatic insects and "indicator" factors such as temperature and oxygen levels in the water.

ii. How to Do Aquatic Insect Sampling

Another good way to find out whether a stream is healthy is to sample the aquatic insects. Aquatic insects, known by scientists as benthic macro invertebrates, have relatively long lives in the water (averaging one year), and this makes them a more reliable way to assess water quality over time than a single water sample collected at a point in time. For example, some aquatic insects can only live in very clean water, while others are more tolerant of pollution. This means that if your sample contains no pollution-sensitive species, the stream may be polluted.

To learn how to take samples of aquatic insects, see Appendix 2.

iii. How to Do Water Physical/Chemical Sampling

Testing the water is a good way to find out what pollutants are present in a stream. For the purpose of this guide, only "indicator" factors are discussed. As the name implies, indicators "indicate" that something may be wrong with the water. The most basic tests are for pH, temperature, turbidity, and dissolved oxygen.   If the indicator parameters are outside certain limits (see field data sheet in Appendix 3), they indicate potential problems.

You can perform water sampling by taking samples of the water and testing to find out if known pollutants are present in your stream. Testing water for a targeted pollutant however can be very costly and requires basic water testing training. It can also take time and expertise to determine which pollutants you should test for in your stream.

Testing for pH, dissolved oxygen, and nutrients is commonly done with a basic chemical test kit, while temperature is measured with a thermometer. Turbidity (the cloudiness of the water) is measured with a transparency tube. This is a very important "indicator" of sediment, which is a leading cause of water pollution. Indicator parameters are easy to collect, and extensive research has shown that they are an effective way to determine water quality.

Figure 3 When collecting water samples always enter the stream downstream of the sampling point so as not to stir up stream sediment and contaminate your sample.

See Appendix 2 for a list of water testing resources and suppliers. Also, note that almost all of the gear necessary for aquatic insect and turbidity testing can easily be made from materials purchased from a local hardware store.

Always follow the manufacturer's directions with any physical or chemical test. This will help you obtain consistent and reliable results. For example, dissolved oxygen tests must be done on the streamside immediately after the sample is collected, while colorimetric nutrient tests can be done back in the comfort of your work area. However, all transported samples must be placed on ice if analysis occurs 15 minutes or more following the sample collection. Data sheet example(s) and general sampling guidelines/procedures are included in Appendix 2.

You should share your stream data with TEC, your local stormwater coordinator, and TDEC. See Table 3 below and Appendix 5 for contact information.

Table 3: Sharing Water Quality Assessment Results

Share Your Results with TEC, your Local Stormwater Coordinator and TDEC Field Office Contact

Citizen data is important in identifying water quality problems and bringing them to the attention of communities and regulators who can investigate in more detail and add the information to their water quality databases.

After you have tested your water samples, share your results with:

1. Your Local Stormwater Coordinator who works for your Local Municipal Separate Storm Sewer System (MS4) Program (http://www.tn.gov/environment/water/water-quality_storm-water.shtml)

2. Tennessee Environmental Council (www.tectn.org)

3. Tennessee Department of Environment and Conservation (see Appendix 5 for the field office closest to you)

Part III: What You Can Do to Restore Streams

Now that you and your citizen group have sampled the water and gathered data on the watershed and river that concerns you, you have probably uncovered some problem areas. The next and most important question is "What are we going to do about it?"

This part will answer that question by explaining what actions you can take to help restore streams. Direct restoration actions covered here include litter cleanups, debris dam removal, streamside reforestation, bank stabilization, bank reshaping, and bioengineering, including rock barbs and vanes. Indirect, or off-stream, restoration actions covered here include rain water harvesting systems, water detention and retention systems, and water infiltration systems.

It is important to note that prior to beginning your restoration activities, you should look at the data you collected during the assessment phase and try to determine what the key problems are and how to approach fixing them. This effort will help you estimate the amount and types of work to be done, whether any permits will be needed, and the costs associated with restoring your stream. The results of this overview are the beginnings of a Watershed Restoration Plan (Appendix 6).

The following is a brief description of these actions and a discussion of how they help restore streams. More detail can be found in Appendix 3.

I. Direct Actions You Can Take to Restore Streams

Direct stream restoration actions are completed in or along the stream. These activities are often fun because you get to be outdoors and you can sometimes see improvement right away (e.g., if you clean up trash or plant trees). Before undertaking any of these restoration actions, you should make sure that all of the participants are adequately trained and dressed appropriately for field conditions. Try to plan your activity for a day with good weather, especially if participants will be working in the stream. Stream water can be cold even when the weather is warm. Finally, make sure you have landowner permission to access privately-owned sites along the chosen stream section.

a. How to Conduct a Litter Cleanup

Litter cleanups are easy to organize and are a highly visible way to improve stream health and educate citizens. Volunteers can walk along the stream and streamside zone picking up trash and recyclables, which should be properly recycled or disposed of following the event. Areas around bridges and stream crossings typically require trash removal and are easy to access. The length of the stream section that can be covered during a cleanup depends on the number of volunteers, the time available, and how much trash is present. Appendix 3 provides resources and information about how to organize, implement, and oversee a stream cleanup project.

b. How to Remove a Debris Dam

Debris dam removal is a form of cleanup that focuses on a specific site rather than a section of stream. Debris dams form when tree logs and other materials are wedged across a stream. The debris dam may start with a single log, but once one log is caught in the stream other logs and materials also can be caught. The result is a debris dam that may contain many types of materials. At first, water may flow around the debris dam, but as more materials gather at the site, the water flow is blocked and can only seep through the debris dam. At that point, fish can no longer move upstream or downstream through the debris dam. A debris dam may also cause stream bank erosion. In addition, debris dams can cause local flooding and damage when they are dislodged by storms.[2] Debris dams are classified as one of five types based on a U.S. Fisheries Association publication.

i. Permits for Debris Dam Removal

Before removing a debris dam, find out if you need a permit. Permits often require special measures to protect the stream, stream bottom, and the people who do the work. Permits may be required for debris dam removal in two situations. First, removing a debris dam that is large and has been in place for many years may require an Aquatic Resource Alteration Permit (ARAP), because removal will release sediment stored behind the dam. Second, using heavy equipment in streams also requires an ARAP. Permits are not otherwise typically required for debris dam removal. TDEC has a dedicated webpage on ARAP that contains information about when an ARAP permit is required and how to apply for one (see Appendix 5 for field office contacts).[3]

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[2] Document is referenced in Appendix 3.

[3] Tennessee Department of Environment & Conservation, Aquatic Resource Alteration Permit http://www.tn.gov/environment/permits/arap.shtml.

ii. Debris Dam Removal Techniques and Safety Tips

Debris dams should be carefully assessed before removal is attempted. The larger the debris dam, the greater the potential hazards to people who work to remove it. For example, if a dam is sealed and holding back water, the pressure on the logs is stronger than it would be if water was flowing through the logs. In these situations, upstream water should be pumped around the debris dam prior to removing the dam.

Debris dams on small streams can often be disassembled by hand. You should stand upstream from the dam and pull branches and logs off the dam from the upstream side. Never stand downstream from a debris dam while it is being removed, because the structure may suddenly break apart and injure you.

Citizens can remove large debris dams as well as small ones, but a chainsaw may be needed to remove large logs that are hard to remove by hand. To reduce the risk of injury, only trained chainsaw users should perform this task. Using a chainsaw to remove a debris dam can be especially dangerous because of unsure footing in the stream or on the stream bank. To cut through the logs, the operator must operate the chainsaw while standing in the water or on the debris dam, which may be slippery and unstable.

Removal of debris dams should take place during the lowest water flows of the year, which are generally during the summer, to reduce water dangers and improve access to the dam. Lower levels of stream water also mean that there will be less flow and more of the streambed will be exposed. Low flow conditions result in safer conditions, and make dismantling debris dams easier than in high flow conditions.

After you have dismantled the debris dam, move the debris dam material so the material does not reenter the stream. Material removed from debris dams should either be removed entirely from the site or should be placed well above the flood zone. Make every effort to ensure that the debris dam does not reenter the stream.

c. How to Plant Streamside Forestation

Streamside reforestation (i.e., planting trees) is perhaps the most important direct action citizens can take to improve stream health. Tree planting projects are a fun, low-cost, and effective way to protect and restore our streams and engage a large group of citizens. In addition, streamside reforestation projects are popular with the public because they are safe, the tree planting technique is easily taught, and the resulting efforts are realized that day – trees are planted! Also, tree planting projects do not cost much compared to other restoration efforts.

Reforestation projects should include trees that grow to large sizes and smaller under-story native ornamental trees, shrubs, and grasses. For information on how to organize and oversee a reforestation project, see "How to plan and implement a riparian reforestation project" in Appendix 3.

Native Tennessee Trees and Plants for Water's Edge and Moist Upland Sites[4] lists trees that are suitable and readily available to plant in and around stream side zones (see Table 4, Appendix 3). The purchase and installation of these species is not only good for the environment, but also helps support growers of trees and shrubs in Tennessee. Native tree seedlings and shrubs can be purchased inexpensively from the Tennessee Division of Forestry and other state nurseries with prices per plant of less than one dollar. Plants can be ordered from the Tennessee Division of Forestry (TDOF) online or by filling out and faxing or mailing an order form that you can find on TDOF's web site.[5]

d. How to Use Bioengineering to Improve Stream Health

Bioengineering is a restoration method that uses engineering and biological techniques to accomplish bank stabilization. Stream bank stabilization refers to techniques to repair and stabilize stream bank erosion. Stabilization projects are important because channel erosion can contribute 40% to 60% of stream sediment,

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[4] Harpeth River Watershed Association, Native Tennessee Trees and Plants for Water's Edge and Moist Uplands Sites.
[5] Tennessee Department of Agriculture, Division of Forestry, Seedling Order Form 2013-2014, http://www.tn.gov/agriculture/publications/forestry/seedlingcatalog.pdf. You can also reach the Division of Forestry by calling (423) 263-1626.

particularly in small streams. Because sediment is the leading cause of water pollution, bank stabilization and restoration is a critical action that you can take to restore your stream. In addition, stream bank stabilization can increase and redirect stream flows and help stormwater infiltrate into the ground.

Stream channels are always changing, but the rates at which they change and the speed at which they stabilize in new locations are not constant. Erosion occurs when the stream channel deepens and/or widens as sediment is removed from the channel to make room for more water. At some point, the new channel becomes deep and wide enough to handle the higher volumes of water. Erosion slows down, but does not stop. Bank stabilization projects try to lend nature a hand by helping to stabilize these new channels.

Stabilization projects should be prioritized based on the importance of: (1) protecting specific ecological assets (i.e., trees); and (2) treating sites with the most significant bank erosion. For example, streams with only one row of trees or scattered trees on the stream bank that are experiencing bank erosion should be restored in a way that protects the trees, because they provide stability to the bank through their root structure, provide shade to the stream for fish, and add leaves and sticks (i.e. habitat and food) to the stream. In addition, some streams impacted by sediment contain long, highly erosive segments that are typically located on outside bends. These stream sections should receive strong consideration when prioritizing projects, because of the high loss of sediment into the water.

i. Plantings

Planting a stream bank with woody plants is the simplest form of stabilization for a bank not actively eroding (i.e., stream banks that do not highly erode during small to moderate rains). Planting efforts should use either one-year-old seedlings or a technique called "live staking," which involves using cuttings of species that take root easily. In both cases, a slit is made in the bank, the seedling or cutting is inserted, and the dirt is pressed back.

Species that can be submerged in water for periods of time should be selected for planting. If possible, use plants that are native to the county and ideally use plants that are currently growing along the stream. Appendix 3 lists plants that are commonly used for bank and stream edges and includes local contacts that can help with plant selection and planting techniques. Perennial plants and most grasses (except some native grasses with very deep root systems) generally do not have deep enough roots to hold the bank against the force of the water and should not be used. Plant selection is important to plant survival and the project's success.

Live stakes are typically eighteen inches tall. Commonly available species in Tennessee are Black Willow, Sandbar Willow, Box Elder, Swamp Dogwood, Silky Dogwood, Red Maple, and Eastern Cottonwood. When using live stakes it is critical to plant at least 75% of the stake in the ground and to make sure the buds are oriented up. In addition to using live stakes as individual plants, bundles of longer live stakes, known as fascine bundles, can be planted horizontally along the base of a stream bank. This creates vegetation with more roots that can grow rapidly. Live stakes or bundles are recommended for stream bank stability projects.

If the stream bank is actively eroding, a number of bioengineering techniques, which are described in more detail below, may be used to stabilize the bank, depending on the severity of the erosion, the height of the bank, the depth of the water, and the existing vegetation growing in and on the bank. All of these techniques require an ARAP permit from TDEC and possibly the U.S. Army Corps of Engineers. See Appendix 5 for additional permit information.

ii. Bank Reshaping

Bank reshaping and revegetation is an effective way to stabilize eroding stream banks, although it is not always possible in a developed area. To reshape a bank, remove soil from the top of the bank and establish a gentle 3:1 slope, which is three linear feet horizontal for every one foot of vertical drop (Figures 4, 5 and 6).

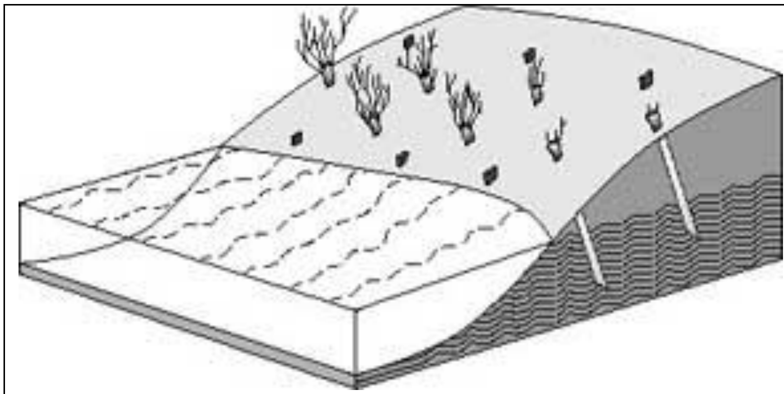
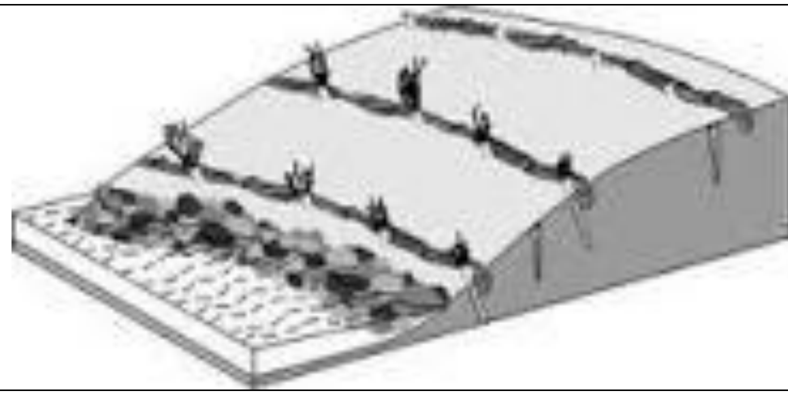


Figure 4 Live stakes, a soft bank stabilization stream repair technique, shown here installed on a "3:1" (three linear feet for one linear foot of drop) stream bank slope.[6]

Figure 5 Live fascines, or bundles of longer live stakes, are a soft bank stabilization stream repair technique shown here installed parallel to the water's edge.[7]



A 3:1 slope reduces force on the eroding banks by giving rising water more space to spread out. Also, it is easier to vegetate. After a 3:1 slope has been established, add the vegetation to stabilize the bank. Erosion control matting, which should always be composed of biodegradable (never use plastic) material, should be used to hold the soil in place while the vegetation is established.

Volunteers can install erosion matting and reshape smaller banks with hand tools. However, heavy equipment may be required for larger projects. If heavy equipment is required, a skilled operator will be needed to remove soil. The soil removed should not reenter the stream. For more information on bank reshaping and revegetation, see the Natural Resource Conservation Service (NRCS) field office technical guide referenced in Appendix 3 under bank Stabilization Projects. In many cases a permit will be required to reshape the bank.

iii. Cedar Revetments

"Revetment" is a general term that refers to trees or bundles of woody materials that are placed along a bank to protect the bank from the force of the water (which causes erosion) and to trap sediment, which reduces in-stream sedimentation and promotes wildlife habitat. Revetments can be used in a variety of configurations and are most effective when bank erosion has overly widened the channel. Cedars are used most often, due to their resistance to rotting in water. Revetments are discussed in more detail below and in Appendix 3 and 3.1.

One cedar revetment option is to create a "bench" or small floodplain in the channel (see Figure 6). A bench helps maintain depth during low flows while allowing the full width of the channel to be used during high flows. Once the "bench" has been created, volunteers can reshape and revegetate the bank with hand tools. A second option is to fill the undercut and eroding banks with revetments. An undercut bank provides wildlife

[6] Schueler, T., Brown, K. 2004. Manual 4: Urban Stream Repair Practices. Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. http://www.cwp.org/online-watershed-library?view=docman.
[7] *Id.*

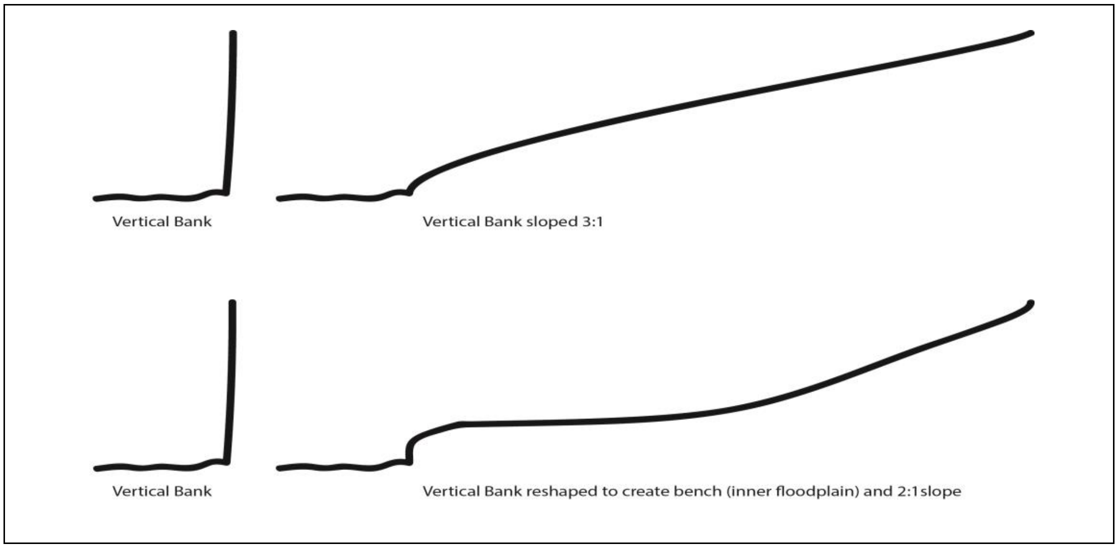


Figure 6 3:1 Slope (three linear feet horizontal for every one foot of vertical and 2:1 Slope (two linear feet horizontal for every ine foot vertical) with Small "Floodplain" Bench.[8]

habitat, but is unstable because the surface layers collapse without the support of material below the undercut bank (Figure 9). Adding revetments prevents this bank instability and failure. A third option is to create a vertical bank by stacking revetments in layers halfway to two-thirds of the way up the bank. Revetments with larger diameters should be placed at the bottom layer and smaller ones placed on top. This stacking creates a sloped bank (Figures 7 and 8). All three of these installation techniques may be needed for your stream restoration project.

A number of organizations in Tennessee have developed an improved bioengineering technique using cedar revetments. Cedar revetments, as adapted by these organizations, use small cedar trees and large cedar branches tightly wrapped in 700 gram coir (coconut fiber) matting to form a relatively uniform "burrito" ten feet long and fourteen to twenty inches in diameter. The hairy fibers of the coir matting, combined with the fine needles and branches of the cedar, trap sediment during periods of flooding and eventually fill with sediment. The cedar revetments that trap sediment create a natural seedbed that can be planted to provide more bank stability and wildlife habitat. The revetments are attached to the bank with steel cables. The steel cables are attached to anchors driven into the banks or stream bottom. See Appendix 3 for details on how to create and install cedar revetments.

Revetments (and all other engineering solutions) are only a permanent restoration technique when they become the foundation for the root systems of woody plants. While the cedar trees and many of its branches will provide structure for some time, the coir matting, cedar tree needles and small twigs will break down naturally over time. Planting one-year seedlings or live stakes should occur in late fall or early winter after the revetment installation and may have to be repeated the following year in areas where the revetments were not filled with sediment during the first year. Vegetation is critical to the success of all stream bank stabilization efforts and the ecological health of your stream.

Rock Barbs and Vanes

Rock barbs, also known as jetties, and vanes are used to deflect the force of the stream's water current where erosion occurs. Barbs are rock structures that are keyed (dug) into and extend upstream of the bank. The area of the bank where the barb is keyed in must be covered with a geotextile, a non-degradable, blanket-like material. Geotextile helps prevent high flows from getting behind the rocks and eroding around the barb. Barbs

[8] Gregg, Dennis, Obed Watershed Community Association.

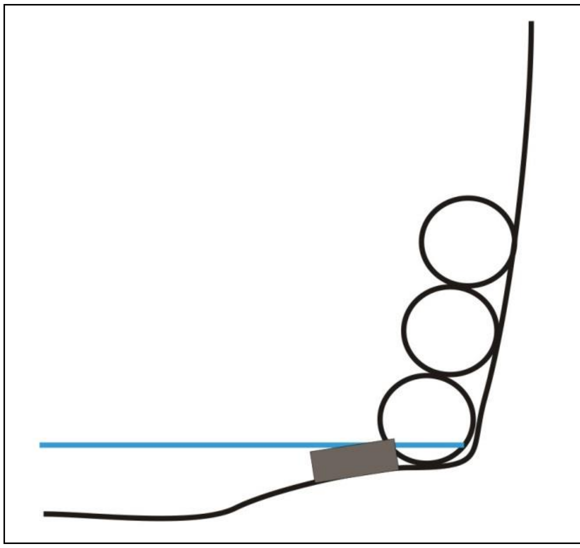


Figure 7 Cross section of cedar revetment with stone placed at bottom of bank. Cedar revetments trap sediment and buffer the creek bank from eroding flood flows. Number of revetments is dependent on bank height, although covering at least the bottom third of the creek bank is recommended.[9]

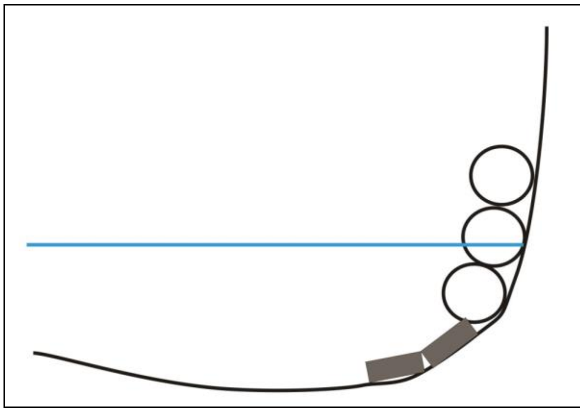


Figure 8 Rock placement to protect bottom of revetments when bank has greater slope toward center of stream. Two rocks are placed to prevent the rock under the revetment from sliding toward the stream's center.[10]

and vanes are often used in combination with other bank stabilization techniques, including revetments and revegetation.

Rock barbs may be used to protect highly erosive stream banks (e.g., outside bends). A common feature found on highly erosive stream banks are undercut trees that are falling or have fallen into the stream. Trees are undercut by erosion caused by high flows and fall into the stream when the soil under the trees is washed out. Eventually the tree roots do not have enough soil to stabilize the tree and the tree falls into the stream. To prevent this, a barb should be placed immediately upstream of at-risk trees and may be located downstream and extend under and around the exposed root systems.

Revetments may also be used to fill in and cover exposed soil in conjunction with the barb. Revetments may be used to provide structure for sediment capture and revegetation. The end of the barb farthest away from the bank should be pointed upstream at about a 30 degree angle off the bank and slanted down from the bank. This causes the water to spill into the center of the channel during high and low flows and protects the bottom of the stream bank. For the best diagrams of these structures, visit the NRCS and/or Center for Watershed Protection website referenced in footnote 6 above and Appendix 3 under bank stabilization. A series of barbs can also be installed where the stream has a major bend to reduce the force on the outside part of the turn. The rocks used in the barb must be shaped so they can easily interlock with the other rocks, and be large enough that they will not move in high water or in large storm events. Use similarly sized and shaped rocks that you see in the stream and that are stable. Successful rock barb installation can prevent stream erosion, save trees from falling into the stream, and provide future revegetation along the stream bank.

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[9] *Id.*
[10] *Id.*

Vanes serve a similar function as rock barbs. However, vanes are longer and extend further into the channel than barbs. Vanes have a gentler slope and should be angled upstream at no more than 30 degrees from the bank, similar to barbs. In addition to spilling water towards the center of the channel, vanes encourage sediment to fill in behind them. Vanes can be placed on one side of the stream. If the goal is to increase flow in the center of the channel, vanes can be placed on both sides of the stream (see appendix 3 for additional details, including the NRCS and /or Center for Watershed Protection website referenced in footnote 6 above for more specific drawings and information). As with barbs, determining the appropriate rock size (i.e., the size that will be stable in the stream) is important. Vanes are an effective technique in larger streams, but heavy equipment may be needed to place larger rocks. If heavy equipment is needed, an ARAP permit will be required (see Appendix 5).

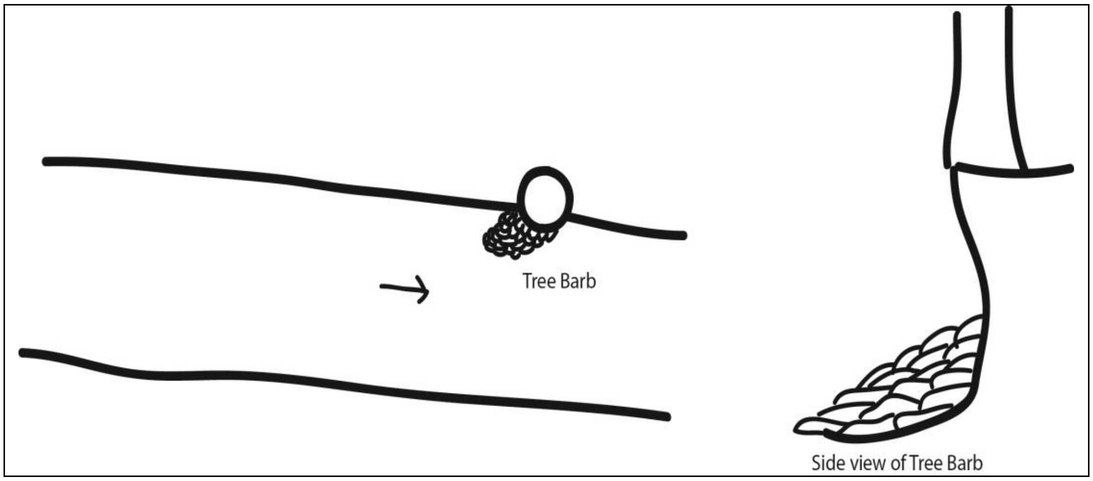

Figure 9 Tree/rock barb (top down view) and tree/rock barb (side view) placed at undercut stream bank.[11]

Direct Actions You Can Take to Restore Streams:

- Conduct a Litter Cleanup
- Remove a Debris Dam
- Plant Vegetation Near Streams
- Use Bioengineering to Improve Stream Bank Stability

II. Indirect (Off-Stream) Actions You Can Take to Restore Streams

Citizens can engage in a wide range of watershed restoration projects to prevent water pollution and control runoff from developed areas. These projects occur in areas that are up gradient from the stream. These watershed restoration practices aim to slow the rain or stormwater down and clean it before it enters the stream. Stormwater is a major problem for stream health, as discussed earlier, because it pollutes streams and causes stream bank erosion.

In addition, some older subdivisions and urban areas have no stormwater treatment systems and others have poorly designed systems. In some cases you can “retrofit” older areas’ with stormwater treatment systems, which can help address its problems. An example of a stormwater retrofit is a rain garden that soaks up water, using plants and soil. Retrofitting areas with appropriate indirect watershed restoration techniques is an important way to improve water quality and restore stream health.

[11] *Id.*

Ideally, restoration strategies are most successful when they are implemented as part of a watershed restoration plan. Watershed restoration plans consider the area that drains to a common point such as a river or lake and identifies citizen actions and restoration strategies that will help clean the water before it leaves the watershed. For example, a watershed plan will help you determine where problems exist and suggest projects or strategies to fix these problems. A watershed plan will also provide guidance for what actions to take and what projects to implement, provide details for implementing projects, point to resources for assistance and funding to do the work, and may estimate the ecosystem value for the restoration actions. You should contact your local stormwater program (see Table 3 above for contact information), which is typically housed in the public works or engineering department of your city or county government, to discuss watershed restoration plans. Additionally, see Appendix 6 for the Environmental Protection Agency's (EPA) Guidance on Watershed Restoration Plans. Be careful not to get caught up too much in the "planning" process. The focus should be on determining where or what your major problems are and how you can address them – and then to take action to fix them.

The off-stream watershed restoration strategies covered here fall into four categories: (1) rainwater harvesting, (2) water detention and retention, (3) water infiltration, (4) proper use or elimination of lawn chemicals, and 5) proper handling of household automotive fluids, chemicals and pet waste.

a. Use Rainwater Harvesting Systems

Rainwater harvest systems collect rainwater, which is then stored for use. The environmental benefit of rainwater harvest systems is that stormwater is slowly released over time to the stream, for example, through your garden or flower beds. This reduces pollution and erosion. Rain barrels and cisterns or tanks are common examples of rainwater harvest systems.

A rain barrel is a large drum that saves water by catching rainwater from roof gutters and storing it for later use. Many communities in Tennessee have rain barrel programs to help alleviate stormwater runoff problems. Rain barrels are a great way to capture roof runoff, which is then available for home or business owners to use on landscaping and other gardening needs. The water also can be used to wash outdoor furniture or hard surfaces. Lawn and garden watering make up about 40% of total household water use during the summer, so rain barrels can cut water use significantly. Installing just one rain barrel can save up to 1,300 gallons of water during the summer months. The water collected is "soft water," which cannot be used as drinking water but is free of additives such as fluoride, chlorine, calcium, and lime and is ideal for car and window washing, topping off a swimming pool, and watering plants.[12] Also, rainwater collected in rain barrels can be saved and used during periods of drought when water use is often restricted.[13] More information about rain barrels and how to construct and install them see Appendix 3.

b. Promote Water Detention (Dry ponds) and Retention (Wet Ponds) Systems

Water detention and water retention systems, including rain barrels and small ponds, hold back water so it reaches a stream only after a storm has ended and the storm flow has been reduced. Water detention systems reduce stream bank erosion, reduce flooding, and remove pollutants from the water by holding the water a short period of time, for example, for less than seven days. These stormwater ponds often have water cleaning capacity and in some cases areas at the head of the pond called forebays, which help clean the water before it enters the pond. Forebays are important because they allow for cleaning out sediment from a small area as opposed to the entire pond. In addition, rock and soil "check" dams or berms are common ways to slow down or detain stormwater. Anytime the water is slowed down, sediment and other pollutants "settle" out of the

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[12] Anderson, David, Rain Barrel Uses, Home Guides, SFGate, http://greenliving.nationalgeographic.com/rain-barrel-uses-2401.html.

[13] United States Environmental Protection Agency, Rain Barrels, Mid-Atlantic Region Green Landscaping, http://www.epa.gov/reg3esd1/garden/rainbarrel.html.

water, cleaning it before it reaches the river or stream. Check dams and berms are typically low cost and low technology practices that can be installed by properly trained volunteers.

Although stormwater ponds are a common stormwater management practice that protects streams from stormwater runoff and associated stream degradation, such detention systems are typically part of larger, engineered stormwater projects. Accordingly, detailed information about detention systems is not included in this guide, although citizens can certainly promote these practices and implement them at a smaller scale (e.g., ponds around the house collecting down spout rainwater).

c. Build Water Infiltration Systems

Water infiltration systems, such as rain gardens, allow stormwater to soak into the ground. Stormwater runoff enters the water infiltration system, soaks into the soil, and becomes available for plants in the system, and is slowly released to the subsurface groundwater. Common examples of water infiltration systems include rain gardens (see Appendix 3 and Figure 10), infiltration swales and trenches, pervious concrete, pervious pavers, and forested areas, including the stream bank. Infiltration swales and trenches are linear rain gardens that direct water flow. Forested stream sides or riparian zones absorb storm and flood waters, soaking into the ground through root channels. All of these processes filter pollutants from the water that enters the stream and slows the water down before it enters the stream. Reforesting streamside areas is one of the most critical activities citizens can accomplish, as discussed earlier. Infiltration systems (e.g., rain gardens) are a way that homeowners can slow rainwater runoff, reduce flooding, and clean stormwater before it enters a stream.

d. Use Lawn Chemicals Properly

Using lawn chemicals, such as fertilizer and pesticides, can harm plants, animals, and humans. When it rains, stormwater runoff carries some of the chemicals on your lawn to nearby streams and rivers. Pesticides can kill aquatic life that is essential to making sure that a stream supports its uses (e.g. recreation). Additionally, excess nutrients from fertilizer can harm animals and plants that live in or near the stream. For example, excess nutrients/fertilizers feed algae that grow into large hair-like mats and produce large amounts of oxygen during the day, but lead to low dissolved oxygen levels in the early mornings, which stresses aquatic life and may cause fish kills in streams. Some algae are harmful to people and animals that come into contact with the contaminated water.

i. Fertilizer

In many cases, organic lawn fertilizers can be used instead of chemical fertilizers.[14] First, test your soil before using fertilizer to make sure you address your lawn's needs and do not over-fertilize.[15] If you choose to use chemical fertilizers: always follow the directions on the packaging, never exceed the amount specified for your lawn, be careful not to over water (also water in the early morning) and do not apply the fertilizer prior to a rain event. These practices will save you money, make our lawn healthier and look better and limit the amount of lawn chemicals/fertilizer entering your stream. If a lawn is overwatered, the unneeded water will run off, carrying excess lawn chemicals/fertilizers into the stormwater drains. If you apply fertilizer right before a heavy rain event, much of the fertilizer will wash away and may enter a stream through the stormwater drains.

Proper application of fertilizer is essential. Grass cannot absorb fertilizer above a certain amount, and applying too much fertilizer can harm your lawn. [16] Fertilizer that is not absorbed washes away in the runoff

[14] Planet Natural, Organic Lawn Care 101, http://www.planetnatural.com/organic-lawn-care-101/

[15] Missouri Botanical Garden, What Do You Know About Your Site?" RainScaping Guide, http://www.missouribotanicalgarden.org/sustainability-conservation/sustainable-living/at-home/rainscaping-guide/what-do-you-know-about-your-site/understand-your-soil.aspx#id.

[16] University of Florida, Avoid These 5 Common Landscaping Mistakes, Gardening Solutions,

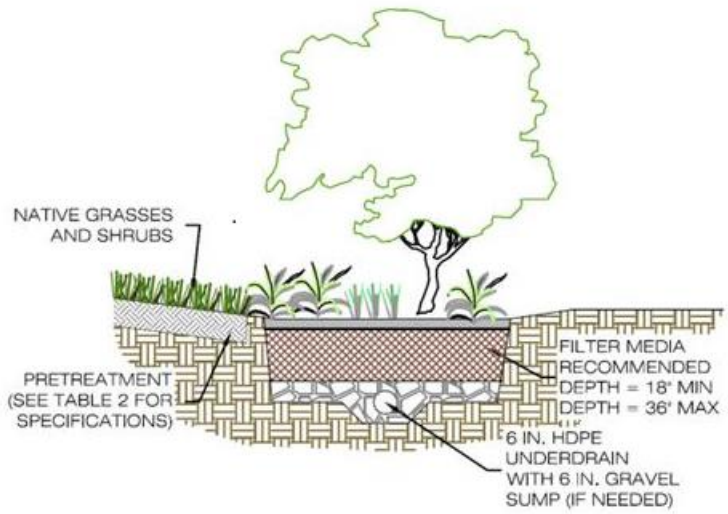

Figure 10. Typical rain garden cross section[17]

from storms or the next time your lawn is watered. Always follow the directions on the package to prevent excess chemical fertilizers from entering nearby streams and eventually ending up in your community's drinking water.[18]

ii. Pesticides

Overuse of pesticides can also cause water quality problems in your watershed. As an alternative, try using a combination of pest management strategies[19], which can be good for your lawn, your health, and your watershed. For example, encouraging beneficial insects, birds, and bats to live in or near your yard can help control problem insects. If that does not work, spot-treating plants with chemical pesticides, instead of applying a blanket coat to your yard, can be done as a last resort. To avoid contaminating drinking water with chemical pesticides, always follow the instructions on the packaging.[20]

e. Identify and Correct Pollution Hot Spots

Hot spots are areas where obvious pollution is occurring and areas where pollution is likely to occur. Hot spots are often areas where there is a high risk of spills, leaks, or illicit discharges. Hot spots are most often found in commercial areas, industrial areas, and homeowner lots. As a citizen, you can quickly identify hot spots and recommend corrective actions to stop or prevent pollution from harming the environment.

Common hot spots include potentially toxic material such as batteries, gas, oil, paint, restaurant waste, and trash receptacles. These hot spot areas should have secondary containment such as a plastic tub under the materials and should have covers (i.e., a roof) to protect rainwater from transferring the toxic materials to the

http://www.gardeningsolutions.ifas.ufl.edu/giam/news/2009/five_mistakes.html.

[17] http://vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec9BIORETENTION.html

[18] *Id.*

[19] Alliance for the Bay. https://allianceforthebay.org/wp-content/uploads/2010/08/IntPestMgmt-HO_Guide.pdf

[20] University of Florida, Avoid These 5 Common Landscaping Mistakes, Gardening Solutions, http://www.gardeningsolutions.ifas.ufl.edu/giam/news/2009/five_mistakes.html.

streams. Assessment protocols and field sheets are available to help you identify and address hot spots. One example of a national standardized method is the Hot Spot Investigation, provided by the Center for Watershed Protection, Inc.[21] Hot spot investigations quickly identify pollution sources and potential pollution sources that can be corrected before they contaminate your stream.

f. Handling Household Automotive Fluids, Chemicals and Pet Waste Appropriately

Many household chemicals, including automotive fluids, can contaminate water and harm human health and animal life. The most common automotive fluids are brake fluid, power steering fluid, transmission fluid, gasoline, diesel gas, windshield wiper fluid, antifreeze and motor oil. Some household chemicals and products that can cause water pollution include fertilizer, cleaning fluids, and batteries. In addition, pet waste can cause water pollution and human disease.

As discussed earlier, some of these household chemicals are used on lawns and can be washed into rivers and streams when it rains. But, household chemicals also can contaminate water in a variety of other ways such as motor vehicle leakages, disposal down a storm drain, failure to pick up pet waste and garbage bag leakages. In these cases, the chemicals or waste enters sewers or storm drains and may flow directly into streams untreated. In addition, in some cases disposal down a household drain can result in water pollution. For example, paint remover usually contains the chemical methylene chloride, which cannot be broken down by septic tanks. Flushing paint remover down the sink or toilet will cause the methylene chloride to contaminate water sources and potentially harm human health and other living organisms. Chlorine and bleach cannot be treated by septic tanks or municipal sewage systems. Appendix 3 includes a list of resources that contains more information about household chemicals and water pollution.

Chemicals found in automotive fluids can harm the environment and humans in a variety of ways. Many automotive fluids contain high levels of heavy metals that poison organisms and disrupt their living processes. Heavy metals also remain in water ecosystems for a long time. Antifreeze will deplete a water source's oxygen levels and kill wildlife, including fish. In addition, motor oil can severely harm organisms inhabiting any water ecosystem. Although individual households may contribute minimally to water pollution, an entire neighborhood or city of households can severely pollute water sources. In fact, households currently contribute to more than 60% of water pollution.[22] Appendix 3 includes a list of resources that contains more information about automotive fluids.

Pet waste left on the ground can be washed into rivers and streams when it rains or snows. Pet waste can cause oxygen depletion and ammonia release, which harms wildlife and can kill fish. Pet waste also carries disease. Children and adults exposed to water sources contaminated by pet waste risk infection from bacteria and parasites.[23] Appendix 3 includes a list of resources that contains more information about pet waste.

To help keep your community's rivers, streams and lakes free from household chemical pollution, including automotive fluids and pet waste you can:

- Stop drips from your car and check for oil leaks regularly;

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[21] Wright, Tiffany et, al., Unified Subwatershed and Site Reconnaissance: A User's Manual, Center for Watershed Protection, 2005. http://www.cwp.org/online-watershed-library?view=docman.

[22] City of Carmel Engineering Department, Autofluids Fact Sheet, http://www.carmel.in.gov/modules/showdocument.aspx?documentid=179/showdocument.aspx?documentid=179.

[23] Wisconsin Department of Natural Resources, Pet Waste and Water Quality, 1999, http://clean-water.uwex.edu/pubs/pdf/pet.pdf.

- Keep your car tuned to reduce oil use;
- Use a drip pan or ground cloth when you repair your car engine to collect any spillage;
- Store fluids in containers with tight fitting lids;
- Make sure trash bags are securely closed and do not leak;
- Pick up after your pets;
- Do not pour certain chemicals down the sink;
- Never pour household chemicals or automotive fluids down a storm drain, into a ditch or onto the ground.
- Contact your local recycling facility or public works department to find out where to dispose of household chemicals.[24]

In addition, fluids including motor oil, antifreeze, and transmission fluid can be recycled and reused. Many auto supply stores and gas stations will accept used fluids. You can call 1-800-287-9013 to find an oil collection center near you.[25] You can also buy re-refined oils, which work just as well.

Finally, because some household chemicals, including automotive fluids, are considered hazardous by the EPA and TDEC, you can check TDEC's website for additional tips on proper disposal that reduces and prevents water contamination, among other environmental harms.

Indirect Actions You Can Take to Restore Streams:

- Use Rainwater Harvesting Systems
- Promote Water Detention and Water Retention Systems
- Build Water Infiltration Systems
- Use Lawn Chemicals Properly
- Identify and Correct Pollution Hotspots
- Handle Household Automotive Fluids, Chemicals and Pet Waste Appropriately

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24 Recycling.org, Tennessee Local Recycling Centers, http://www.recyclingcenters.org/Tennessee/.

25 Tennessee Department of Environment and Conservation, Used Oil Program, http://www.tn.gov/environment/solid-waste/solid-waste_used-oil.shtml.

Part IV: How You Can Take Action Under State and Federal Water Quality Laws

Part IV provides an overview of opportunities for citizen engagement under the federal CWA and the Tennessee Water Quality Control Act, the key laws that protect water quality in Tennessee.

The main ways citizens can get involved under the federal and state clean water laws are: (1) comment on proposed permit conditions, (2) notify the state of violations, and (3) bring lawsuits under the CWA's "citizen suit" provision and Section 118(a) of the Tennessee Water Pollution Control Act.

A detailed description of the CWA, which includes citations to the law, is included in Appendix 7. This appendix provides useful background information about the citizen involvement activities that are outlined in this Part.

I. What You Need to Know About the Federal Clean Water Action and the Tennessee Water Quality Control Act

The federal CWA was passed in 1972, and the Tennessee Water Quality Control Act was passed in 1977. The EPA has given the State of Tennessee and many other states the authority to implement federal CWA programs with federal oversight.

The laws make it illegal to discharge pollutants from any "point source" into the waters of the United States without a permit. Point sources include, for example, factories and sewage treatment plants. In contrast, "non-point source" pollution, which is caused by rain and snow melt that picks up pollutants from the ground and deposits them in rivers, lakes, and streams, is typically from many spread-out sources and does not require a permit. However, some stormwater pollution is considered to be point source pollution, including some local government stormwater systems and some construction sites, and therefore does require a permit.

a. National Pollution Discharge Elimination System (NPDES) Permits and Section 404 Permits Help Protect Water Quality

The CWA created two nationwide permitting programs: (1) NPDES permits, and (2) Section 404 or dredge and fill permits.

i. NPDES Permits

A point source must get a NPDES permit before it can discharge pollutants into the water. Stormwater discharges from mostMS4s, construction activities, and industrial activities must get special "stormwater NPDES" permits.

Because Tennessee runs the NPDES program (with oversight from EPA), the TDEC Division of Water Resources reviews permit applications and drafts the permits. More information about the Tennessee NPDES permit program is available on TDEC's website.[26]

ii. Section 404 Permits

Section 404 of the CWA requires permits for the discharge of dredged or fill material into the waters of the United States (including wetlands). These permits are known as dredge and fill permits or Section 404 permits. The U.S. Army Corps of Engineers runs the Section 404 program in Tennessee. More information about Section 404 permits is available on EPA's website.[27]

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[26] Tennessee Department of Environment and Conservation, National Pollution Discharge Elimination System (NPDES) Permit, http://tn.gov/environment/permits/npdes.shtml.

[27] United States Environmental Protection Agency, Section 404 Permitting, http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/.

b. How to Search for Water Permits

TDEC maintains active databases, called Dataviewers, which are available on the agency's website.[28] You can click on Water Resources Permits Dataviewer to view current lists of water permits, permit appeals, complaints, inspections, and exceptional Tennessee waters.

TDEC also has a Mapviewer that you can use to search for existing water permits online.[29] You can find existing permits by zooming into the map until small colored icons appear. Each icon represents a permit. To learn more about a particular permit, click on the icon. You can also search for permits in a particular location by entering the address in a box on the upper right-hand side of the screen.

c. How to Participate in the Permitting Process

Citizen involvement in the permitting process is important to ensure that permit conditions reflect input from the local community. If citizens do not participate in permit decisions, the final permit is less likely to reflect their concerns. Citizen participation reminds polluters and permit writers that citizens want clean water and that they support protective permit conditions to control pollution.

Public participation opportunities are posted on TDEC's website.[30] To view public notices and hearings that relate to water, scroll down the page until you reach the "Water" heading. The notices are arranged by date, with the most recent ones at the top. There is a link to each document next to the date it was issued, so you can easily view the notices that most interest you.

i. Comment on a Draft Permit Action, Request Permit Details, and Request a Public Hearing

On the TDEC website, look for notices requesting public comments on draft permit actions. These will include a list of draft permits, followed by instructions on how to comment, how to request a public hearing, and how to obtain permit details.

ii. Attend a Public Hearing and Submit Comments

Notices of public hearings will include the date, time, and location of the hearing, and will contain instructions that will tell you what to do if you want to submit comments or speak at the hearing. Submitting comments or speaking at the hearing preserves your ability to appeal the final permit decision.

iii. Appeal a Permit Decision

Notices of permit decisions trigger the start of a thirty-day period in which the decision can be appealed. You can only appeal a permit decision if: (1) you participated in the public comment period or gave testimony at a formal public hearing, or (2) for any permit that was subject to public comment, you can appeal if the final permit contains significant changes from the draft permit, unless the change was subject to an additional opportunity for public comment.[31]

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[28] Tennessee Department of Environment and Conservation, Dataviewers, http://tn.gov/environment/dataviewers.shtml.

[29] Tennessee Department of Environment and Conservation, Water Resources Permits, http://tdeconline.tn.gov/tdecwaterpermits/.

[30] Tennessee Department of Environment and Conservation, Public Participation Opportunities, http://tn.gov/environment/ppo/.

[31] The process is governed by state law. Tennessee Code 69-3-105(i)), http://www.lawserver.com/law/state/tennessee/tn-code/tennessee_code_69-3-105.

d. How to Report Violations and Concerns

You can help protect Tennessee's waters by identifying and reporting environmental concerns and violations. If you think a company is causing water pollution or is causing other violations of Tennessee's environmental regulations, you can file a complaint with the local Environmental Field Office. You may file a complaint by phone, in writing or by email. Appendix 5 includes a list of the Field Offices and phone numbers and addresses.

e. How to File a Citizen Suit Under the Federal Clean Water Act

The CWA citizen suit provision authorizes any citizen to bring a lawsuit against anyone who violates the statute. Violators include point sources that discharge pollutants without a permit, as well as point sources that violate their permits. Citizens can also bring suit against EPA if the agency fails to do anything that it is required to do under the CWA.

Before filing a citizen suit, a citizen must provide notice to: (1) EPA, (2) TDEC, and (3) the alleged violator. If EPA and TDEC do not take action against the violator, the citizen suit may be filed after 60 days have passed. If EPA or TDEC do take action, any citizen may intervene (i.e., may participate) in the lawsuit. Citizen suits must be filed in federal district court in the place where the violation occurred or is occurring.

Citizen suits are an extremely effective way to ensure that people do not violate the CWA, and that violators are appropriately penalized. TDEC and EPA have limited resources and cannot bring suit against every person who violates the CWA. Citizens can fill this gap by making sure that people who violate the law are held accountable. Citizen suits tell all permit holders that citizen groups are watching and will make sure that they follow the law, which can help deter permit holders from violating their permits. Finally, citizen suits hold violators and permit writers accountable and ultimately can lead to cleaner streams.

See Table 3 for a list of organizations and contacts that may be able to help you file a citizen suit.

Part V: Conclusions

Clean water is critical to Tennesseans' quality of life, economy and communities. Many streams in Tennessee, in particular urban streams, are polluted and do not meet their designated uses for recreation, aquatic life and other uses. Citizen engagement and understanding is critical if we are ever to get these streams cleaned up and fully fishable and swimmable. This Citizen Action Guide to Watershed Assessment and Restoration is intended as a step toward engaging citizens in the goal of cleaning up our Tennessee waterways.

The Action Guide covers much of the science that citizens, stormwater directors, educators and students need both to assess and to restore our streams, including sections on watershed mapping, assessment and restoration. Part I of the Action Guide provides important background information and the regulatory basis for cleaning up our rivers and streams. It also explains why it is critical for citizens to be engaged in the process of assessment and restoration. Part II and Appendix 2 address watershed assessment methods and include background on basic watershed science, watershed mapping and water quality monitoring. The water quality monitoring section outlines the methods for carrying out visual stream assessments, aquatic insect sampling and physical/chemical sampling. These data form the basis for action.

Part III and Appendix 3 begin to help citizens design and take actions to clean up the streams in their neighborhoods, towns and counties. This section is perhaps the most critical of all in that it contains much of the information needed to restore your stream, to make it fishable and swimmable again. While the Action Guide is not comprehensive, it does include many actions proven to be effective in watershed restoration. It also includes many resources you can use to gain further knowledge that will help in designing and implementing effective projects.

Part IV and Appendix 7 address legal remedies under the Federal Water Pollution Control Act (Clean Water Act), including how to get engaged in the permitting process. This activity is critical to the issuance of effective permits, as often times the only outside interest involved in the permitting process is the permittee. Citizen interests are necessary to keep the permit balanced.

The Action Guide is designed to achieve just that: ACTION! By understanding the basics of watershed science and assessing your watershed and streams, you will be capable of designing and implementing restoration strategies and techniques that can make your local streams fishable and swimmable again.