Appendix 2 - Stream and Watershed Assessment Tools and Data Sheets

Introduction

The water quality sampling protocols below were developed by the U.S. Tennessee Valley Authority (1996) for use in the Tennessee Valley region. The Tennessee Scenic Rivers Association's Duck River Opportunities Project (now housed at Tennessee Environmental Council (TECTN.org)), the Harpeth River Watershed Association (www.HarpethRiver.org) and Cynthia Rohrbach, an aquatic biologist formerly with the Tennessee Department of Environment and Conservation, condensed the protocol into the following pages. It is by no means designed to be all inclusive, as there are many aspects to water quality monitoring. Nevertheless, this protocol will help you conduct sampling that generates quality results, which can provide a basis for watershed restoration and other actions necessary for clean water. Time and experience will make you an expert!

Sections include the following:

1. **Visual Stream Assessment Guidance and Data Sheets**

PART I – General information

1. Fill in the requested information. If it is in bold type we need you to circle your answer.
2. Sub-watershed: This refers to the specific stream you are on (e.g., West Harpeth is the larger watershed and Polk Creek)
3. Map #/name: This refers to the 7.5 minute series USGS topographical map. One could also use the Tennessee Gazetteer, giving page number and quad of location (i.e. B1).
4. Point #: This refers to the point you make on the USGS topographical or other map to identify the site.
5. Lat./Long.: If you have a GPS unit, record this in the field. Or, retrieve the information from Google Earth.
6. Flow: This information will be acquired from the nearest USGS gauge (on the internet) or estimate as low, medium or high based on channel fullness. There are more accurate field methods referenced in the data sheet.

PART II – Weather data

1. Acquire from the internet, local weather station or personal observation.

PART III – Land use information

1. Check each land use that applies to the specific-site along the stream.
2. Specify the exact nature of each type of land use (e.g., residential, single family homes).

PART IV - Other

1. This section contains information about the stream and its surrounding characteristics. Many of these are indicators of stream health or problems. The section requests data on litter, algae (indicator of nutrient pollution), stream side vegetation, stream bank erosion, water color and odors, streambed characteristics, discharge pipes, and fish indicators. Circle the condition or conditions (e.g., no litter) that best apply to your stream.

PART V - Pictures

1. Identify the picture numbers, the direction in which the picture was taken, and description of picture. Photograph any unusual condition(s) observed.

PART VI – Comments

1. Add any comments you believe may help target this site for more detailed field review or to guide improvement efforts.

PART VII – Diagram of the site

1. Draw a simple diagram of the site. Show the stream meanders, roads and the locations of land uses identified in PART III. Indicate picture locations on diagram.

PART VIII – Stream Visual Assessment Score

1. Riparian zone is the land area next to the stream. This category asks one to measure (estimate by stepping it off) the width of the riparian zone, rating both the right and left bank. In addition, investigators should add in the comments section information about the type of vegetation in the riparian zone. A healthy riparian area has trees, shrubs and herbaceous vegetation. For example, one might see large trees, some privet (shrub), but no herbaceous vegetation.

2. Bank stability is important as a measure of erosion or erosion potential. It should be assessed for both the right and left banks. Some bank instability is normal in streams. However, excess bank instability leads to sedimentation and additional erosion. In addition, this category may reflect some streamside land uses.

3. Canopy cover is the shade provided to the water by the overstory or trees. It is important to streams as it helps to keep the water cooler and generally indicates that the stream will receive a leaf load during fall. Canopy cover is estimated in percent by the investigator. The larger streams (e.g., main stem of the Stones River) do not have the potential for the optimal rating in this category. And, depending on the time of year and time of day this characteristic could change (e.g., no leaves on the trees = less shade)

4. Aquatic insect / invertebrate habitat is important when stream biologists assess the health of an aquatic system. Pollutants (e.g., sediment) can reduce the number of habitats and/or degrade their quality. The five habitat types are riffles, submerged woody materials, undercut banks, vegetated banks and leaf packs. Following is a brief description of each.

- **Riffles:** areas where fast moving water "bubbles" over rocks (AKA whitewater), which may include narrow, deeper channels that have swift moving water.
- **Submerged woody materials:** logs, sticks and twigs that may be overhanging into the water or completely underwater and woody material that has been in the water for some time, but not recent deadfall or woody material that has collected in pools.
- **Undercut banks:** banks where overhangs exist, often times associated with tree or vegetation root systems.
- **Vegetated banks**: areas where vegetation overhangs into the water and many times associated with undercut banks.
- **Leaf packs:** areas where leaves have built up in the stream, typically in riffles, runs or along the stream margins or anywhere leaves are carried by the flow and trapped by sticks, rocks, etc.

5. Riffle and pool sedimentation describes the amount of silt that has settled out into the different habitats. This characteristic is important, as it indicates the potential quality of habitat for the aquatic insects.

6. Water appearance and characteristics includes color of the water, as well as the presence or absence of surface film, scum, oil, etc. Any condition (e.g., oil on the surface) that applies should be circled or included in the comments section if not identified in the rating.

7. Nutrient enrichment is an important characteristic, as many streams are impaired by an overabundance of nitrates and phosphates. The main indicator of nutrient enrichment is excessive green filamentous algae. However, other aquatic plants may be present and other types of algae (e.g.., brown bottom dwelling) may exist in the stream. Investigators should know how to tell the difference between filamentous or hair-like algae and mosses.

8. Channel condition is important as it represents activities (e.g., gravel dredging) that may be occurring or have occurred in the stream. Circle the condition that best applies to the site.

9. Total stream visual assessment score represents the overall quantitative rating for the site. Category 1 through 8 are added together the get the score.

Data Sheet 1: Stream Visual Assessment

Part I – General Information

Investigator(s)	
Contact information	
Date/Time	
Stream Name	
Sub-Watershed	
County	
Location (give roads, directions to the site)	
Map # / name	
Point # (on map)	
Lat./long.	
Flow @ nearest USGS gauge or estimate	low - medium - high

Part II - Weather Data

Weather in past 24 hours		Current weather	
Storm (heavy rain)		Storm (heavy rain)	
Steady Rain		Steady Rain	
Intermittent Rain		Intermittent Rain	
Overcast		Overcast	
Clear/Sunny		Clear/Sunny	

Part III - Specific Land Uses Identified (check as many as apply).

	Streamside (< 200')	< ¼ mile from stream bank	> ¼ mile from stream bank
Residential			
Agricultural			
Forestry			
Commercial (shopping centers, etc.)			
Industrial			
Development/ construction			
Mining			
Parkland			
Other (please specify)			

Please specify the exact nature of the land uses identified above (e.g., agricultural: livestock are in the creek or row crops are next to stream) and any comments.

Part IV – Other (circle all that apply to the site)

Litter		
No litter visible - Small litter **Occasional** (cans, etc.) - Small litter **Common**		
Large litter **Occasional** (tires, shopping carts, etc.) - Large litter **Common**		
Algae Present **Yes** **No**		
Green algae present in **no/few/several / many** spots		
Brown algae covers **no/few/several / many** rocks		
Riparian Zone Vegetation		
Right bank - Estimated width = _____ feet **Trees/Shrubs/grasses or herbaceous**		
Left Bank - Estimated width = _____ feet **Trees/Shrubs/grasses or herbaceous**		
Erosion		
Right Bank - Stream bank erosion in **no/few/several/many** spots – Estimated length = **_____** feet		
Left Bank - Stream bank erosion in **no/few/several /many** spots – Estimated length = **_____** feet		
Artificial areas of stream bank stabilization present (e.g., rip rap) - **Yes or No**		
Is sediment present in the middle of the stream? **Yes or No** On the margins of the stream? **Yes or No**		
Water Color/odor - **Please describe-**_____		
Special Problems		
Chemical spills, fish kills, wildlife/waterfowl kills *		
Flooding, Periods of no flow		
Streambed (circle all that apply)		
Bottom deposits?	Stability – stream bed sinks beneath your feet in?	What does the streambed consist of?
Grey	**No spots**	____ % silt (mud)
Orange/red	**A few spots**	____ % sand (gritty)
Yellow	**Many spots**	____ % gravel (1/4" to 2" stones)
Brown		____ % cobbles (2" – 10" stones)
		____ % boulders (> 10" stones)
Discharge Pipes		
Are there any discharge pipes located in the area that you sampled? **Y** or **N**		
What type of pipes?		
_____ Sewage treatment plant		
_____ Storm water runoff		
_____ Other		
Fish Indicators		
____ scattered individuals		
____ scattered schools		

* If observed contact -- as soon as possible -- your local Stormwater Coordinator, Tennessee Environmental Council and your TDEC Field Office (Table 3).

Part V - Pictures & comments

Picture #	Direction (upstream or downstream)	Description

PART VI **- Comments**: Add any information that may help target areas for more detailed review or to guide improvement efforts.

Part VII **- Sketch of Site**: Draw a general diagram of the site showing stream meanders, roads, fields, etc. below or on back of this sheet.

Part VIII - Stream Visual Assessment Score (Adapted from Stream Visual Assessment Protocol; National Water and Climate Center, Technical note, 99-1; United States Department of Agriculture, Natural Resources Conservation Service)

DIRECTIONS: Using the tables below circle the number of the condition that best represents the specific site characteristics. Please feel free to add comments to explain your rationale for scoring a particular category.

1. Riparian zone (rate each bank - A healthy riparian area has trees, shrubs and herbaceous vegetation.

Vegetation extends at least 30 to 40 feet or more from the top edge of stream bank.	Vegetation extends at least 20 to 30 feet from the top edge of stream bank.	Vegetation extends at least 10 to 20 feet from the top edge of stream bank.	Vegetation extends less than 10 feet from the top edge of stream bank.
Right Bank-4	**3**	**2**	**1**
Left Bank -4	**3**	**2**	**1**

2. Bank Stability (rate each bank)

Banks are mostly stable. 75% or more of bank surface is protected by roots and/or vegetation that extend from top of bank to the water.	Moderately stable. 50% to 74% of bank surface is protected by roots and/or vegetation that extend from top of bank to the water.	Moderately unstable. 25% to 49% of bank surface is protected by roots and/or vegetation that extend from top of bank to the water. Active erosion is occurring.	Unstable; 0 % to 24% of bank surface is protected by roots and/or vegetation that extend from top of bank to the water. Active erosion is occurring
RB - 4	**3**	**2**	**1**
LB – 4	**3**	**2**	**1**

*3. Canopy cover- S*hade provided to the water by the over story or trees; leaves on or off affect shade.

> 75% of water surface shaded -- generally well shaded.	50% to 75% of water surface shaded.	25% to 49% of water surface shaded.	< 25% of water surface shaded.
4	**3**	**2**	**1**

4. Aquatic insect / invertebrate habitat

Five (5) habitat types present.	Four (4) habitat types present.	Three (3) habitat types present.	Two (2) or fewer habitat types present.
4	**3**	**2**	**1**

Habitat types (*descriptions in Section II under aquatic insect sampling*)..

1. *Riffles* - areas where fast moving water "bubbles" over rocks - (also known as “Whitewater").
2. *Submerged woody materials* - logs, sticks and twigs overhanging into water or completely underwater.
3. *Undercut banks* - banks where overhangs exist, many times associated with tree root systems.
4. *Vegetated banks* - areas where vegetation overhangs into the water.
5. *Leaf packs* - areas where leaves have built up in the stream.

5. Riffle & pool sedimentation

Riffles or pools < 20 % covered***** with sediment (silt or mud).	Riffles or pools 20% to 40% covered with sediment (silt or mud).	Riffles or pools 40% to 60% covered with sediment (silt or mud).	Riffles or pools > 60% covered with sediment (silt or mud).
4	**3**	**2**	**1**

* *Covered refers to how much silt has built up around rocks or other submerged material.*

Part VIII - Stream Visual Assessment score (cont.)

6. Water appearance/characteristics

Clear or slightly tea-colored; No substances present on surface.	Water slightly cloudy. No substances present on surface. Slight green tint may be present.	Water moderately cloudy. Pools or runs may appear pea green; bottom rocks covered with heavy green or olive film. Or, may be odor of rotten egg or ammonia.	Water very cloudy or muddy. Areas may be bright green, other obvious pollutants present; floating alga mats, surface scum, sheen or heavy coat of foam on surface. Or, may be strong odor of chemicals, oil, sewage or other pollutant.
4	**3**	**2**	**1**

7. Nutrient enrichment

Clear water present; lots of different kinds of plants present; little algae growth present (< 10% of stream affected).	Fairly clear or slightly greenish water present; moderate algae present (10% to 30% of stream affected).	Greenish water present; numerous lush green aquatic plants; abundant algae (30% to 70% of stream affected).	Pea green, gray or brown water present; dense stands of plants may clog stream; severe algae present (> 70% of stream affected).
4	**3**	**2**	**1**

8. Channel condition

Natural Channel; no structures, dikes or evidence of erosion along banks or streambed.	Evidence of past channel alteration, but significant recovery of channel and banks. Some evidence of erosion along banks or streambed may be present.	Altered channel; <50% bank armored with large rock or similar non-natural material and/or channelization present.	Streambed/banks are actively eroding or widening; >50% of streambank with riprap or channelization.
4	**3**	**2**	**1**

TOTAL SCORE: _____

COMMENTS (use additional sheets if needed):

Scores range: 0 – 40

_____ 34 – 40 – Excellent
_____ 28 – 33.9 – Good
_____ 22 – 27.9 – Fair
_____ < 22 – Poor

2. Aquatic Insect Assessment Guidance and Data Sheets

I. Visual Stream Assessment (see Section 1 and Data Sheet 1 above)

The team should fill out the entire Visual Stream Assessment (VSA) every time the Aquatic Insect Assessment is conducted. Locate your sampling site and the area 50 yards upstream and downstream of your sampling point (i.e. riffle area) on a USGS topographic map or any other local map marked with streams and rivers. This information may help determine whether a problem is due to a habitat limitation, such as poor bank conditions. The information can also explain why an aquatic insect assessment improves, such as when fencing cows out of a stream. Questions about land use in the area may have to be determined on the way to or from the site, but make a good attempt to complete the land use section. You may also want to refer back to Appendix 1 on Watershed Science and Mapping to better understand land use.

II. <u>Aquatic Insect Assessment</u>

Macro invertebrates are relatively stationary in a stream and are, to varying degrees, sensitive to pollution. Changes in their numbers and kinds may illustrate the impact pollution is having on the stream. It is important to sample a stream in different seasons to learn what is typically found there in the different seasons. Familiarity with the stream organisms and water quality is invaluable in determining if there has been degradation or improvement.

<u>Sampling Procedure</u>[1]

Sampling should be done as uniformly as possible at all sites. You should use two sampling techniques with two different types of nets: riffle or run sampling with the kick seine and multi-habitat sampling with the D-net. All samples will be combined in a large picking tray and sorted into major taxonomic groups for at least 30 minutes.

The following habitat types may be sampled:

- **Riffles** – shallow areas where fast-moving water "bubbles" over rocks of different sizes (boulders are >10 inches; cobbles are 2-10 inches; gravel is 0.1-2 inches; sand is up to 0.1 inch and has a gritty feel; silt/clay/mud has the finest particles that make the water cloudy when stirred up). Riffles are the most productive areas in the stream and should almost always be sampled. Use a kick-seine for this habitat (see procedure below).
- **Runs** – transition zones connecting riffles and pools with deeper, less turbulent water. The substrate is mostly sand, gravel, and cobbles. Use a kick-seine for this habitat (see below).
- **Pools** – the deepest areas with slow-moving water and sandy/silty substrates. Use a D-net, placing the net with one edge against the stream bottom, and push it forward in an upstream direction about 1 foot to dislodge the first few inches of sediment. To avoid gathering a net full of mud, sweep the bottom of the net back and forth in deep water to allow fine silt to rinse out of the net before emptying the net into the sample container**. PLEASE do not add a net full of mud** to the sample container.

[1] Tennessee Wildsides Watershed Education Video, available at: http://tectn.org/programs/watershed-support-center/.

- **Root mats and vegetated bank margins** – submerged root mats attached to banks and submerged overhanging bank vegetation. Use a D-net, jabbing the roots and vegetation vigorously, brushing with an upward motion and keeping the net underwater.
- **Submerged snags and logs –** woody material that has been in the water for some time, not recent deadfall. Hold a D-net with one hand, downstream of the section of submerged log to be sampled. With the other hand gloved or using a scrub brush, rub about 1 square foot of the log, and scoop whatever organisms, bark, twigs, or other organic matter you dislodge into your net.
- **Leaf packs –** areas where leaves have become trapped along the bank, between rocks or logs. Use a D-net to scoop up a leaf pack. Scoop in an upstream direction so that organisms and organic matter will float into the net.
- **Aquatic vegetation beds –** beds of submerged or emergent green, leafy plants that are rooted in the stream bottom. Use a D-net to jab vigorously with an upward motion through the plant bed, keeping the net underwater so that only aquatic (not terrestrial) organisms are captured.
- **Algae-covered rocks or bedrock –** Look for areas where caddis fly larvae, black fly larvae, snails, or other attached organisms can be seen. Facing upstream, hold the D-net downstream from about a 1-foot square area that you rub with a gloved hand or scrub brush so that the organisms will float down into the net.

How to collect aquatic insect samples:

1) Locate your sampling area around a couple of gravelly riffles or runs with other habitats, if possible. Make sure to check your sampling area for glass or other sharp objects that could cut or puncture a boot and/or skin.
2) Find a flat, sunny spot to set up the sorting station with items from the Aquatic Insect Sampling Equipment Check List (page 18).
3) Always sample from downstream to upstream to prevent contaminating the downstream waters or disturbing the critters.
4) Choose 3 ft. x 3 ft. area of a turbulent riffle to sample with the kick-seine.
5) Place the bottom of the net against the bottom of the stream. You may want to put some rocks on the bottom of the net to help hold it down.
6) Once the net is down, disturb the creek bottom by kicking into the center of the 3 X 3 ft. area. This dislodges the aquatic insects who then flow into and are trapped by the net. Be careful not to allow water to flow over your net or to have the net too vertical. Ideally the net is placed at about a 45 degree angle held in place by your sampling partner while you do the kicking.
7) Once you have kicked up the entire 3 X 3 ft. area, carefully lift the lower end and upper end of the net to remove the sample from the stream. You and your partner should pick up the net in the middle and on the edges to make a pocket so the insects won't fall out.
8) Empty the sample into a large sorting tray or five gallon bucket by placing the net bottom into the container and scraping the material. Rinse the net a few times to make sure you have washed all the insects into your container.
9) Take a second sample, preferably from another riffle, and add it to the first sample.
10) Use D-nets to collect samples from any of the other habitats described above that are present at the site.

11) Follow the directions above for each of the habitats. Rinse the net with jugs of water into the composite sample.
12) If there is too much water in the sorting tray, carefully pour some off through the net to prevent losing insects.
13) Examine the net closely and handpick worms and other critters that get stuck in the mesh. These can be put directly in the compartmentalized sorting tray, which has water added to each section.

Sorting Procedure

There should be many swimming and crawling organisms in the sample. Release fish, amphibians, or reptiles back into the creek. Capture crayfish and isolate them in a larger separate container of water for counting. They can be released after counting. Team members should gather around the composite sample and, using plastic spoons or forceps, capture every organism possible. Use the bug identification cards and sort like organisms into the cups of the compartmentalized sorting tray. It helps simplify the capture of macro invertebrates if leaves, stones, and large organic matter are examined first and discarded. Many organisms can be found on the surfaces of leaves and rocks, such as water pennies, stoneflies, and mayflies.

Sort the sample with the group for at least 30 minutes, attempting to find all the different kinds of macro invertebrates present in the sample and as many of each kind as possible. If organisms are very small, use the bug magnifier box or hand lens to try to identify them. When you are finished picking, look over the sorting tray and refine the initial sort so that like individuals are placed in the same section. If an organism cannot be identified, put several specimens of it in an alcohol-filled vial to be identified later.

Resources for Identifying Aquatic Insects and Determining Stream Health

1) Hoosier River Watch, Taxonomic Key to Benthic Macroinvertebrates: http://alvaroalonsodocencia.wikispaces.com/file/view/Guia+Benthic+Macroinvertebrates.pdf
2) Texas A&M University, Entomology: https://insects.tamu.edu/extension/insctans/identification/
3) Insect Identification: http://www.insectidentification.org/identifying.asp
4) What's that Bug?: http://www.whatsthatbug.com/
5) Iowa State University, Entomology: http://bugguide.net/node/view/15740
6) Penn State University, Entomology: http://ento.psu.edu/public/insect-images

Counting the Critters

A team member should take responsibility for recording the data, including the site information at the beginning of the data sheet. On the data sheet, note the number of individuals of each type of organism you have identified and separated into a cup of the sorting tray. When you have identified all the organisms as best as you can, return them to the creek.

Assign one of the following abundance codes to each type of organism. Record the code next to the actual counted number on the data sheet.

R (rare)	=	if 1-9 individuals are found
C (common)	=	if 10-99 individuals are found
A (abundant)	=	if 100 or more organisms are found

You will see on Izaak Walton League and other aquatic insect data sheets, referenced above, the columns represent groups of organisms based on their ability to handle/tolerate pollution.

Group I (sensitive to pollution)
Group II (somewhat sensitive to pollution)
Group III (tolerant of pollution)

Calculating a Water Quality Rating

This method of water quality rating takes into account the pollution sensitivity of the organisms and their relative abundance in the sample. This is accomplished through use of a weighting factor, which gives more weight to the more sensitive organisms.

Add the number of R's, C's and A's in each column, and calculate an index value for each group according to the chart on the data sheet. Add the index values for each group together to get a water quality rating score. Compare the score to the number ranges on the data sheet to determine a rating of Excellent, Good, Fair, or Poor for this stream site.

Data Sheet 2: Aquatic Insect Survey

Investigators names and affiliations (School, students)	
County:	**State:**
Stream Name:	
Monitoring Location (give specific location):	
Site Number on Map:	
Date:	**Time:**

SAMPLING LOCATIONS (Check all that apply)

Riffle _____ Submerged Snags and Logs _____
Run _____ Aquatic Vegetation Beds _____
Pool _____ Algae-covered Rocks or Bedrock _____
Submerged Root Mats and Vegetated Bank _____
Leaf Packs _____

Aquatic Insect Count

Identify the aquatic insects in your sample, write the number of each, and assign a letter code based on how many are present:
R (rare) = 1-9 organisms C (common) = 10-99 organisms A (abundant) = 100 plus

Group I Sensitive	Group II Somewhat Sensitive	Group III Tolerant
___ ___ caddisfly larvae	___ ___ beetle larvae	___ ___ aquatic worms
___ ___ hellgrammites	___ ___ clams	___ ___ leeches
___ ___ riffle beetle adult	___ ___ crayfish	___ ___ midge larvae
___ ___ mayfly nymphs	___ ___ crane fly larvae	___ ___ blackfly larvae
___ ___ gilled snails	___ ___ damselfly nymphs	___ ___ other snails
___ ___ riffle beetle adult	___ ___ scuds	
___ ___ stonefly nymphs	___ ___ sowbugs	
___ ___ water penny larvae	___ ___ dragonfly nymphs	
	___ ___ limpets	

To calculate the index value, add the number of letters found in the three Groups above and multiply by the indicated weighting factor. Then add the column to get the index value for each Group.

Group I	Group II	Group III
___ # of R's x 5.0 = _____ ___ # of C's x 5.6 = _____ ___ # of A's x 5.3 = _____ Index Value for Group I = _____	___ # of R's x 3.2 = _____ ___ # of C's x 3.4 = _____ ___ # of A's x 3.0 = _____ Index Value for Group II = _____	___ # of R's x 1.2 = _____ ___ # of C's x 1.1 = _____ ___ # of A's x 1.0 = _____ Index Value for Group III = _____

To calculate the water quality score for the stream site, add together the index values for each group. The sum of these values equals the water quality score: _____.

Water Quality Rating

Compare this score to the following number ranges to determine the quality of your stream site.

- Excellent (>39)
- Good (39-26)
- Fair (25.9-17)
- Poor (<17)

3. Field Water Chemistry and Physical Conditions Guidance and Data Sheets

Take the water samples for the chemical tests upstream from the aquatic insect sampling area in order to get the cleanest water possible. Have only one person at a time enter the stream to collect water and avoid muddying the area downstream. Read and follow the directions included with each test kit before conducting the test. The directions should be self-explanatory. The following test kits can be used:

- **Turbidity** – do this test first to get the cleanest water. See turbidity testing section below.
- **Dissolved Oxygen** – be sure to completely fill the sample bottle to overflowing with water so that when the tablets are added and lid replaced, there is no air in the sample
- **Temperature**
- **pH**
- **Nitrate**
- **Phosphate**

Each test should be repeated a minimum of three times. A team member should be chosen to record the results on the Water Chemistry and Physical Conditions Field Data Sheet 3.

Turbidity Testing

Turbidity tubes are a relatively reliable testing method for turbidity. The tubes can be purchased or built from readily available parts. A turbidity tube is marked with centimeters on its side and has a black and white pattern on the bottom. A water sample is added to the tube until it is impossible to see the pattern.

The more turbid the water, the less water is needed to block the pattern at the bottom of the turbidity tube. The basic principle of a turbidity tube is that the more material in a stream, the cloudier the water.

For consistency, three separate samples should be collected and evaluated at each site. Although this test does not give an absolute value for turbidity, relative values are still very important. For example, suppose a sample from a stream at normal low flow is clear even when filled to the top of the tube. That stream has low turbidity under normal conditions. If a sample is taken from the same site during or immediately after a rain, and it takes only ten centimeters to block the view of the pattern, you can say with some certainty that stormwater runoff contributes to turbidity in the stream.

Streams with the highest turbidity readings can be targeted for more investigation. If a turbidity meter is available, a chart can be created to show how the turbidity tube readings correlate to the meter readings. This should be done in each watershed because both chemical composition (dissolved materials) and suspended materials affect turbidity, and water chemistry differs from watershed to watershed.

Data Sheet 3: Field Water Chemistry and Physical Conditions

Date_____ Time_____ Location _____

Sampling team/persons _____

Parameter/ Replicate #	1	2	3	4	5	6
Dissolved Oxygen (ppm) Should be >5ppm						
-pH (SU) should be between 6-8						
Temperature (degrees C)						
Nitrate (ppm) <1ppm						
Phosphate (ppm) <1ppm						
Turbidity (JTUs) <25						
Flow[2] (cfs)						
Velocity (f/s)						
Width (ft)						
Depth (ft)						

[2] TVA *Volunteer Stream Monitoring Methods Manual*, http://tectn.org/programs/watershed-support-center/.

Suggested Water Quality Monitoring Equipment Checklist

Aquatic insect sampling equipment

3X3 ft. kick net, D- Net	
Bug Magnifier boxes (2-4)	
Hand lens	
Plastic spoons – poly extruded benthic macro invertebrate extraction devices	
5 gallon bucket or big tub or plastic tray	
Sorting trays or 20 small plastic cottage cheese containers	
Compartmentalized sorting tray	
Bug Identification Cards	
Washed down 1/2 gallon milk jugs (2)	
Specimen jars with isopropyl alcohol	
Sediment scoop	
Scrub brush	

CHEMICAL MONITORING EQUIPMENT

Dissolved oxygen kit	
pH kit	
Nitrate kit	
Phosphate kit	

PHYSICAL MONITORING EQUIPMENT

Turbidity tube	
Thermometer (armored)	
Meter stick	
100’ cord	
Float (orange)	

OTHER

Waders/knee boots	
Field data sheets, protocols, clipboards/Pencils (3)	
Maps and GPS if available	
First aid kit	
Waterless soap	
Drinking water	