THE UNIVERSITY OF TENNESSEE
MUNICIPAL TECHNICAL ADVISORY SERVICE'S

RECOMMENDED GUIDANCE
TO

THE TENNESSEE DEPARTMENT
OF
ENVIRONMENT AND CONSERVATION'S

MINIMUM MONITORING REQUIREMENTS
FOR
NPDES MS4 PROGRAM EFFECTIVENESS AND COMPLIANCE

2008

UT | Municipal Technical Advisory Service
In cooperation with the Tennessee Municipal League

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The Tennessee Department
Of Environment And Conservation
Water Pollution Control

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FORWARD AND OVERVIEW

In 1996, the Tennessee Department of Environment and Conservation Division of Water Pollution Control adopted a watershed approach to water quality. This approach is based on the idea that many water quality problems, like the accumulation of point and non-point pollutants, are best addressed at the watershed level. Focusing on the whole watershed helps reach the best balance among efforts to control point sources of pollution and polluted runoff as well as protect drinking water sources and sensitive natural resources such as wetlands. Tennessee has chosen to use the USGS 8-digit Hydrologic Unit Code (HUC-8) as the organizing unit.

The Watershed Approach recognizes awareness that restoring and maintaining our waters requires crossing traditional barriers (point vs. non-point sources of pollution) when designing solutions. These solutions increasing rely on participation by both public and private sectors, where citizens, elected officials, and technical personnel all have opportunities to participate. The Watershed Approach provides the framework for a watershed-based and community-based approach to address water quality problems.

A primary mandate of Water Pollution Control (WPC) is to preserve and protect the right of the people of Tennessee to unpolluted water. To safeguard this valuable resource, the goals of WPC are to assist in the establishment of clean water objectives, implement a surface water monitoring program, and determine if waters support their intended uses. The *Federal Water Pollution Control Act*, Section 305(b) (US Congress, 2002) requires a biennial accounting to congress of the water quality of each state. The *Tennessee Water Quality Control Act* (Tennessee Secretary of State, 1999) also requires a report on water quality. The Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control (WPC) has primary responsibility for assessment and reporting of the quality of surface waters.

Water Quality Standards

The specific water quality standards are established in *Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control*, Chapter 1200-4-3, General Water Quality Criteria and Chapter 1200-4-4, Use Classifications for Surface Water (Tennessee Department of Environment and Conservation, Water Quality Control Board, 2004). Tennessee's water quality standards have three sections. The first establishes seven designated uses for Tennessee waterways. The second identifies numeric or narrative water quality criteria to protect each of the designated uses. The final section is an antidegradation policy designated to protect existing water uses and prevent future damage to water quality.

Monitoring Programs

Tennessee has an abundance of water resources with over 60,000 miles of rivers and streams and nearly 538,000 lake and reservoir acres. However, this vast system of streams, rivers, reservoirs and wetlands requires efficient use of Tennessee's monitoring resources. TDEC's watershed approach serves as an organizational framework for systematic assessment of the state's water quality problems. By viewing the entire drainage area or watershed as a whole, the department is better able to address water quality monitoring, assessment, permitting, and stream restoration efforts. This unified approach affords a more in-depth study of each watershed and encourages coordination of public and governmental organizations. The watersheds are addressed on a five-year cycle that coincides with permit issuance.

In addition to systematic watershed monitoring, waterbodies are sampled to fulfill other information needs within the division. Some of these other needs include continuation of the ecoregion reference stream monitoring, Total Maximum Daily Load (TMDL) generation, complaint investigation, antidegradation tier evaluations, trend investigations, compliance monitoring, and special studies.

Assessment Process

Using a standardized assessment methodology, monitoring data from individual streams are compared to water quality standards. Violations of water quality standards are identified and the degree to which each individual waterbody meets its designated uses is determined. Assessment categories recommended by EPA are used to characterize water quality.

Assessment results are compiled and reported to the public periodically. The principal vehicles for this water quality assessment reporting are the 305(b) Report and the 303(d) List.

Water Quality

Approximately half of the stream miles and almost all the large reservoirs have recently been monitored and assessed. Waters without data collected within the last five years are usually identified as not assessed. About 64 percent of assessed streams and over 78 percent of assessed reservoir acres are found to be fully supporting of designated uses. The remainder of the assessed waterbodies are impaired to some degree and therefore, not supporting of all designated uses.

Causes and Source of Pollution

Once it is determined that a stream, river, or reservoir is not fully supporting of its designated uses, it is necessary to determine what the pollutant is (cause) and where it is coming from (source). The most common causes of pollution in rivers and streams are sediment/silt, habitat alteration, pathogens, and nutrients. The main sources of these pollutants are agriculture, hydrologic modification, municipal dischargers, and construction. The leading causes of pollution in reservoirs and lakes are organic substances, like PCBs, dioxins, and chlordane, plus nutrients, sediment/silt, and low dissolved oxygen. The principal source of problems in reservoirs and lakes is the historical discharge of pollutants that have accumulated in sediment and fish flesh. Other sources include agriculture, hydrologic modifications, municipal dischargers, and construction.

TMDL Definition -- What is a total maximum daily load (TMDL)?

A TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

Water quality standards are set by States, Territories, and Tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use.

A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality.

The Clean Water Act, section 303, establishes the water quality standards and TMDL programs.

Each MS4 should become familiar with the following:
1) The TMDL(s) issued/proposed in their jurisdictions http://state.tn.us/environment/wpc/tmdl
2) The Watershed Water Quality Management Plan http://state.tn.us/environment/wpc/watershed/wsmplans written for each TMDL watershed
3) Maps identifying features such as existing jurisdictional boundaries, waterways, land use, construction activities, roads and storm water infrastructure

MS4 TMDL Monitoring Minimum Requirements, or Equivalent, require, depending on the published TMDL:

A monitoring plan for Siltation and Habitat Alteration TMDL

A monitoring plan for Pathogen TMDL.

This document includes an easy-to-use visual assessment protocol to evaluate the condition of aquatic ecosystems associated with streams. The protocol does not require expertise in aquatic biology or extensive training. A stream visual assessment protocol is the first level in a hierarchy of ecological assessment protocols. *Use of the SCA methodology as presented herein is encouraged, but not required. Other methodologies may be proposed to and evaluated by the Tennessee Department of Environment and Conservation on an individual basis.*

I. DESKTOP SURVEYING AND ASSESSMENT

A. Desktop Survey and Assessment Methods: Preliminary

B. Desktop Survey and Assessment Methods: Comprehensive

Desktop Survey and Assessment Methods: Preliminary

MS4 TMDL Monitoring Minimum Requirements, or Equivalent, require, depending on the published TMDL:

- A monitoring plan for Siltation and Habitat Alteration TMDL.
- A monitoring plan for Pathogen TMDL.
- Visual Stream Surveys and Impairment Inventories, which must be performed in an effort to identify and prioritize MS4 stream impairment sources, regardless of which published TMDL applies. TDEC strongly recommends that visual stream surveys be performed throughout the entire HUC-12 subwatershed of a stream segment listed in the TMDL. At a minimum, a survey must be performed immediately upstream and downstream of each MS4 outfall that discharges into a TMDL listed stream segment.

Prior to developing a monitoring plan and/or conducting visual assessments, it is recommended that a desktop survey and assessment be completed. The process of conducting the desktop survey will yield the most efficient way to proceed with the monitoring plan, identifying potential areas of concern and primary locations for sampling and assessment. An area may be determined to be inaccessible for field work, so that only desktop assessment can be performed. Land use information when viewed in conjunction with drainage information may show that an area is not a possible source of the published TMDL. Conversely, potential pollution producing "hot spots" when viewed in juxtaposition with drainage information can highlight primary areas of concern.

Establishing baseline conditions for the watershed is key to determining how best to manage it in order to maintain or improve designated uses and water resources condition.

Establishing a baseline is primarily a GIS analysis, and involves data acquisition, map creation and generation of descriptive metrics. Where possible, most recent data should be used so that the most accurate conditions can be seen. Figure 1 illustrates how using more detailed land use data provides more accurate estimates of land use in a watershed, compared to land use data derived from satellite imagery.

Establishing a baseline includes five major components that are listed below.

1) Watershed characterization
2) Land use analysis
3) Impervious cover analysis
4) Summary of monitoring data
5) Sensitive areas analysis

For preliminary planning purposes, prior to embarking on developing the TMDL monitoring and visual assessment plan, the initial brush could include only components 1, 2, and 4. The information thus yielded could determine the need for proceeding with components 3 and 5.

1. Watershed characterization
A watershed characterization is a simple summary of basic watershed characteristics that provides some context to the plan. It is usually presented in narrative form, and is accompanied by maps and summary tables. Minimum elements to include in a watershed characterization are described below.

Geographic setting - the watershed characterization should identify the major basin in which the watershed is located

Regulatory status - the watershed characterization should identify all 303(d) listings and any TMDLs that exist for waterbodies in the watershed. It should also indicate all designated stream uses, and identify any Phase I or Phase II communities.

Watershed metrics – the watershed characterization should summarize basic watershed metrics, including watershed area, stream miles, number of subwatersheds, and population. Additional watershed metrics can be summarized, if desired. Calculating subwatershed metrics is discussed later.

2. Land Use Analysis
An analysis of current and future land use is an extremely important part of any watershed plan. Current land use can be easily summarized for the watershed with a map and a table with the acreage of land in each land use category The ultimate land use tool for a “snaphot” of current conditions for initial planning purposes and establishing a baseline, is a zoning map.

3. Impervious Cover Analysis
An important step in crafting a watershed plan is to evaluate current land use, and determine impervious cover, which will affect watershed conditions. The importance of impervious cover is described below.

A wide array of research has documented the strong relationship between impervious cover and stream quality (Center for Watershed Protection (CWP), 2003b). CWP (2003b) has integrated these research findings into a watershed planning model, known as the Impervious Cover Model (ICM). The ICM predicts that most stream quality indicators decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25% impervious cover. The ICM identifies four classifications of streams: sensitive, impacted, non-supporting, and urban drainage (Figure 2).

From a watershed planning perspective, imperviousness is one of the few variables that can be explicitly quantified, managed, and controlled at each stage of land development. The ICM should be used to initially classify subwatersheds into one of these four categories based on current and future impervious cover estimates, to help managers set expectations about what can be achieved in each subwatershed, and guide decisions in the watershed plan. The ICM should only be used for an initial classification, as additional information such as field verification should be taken into account.

Current impervious cover There are several methods to measure current impervious cover (IC) at the subwatershed scale. Deciding which method is best for a subwatershed depends largely on the resources and data available. The most commonly used methods are direct measurement and the land use method. The direct measurement method calculates the area of all rooftops, roads, parking lots, and other impervious surfaces in a subwatershed directly from the watershed-based GIS. This is the most accurate method of calculating current IC, but is also the most labor-intensive and expensive. Additional information on the direct measurement method and other methods to estimate IC is provided in Cappiella and Brown (CWP, 2001). The land use method is summarized below.

The land use method is a simple four-step procedure that produces reliable estimates of current IC for subwatersheds. More detail on these steps and the input data required for the land use method is provided below. Table 1 can be used as a worksheet for calculating current IC.

Step 1: Large areas of known “unbuildable land” are subtracted from the subwatershed area. These include large tracts of land in floodplains, wetlands, stream valleys, easements, and major conservation areas.

Step 2: The current land use distribution for the remaining buildable portions of the subwatershed are multiplied by impervious cover coefficients (ICC) to yield a provisional estimate of current IC.

Step 3: The contribution of impervious cover from existing freeways and limited access arterial roads is calculated based on their length and width, and incorporated into the IC estimate.

Step 4: The percentage of imperviousness is calculated for the subwatershed.

ICCs represent the fraction of a particular land use category that consists of IC such as roads, parking lots and rooftops. Highly urban or rural communities may wish to use coefficients that are more appropriate for the type of development in their communities.

In the land use method, unbuildable lands must be subtracted from the total subwatershed area to yield a more accurate estimate of current IC (Cappiella and Brown, 2001). The amount and type of unbuildable land will depend on both the natural topography and local land use regulations, such as open space requirements, or stream buffer regulations. Information regarding unbuildable land can usually be acquired from the local planning department.

Table 1: Calculating Current IC Using Impervious Cover Coefficients for Land Use Categories

*Land Use Category**	*Buildable Area (Acres)*	*Impervious Cover Coefficient***	*Impervious Cover (Acres)*
Low Density Residential (11)		0.14	
Medium Density Residential (12)		0.28	
High Density Residential (13)		0.41	

Table 1: Calculating Current IC Using Impervious Cover Coefficients for Land Use Categories			
*Land Use Category**	*Buildable Area (Acres)*	*Impervious Cover Coefficient***	*Impervious Cover (Acres)*
Commercial (14)		0.72	
Industrial (15)		0.53	
Institutional (16)		0.34	
Extractive (17)		0.02	
Open Urban Land (18)		0.09	
Rural Residential (191, 192)		0.04	
Cropland (21)		0.02	
Pasture (22)		0.02	
Orchards (23)		0.02	
Feeding Op (24)		0.02	
Ag Building (242)		0.02	
Crops (25)		0.02	
Forest/Brush (41, 42, 43, 44)		0.0	
Water (50)		0.02	
Wetlands (60)		0.0	
Beaches (71)		0.0	
Bare Rock (72)		0.09	
Bare Ground (73)		0.09	
Highway Corridors		0.95	
Total IC (Acres)			
Subwatershed Area (Acres)			
Current IC (%)			
** Includes all land use categories. Highway corridors must be derived from local sources. Land use code(s) are provided in ( ) after each category. **All impervious cover coefficients except highway corridors were adapted from Cappiella and Brown (2001).*			

Management classification Once the current impervious cover is determined, subwatersheds should be classified into one of the following four management categories based on the percentage of impervious cover (CWP, 2003b):

- Sensitive <10% impervious cover
- Impacted 10-25% impervious cover
- Non-Supporting* 26-60% impervious cover
- Urban Drainage >60% impervious cover

*The term "non-supporting" as used in this management classification is generally defined as streams that are so degraded that they may no longer support certain types of aquatic life. This term bears no relation to the similar regulatory terminology that pertains to whether a water body

is meeting its designated use.
Sensitive subwatersheds have an impervious cover of 0 to 10%. Consequently, streams in these subwatersheds are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects (CWP, 1998). The main goal for these types of subwatersheds is to maintain predevelopment stream biodiversity and channel stability.

Impacted subwatersheds have an impervious cover ranging from 11 to 25% and show clear signs of degradation due to watershed urbanization. Greater storm flows have begun to alter the stream geometry. Both erosion and channel widening are evident. Stream banks become unstable, and physical habitat in the stream declines noticeable. Stream biodiversity declines to fair levels, with the most sensitive fish and aquatic insects disappearing from the stream (CWP, 1998). The main goals for these types of subwatersheds are to limit the degradation of stream habitat quality and maintain a good biological community.

Non-supporting subwatersheds have an impervious cover ranging from 26 to 60%. Streams in this category essentially become a conduit for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, down-cutting and streambank erosion. The water and biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish. The goals for these subwatersheds are to minimize downstream pollutants, alleviate downstream flooding, and improve aesthetic appeal.

Subwatersheds with more than 60% impervious cover are classified as urban drainage. In these highly developed subwatersheds, streams are often piped underground, or consist of concrete channels that do not support any aquatic life and serve only to convey flows. The goals for these subwatersheds are usually similar to goals for non-supporting subwatersheds.

Subwatershed classification should be done for both current cover estimates. Field verification may be necessary to verify current impervious cover classification.

4. Summary of Monitoring Data

This task involves a review of existing monitoring data available for the watershed. Monitoring data falls into four general categories: hydrologic, physical, water quality, and biological. Hydrologic monitoring deals with stream flow or groundwater flow, while physical monitoring evaluates in-stream and near-stream habitat based on physical characteristics. Water quality monitoring involves analyzing water samples for various chemical parameters, and biological monitoring typically consists of surveys of plant and animal populations. Biological monitoring need not be limited to in-stream data, and often includes upland surveys of plant or animal communities.

While monitoring data is available from numerous state and local sources, planners should acquire the data described in Table 3 at a minimum. Water quality data is particularly important to summarize in order to provide a baseline, since reducing pollutants of concern is a major goal of the watershed plan.

Table 3: Important Monitoring Data in Tennessee		
Type of Data	*Data*	*Description*
Hydrologic, Physical, Water Quality	USGS National Water Information System	Surface water data, groundwater data, and water quality data for more than 1.5 million sites nationwide.
Biological, Water Quality, Physical	TDEC Biological Stream Survey	Random sampling of wadeable streams and rivers in TN.
Biological, Water Quality, Physical	STORET	EPA Repository for water quality, biological, and physical data.
Biological	North American Breeding Bird Survey	Large-scale roadside survey of North American breeding birds.
	North American Amphibian Monitoring Program	Data collected by USGS and other partners to monitor populations of vocal amphibians.
	Tennessee Wildlife Resources Agency	Survey documents relative abundance of fish.
Water Quality	TDEC long-term water quality	Water quality monitoring on major l rivers in TN. Results are incorporated into the 305(b) reports.
	TDEC 303(d) list	Online searchable database of the State's 303(d) list

Monitoring data should be summarized to provide an overview of stream conditions in the watershed and subwatersheds, and can even be used to update the current subwatershed classifications of stream condition based on the ICM. Results should be summarized using tables, and the bulk of raw data can be provided in an appendix to the watershed plan, if desired. Figures such as charts and maps are helpful for displaying this data.

5. Sensitive Areas Analysis

Sensitive areas include the following types of land that have special significance, provide watershed benefits, or are particularly vulnerable to land development:

- Streams and their buffers • Groundwater
- 100-year floodplains • Mineral resources
- Habitats of threatened and endangered species • Wetlands
- Steep slopes • Oysters, clams, crabs, and benthic habitat
- Contiguous forest • Scenic vistas and geologic features
- Hydric and erodible soils • Springs and seeps
- Public drinking water supplies • Submerged aquatic vegetation
- Historic and archaeological sites •
- Critical Areas • Wetlands
- Agricultural land • Trout stream watersheds
- Vernal pools
- Bogs • Waterfowl areas
- Caves • Wellhead protection areas

- Colonial waterbird nesting sites • Wildlife corridors
- Eroding shorelines

The purpose of a sensitive areas analysis is to inventory these resources in order to identify potential protection and restoration sites that can be further evaluated through field assessments, and ultimately recommended as part of the watershed plan. The products of a sensitive areas analysis include: an inventory of sensitive areas, and maps of potential protection and restoration sites.

Sensitive areas inventory A sensitive areas inventory provides a desktop review of all sensitive resources in a watershed, and produces a map and associated data for each type of sensitive area. TDEC and Tennessee OIR provides free downloadable GIS data that can be used as part of a sensitive areas inventory (Table 4).

Table 4: TDEC GIS Data for Use in Sensitive Areas Inventory		
GIS Data Type	*Data Layer Name*	*Description*
Floodplain	Floodplain	100-year and 500-year floodplains derived from FEMA Q3 Flood data.
Protected Land	Protected Lands	Includes parks, conservation lands, agricultural preservation lands, easements, and state and federal protected land.
	Greenways	Greenways are natural corridors set aside by county, state or federal authorities to connect larger areas of open space and to provide for the conservation of natural resources, protection of natural resources, protection of habitat, movement of plants and animals, and to offer opportunities for linear recreation, alternative transportation, and nature study.
Rare, Threatened, and Endangered Species	Sensitive Species Project Review Areas	Contains buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Natural Heritage Areas	Natural Heritage Areas are areas designated in the state's Threatened and Endangered Species regulations because they: contain one or more threatened or endangered species or wildlife species in need of conservation; are a unique blend of geologic, hydrologic, climatologic or biological features; and are considered to be among the best statewide examples of its kind.
	TDEC Wetlands Inventory	Statewide wetland inventory that includes records of wetlands location and classification as defined by the U.S. Fish & Wildlife Service's National Wetlands Inventory program.
	National Wetlands Inventory	Although outdated, this inventory occasionally identifies wetlands that do not appear in other inventories.

An inventory of all wetlands in the watershed should be conducted as part of a sensitive areas inventory. An inventory of wetlands in the watershed provides a starting point for a watershed approach to wetland permitting that can impact future permitting decisions. More detailed local wetlands data may be supplemented, if available, as part of the inventory. A sensitive areas inventory should also include a detailed assessment of forest cover in the watershed. It is important to know the percent forest cover in a watershed in order to set future goals for maintaining or increasing this cover, and to use in estimating future pollutant loads from different types of land. There is currently no statewide forest cover layer in Tennessee that is of sufficient resolution to quantify forest cover at the watershed scale. Local governments should use detailed local forest cover data, where available. If no such data exists, another option is to develop a detailed forest cover or forest canopy layer using high-resolution aerial photos or satellite imagery.

The results of a sensitive areas inventory include various maps and statistics that summarize the number and acreage of the different sensitive resources by subwatershed and are used to identify potential protection and restoration sites later on.

Protection and restoration sites The sensitive area inventory should be used to identify potential protection and restoration sites. TDEC data provides a good starting point, but it is also necessary to review additional GIS data, and take a comprehensive look at all the sensitive areas in the watershed to identify additional sites. Table 6 provides guidance on identifying potential protection and restoration sites.

Potential protection sites are further evaluated through different sensitive areas assessments, depending on whether the site is a forest, a wetland, stream buffer, steep slope, or RTE species habitat. The products of this method are maps of potential protection and restoration sites.

Table 6: Potential Protection /Restoration Sites within a Sensitive Areas Analysis	
Potential Protection Sites	*Potential Restoration Sites*
• Green Infrastructure hubs and corridors • Wetlands of Special State Concern • Forest Interior Dwelling Species Potential Habitat • Sensitive Species Project Review Areas • Natural Heritage Areas • Officially designated reference sites • Other forests, wetlands, or agricultural lands that: − are large, contiguous tracts − are currently unprotected − have key position in the watershed (e.g., headwaters, adjacent to drinking water reservoir, trout stream, or existing protected lands) − contain sensitive areas such as 100-year floodplains, steep slopes, erodible soils, or stream buffers. − have special significance such as locally rare or difficult-to-replace wetland type, or prime farmland	• Green Infrastructure gaps • Former or existing degraded wetlands with land use and hydrology that are suitable for restoration (e.g., farm land, sand or gravel pits, high water table) • Public turf (e.g., schools, parks, rights-ofway) • Vacant land • Unbuffered streams • Other open lands that: − have key position in watershed (e.g., headwaters, adjacent to drinking water reservoir, trout stream, or existing protected lands) − contain sensitive areas such as 100-year floodplains, steep slopes, erodible soils, or stream buffers. − provide a connection between existing forest, wetlands, or other potential protection sites

Classify and Rank Subwatersheds

The purpose of classifying and ranking subwatersheds is to provide a basis for identifying priority subwatersheds on which planning efforts should be focused. Classifying and ranking subwatersheds is particularly useful in large watersheds where planning and implementation funding is limited. The classification and ranking process generally identifies the subwatersheds that are the most vulnerable to future development and/or have the greatest restoration potential.

While the ICM provides a first cut at classifying subwatersheds according to their current and expected stream quality, it is sometimes necessary to create subwatershed classification categories beyond those presented by the ICM. For example, in rural watersheds where most of the subwatersheds have less than 10% impervious cover, the ICM may be inadequate to distinguish differences between truly sensitive subwatersheds, and subwatersheds that are impacted by agricultural activities. Additional classification of these subwatersheds beyond the ICM can be done through a simple spreadsheet analysis of selected subwatershed metrics. Subwatershed metrics are usually numeric values that describe subwatersheds based on a single characteristic. A simple example is to use the percent forest and the percent agricultural land in each subwatershed to further classify “sensitive” subwatersheds into “sensitive forested” and “sensitive agricultural” (Figure 6).

The basic steps associated with classifying and ranking subwatersheds are presented below.

1) Review the initial ICM subwatershed classifications.
2) Expand the classification to account for factors other than impervious cover.
3) Select subwatershed metrics for use in ranking subwatersheds. Subwatershed metrics represent factors that determine the relative vulnerability or restorability of a subwatershed.

The metrics used to rank subwatershed vulnerability should be selected separately from the metrics used to rank subwatershed restorability. Various metrics can be estimated, depending on available data and the goals of the watershed plan. Table 7 lists the range of possible metrics that can be derived from the GIS data layers.

1) Assign points to each metric. To keep the subwatershed ranking system simple, the total number of possible points should be 100. More ‘important’ metrics should be assigned more points than others.
2) For each subwatershed, compute metrics and assign points for each metric.
3) Add the total points for each subwatershed to get a comparative ranking.

The ranking process refines the subwatershed classification, and is used to identify priority subwatersheds, which are typically the top-ranked subwatersheds in each classification category.

Table 7: Examples of Metrics Used to Classify and Rank Subwatersheds	
• # road crossings per stream mile • # violations of water quality standards • % critical habitat for RTE species • % cropland • % current impervious cover • % detached residential land • % developable land • % forest cover • % forest interior • % forested stream buffer • % future forest loss • % industrial land • % public land • % streams with 303(d) listing • % wetlands • Age of development • Modeled pollutant loads (e.g., total phosphorus or total nitrogen)	• Benthic macroinvertebrate diversity • Condition of sewer system • Density of point sources or hotspots • Density of septic systems • Density of stormwater outfalls • Density of stormwater treatment practices • Density of streams • Fish diversity • Length of eroded stream bank • Livestock density • Net change in future impervious cover • Physical in-stream habitat • Presence of combined sewer systems • Presence of community or watershed organization • Presence of public drinking water supply • Modeled peak flow and runoff volume for 1- and 2-year storm events

Desktop Assessment Methods: Comprehensive

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Desktop surveys and assessments are useful tools that can provide preliminary direction, or, in cases where conditions warrant, *with TDEC approval,* can be *used in place of field sampling and monitoring* to model results. Prior to developing a monitoring plan and/or conducting visual assessments, it is recommended that a desktop survey and assessment be completed. The process of conducting the desktop survey will yield the most efficient way to proceed with the monitoring plan, identifying potential areas of concern and primary locations for sampling and assessment. An area may be determined to be inaccessible for field work, so that only a desktop assessment can be performed. Land use information, when viewed in conjunction with drainage information, may show that an area is not a possible source of the published TMDL. Conversely, potential pollution producing “hot spots” when viewed in juxtaposition with drainage information can highlight primary areas of concern.

Establishing baseline conditions for the watershed is the key to determining how best to manage it in order to maintain or improve designated uses and water resources condition. Establishing a baseline is primarily a GIS analysis, and involves data acquisition, map creation and generation of descriptive metrics. Where possible, the most recent data should be used so that the most accurate conditions can be seen. Figure 1 illustrates how using more detailed land use data provides more accurate estimates of land use in a watershed, compared to land use data derived from satellite imagery.

Establishing a baseline includes five major components that are listed below.

1. Watershed characterization
2. Land use analysis
3. Impervious cover analysis
4. Summary of monitoring data
5. Sensitive areas analysis

1. Watershed characterization

A watershed characterization is a simple summary of basic watershed characteristics that provides some context to the plan. It is usually presented in narrative form, and is accompanied by maps and summary tables. Minimum elements to include in a watershed characterization are described below.

Geographic setting - the watershed characterization should identify the major basin in which the watershed is located

Regulatory status - the watershed characterization should identify all 303(d) listings and any TMDLs that exist for waterbodies in the watershed. It should also indicate all designated stream uses, and identify any Phase I or Phase II communities.

Watershed metrics – the watershed characterization should summarize basic watershed metrics, including watershed area, stream miles, number of subwatersheds, and population. Additional watershed metrics can be summarized, if desired. Calculating subwatershed metrics is discussed later.

2. Land Use Analysis

An analysis of current and future land use is an extremely important part of any watershed plan. Current land use can be easily summarized for the watershed with a map and a table with the acreage of land in each land use category. Future land use is more difficult to project; however, future land use projections can be used to determine if land use changes are compatible with watershed or subwatershed protection goals or if they will threaten specific sensitive water bodies. This analysis also enables the estimation of future pollutant loads based on land use changes and assess alternative zoning options to ensure that pollutant reduction goals are met. Methods for estimating pollutant loads and reductions are provided later.

The ultimate future land use projection is a zoning map. However, many zoning categories, such as agriculture, simply act as 'holding zones' for future development and are ultimately rezoned and developed, especially in watersheds with high development pressure. In other watersheds, economic or social factors may make full buildout of the watershed infeasible or impractical. Either way, zoning maps are not always an accurate depiction of future land use because they fail to take into account areas reserved for natural resource protection, large transportation projects and/or special exception uses.

Local governments should evaluate resources such as water and sewerage plans, transportation plans, comprehensive plans, protected or unbuildable lands, real estate trends, population forecasts, and other data to project future land use in the watershed for specified time periods. A potential data resource for this analysis is Weber (ND), which predicts risk of loss to development of green infrastructure lands based on many of the above factors. This future land use projection should be done as part of a watershed plan and revisited regularly on a schedule that coincides with other required updates, such as Phase 1I or Phase II comprehensive plans (5 years), or TMDL monitoring plans. Watershed plans may be able to provide a framework for updating these other plans, although, ideally, these plans would be integrated as one plan.

One resource that is very useful in projecting future land use is Development Capacity Analysis. Development Capacity Analysis can be used with the urban growth plans developed under the State of Tennessee's Growth Policy Act: Public Chapter 1101. The Development Capacity Analysis is an estimate of the total amount of development that may be built in an area under a certain set of assumptions, including applicable land use laws, zoning, environmental constraints, and more. Steps for conducting this analysis are provided below.

1. *Identify vacant land*. The most efficient method is to identify parcels classified as vacant in tax assessor's records. Due to database errors, these should also be spot-checked using aerial photographs, which works best in rural areas.

2. *Identify environmental constraints*. Subtract out land that is "unbuildable" based on local regulations. This may include steep slopes, floodplains, wetlands, buffers, or areas subject to natural hazards.

3. *Identify potential for redevelopment and infill*. This can be based on an analysis of land values and assessed improvements, or past rates of infill. These are probably not the most accurate methods but are all that exists right now.

4. *Identify serviced land*. This is the supply of land with access to services such as water, sewer, schools, and emergency services.

5. *Identify development capacity of the net supply of serviced land.* Simple or complex assumptions and equations can be used to estimate the land needed for infrastructure. Common assumptions include setting aside 25% of all buildable land for streets, and 15 acres of parkland per 1,000 estimated population growth. After subtracting out land needed for infrastructure, do a buildout analysis based on the maximum allowable dwelling units for each zoning category.

Results of the Development Capacity Analysis should be used to estimate future land use to use in later analyses, such as impervious cover projections, and pollutant load estimates. They should also be used to determine if estimated growth projections for the watershed are realistic under current conditions. This analysis is key in determining if changes should be made to local land use plans and development regulations to align with the watershed plan.

3. Impervious Cover Analysis

An important step in crafting a watershed plan is to evaluate current land use, and to project how future changes in land use, specifically the addition of impervious cover, will affect watershed conditions. An impervious cover analysis includes two components: current impervious cover and future impervious cover. Both are analyzed at the subwatershed scale. The importance of impervious cover is described below.

A wide array of research has documented the strong relationship between impervious cover and stream quality (Center for Watershed Protection (CWP), 2003b). CWP (2003b) has integrated these research findings into a watershed planning model, known as the Impervious Cover Model (ICM). The ICM predicts that most stream quality indicators decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25% impervious cover. The ICM identifies four classifications of streams: sensitive, impacted, non-supporting, and urban drainage (Figure 2). The ICM predicts the average behavior of a group of indicators over a range of impervious cover; therefore, extreme care should be exercised if using to predict the fate of individual species.

From a watershed planning perspective, imperviousness is one of the few variables that can be explicitly quantified, managed, and controlled at each stage of land development. The ICM should be used to initially classify subwatersheds into one of these four categories based on current and future impervious cover estimates, to help managers set expectations about what can be achieved in each subwatershed, and guide decisions in the watershed plan. The ICM should only be used for an initial classification, as additional information such as field verification should be taken into account.

Current impervious cover

There are several methods to measure current impervious cover (IC) at the subwatershed scale. Deciding which method is best for a subwatershed depends largely on the resources and data available. The most commonly used methods are direct measurement and the land use method. The direct measurement method calculates the area of all rooftops, roads, parking lots, and other impervious surfaces in a subwatershed directly from the watershed-based GIS. This is the most accurate method of calculating current IC, but is also the most labor-intensive and expensive. Additional information on the direct measurement method and other methods to estimate IC is provided in Cappiella and Brown (CWP, 2001). The land use method is summarized below. The land use method is a simple four-step procedure that produces reliable estimates of current IC for subwatersheds. More detail on these steps and the input data required for the land use method is provided below. Table 4.1 can be used as a worksheet for calculating current IC.

Step 1: Large areas of known "unbuildable land" are subtracted from the subwatershed area. These include large tracts of land in floodplains, wetlands, stream valleys, easements, and major conservation areas.

Step 2: The current land use distribution for the remaining buildable portions of the subwatershed are multiplied by impervious cover coefficients (ICC) to yield a provisional estimate of current IC.

Step 3: The contribution of impervious cover from existing freeways and limited access arterial roads is calculated based on their length and width, and incorporated into the IC estimate.

Step 4: The percentage of imperviousness is calculated for the subwatershed.

ICCs represent the fraction of a particular land use category that consists of IC such as roads, parking lots and rooftops. Highly urban or rural communities may wish to use coefficients that are more appropriate for the type of development in their communities.

In the land use method, unbuildable lands must be subtracted from the total subwatershed area to yield a more accurate estimate of current IC (Cappiella and Brown, 2001). The amount and type of unbuildable land will depend on both the natural topography and local land use regulations, such as open space requirements, or stream buffer regulations. Information regarding unbuildable land can usually be acquired from the local planning department.

Table 1: Calculating Current IC Using Impervious Cover Coefficients for Land Use Categories

*Land Use Category**	*Buildable Area (Acres)*	*Impervious Cover Coefficient***	*Impervious Cover (Acres)*
Low Density Residential (11)		0.14	
Medium Density Residential (12)		0.28	
High Density Residential (13)		0.41	
Commercial (14)		0.72	
Industrial (15)		0.53	
Institutional (16)		0.34	
Extractive (17)		0.02	
Open Urban Land (18)		0.09	
Rural Residential (191, 192)		0.04	
Cropland (21)		0.02	
Pasture (22)		0.02	
Orchards (23)		0.02	
Feeding Op (24)		0.02	
Ag Building (242)		0.02	
Crops (25)		0.02	
Forest/Brush (41, 42, 43, 44)		0.0	
Water (50)		0.02	
Wetlands (60)		0.0	
Beaches (71)		0.0	
Bare Rock (72)		0.09	
Bare Ground (73)		0.09	
Highway Corridors		0.95	
Total IC (Acres)			
Subwatershed Area (Acres)			
Current IC (%)			

** Includes all land use categories. Highway corridors must be derived from local sources. Land use code(s) are provided in ( ) after each category. **All impervious cover coefficients except highway corridors were adapted from Cappiella and Brown (2001).*

Future impervious cover

Future impervious cover (FIC) should be estimated to determine the potential changes in stream quality with future growth and buildout of the watershed. FIC should be estimated for each subwatershed, and used to classify subwatersheds based on the ICM to determine whether designated stream uses can be maintained in future land use scenarios.

FIC projections are based on a combination of current IC estimates and the most current version of local zoning data. To estimate FIC, all buildable land in the subwatershed (identified when calculating current IC) is divided into two categories: developed land and undeveloped land. Developed land can be identified based on local parcel data, but a simpler method is to assume that the following land use categories are developed: commercial, industrial, institutional, medium density residential and high density residential. Highway corridors should also be considered developed land. All remaining land use categories are considered to be undeveloped for the purposes of this analysis. Low density residential falls into the undeveloped land category because it has some potential for future development if land is subdivided. Figure 3 illustrates the division of developed and undeveloped land in a watershed, and the different land use data sources used to estimate FIC for each.

To estimate FIC for developed land in the subwatershed, the buildable area of each land use category is multiplied by the corresponding ICC provided in Table 1. This is essentially the same as estimating current IC, but is only done for the developed portion of the subwatershed. To estimate FIC for undeveloped land in the subwatershed, zoning maps are used to calculate the area of each zoning category that falls within the undeveloped area. The buildable area of each zoning category is then multiplied by a corresponding ICC. ICCs for 12 zoning categories from Cappiella and Brown (2001) are provided in Table 2, and should be adapted to fit local zoning categories. Total FIC estimates for developed and undeveloped land are added together, and divided by the subwatershed area to determine the percent imperviousness. Table 2 provides a worksheet for estimating FIC for undeveloped land.

Table 2: Estimating Future Impervious Cover for Undeveloped Land

Zoning Category	*Buildable Area (Acres)*	*Impervious Cover Coefficient**	*Impervious Cover (Acres)*
Agriculture		0.02	
Open Urban		0.09	
2 Acre Residential		0.11	
1 Acre Residential		0.14	
½ Acre Residential		0.21	
1/4 Acre Residential		0.28	
1/8 Acre Residential		0.33	
Townhomes		0.41	
Multifamily		0.44	
Institutional		0.34	
Light Industrial		0.53	

Table 2: Estimating Future Impervious Cover for Undeveloped Land			
Zoning Category	*Buildable Area (Acres)*	*Impervious Cover Coefficient**	*Impervious Cover (Acres)*
Commercial		0.72	
Highway Corridor		0.95	
Total IC (Acres)			
Subwatershed Area (Acres)			
Current IC (%)			
**All impervious cover coefficients except highway corridors are from Cappiella and Brown (2001).*			

The method described above gives a more realistic estimate of FIC than using zoning alone, because it accounts for development patterns that are already in place. However, this technique has potential to over-estimate impervious cover because it is based on the assumption that full buildout of zoning categories will occur, which may not be feasible due to economic conditions or lack of infrastructure. The method also cannot account for re-zoning that may occur in the future. Therefore, changes to local zoning may require a revision of FIC estimates. An FIC analysis can also be done for interim time periods based on the results of a Development Capacity Analysis.

Management classification

Once the current and future percent impervious cover is determined, subwatersheds should be classified into one of the following four management categories based on the percentage of impervious cover (CWP, 2003b):

- Sensitive <10% impervious cover
- Impacted 10-25% impervious cover
- Non-Supporting* 26-60% impervious cover
- Urban Drainage >60% impervious cover

*The term "non-supporting" as used in this management classification is generally defined as streams that are so degraded that they may no longer support certain types of aquatic life. This term bears no relation to the similar regulatory terminology that pertains to whether a water body is meeting its designated use.

Sensitive subwatersheds have an impervious cover of 0 to 10%. Consequently, streams in these subwatersheds are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects (CWP, 1998). The main goal for these types of subwatersheds is to maintain predevelopment stream biodiversity and channel stability.

Impacted subwatersheds have an impervious cover ranging from 11 to 25% and show clear signs of degradation due to watershed urbanization. Greater storm flows have begun to alter the stream geometry. Both erosion and channel widening are evident. Stream banks become unstable, and physical habitat in the stream declines noticeable. Stream biodiversity declines to fair levels, with the most sensitive fish and aquatic insects disappearing from the stream (CWP, 1998). The main goals for these types of subwatersheds are to limit the degradation of stream habitat quality and maintain a good biological community.

Non-supporting subwatersheds have an impervious cover ranging from 26 to 60%. Streams in this category essentially become a conduit for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, down-cutting and streambank erosion. The water and biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish. The goals for these subwatersheds are to minimize downstream pollutants, alleviate downstream flooding, and improve aesthetic appeal.

Subwatersheds with more than 60% impervious cover are classified as urban drainage. In these highly developed subwatersheds, streams are often piped underground, or consist of concrete channels that do not support any aquatic life and serve only to convey flows. The goals for these subwatersheds are usually similar to goals for non-supporting subwatersheds.

Subwatershed classification should be done for both current and future impervious cover estimates. Field verification may be necessary to verify current impervious cover classification. Subwatersheds whose management classifications change from one category to another with future buildout are of primary interest in watershed planning efforts because they are likely to experience significant degradation in stream quality unless changes are made to zoning, comprehensive plans and development regulations. Figure 4 illustrates current and future impervious cover classifications for the Appoquinimink Watershed in Delaware. These graphics powerfully illustrate the potential changes in stream quality based on future growth. In this example, subwatersheds near the ICM thresholds were classified using both of the stream quality categories in question (e.g., Sensitive/Impacted). More detailed methods to classify and rank subwatersheds are discussed later in this chapter.

4. Summary of Monitoring Data

This task involves a review of existing monitoring data available for the watershed. Monitoring data falls into four general categories: hydrologic, physical, water quality, and biological. Hydrologic monitoring deals with stream flow or groundwater flow, while physical monitoring evaluates in-stream and near-stream habitat based on physical characteristics. Water quality monitoring involves analyzing water samples for various chemical parameters, and biological monitoring typically consists of surveys of plant and animal populations. Biological monitoring need not be limited to in-stream data, and often includes upland surveys of plant or animal communities.

While monitoring data is available from numerous state and local sources, planners should acquire the data described in Table 3 at a minimum. Water quality data is particularly important to summarize in order to provide a baseline, since reducing pollutants of concern is a major goal of the watershed plan. Methods for estimating current and projected pollutant loads for the watershed are provided later in this chapter.

Table 3: Important Monitoring Data in Tennessee		
Type of Data	*Data*	*Description*
Hydrologic, Physical, Water Quality	USGS National Water Information System	Surface water data, groundwater data, and water quality data for more than 1.5 million sites nationwide.
Biological, Water Quality, Physical	TDEC Biological Stream Survey	Random sampling of wadeable streams and rivers in TN.
Biological, Water Quality, Physical	STORET	EPA Repository for water quality, biological, and physical data.
Biological	North American Breeding Bird Survey	Large-scale roadside survey of North American breeding birds.
	North American Amphibian Monitoring Program	Data collected by USGS and other partners to monitor populations of vocal amphibians.
	Tennessee Wildlife Resources Agency	Survey documents relative abundance of fish.
Water Quality	TDEC long-term water quality	Water quality monitoring on major l rivers in TN. Results are incorporated into the 305(b) reports.
	TDEC 303(d) list	Online searchable database of the State's 303(d) list

Monitoring data should be summarized to provide an overview of stream conditions in the watershed and subwatersheds, and can even be used to update the current subwatershed classifications of stream condition based on the ICM. Results should be summarized using tables, and the bulk of raw data can be provided in an appendix to the watershed plan, if desired. Figures such as charts and maps are helpful for displaying this data.

5. Sensitive Areas Analysis

Sensitive areas include the following types of land that have special significance, provide watershed benefits, or are particularly vulnerable to land development:

- Streams and their buffers • Groundwater
- 100-year floodplains • Mineral resources
- Habitats of threatened and endangered species • Wetlands
- Steep slopes • Oysters, clams, crabs, and benthic habitat
- Contiguous forest • Scenic vistas and geologic features
- Hydric and erodible soils • Springs and seeps
- Public drinking water supplies • Submerged aquatic vegetation
- Historic and archaeological sites •
- Critical Areas • Wetlands
- Agricultural land • Trout stream watersheds

- Vernal pools
- Bogs • Waterfowl areas
- Caves • Wellhead protection areas
- Colonial waterbird nesting sites • Wildlife corridors
- Eroding shorelines

The purpose of a sensitive areas analysis is to inventory these resources in order to identify potential protection and restoration sites that can be further evaluated through field assessments, and ultimately recommended as part of the watershed plan. The products of a sensitive areas analysis include: an inventory of sensitive areas, an evaluation of future impacts to sensitive areas, and maps of potential protection and restoration sites.

Sensitive areas inventory

A sensitive areas inventory provides a desktop review of all sensitive resources in a watershed, and produces a map and associated data for each type of sensitive area. TDEC and Tennessee OIR provides free downloadable GIS data that can be used as part of a sensitive areas inventory (Table 4).

Table 4: TDEC GIS Data for Use in Sensitive Areas Inventory

GIS Data Type	*Data Layer Name*	*Description*
Floodplain	Floodplain	100-year and 500-year floodplains derived from FEMA Q3 Flood data.
Protected Land	Protected Lands	Includes parks, conservation lands, agricultural preservation lands, easements, and state and federal protected land.
	Greenways	Greenways are natural corridors set aside by county, state or federal authorities to connect larger areas of open space and to provide for the conservation of natural resources, protection of natural resources, protection of habitat, movement of plants and animals, and to offer opportunities for linear recreation, alternative transportation, and nature study.
Rare, Threatened, and Endangered Species	Sensitive Species Project Review Areas	Contains buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Natural Heritage Areas	Natural Heritage Areas are areas designated in the state's Threatened and Endangered Species regulations because they: contain one or more threatened or endangered species or wildlife species in need of conservation; are a unique blend of geologic, hydrologic, climatologic or biological features; and are considered to be among the best statewide examples of its kind.
	TDEC Wetlands Inventory	Statewide wetland inventory that includes records of wetlands location and classification as defined by the U.S. Fish & Wildlife Service's National Wetlands

Table 4: TDEC GIS Data for Use in Sensitive Areas Inventory		
GIS Data Type	*Data Layer Name*	*Description*
		Inventory program.
	National Wetlands Inventory	Although outdated, this inventory occasionally identifies wetlands that do not appear in other inventories.

An inventory of all wetlands in the watershed should be conducted as part of a sensitive areas inventory. An inventory of wetlands in the watershed provides a starting point for a watershed approach to wetland permitting that can impact future permitting decisions. More detailed local wetlands data may be supplemented, if available, as part of the inventory. A sensitive areas inventory should also include a detailed assessment of forest cover in the watershed. It is important to know the percent forest cover in a watershed in order to set future goals for maintaining or increasing this cover, and to use in estimating future pollutant loads from different types of land. There is currently no statewide forest cover layer in Tennessee that is of sufficient resolution to quantify forest cover at the watershed scale. Local governments should use detailed local forest cover data, where available. If no such data exists, another option is to develop a detailed forest cover or forest canopy layer using high-resolution aerial photos or satellite imagery.

The results of a sensitive areas inventory include various maps and statistics that summarize the number and acreage of the different sensitive resources by subwatershed and are used to identify potential protection and restoration sites later on.

Future impacts to sensitive areas

After completing an inventory of sensitive areas in the watershed, local governments should also evaluate the potential impacts to these areas, as a result of future growth and land use changes. Growth projections are regularly completed by the University of Tennessee. Using these statewide projections can provide a simple way to estimate future land use and land cover, and to quantify pollutant loads and the potential loss of sensitive areas. However, these projections may not be appropriate for use at the watershed scale. Future impacts to sensitive areas can be estimated using local land use data and assumptions. A proposed method for projecting future forest loss is provided below.

Protection and restoration sites

The sensitive area inventory should be used to identify potential protection and restoration sites. TDEC data provides a good starting point, but it is also necessary to review additional GIS data, and take a comprehensive look at all the sensitive areas in the watershed to identify additional sites. Table 6 provides guidance on identifying potential protection and restoration sites.

Potential protection sites are further evaluated through different sensitive areas assessments, depending on whether the site is a forest, a wetland, stream buffer, steep slope, or RTE species habitat. The products of this method are maps of potential protection and restoration sites.

Table 6: Identifying Potential Protection and Restoration Sites within a Sensitive Areas Analysis	
Potential Protection Sites	*Potential Restoration Sites*
• Green Infrastructure hubs and corridors • Wetlands of Special State Concern • Forest Interior Dwelling Species Potential Habitat • Sensitive Species Project Review Areas • Natural Heritage Areas • Officially designated reference sites • Other forests, wetlands, or agricultural lands that: − are large, contiguous tracts − are currently unprotected − have key position in the watershed (e.g., headwaters, adjacent to drinking water reservoir, trout stream, or existing protected lands) − contain sensitive areas such as 100-year floodplains, steep slopes, erodible soils, or stream buffers. − have special significance such as locally rare or difficult-to-replace wetland type, or prime farmland	• Green Infrastructure gaps • Former or existing degraded wetlands with land use and hydrology that are suitable for restoration (e.g., farm land, sand or gravel pits, high water table) • Public turf (e.g., schools, parks, rights-ofway) • Vacant land • Unbuffered streams • Other open lands that: − have key position in watershed (e.g., headwaters, adjacent to drinking water reservoir, trout stream, or existing protected lands) − contain sensitive areas such as 100-year floodplains, steep slopes, erodible soils, or stream buffers. − provide a connection between existing forest, wetlands, or other potential protection sites

Classify and Rank Subwatersheds

The purpose of classifying and ranking subwatersheds is to provide a basis for identifying priority subwatersheds on which planning efforts should be focused. Classifying and ranking subwatersheds is particularly useful in large watersheds where planning and implementation funding is limited. The classification and ranking process generally identifies the subwatersheds that are the most vulnerable to future development and/or have the greatest restoration potential.

While the ICM provides a first cut at classifying subwatersheds according to their current and expected stream quality, it is sometimes necessary to create subwatershed classification categories beyond those presented by the ICM. For example, in rural watersheds where most of the subwatersheds have less than 10% impervious cover, the ICM may be inadequate to distinguish differences between truly sensitive subwatersheds, and subwatersheds that are impacted by agricultural activities. Additional classification of these subwatersheds beyond the ICM can be done through a simple spreadsheet analysis of selected subwatershed metrics. Subwatershed metrics are usually numeric values that describe subwatersheds based on a single characteristic. A simple example is to use the percent forest and the percent agricultural land in each subwatershed to further classify “sensitive” subwatersheds into “sensitive forested” and “sensitive agricultural” (Figure 6).

The basic steps associated with classifying and ranking subwatersheds are presented below.

1) Review the initial ICM subwatershed classifications.
2) Expand the classification to account for factors other than impervious cover.

3) Select subwatershed metrics for use in ranking subwatersheds. Subwatershed metrics represent factors that determine the relative vulnerability or restorability of a subwatershed.

The metrics used to rank subwatershed vulnerability should be selected separately from the metrics used to rank subwatershed restorability. Various metrics can be estimated, depending on available data and the goals of the watershed plan. Table 7 lists the range of possible metrics that can be derived from the GIS data layers.

1) Assign points to each metric. To keep the subwatershed ranking system simple, the total number of possible points should be 100. More 'important' metrics should be assigned more points than others.
2) For each subwatershed, compute metrics and assign points for each metric.
3) Add the total points for each subwatershed to get a comparative ranking.

These steps are illustrated in the Real World Example of the Bush River Watershed presented later in this section.

The ranking process refines the subwatershed classification, and is used to identify priority subwatersheds, which are typically the top-ranked subwatersheds in each classification category.

Table 7: Examples of Metrics Used to Classify and Rank Subwatersheds	
• # road crossings per stream mile • # violations of water quality standards • % critical habitat for RTE species • % cropland • % current impervious cover • % detached residential land • % developable land • % forest cover • % forest interior • % forested stream buffer • % future forest loss • % industrial land • % public land • % streams with 303(d) listing • % wetlands • Age of development • Modeled pollutant loads (e.g., total phosphorus or total nitrogen)	• Benthic macroinvertebrate diversity • Condition of sewer system • Density of point sources or hotspots • Density of septic systems • Density of stormwater outfalls • Density of stormwater treatment practices • Density of streams • Fish diversity • Length of eroded stream bank • Livestock density • Net change in future impervious cover • Physical in-stream habitat • Presence of combined sewer systems • Presence of community or watershed organization • Presence of public drinking water supply • Modeled peak flow and runoff volume for 1- and 2-year storm events

Estimate Pollutant Loads and Reductions

A major goal of any watershed plan is to reduce pollutant loads to the watershed. TMDL implementation requires tracking pollutant loads and reductions. In order to assess consistency with TMDLs, local governments need a consistent framework for first estimating pollutant loads in the watershed, and then estimating the pollutant reductions attributed to plan implementation. A framework for estimating pollutant loads and reductions is described below.

Estimate Pollutant Loads

Local governments should estimate current and future pollutant loads for their watersheds for use in evaluating the effects of land use changes and project implementation on watershed goals. Since watershed plans generally focus on reducing pollution from nonpoint sources, pollutant loads are estimated based on land use/land cover data and pollutant concentrations. One fairly straightforward approach is the Simple Method. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration. As such, this method can be used to estimate average annual pollutant loads for a watershed, by estimating pollutant loads for each type of land in the watershed. Annual pollutant loads are derived using the equations presented in Table 12.

Table 12: Using the Simple Method to Estimate Pollutant Loads

Factor	*Equation*	*Description*
Annual Pollutant Load (L, in pounds)	L = 0.226 * R * C * A	Where: R = Annual runoff (inches) C = Pollutant event mean concentration (mg/L) A = Area (acres) 0.226 = A conversion factor
Annual Runoff (R, in inches)	R = P * Pj * Rv	Where: P = Annual rainfall (inches) Pj = Fraction of annual rainfall events that produce runoff (usually 0.9) Rv = Runoff coefficient (fraction of rainfall that becomes runoff)
Runoff Coefficient (Rv)	Rv = 0.05 + 0.9Ia	Where: Ia = Fraction of land that is impervious (determined from Establishing a Baseline)

Several models also exist to estimate watershed pollutant loads under different land use scenarios.. The Watershed Treatment Model (WTM) is a simple spreadsheet model that is recommended for estimating current and future pollutant loads as part of a watershed plan. More information about using the WTM is provided below and in Caraco (2001).

The WTM provides rapid, inexpensive, and reasonably accurate estimates of watershed loads of sediment, nutrients, and bacteria. The WTM is an ideal tool for planning in most watersheds, although more complex models may be warranted in some locations. The first component of the WTM estimates watershed pollutant loads without any implementation of projects. The WTM can be applied to current land use scenarios, or to future land use scenarios to assess the impacts of future growth on pollutant loads.

The WTM predicts annual pollutant loads from primary and secondary pollution sources (Table 13). Primary sources include stormwater runoff loads generated from general land use, as well as atmospheric deposition of pollutants over open water. Secondary sources are pollutant sources dispersed throughout the watershed whose magnitude cannot be directly estimated from land use data. Input data needed for secondary sources ranges widely, but most can be estimated using available GIS data. Land use data is the major input required to estimate loads from primary sources. Event mean concentrations (EMCs) of sediment, phosphorus and nitrogen for various land uses are provided in the WTM as defaults.

Table 13: Primary and Secondary Pollutant Sources Considered by the WTM	
Primary Land Uses	*Secondary Pollution Sources*
• Residential land • Commercial land • Roadway • Rural land • Forest • Open water	• Septic systems • Active construction • Managed turf • Channel erosion • Marinas • Hobby farms/livestock • NPDES dischargers • Sanitary sewer overflows • Combined sewer overflows • Illicit connections

Local governments should use the WTM or similar tool to estimate current pollutant loads in their watersheds and should also evaluate how these loads will increase under future land use scenarios. Future land use scenarios should reflect zoning and local growth projections, and development capacity analysis. Water and sewer projections are particularly useful in projecting future growth, as they provide a clue to both the timing and placement of future development. Methods to estimate pollutant reductions due to project implementation are described below.

Estimate Pollutant Reductions

Pollutant reductions associated with individual protection and restoration projects are estimated as part of project design and ranking. It can be difficult to quantify the collective impact of land use changes and project implementation on attaining specific pollutant reduction goals for the watershed. Several good desktop models can assist in this effort by estimating the pollutant reduction associated with implementation of specific projects in a watershed. Models fall into two general categories: spreadsheet models and simulation models. Both types of models return information that is useful to evaluate watershed goals and develop TMDLs. Generally speaking, spreadsheet models have less input data and require less effort and funding to perform than simulation models

Local governments should apply modeling tools to estimate pollutant reduction as a result of watershed plan implementation. The WTM and the CBP Watershed Model are two good options. The WTM assesses the ability of land use and current or proposed projects such as stormwater retrofits, reforestation, and watershed education, to reduce pollutant loads. The WTM evaluates pollutant reduction by applying a pollutant removal rate to the treatable load, and then adjusting the total reduction achieved to reflect the projected level of watershed implementation. The reliability of pollutant reduction estimates made by the WTM varies with the type of project. Table 16 shows the range of projects that can potentially be evaluated by the WTM, along with a general indication of the reliability of the estimate.

Table 16: Protection and Restoration Projects Evaluated by WTM	
Stormwater Retrofits Storage Retrofits1 On-Site Residential Retrofits1 On-Site Non-Residential Retrofits1	Stream Repair Simple Practice4 Comprehensive Applications4
Reforestation Riparian Reforestation4 Upland Reforestation2	Discharge Prevention Illicit Connections Sewage1 Failing Sewage Lines1
Municipal Operations Street and Storm Drain Practices2 Pollution Prevention at Municipal Operations2 Best Practices for Municipal Construction3 Stewardship of Public Land2	Pollution Source Control Residential Pollution Prevention2
Other Land Reclamation2 Management of Natural Area Remnants2 Floodplain / Wetland Restoration2 Hill-Slope Bioengineering3	Overall WTM Capability 1 provides reasonable estimate of treatment if detailed subwatershed data is available 2 provides ballpark estimate of treatment 3 provides very rough estimate of treatment due to data limitations 4 provides very rough estimate of treatment that is considered a secondary benefit, not primary benefit, of the project

Default pollutant removal rates are provided in the WTM and other models for various protection and restoration projects. Tables 17a and b present nutrient and sediment removal efficiencies for various protection and restoration projects. For consistency with this model and other state-level efforts that are based on this model, local governments should use both the efficiencies and the reporting units presented in the tables when estimating pollutant reductions as part of watershed plans.

Table 17a: Pollutant Reduction Efficiencies and Reporting Units for Urban Best Management Practices				
Urban Practice	*Total Nitrogen (TN) Efficiency (%)*	*Total Phosphorus (TP) Efficiency (%)*	*Total Suspended Solids (TSS) Efficiency (%)*	*Reporting Units*
Wet ponds/stormwater wetlands	*30*	*50*	*80*	Acres treated by practice
Dry detention ponds	*5*	*10*	*10*	
Hydrodynamic structures*	0	5	10	
Dry extended detention ponds	*30*	*20*	*60*	
Infiltration practices	*50*	*70*	*90*	
Filtering practices	*40*	*60*	*85*	
Bioretention areas *	40	40	90	
Impervious cover reduction*	90	90	90	
Storage retrofits*	35	45	80	
On-site retrofits*	40	60	90	
Stream repair	*0.02 lbs/ft*	*0.0035 lbs/ft*	*2.55 lbs/ft*	Linear feet
Erosion and sediment control	*33*	*50*	*50*	Acres
Residential nutrient management	*17*	*22*	0	Acres
Forest conservation*	same as impervious cover reduction			Acres
Riparian forest buffer planting	*25*	*50*	*50*	Acres
Upland reforestation (from turf) *	90	90	0	Acres
Upland reforestation (from Impervious Cover) *	95	95	50	Acres
Hotspot pollution prevention*	derived	derived	derived	Site
Septic denitrification	*50*-60	0	0	Systems
Septic pumping	5	0	0	
Septic connections/hookups	55	0	0	
Emergent marsh wetland restoration	42	55	75	Acres
Palustrine forested wetland restoration	43	58	75	
Street sweeping *	5	15	20	Miles
Catch basin cleaning *	5	15	20	Inlet

Table 17b: Pollutant Reduction Efficiencies and Reporting Units for Rural Best Management Practices				
Rural Practice	*Total Nitrogen (TN) Efficiency (%)*	*Total Phosphorus (TP) Efficiency (%)*	*Total Suspended Solids (TSS) Efficiency (%)*	*Reporting Units*
Forest harvesting practices	*50*	*50*	*50*	Acres
Septic connections/hookups	55	0	0	System
Septic denitrification	*50*-60	0	0	
Septic pumping	*5*	0	0	
Conservation tillage*	25	30	75	Per acre treated
Riparian forest buffers*	60	70	75	
Riparian grass buffers	*17-57*	*50-75*	*50-75*	
Land retirement *	50	80	80	
Reforestation (from row crops)*	90	95	90	
Nutrient management plan implementation	derived	derived	0	
Cover crops	*17 - 45*	*0 - 15*	*0 - 20*	
Conservation plans	*3 - 8*	*5 - 15*	*8 - 25*	
Livestock Animal Waste Management System (AWMS)	*100*	*100*	0	Per operation
Poultry AWMS	*100*	*100*	0	
Barnyard runoff control	*100*	*100*	0	
Stream fencing, rotational grazing and off-stream watering	*20*	*20*	*40*	Acres, linear feet
Stream fencing and off-stream watering	*60*	*60*	*75*	Acres
Off-stream watering only	*30*	*30*	*38*	Acres
Wetland restoration*	40	55	75	Acres

The results of the modeling efforts to estimate pollutant loads and reductions should be used to revisit project ranking or modify recommendations made as part of the plan, if future pollutant reduction with full plan implementation is not sufficient to meet TMDLs or pollutant reduction goals.

II. MINIMUM MONITORING FOR A SILTATION AND HABITAT ALTERATION TMDL

MINIMUM MONITORING FOR SILTATION AND HABITAT ALTERATION TMDL

At a minimum, a monitoring plan for a **Siltation and Habitat Alteration TMDL** must include the following:

1. Biological stream sampling must be performed utilizing the Semi-Quantitative Single Habitat (SQSH) Method as identified in the Division's Quality System Standard Operating Procedure for Macroinvertebrate Stream Survey, revised October 2006. At least one sample per stream segment listed in the TMDL must be collected, with all segments in the MS4 jurisdiction sampled in a five-year period. The standard operating procedure can be found online at http://state.tn.us/environment/wpc/publications/bugsop06.pdf.

2. Visual Stream Surveys and Impairment Inventories must be performed in an effort to identify and prioritize MS4 stream impairment sources. It is strongly recommended that visual stream surveys be performed throughout the entire HUC-12 subwatershed of a stream segment listed in the TMDL. At a minimum, a survey must be performed immediately upstream and downstream of each MS4 outfall that discharges into a TMDL listed stream segment. There are many existing protocols available through the Environmental Protection Agency, Natural Resources Conservation Service, U.S. Fish and Wildlife Services, Center for Watershed Protection and states such as Maryland. MS4s have the flexibility to select or modify a protocol to complement the existing MS4 program, as long as the main objective is accomplished. All TMDL listed stream segments in the MS4 jurisdiction must be surveyed in a five-year period.

Guidelines for filling out Macroinvertebrate Monitoring Worksheet Forms A-1, A-2 & A-3

For questions, please contact Debbie Arnwine at 615-532-0703, or at Debbie.Arnwine@state.tn.us.

1. Benthic sampling must be performed utilizing methods as identified in the Division's **Quality System Standard Operating Procedure for MACROINVERTEBRATE STREAM SURVEYS, October 2006.** The SOP may be viewed at:

http://state.tn.us/environment/wpc/publications/bugsop06.pdf

2. Biological stream monitoring utilizing the Semi-Quantitative Single Habitat (SQSH) Method must be conducted by a qualified biologist.

3. You must notify the appropriate Environmental Field Office at least two weeks prior to conducting the survey.

4. Monitoring locations must be consistent with your previously approved monitoring plan and provide appropriate habitat and be generally comparable. If these locations do not have appropriate habitat, and are not generally comparable, then alternate sites must be chosen. Prior to sampling at these alternate sites, they must be identified on a topographical map, and submitted to the EFO for approval.

5. All data must be submitted on this worksheet and submitted electronically to Debbie Arnwine at:

Debbie.Arnwine@state.tn.us

Please enter the data electronically into the yellow highlighted columns in the three worksheets (Forms A-1, A-s, and A-3) provided with this workbook (see tabs along the bottom). The three forms are Station ID informations, Macroinvertebrate data, and SQSH Habitat information. **Please do not delete, rename, alter, or add any columns to these worksheets as the entire worksheet will be pasted directly into the division's database**. The Division's **Quality System Standard Operating Procedure for MACROINVERTEBRATE STREAM SURVEYS, October 2006** describes the data formats. Please fill out the Station ID Form A-1 for each station, as well as the Macroinvertebrate Data Sheet Form A-2 and the SQSH Habitat Form A-3 info for each sample. If you have additional comments, please submit as a separate attachment with your submittal.

FORM A-1 STATION ID INFO Column Definitions	
PROJECT NAME	Unique Project ID (ex. MS4 PROJECT)
STATION ID	Unique Station Designator (ex: CLEAR008.6MG)
CURRENT FISCAL YEAR COLLECTED	State Fiscal Year - July 1 - June 30 (ex. 2007)
RM	River Mile (ex. 8.6)
NAME	Water Body Name (Ex. Clear Creek)
STATION LOCATION	Description (ex. Barnett Bridge at confl with White Ck)
COUNTYNAME	County Name
STATE	TN
STREAM ORDER	Stream Order (ex. 4)
LATDECIDEG	In Decimal Degrees (ex. 36.1226)
LONGDECIDEG	In Decimal Degrees (ex. -84.7954)
HUC	HUC 8 Number (ex. 06010208)
HUCNAME	HUC 8 Name (ex. Emory)
USGSQUAD	Number - not Name (ex. 16SE)
ECOIV	Ecoregion 4 (Ex. 68A)

CHEMSAMPBY1	Actual Sampling Entity (ex. MS4 METRO)
CHEMFREQ1	Ex. Once
BACTFREQ1	Ex. Once
BENSAMPBY1	Actual Sampling Entity (ex. MS4 METRO)
BENTHFREQ1	Ex. Once
BENTHMETH1	SQSH, specifically SQKICK or SQBANK

FORM A-2 MACROINVERTEBRATE DATA Column Definitions	
Station ID	Unique Station Designator (ex: CLEAR008.6MG)
Log Number	Unique log # assigned by lab (ex: N0801001)
HUC 8	Number (ex. 06010208)
HUC 12	Number (ex. 060102080101)
Sampler	Sampler Name
Taxonomist	Taxonomist Name
Number of Individuals in Subsample	Number of Individuals in Subsample
Sample Date Format	00-00-0000
Sample Type	SQSH, specifically SQKICK or SQBANK
ECOREGION	Ecoregion 4 (Ex. 68A)
Project Name	Unique Project ID (MS4 Monitoring)

FORM A-3 SQSH HABITAT Column Definitions	
MS4 Permittee Name:	ex. MS4 METRO
Assessment Lab/Organization:	Actual Sampling Entity (ex. MS4 METRO)
Stream type:	Riffle/Run or Glide/Pool
HUC 12:	Number (ex. 060102080101)
Ecoregion:	Ecoregion 4 (Ex. 68A)
Station Id:	Unique Station Designator (ex: CLEAR008.6MG)
Stream Name:	Stream Name
Location:	Description (ex. Barnett Bridge at confl with White Ck)
Assessor:	Assessor's name
Date:	00-00-0000

Station ID Information Form A-1

*** Please do not delete, rename, alter, or add columns.**

**** Please fill out only yellow highlighted columns.**

MS4 Name:	

PROJECT NAME:	STATION ID:	CURRENT FISCAL YEAR COLLECTED	RM	NAME:	STATION LOCATION:	COUNTYNAME	STATE:	STREAM ORDER:	LATDECIDEG:	LONGDECIDEG:	HUC:	HUCNAME	USGSQUAD	ECOIV:	CHEMSAMPBY1:	CHEMFREQ1:	BACTFREQ1:	BENSAMPBY1:	BENTHFREQ1:	BENTHMETH1:

MS4 Macroinvertebrate Monitoring Worksheet, Form A-2

MS4 Permittee Name:		**Station Id:**	
Collection Lab/Organization:		**Log Number:**	
ID Lab/Organization:		**Stream Name:**	
Weather Conditions:		**Location:**	
Ecoregion:		**Sample Type (SQKICK or SQBANK):**	
Stream order:		**Sample Date:**	
Sampler:		**Taxonomist:**	
HUC 12:		**Number of individuals in sample:**	

Order	Family	Genus	Number

SQSH Habitat Form A-3

MS4 Permittee Name:		**Station Id:**	
Assessment Lab/Organization:		**Stream Name:**	
Stream type (Riffle/Run or Glide/Pool):		**Location:**	
HUC 12:		**Assessor:**	
Ecoregion:		**Date:**	

High Gradient Habitat Parameter	Score	Low Gradient Habitat Parameter	Score
Epifaunal Substrate/Available Cover		Epifaunal Substrate/Available Cover	
Embeddedness		Pool Substrate Characterization	
Velocity/Depth Regime		Pool Variability	
Sediment Deposition		Sediment Deposition	
Channel Flow Status		Channel Flow Status	
Channel Alteration		Channel Alteration	
Frequency of Riffles		Channel Sinuosity	
Bank Stability - Left Descending Bank		Bank Stability - Left Descending Bank	
Bank Stability - Right Descending Bank		Bank Stability - Right Descending Bank	
Vegetative Protection Left Descending Bank		Vegetative Protection Left Descending Bank	
Vegetative Protection - Right Descending Bank		Vegetative Protection - Right Descending Bank	
Riparion Vegetative Zone Width - Left Descending Bank		Riparion Vegetative Zone Width - Left Descending Bank	
Riparion Vegetative Zone Width - Right Descending Bank		Riparion Vegetative Zone Width - Right Descending Bank	

III. MINIMUM MONITORING FOR A PATHOGEN TMDL

MINIMUM MONITORING FOR A PATHOGEN TMDL

At a minimum, a monitoring plan for a **Pathogen TMDL** must include the following:

1. Pathogen stream sampling must be performed utilizing methods as identified in the Division's Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water, March 2004. Sampling shall include the collection of five samples and corresponding flow measurements, in a thirty-day period (to establish a geometric mean), and be performed within the months of June to September. Pathogen sampling must be performed on stream segments listed in the TMDL, with all segments in the MS4 jurisdiction sampled in a five-year period. The standard operating procedure can be found online at http://state.tn.us/environment/wpc/publications/ChemSOP03QUAP.pdf.

2. Visual Stream Surveys and Impairment Inventories must be performed in an effort to identify and prioritize MS4 stream impairment sources. It is strongly recommended that visual stream surveys be performed throughout the entire HUC-12 subwatershed of a stream segment listed in the TMDL. At a minimum, a survey must be performed immediately upstream and downstream of each MS4 outfall that discharges into a TMDL listed stream segment. There are many existing protocols available through the Environmental Protection Agency, Natural Resources Conservation Service, U.S. Fish and Wildlife Services, Center for Watershed Protection and states such as Maryland. MS4s have the flexibility to select or modify a protocol to complement the existing MS4 program, as long as the main objective is accomplished. All TMDL listed stream segments in the MS4 jurisdiction must be surveyed in a five-year period.

Guidelines for filling out Pathogen Monitoring Worksheet Forms B-1 & B-2

For questions, please contact Linda Cartwright at 615-532-0704, or at Linda.Cartwright@state.tn.us.

1. Pathogen stream sampling must be performed utilizing methods as identified in the Division's **Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water, March 2004.** The SOP may be viewed at:
http://state.tn.us/environment/wpc/publications/ChemSOP03QUAP.pdf
The procedure for flow measurement is in Protocol L and the pathogen procedure is in Protocol M.

2. Sampling shall include the collection of five samples and corresponding flow measurements, in a thirty-day period (to establish a geometric mean).

3. Sampling must be performed within the months of June to September.

4. At least one pathogen sample per stream segment listed in the TMDL must be collected, with all segments in the MS4 jurisdiction sampled in a five-year period.

5. Monitoring locations must be consistent with your previously approved monitoring plan and be generally comparable. If these locations are not generally comparable, then alternate sites must be chosen.

6. All data must be submitted on this worksheet and submitted electronically to Linda Cartwright at:

Linda.Cartwright@state.tn.us

7. Please use the following unit specifications:

Test	Units
Field Determinations:	
pH	pH units
Conductivity	uMHO
Dissolved Oxygen	mg/l
Temperature	Celsius
Env. Microbiology	
Total Coliform	CFU/100ml
E. Coli	CFU/100ml
Fecal Coliform	CFU/100ml
Enterococcus	CFU/100ml
Fecal Strep	CFU/100ml

Please enter the data electronically into the yellow highlighted columns in both Forms B-1 and B-2 provided with this workbook (see tabs along the bottom). **Please do not delete, rename, alter, or add any columns to these worksheets as the entire worksheet will be pasted directly into the division's database**. The Division's **Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water, March 2004** describes the data formats. Please fill out both the station ID info for each station and the WQ Bacteria Data Sheet info for each sample. If you have additional comments, please submit as a separate attachment.

FORM B-1 STATION ID INFO Column Definitions	
PROJECT NAME	Unique Project ID (ex. MS4 PROJECT)
STATION ID	Unique Station Designator (ex: CLEAR008.6MG) ID can not be longer than 12 digits.

CURRENT FISCAL YEAR COLLECTED	State Fiscal Year - July 1 - June 30 (ex. 2007)
RM	River Mile (ex. 8.6)
NAME	Water Body Name (Ex. Clear Creek)
STATION LOCATION	Description (ex. Barnett Bridge at confl with White Ck)
COUNTYNAME	County Name
STATE	TN
STREAM ORDER	Stream Order (ex. 4)
LATDECIDEG	In Decimal Degrees (ex. 36.1226)
LONGDECIDEG	In Decimal Degrees (ex. -84.7954)
HUC	HUC 8 Number (ex. 06010208)
HUCNAME	HUC 8 Name (ex. Emory)
USGSQUAD	Number - not Name (ex. 16SE)
ECOIV	Ecoregion 4 (Ex. 68A)
CHEMSAMPBY1	Actual Sampling Entity (ex. MS4 METRO)
CHEMFREQ1	Ex. Once
BACTFREQ1	Ex. Once
BENSAMPBY1	Actual Sampling Entity (ex. MS4 METRO)
BENTHFREQ1	Once
BENTHMETH1	SQSH (Specifically SQKICK or SQBANK)

FORM B-2 WQ Bacteria Monitoring Data Sheet Column Definitions	
Station ID	Unique Station Designator (ex: CLEAR008.6MG)
Activity ID	Unique log # assigned by lab. SOP states to put in a P (ex. NP0801001 or METRP0801001. ID can not be longer than 12 digits.
Date Format	00-00-0000
Time Format	0000 - Military Time
Project Name	Unique Project ID (MS4 Monitoring)
Activity Type	Either a Sample or Trip QA/QC
Activity Category	Routine Sample or a Field Replicate (Trip QC) every 10 samples.
Trip QC Type	Field or Trip Blank (if activity category is Trip QC)
ChemSampBy	Sampling Organization Name (ex. MS4 Metro)
Bact Analyzed By	Analyzing Organization Name

Station ID Information Form B-1

*** Please do not delete, rename, alter, or add columns.**

**** Please fill out only yellow highlighted columns.**

MS4 Name:	

PROJECT NAME:	STATION ID:	CURRENT FISCAL YEAR COLLECTED	RM	NAME:	STATION LOCATION:	COUNTYNAME	STATE:	STREAM ORDER:	LATDECIDEG:	LONGDECIDEG:	HUC:	HUCNAME	USGSQUAD	ECOIV:	CHEMSAMPBY1:	CHEMFREQ1:	BACTFREQ1:	BENSAMPBY1:	BENTHFREQ1:	BENTHMETH1:

MS4 Water Quality Bacteria Monitoring Worksheet, Form B-2

* Please do not delete, rename, alter, or add columns.	
** Please fill out yellow highlighted columns.	
MS4 Name:	

Station ID:	Activity ID:	Date:	TIME	Project Name:	Activity Type:	Activity Category:	Trip QC Type:	ChemSampBy:	Bact Analyzed By:	pH field:	pH units:	Field Conduct:	FC units:	DO field:	DO units:	Flow:	Flow units:	Temp field:	Temp units:

MS4 Water Quality Bacteria Monitoring Worksheet, Form B-2

* Please do not delete, rename, alter, or add columns.	
** Please fill out yellow highlighted columns.	
MS4 Name:	

Station ID:	Activity ID:	Date:	TIME	Project Name:	Activity Type:	Tot Col:	Tot Col units:	E Coli:	E Coil units:	E Coli-dilu:	E Coli-dilu units:	Fec Col:	Fec Col units:	Entero:	Entero units:	Fec Strep:	Fec Strep units:

IV. VISUAL ASSESSMENT PROTOCOL

Adapted with permission from: Stream Corridor Assessment Survey Protocols , with the assistance of the Watershed Restoration Division, Chesapeake and Coastal Watershed Services, Maryland Department of Natural Resources, Annapolis, Maryland. Visual assessments are common to monitoring Siltation and Habitat Alteration TMDL's, and Pathogen TMDL's.

IV. VISUAL ASSESSMENT PROTOCOL

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    4.3.2 GIS DATA VERIFICATION

REFERENCES

APPENDIX A. SAMPLE PROPERTY OWNER NOTIFICATION LETTERS

APPENDIX B. SAMPLE RIGHT OF ENTRY PERMIT

APPENDIX C. SAMPLE DATA SHEETS AND DOCUMENTATION

IV. VISUAL ASSESSMENT PROTOCOL

Adapted with permission from: Stream Corridor Assessment Survey Protocols , with the assistance of the Watershed Restoration Division, Chesapeake and Coastal Watershed Services,Maryland Department of Natural Resources, Annapolis, Maryland.

Visual assessments are common to monitoring Siltation and Habitat Alteration TMDL's, and Pathogen TMDL's.

1.0 INTRODUCTION

1.1 PURPOSE OF SURVEY AND PROTOCOLS

The Stream Corridor Assessment (SCA) survey is designed to provide a method which can be used to both rapidly assess the general physical condition of a stream system and identify the location of a variety of common environmental problems within the stream's corridors. *Use of the SCA methodology as presented herein is encouraged, but not required. Other methodologies may be proposed to and evaluated by the Tennessee Department of Environment and Conservation on an individual basis.*

The SCA is intended to be a tool that can help resource managers identify not only the location of environmental problems but also restoration opportunities that exist within a drainage network. Potential environmental problems identified as part of the SCA survey include:

* Erosion Sites * Inadequate Stream Buffers
* Fish Blockages * Exposed or Discharging Pipes
* Channelized Stream Sections * Trash Dumping Sites
* In or Near Stream Construction * Unusual Conditions

In addition, the survey also collects information on potential wetlands creation/water quality retrofit sites, as well as data on the general condition of both in-stream and riparian corridor habitats. The survey can also be used to assist in the identification of healthy stream sections that may be in need of environmental protection.

The data sheets and methods used in the SCA survey have been developed over several years. During that period, some of the data sheets have changed in response to needs of the survey's sponsors which have usually been county and city government agencies.

While these survey protocols represent the data sheets and methods that are now being used, it is possible that additional changes will be made in the future.

1.2 SURVEY OBJECTIVES

The SCA survey has four main objectives:

1. To provide a list of observable environmental problems present within a stream system and along its riparian corridor.

2. To provide sufficient information on each problem so that a preliminary determination of both the severity and correctability of a problem can be made.

3. To provide sufficient information so that restoration efforts can be prioritized.

4. To provide a quick assessment of both in- and near-stream habitat conditions so that comparative assessments can be made of the condition of different stream segments.

It is important to note that SCA is not intended to be a detailed scientific survey of a stream system nor will it replace the more standard chemical and biological surveys. Instead SCA is intended to provide a rapid method of examining an entire drainage network so future monitoring, management and/or conservation efforts can be better targeted. The survey was developed because most existing scientific surveys are time consuming, expensive to do on a wide scale and often collect information for a relatively small section of stream at any one time. In contrast, the SCA survey is designed so that teams of two or three individuals will be able to survey an average of two to three stream miles per day, at a relatively low cost.

1.3 BACKGROUND ON SURVEY DEVELOPMENT

The SCA survey is really not a new concept but a refinement and the systematic implementation of an old approach, which in its simplest form is often referred to as a stream walk survey. The survey is based on the fact that many of the common environmental problems affecting streams, such as excessive stream bank erosion or blockages to fish migration are fairly easy to identify by an individual walking along a stream. With the proper training most people can identify these common environmental problems.

The survey is designed to be done by a small group of well-trained individuals that walk the entire stream network in a watershed. While the individuals doing the survey are usually not professional natural resource managers, they do receive several days of training before beginning the survey. The intention of the survey is to identify and collect some basic information about potential environmental problems so that future restoration and management activities can be better targeted.

1.4 RESPONSIBILITIES OF SURVEY PARTICIPANTS

The duties and responsibilities of the main participants in an SCA survey can be separated into six primary areas. Depending on the size of the survey and the expertise of the people involved, two or more of these duties may be done by a single individual or group. The primary areas of responsibility are:

Survey Sponsor - The survey sponsor is usually a Federal, State or local government agency, although there is no reason why a watershed association or other citizen group could not sponsor a SCA survey. The main responsibilities of the survey sponsors are to help finance the survey, to work with the survey manager to notify watershed residents of the survey and to work with watershed stakeholders after the survey is completed to address the problems identified.

Survey Manager - The survey manager is the individual that is responsible for making sure the SCA survey is done properly and that information collected during the survey is compiled in a way that will be useful to the survey's sponsor. The survey manager will oversee all aspects of the survey. The individual is usually responsible for data analysis and producing a final product for the survey's sponsor.

Data Manager - The data manager is the individual responsible for overseeing management of the data collected during a SCA survey. While the survey crew will usually be responsible for entering survey data into the project database including scanning all photographs into a digital photo album, it is the responsibility of the data manager to insure that this work is done properly. The data manager is also responsible for making sure that the data, scanned photographs and maps have been properly verified and all the information entered into the project digital databases are accurate. The data manager is also responsible for insuring that the original data sheets and maps are properly archived and that all digital data is not only properly stored, but also backed up. In general, the data manager is responsible for overseeing all data quality assurance work.

GIS Manager - The GIS manager is responsible for providing the map products for the initial field survey work and for producing the finished maps that are used to analyze the data collected. At the beginning of the survey the GIS manager will usually produce a base map of the entire watershed and a series of field survey maps to be used by field teams during the survey. After the field work has been completed and the information entered into the project database, the GIS manager will make sure that station location data is entered correctly into the GIS system and verified. The GIS manager will then work with the survey manager to produce a series of maps to display the information collected during the survey so that it can be analyzed and used by the survey's sponsor.

Survey Crew Chief - The survey crew chief oversees the daily work of the field teams during the survey. The crew chief is responsible for determining when and where the field teams will be working, making sure that the field teams have all the equipment that they need and coordinating travel logistics. The crew chief is also responsible for overseeing data entry and data verification. One of the main duties of the crew chief is to act as a conduit between the field teams and both the survey manager and sponsor to resolve any questions or problems that might arise during the survey.

Field Teams - Field teams are composed of two to four trained individuals. Each field team will have a team leader who will work with the survey crew chief to coordinate the activities of their team with those of the other survey teams. Team leaders are responsible for making sure that the team has everything that it needs before the survey begins each day and for reviewing the data sheets and map at the end of the day to make sure they are complete.

2.0 PREPARING FOR A SURVEY

2.1 SELECTING A WATERSHED TO SURVEY

It is important that whenever possible, the survey be done on a watershed basis. One of the main goals of the survey is to develop a prioritized list of problems to be corrected throughout the entire watershed. When prioritizing stream restoration or recommending improved storm water management, it is important that the area be looked at as a complete ecological system and that management activities be targeted at those areas where they can do the most good.

The main consideration in selecting a watershed for a SCA survey is whether there is a local sponsor that can help correct the problems identified in the survey. Almost all of the problems identified in the SCA survey have solutions. Implementation of those solutions, however, takes time and commitment. Whoever the local sponsor is, it is important that after the survey if completed, that someone has been identified as taking the lead in working with watershed stakeholders to correct the problems identified.

2.2 PARTNERING WITH WATERSHED STAKEHOLDERS

In addition to working with a local sponsor, it is also very important that a variety of government and non-government groups be contacted during the planning stages of the survey. The main purpose in contacting these groups is to let them know that a SCA survey is being done and to solicit their assistance in correcting the environmental problems identified.

The groups to contact about a SCA survey will vary depending on the watershed and who are the major stakeholders in that watershed. Some very important partners in any SCA survey will be the local county, city and town governments. It is very important that if local governments are not the survey's sponsor that they at least be a very active participant in it.

In watersheds where agriculture is a dominant land use, it is very helpful if the local Soil Conservation Districts (SCD) are involved in the survey. SCD agents often know most of the farmers in the watershed and can assist survey teams in gaining access to the streams that run through farms. In addition, SCDs are usually the lead agencies working with farmers to correct agricultural pollution problems. SCDs administer a number of programs that can assist farmers in installing Best Management Practices (BMPs) on their farms.

Other groups that may be contacted and/or have been involved in past SCA surveys are:

Federal Government

U.S. Army Corp of Engineers
U.S. Fish and Wildlife Service
U.S. Department of Agricultural
U.S. Department of Defense

State Government

Local Government

County, City and Town Environmental, Public Works and Planning Agencies

Environmental Groups

Watershed Associations
Trout Unlimited
Audubon Naturalist Society

2.3 MAPS & GEOGRAPHICAL INFORMATION SYSTEMS

During a SCA survey, field teams walk a watershed's entire stream network and record the location of environmental problems on field survey maps. Information collected during the field surveys is later entered into computer databases and the location of sites entered into a Geographical Information System (GIS). Modern GIS systems have proven to be very important in not only producing a good set of field survey maps at the beginning of the SCA survey, but also for displaying survey findings.

While a variety of different types of maps have been used in past surveys, we have found that a series of 200 scale (1 inch = 200 ft.) topographic maps printed on 11" x 17" paper works the best. Each map is given a unique number and a master map is also produced that shows the location of all the maps in the map grid system. In most surveys two sets of field survey maps are produced and the maps are laminated for field use. A Sharpie pen is used to record field information on the laminated maps.

While the information on the field survey maps will vary depending on the capabilities of the GIS system being used, it is important that only information that will be useful to the survey teams be printed on the maps. Maps with too much information are often difficult to read. It is also helpful if the maps are printed in color. However, color printing can be expensive, and black and white maps in which the streams are highlighted with a marker prior to being laminated have also worked well.

When producing a series of 200 scale GIS maps is not possible, enlarged versions of the United States Geological Service's 7.5 minute quad maps have been used. These maps can be produced using many GIS systems and commercially available map display programs. It is important when altering the size of the map that a scale bar also be enlarged at the same time and affixed to the map before laminating. Field survey teams will often use the map scale when they have to estimate long distances.

2.4 LOGISTICS

The SCA survey works best if each survey team has two vehicles. First, the survey team will identify which stream segment will be surveyed that day and where they are going to enter and exit the stream. The entire team will then go to the exit point and park one of the vehicles. Everyone will get into the second car and travel to the stream entry point, where they will park the second car. The team will then survey the stream until they reach their exit point, where they will pick up the vehicle left there. The team will then travel back to the point where they entered the stream and retrieve the second vehicle.

2.5 IDENTIFYING AND NOTIFYING PROPERTY OWNERS IN SURVEY AREA

During the initial planning stage, a list of property owners along the streams to be surveyed should be compiled. This can be done fairly easily using a Geographical Information System (GIS) database of State tax maps.

Once a list of property owners has been compiled, a letter should be sent to every property owner notifying them that the Stream Corridor Assessment (SCA) survey is being done in their area. It is usually best if the letter is sent by the local government agency sponsoring the survey. Sample property owner notification letters are presented in Appendix B. Stream reaches on the property of anyone who objects to having survey members cross their property will be excluded from the survey. In addition, survey members will not cross fenced areas or enter areas marked "no trespassing" without obtaining permission from the land owners. A sample “right of entry” permit” for property owners to sign is included in Appendix C.

3.0 CONDUCTING A SURVEY

3.1 IDENTIFYING ENVIRONMENTAL PROBLEMS

One of the main objectives of the SCA survey is to identify environmental problems present within the stream corridor that can be seen by walking along a stream and being observant. As mentioned in the introduction (Section 1.0) the SCA survey is not intended to be a detailed scientific investigation, but a quick survey of the drainage network in a watershed. The problems identified in the SCA survey are, for the most part, fairly obvious. It does not require an advanced college degree to identify a stream reach that does not have any trees along it, or a place where trash is being dumped near a stream. For some problem categories such as erosion sites or fish barriers, there can be cases where there is a question whether a specific problem is present and should it be included in the survey. For example, erosion is a natural process and even on healthy streams there will be some evidence of erosion, especially in a stream's bends. It is not the purpose of the SCA survey to map every site where natural stream erosion is occurring. Survey members must use their best professional judgement to determine if the bank erosion they see on a stream is an indication of an unstable stream channel and if it is an environmental problem. For the most part, these judgement calls only result when the problem is considered borderline. In instances where there is a significant environmental problem present, it is usually very obvious.

While identifying an environmental problem is usually not difficult, properly characterizing the severity and correctability of a problem does require some experience. Survey crew members receive several days of training, which includes both slide presentations of the different problems identified in the SCA survey and field visits to problem sites. Whenever possible, experienced survey members are paired with less experienced individuals to receive additional training during the survey. Because the level of experience can vary among survey teams, it is important that the survey crew chief monitor the survey teams on a daily basis to be sure the survey is done in a consistent manner. The photographs that are taken at each site can also help monitor the work of each team and adjustments to the ratings can be made based on review of the photographs by the survey manager or other experts.

3.2 ASSIGNING A SITE NUMBER

It is very important that before beginning a SCA survey, a system is established to assign field identification numbers to problem and representative sites. In order to enter the information into a database, each survey site must be given a unique number that will distinguish it from all other sites in the survey.

Some problems such as erosion or inadequate stream buffer can extend over fairly long reaches of a stream. In assigning field identification numbers to these problems and noting their location on field maps, it is important that the site ends where it joins with another stream. For example, if surveying a small tributary that has an erosion problem and you come to the point where it enters a larger stream, you should end the erosion site at the tributary's mouth even if there is an additional erosion problem downstream. The erosion problem in the larger stream would be given a separate field identification number because the erosion problem may not only extend downstream but also upstream of where the smaller tributary enters the larger stream (Figure 3.2-2). This does not mean, however, that when surveying a stream that has an inadequate buffer or erosion problem along the stream mainstem that you must stop and assign a new field identification number where each small tributary enters the stream. In this case, a new field identification number would only be needed where two similar size streams come together and both streams have the same problem.

While each site must have a unique site number, it is not uncommon to identify two or more environmental problems at one site. For example, a survey team may find an area with an inadequate stream buffer, an erosion problem and a fish barrier all along the same stream reach. As long as all the problems are within the same limited area, it is not necessary to give each problem its own field identification number. A single field identification number will be sufficient for the site with separate data sheets filled out for each problem. It is possible to assign two or more different problems to the same field identification number because each problem is given a two-letter problem identification code when it is entered into the database. The problem identification codes can be seen on the upper right-hand corner of the data sheets (Appendix C). The combination of the field identification number and problem identification code provide a unique identification code for each identified problem in the database.

When assigning two or more problems the same field identification number, each problem should be located within the same limited area. For example, a trash dumping site that also has a discharge pipe present at the same location could be given the same field identification number. If however one of the problems, such as erosion, extends over a long reach of stream and within that stream reach there is a fish barrier, the fish barrier should be given a separate field identification number. This is because in follow up investigations, surveyors need to be able to relocate problem sites quickly and should not have to search over a long stream reach to find a previously identified problem.

While two or more <u>different</u> problems can have the same field identification number, if there are two or more of the <u>same</u> problems at a site then each problem must be given its own field identification number. For instance, in urban areas there occasionally may be two or more pipe outfall discharging to the same site. When this occurs, each pipe outfall must be given its own individual field identification number.

In addition to assigning field identification numbers to problem sites, the same numbering system will be used for representative sites. Representative sites (Section 3.6.11) are used to document general conditions of both in-stream and riparian corridor habitat. The sites are premarked on survey maps at the beginning of the study and spaced at approximately 1/4 to1/2 mile interval along the stream. When survey teams reach a predesignated representative site they should assign the next field identification number to that site. If any other environmental problems are also present, they can also be given the same field identification number.

3.3 RECORDING PROBLEM LOCATION ON A MAP

It is very important that survey members accurately record the location of all environmental problems on their survey maps so that follow up studies will be able to locate problem sites. Problems such as pipe outfalls, trash dumping, exposed pipes, fish barrier, and representative sites are usually represented on the survey map by a large dot. Next to the large dot the field identification number and two letter problem code should be written on the field map. Other problems such as channel alteration, erosion sites, and inadequate buffers (which can extend over fairly long stream reaches) are usually represented by a line on the map showing where the problem is located. Next to the line, both the field identification number and two letter problem codes should be clearly written. In some cases the problem will extend from one map onto an adjacent map. When this occurs, you should not change the field identification number simply because the map number has changed. The field identification number will be the same on both maps and should be clearly written on both maps.

3.4 PHOTOGRAPHING A SITE

At all problem sites one or more photographs should be taken. Photographers should keep in mind that the photographs will be reviewed by the survey manager and other experts, and should clearly show the problems at the site. At all representative sites photographs should be taken looking both up and downstream. In general, these photographs should be long view photos that show the general condition of the stream and adjacent riparian zone. In all photographs, a number board should be present that clearly shows the site's field identification number. It is important, especially when photographing long view shots, that the number board be close enough to the camera so that the numbers on the board are clearly visible. Past studies have found that when a number board was not used, photo identification and sorting was much more difficult. In addition to a numbering board, it is helpful if a person or measuring stick is also present in the photograph to help provide a sense of scale to the photograph. If asked to stand in a photograph to help provide a sense of scale, look at the camera and act professionally. Please remember that these photographs will be reviewed by several people and may be included in both talks and publications.

The camera used to photograph problems and representative sites must have an accurate internal light meter. It is also helpful if the camera is fairly small, light weight, water resistant and has an internal clock. The majority of the photographs taken during a normal SCA survey will be under poor light conditions. Earlier attempts to use disposal cameras which do not have light metering systems produced very poor quality pictures. Because of the usual poor lighting conditions, 400 ASA print film should always be used. Try to avoid aiming the camera directly into the sun or at highly reflective surfaces. Finally, it is helpful if the camera has an internal clock and is able to print the date on the photograph. Having the date printed on the photograph has proven to be very helpful in sorting photographs. Of course, the date should be checked at the beginning of the survey each day to make sure it is accurate. A high quality light weight digital camera with additional memory cards is ideal.

One or more photographs are taken at all problem sites and two photographs (one looking upstream and another looking downstream) are taken at all representative sites. You should take as many photographs as you need to properly document a problem or set of problems without wasting film. After the photographs are taken you should indicate the film exposure numbers on the data sheets (Appendix C).

3.5 FILLING OUT DATA SHEETS

All data sheets should be filled out completely using either a pencil or waterproof pen. Do not use regular pens because the ink will run if the data sheets get wet. The data sheets have been designed to provide a selection of most likely answers whenever possible. If an appropriate choice is not given, you should circle "Other" and write in an appropriate answer to that question. On questions that do not provide a selection of possible answers, simple write in the appropriate answer. If you do not know the answer to a question you should write "Unknown" in the appropriate space and at the end of the day talk to the survey crew chief for clarification on what the correct response should be. If a correction to the data sheet is needed, it should be done as soon as possible.

When asked to provide a length or height measurement, the number you write down on the data sheet should be the most accurate value you can provide without spending an inordinate amount of time collecting the data. A tape measure or ruler should be used to make most measurements. For moderately long distances it may be necessary to pace off the stream length to provide an accurate distance estimate. If very long distances are involved, you can use you field maps to estimate the length of stream affected by the problem. Please remember, you want to provide the most accurate data possible, however, SCA is not a detailed survey and accurate estimates of some measurements are permissible.

All measurements done during a SCA survey will be in standard English units. On the data sheets the appropriate unit will be shown to the right of the space provided for the data. The data must be provided in the units indicated to be properly entered into the database. For example, if asked to measure the diameter of a pipe with a 4 feet wide opening in inches, you should always write 48 inches, not 4 feet. All pipe diameter measurements will be done in inches and the measurement required is the inside diameter. In some cases, such as when recording an exposed pipe, you will not be able to measure the inside diameter of the pipe directly. In these cases you should measure the outside width of the pipe if possible and estimate the internal diameter. Bank height and length are always measured in feet. In the case of bank height, the measurement is taken from the base flow water level to the top of the bank. If the height of the bank involves a fraction of a foot, the value should be recorded in 10ths of feet. For example a stream bank that was 1 foot 6 inches high would be recorded on the data sheets as 1.5 feet.

3.5.1 SEVERITY, CORRECTABILITY AND ACCESS RATINGS

To help prioritize future restoration work, all problem sites are evaluated and scored by field crews on a scale of one to five for three separate areas: problem severity, correctability and accessability. These scores are subjective and based on the field crew's evaluation at the time of the survey. The rating should therefore be viewed as the field team's opinion of the worst problem within a specific problem category and which problems they believed would be the easiest to correct. The scores provide a starting point for more detailed follow up evaluations by individuals that are more experienced dealing with specific problem categories. This is initially done by reviewing the data and photographs collected by the field teams and can involve follow-up field visits as well. As additional information about a specific problem site is obtained, the site's severity, correctability and/or accessibility ratings can change.

While the criteria for rating problem severity, correctability and access can vary among different problem categories, the general guidelines used by survey teams to assign these values are as follows:

Severity Rating

The severity rating is a rating on how bad a specific problem is relative to other problems in the same problem category. It is used to answers questions such as, where did field crews believe the worst erosion problems were, or where was the largest section of stream with an inadequate buffer? In general, the scoring is based on the overall impression of the survey team of the severity of the problem.

Rating of 1 is for the most severe problems that appear to have a direct and wide reaching impact on the stream's aquatic resources. Within a specific problem category, a 1 rating indicates that the problem is among the worst that the field teams have seen or would expect to see in Tennessee. Rating is based on comparison to good and bad reference sites seen during training. Examples would include a discharge from a pipe that was discoloring the water over a long stream reach (greater than ½ mile) or a long section of stream (greater than ½ mile) that had incised several feet with unstable banks that are showing signs of eroding at a fast rate.

Rating of 3 is for moderately severe problems that appear to be having some adverse impacts at a specific site. While a rating of 3 would indicate that field crews did believe it was a significant problem it also indicates that they have either seen or would expect to see much worse problems in that specific category. Examples would include: a small fish blockage that may be passable by strong swimming fish like trout, but was a barrier to resident species such as sculpins; or a site where several hundred feet of stream had an inadequate forest buffer but the banks do have vegetation on them and are stable.

Rating of 5 is for minor problems that do not appear to be having a significant impact on stream and aquatic resources. A rating of 5 indicates that a problem was present but compared to other problems in the same category it would be considered minor. An example would include an outfall pipe from a storm water management structure that is not discharging during dry weather and does not have any erosion problem either at the outfall or immediately downstream.

Correctability Rating

Correctability ratings provide a relative measure on how easily the field teams believe it would be to correct a specific problem. The correctability rating can be helpful in determining which problems to initially examine when developing a restoration plan for a drainage basin. One restoration strategy would be to initially target the severest problems that are the easiest to fix. The correctability rating can also be useful in identifying simple projects that can be done by volunteers, as opposed to projects that require more significant engineering efforts.

Rating of 1 is for minor problems that could be corrected quickly and easily using hand labor, with a minimum amount of planning. These types of projects would usually not need any Federal, State or local government permits. It is a job that a small group of volunteers (10 people or less) could fix in less than a day without using heavy equipment. Examples would be removing debris from a blocked culvert pipe, removing less than two truck loads of trash from an easily accessible area or planting trees along a short stretch of stream.

Rating of 3 is for moderate size problems that may require a small piece of equipment, such as a backhoe, and some planning to correct. This would not be the type of project that volunteers would do by themselves, although volunteers could assist in some aspects of the project, such as final landscaping. This type of project would usually require several days to complete. The project may require some local, State or Federal government notification or permits, however, environmental disturbance would be small and approval should be easy to obtain.

Rating of 5 is for major restoration problems which would require a large expensive effort to correct. These projects would usually require heavy equipment, significant amount of funding ($100,000.00 or more), and construction could take a month or more. The amount of disturbance would be large and the project would need to obtain a variety of Federal, State and/or local permits. Examples would include a potential restoration area where the stream has deeply incised several feet over a long distance (i.e., several thousand feet) or a fish blockage at a large dam.

Accessibility Rating

Accessibility rating is a relative measure of how difficult it is to reach a specific problem site. The rating is made by the field survey team standing at a site, using their field map and field observations. While factors such as land ownership and surrounding land use can enter into the field judgment of accessibility, the rating assumes that some access to the site could be obtained if requested.

Rating of 1 is for a site that is easily accessible both by car or on foot. Examples would include a problem in an open area inside a public park where there is sufficient room to park safely near the site. If heavy equipment was needed, it could easily access the site using existing roads or trails.

Rating of 3 is for sites that are easily accessible by foot but not easily accessible by a vehicle. Examples would include a stream section that could be reached by crossing a large field or a site that was accessible only by 4-wheel drive vehicles.

Rating of 5 is for sites that are difficult to reach both on foot and by a vehicle. Examples would include a site on private land where there are no roads or trails nearby. To reach the site it would be necessary to hike over a mile. If equipment were needed to do the restoration work, an access road would need to be built over a long distance through rough terrain.

3.6 DATA SHEETS INTRODUCTION

The data sheets for the SCA survey are provided in Appendix C and are designed to record basic information about a problem that can be collected quickly. These data sheets have been developed over several years and have been modified several times. There are a total of 10 separate data sheets used in this survey. There are 9 problem data sheets including an Unusual Condition/Comment data sheet, which can be used to record information on problems not addressed by the other data sheets. The last data sheet is the representative site data sheet which is filled out at 1/4 to1/2 mile intervals during the survey to help document the general condition of both in-stream habitat and the condition of the adjacent stream corridor.

The data sheets presented in the protocols represent a core set used in the Tennessee's SCA survey, however, additional data sheets may be added to a survey when a particular problem is known to exist in the area and collecting data on the problem is of special interest to the survey's sponsor. Adding special data sheets to address problems that may be unique to an area does help to refine the information that is collected by survey teams. When developing new data sheets, it is important to remember that the SCA survey is not intended to be a detailed scientific investigation. Instead, the SCA survey is designed to quickly identify potential environmental problems along a stream corridor.

3.6.1 Channel Alteration

Channelization refers to the once common practice of dredging, straightening and/or widening stream channels in an attempt to reduce flooding or to lower the ground water table. The use of channelization to control flooding has been historically referred to as "stream improvement." It was given this name because the engineers who designed these projects were attempting to improve the hydraulic capacity of the stream to transport flood waters through an area. This was done using a number of different approaches, including: widening the stream channel so it would hold more water, building berms along the edges to the stream to hold the flood flow in the channel, straightening the stream to increase the slope of the water to move it faster through an area and/or reducing the roughness of the stream channel by constructing a smooth channel out of concrete. A channelized stream section is shown in Figure 3.6.1-1. In addition to flood control projects, channelization has also been done in some areas to help lower the ground water table to drain adjacent wetlands and crop land.

While channelization can be partially effective at reducing flooding or lowering the ground water table in an area, it can also have a variety of negative environmental impacts. Channelized steams often have poor instream habitat for aquatic organisms, they can be a barrier to fish migrations and in areas where the riparian buffer has been removed, the water in the stream can be heated by the sun during the day reducing its oxygen holding capacity and raising water temperatures above the tolerance limits of some fish species. In addition, while channelization may be able to reduce flooding in one specific stream reach, often it increases flooding downstream.

In the past, channelization was a common practice in many areas. Fortunately, because of the high cost, limited benefits, and significant environmental impacts, widespread stream channelization is not done any more. In fact, in recent years there have even been several projects in Tennessee to remove concrete channels and restore them to a more natural stream shape.

While widespread stream channelization does not occur anymore, small projects to relocate a section of stream as part of a highway or development projects still occur. These projects, however, do receive a significant amount of oversight by State and Federal government agencies that issue waterway construction and wetlands permits for this work. New techniques have been also developed that can help minimize adverse environmental impacts of these projects.

Survey teams should look not only for stream reaches that are in concrete channels but for any areas where the stream has been significantly altered. A good indication of this is an unusually straight stream channel for a fairly long stretch. Unless the area has a lot of large rock (bedrock, boulders or large cobble) and/or the stream is moving down a fairly steep slope (usually > 4%), the stream should have some meander pattern or sinuosity.

Channelized stream reaches are sections of streams where most of the stream's channel is affected over a significant length (greater than 50 feet) of the stream. In conducting a SCA survey it is important that survey teams concentrate on identifying and recording important stream problems. It is common when doing a stream survey to find short sections of stream where stone has been placed along the stream's banks to stabilize an area. This is often done to stabilize the portion of the stream's banks disturbed during construction of a pipeline that passes under a stream. In most cases, if only one side of the stream is impacted and/or the length of stream affected is less than 50 feet with no other environmental problems present, then there is no need to fill out a channel alteration data sheet. For the purposes of this study, channel alteration does not include road crossing unless there is a significant amount of stream channelization has occurred either up or down stream of the road crossing. Channel alteration also does not include tributaries where storm drains were placed in the stream channel and the entire tributary is now piped underground. While these stream sections have been significantly altered, it is not possible to tell by walking the stream corridor precisely where this was done. Finally, the term channel alteration would normally not apply to some of the more recent stream restoration projects that have been built in the last few years. In areas where a stream restoration project has been recently done the team should fill out an Unusual Condition/Comment data sheet briefly describing the area as well as estimating the length of stream that was restored.

DATA SHEET FOR CHANNEL ALTERATION

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Type:

Indicate on the data sheet if the channelized stream section is constructed of concrete, rip-rap, gabion baskets or an earthen channel. These are the most common types of channelized stream sections that will be encounter. If the channel is constructed by some other means or using a combination of construction materials then indicate it in the space provided. Also fill out an unusual condition/comment sheet and give addition information on the channel design.

Bottom Width:

Measure the width of the stream channel in inches. If the channel varies in width then indicate the average or best representative width for the portion of stream that is channelized. If the channelized stream reach is divided into two sections of significantly different widths, then you may need to fill out two or more Channel Alteration data sheets and possibly an Unusual Condition/Comment data sheet.

Length:

Indicate the length of stream that has been affected by channel alteration in feet. One value that is usually calculated in the final report is the total number of stream miles that have been altered. It is important that this number be as accurate as possible. Whenever possible, you should measure the length of stream impacted using a tape measure. If very long distances are involved, you should estimate the distance by pacing it off or measuring the distance on your field survey maps.

Sediment Deposition:

Indicate if there is a significant amount of sediment deposition in the channelized stream section. A significant amount of sediment deposition occurs in areas where the stream has been over widened and the stream is attempting to go back to a smaller more natural channel. Large stable bars inside the channelized stream reach would be an indication of sediment deposition.

Vegetation in the Channel:

Indicate if the bars inside the channelized stream reach have stable vegetation on them. The vegetation must be inside the channel and not simply along the channel's banks. The vegetation can be either woody vegetation such as shrubs and trees, a large amount of grass or emergent wetland vegetation such as cattails. If only a few wildly scattered clumps of grass are present, then indicate **"no"** on the data sheet, because a small amount of grass on channel bars are usually only temporary and will probably be washed away during the next large storm event. Indicating whether stable vegetation is present is important. It is an indication that the stream is in the process of restoring itself by reestablishing a more natural stream channel inside the overly widened channelized stream reach.

Is it part of a road crossing?

Channel alteration is very common above and below road crossings. The channel alteration is done in an attempt to stabilize the stream channel near the road, preventing erosion that could threaten the road and to help move the water quickly under the road crossing to avoid flooding. Indicate on the data sheets if the channel alteration is part of a road crossing and how much of the stream is channelized above and below the road.

Severity

The severity rating of a channelized stream section will depend on the amount of stream affected and the significance of the impact. Factors that should be taken into consideration in assigning your severity rating are:

* The condition and amount of good instream habitat for fish and macroinvertebrates.
* Is the water depth so shallow that it blocks the passage of some fish?
* Length of stream channelized.
* Is the channelized stream well-shaded or does it contribute to significant temperature increases in the stream?

Following are several examples of this rating system.

<u>Severe rating (1):</u> A concrete channel where water is less than 1/4 inch deep and spread out over an even bottom with little or no natural sediments present in the channel, and the channel is open to full sunlight over a long stretch (i.e., >1000 ft.). An example of a severe Channel Alteration problem is shown in Figure 3.6.1-2.

<u>Moderate rating (3</u>): A stream channel where a significant length of stream (i.e., > 100 ft.) has been channelized, but the channel has stabilized over time and is beginning to show signs that it is functioning as a natural stream channel. Bars may have formed in the channel and vegetation may be present on the bars.

<u>Minor rating (5):</u> An earthen channel of less than 100 feet with good water depth, a natural sediment bottom and with a channel size and shape similar to the unchannelized stream reaches above and below the impacted area. An example of a minor Channel Alteration problem is shown in Figure 3.6.1-3.

Correctability

Once a stream has been channelized, it can be both difficult and expensive to correct the problem. In recent years there have been a few cases where small concrete channels have been removed and a more natural stream channel established. Photographs take of a restored stream channel before and after restoration work was done are shown in Figures 3.6.1- 4 and 3.6.1-5. There have also been a few cases where gabion basket or rip-rap channels have been partially restored by sediment covering the artificial channel and a more natural stream bottom formed inside the channelized reach.   Factors that should be taken into consideration in assigning your Correctability rating are:

* The length of stream impacted.
* The adjacent land use and whether construction staging or access would be a problem?
* The need for heavy equipment
* How much earth, stone or other material would have to be moved?
* How much funding would be needed to do this project?
* Would permits, detailed surveys and detailed construction plans be needed?

Following are examples of this rating system.

Best Correctability (1): A short stream reach (< 100 ft.) that is already beginning to revert into a natural stable channel and only a small amount of work is needed. The new stream channel should have a similar sinuosity and channel dimensions as natural stream reaches up and down stream.

Moderate Correctability (3): A short section of either concrete or stone channel that could be removed or altered fairly quickly using a backhoe, or a longer section of earthen channel that could also be modified fairly quickly using a backhoe. Unless the channel is overly widened and sediment deposition is naturally correcting the problem, the correctability rating will usually be 3 or above.

Worst Correctability (5): A long concrete trapezoid channel with limit space for any restoration work.

Access

The ratings for access are discussed for all problems in section 3.5.

3.6.2 EROSION SITE

Erosion is a natural process and necessary to maintain good aquatic habitat in a stream. Too much erosion, however, can have the opposite effect, destabilizing stream banks, destroying in-stream habitat and causing significant sediment pollution problems downstream. A photograph of a stream section with a stream bank erosion problem is shown in Figure 3.6.2-1. Severe erosion problems occur when either a stream's hydrology and/or sediment supply have been significantly altered. This often occurs when land use in a watershed changes. As a watershed becomes more urbanized, forest and agricultural fields are developed into residential housing complexes and commercial properties. As a result, the amount of impervious surfaces in a drainage basin increases, which in turn causes the amount of runoff entering a stream to also increase. The stream channel will adjust over time to the new flows by eroding the stream bed and banks to increase its size. This channel readjustment can extend over decades during which excessive amounts of sediment from unstable eroding stream banks can have very detrimental impacts on the stream's aquatic resources.

While a very unstable stream channel with a severe erosion problem is fairly easy to recognize, it is not unusual when conducting a SCA survey to find many areas where only minor or moderate bank erosion is occurring. It is not the purpose of the survey to identify the location of every stream bend where minor bank erosion is occurring. Erosion is a natural process. Even in the most undisturbed watershed you can find 3 to 4 foot high banks on the outside bend of a stream. This is especially true when the stream channel has naturally migrated to the edge of its flood plain and the stream is beginning to erode into an abandoned terrace. When conducting a SCA survey, you are primarily interested in identifying unstable stream reaches that are experiencing a significant amount of erosion along the stream's banks.

DATA SHEET FOR EROSION SITE

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Type:

When a stream channel becomes unstable it will normally undergo a period of readjustment. During this readjustment period, which can last for several decades, the stream channel may deepen and widen to accommodate the change in flow or sediment input that has occurred in the watershed. In some cases, the stream may also show signs of headcutting which appears as an abrupt drop in the bed of the stream. Headcutting will often occur in a stream system's tributaries when the main stem of the stream has eroded downward and the bed of the tributaries no longer meet the main stem's stream bed at an even grade. Under these conditions the stream will often form a headcut on the lower end of the tributary and over time the headcut will work its way up the tributary.

It is often very difficult to know exactly where an unstable stream is in the readjustment process without monitoring the stream at several points over an extended period of time. During the SCA survey you will only have a brief look at the unstable stream channel, so you will need to depend on your training, experience and best professional judgment to indicate if you think the stream is still down cutting, widening or headcutting. We realize that this is a judgment call and that even with the most experienced individual some follow up monitoring would be necessary to verify any answer.

Cause:

It is often very difficult to know exactly what is causing an erosion problem in a stream, especially if the problem is caused by a change in hydrology or sediment input from another part of the watershed. At other times however, a cause of an erosion problem may be obvious. An example would include livestock in the stream or erosion at the end of a discharge pipe. Indicate if there is some obvious cause to the erosion problem. If there is no obvious cause for the erosion problem, indicate that the cause of the problem is "**U**nknown."

Length:

Indicate the length of stream in feet that appears to be unstable and has an erosion problem. This very important measurement will be used in the final report to calculate the total length of stream that has an erosion problem. Whenever possible measure the length of stream impacted using a tape measure. If very long distances are involved, you should estimate the distance by pacing it off or measuring the distance on your map.

Average Exposed Bank Height:

Exposed bank height refers to the height of the exposed stream bank above the water line during base flow conditions. Bank height is measured from the water line to the top of the bank. To estimate average exposed bank height, several quick measurements should be taken of the height of the bank within the erosion site and a rough estimate of the average bank height made. Extensive time should not be taken to obtain this value. Measurement should be recorded in feet.

Land Use:

Indicate the dominant (> 50%) land use in the stream's corridor on both the left and right sides of the stream. The left and right sides of a stream are determined when you are facing downstream. Land use choices on the data sheets include "Crop fields, Pasture, Lawn, Paved, Shrubs and Small Trees, Forest, Multiflora Rose." In making your determination, the area closest to the stream (ie., within 50 feet) is the area of greatest interest. If more than one land use type is present on the bank, choose the one that best describes the area's overall land use. Pick only one land use category because the database will only accept one land use entry for each side of the stream. If none of the listed categories accurately describes the land use near the stream, circle "**O**ther" and enter an appropriate answer.

Is infrastructure threatened:

Indicate if infrastructure is or will be threatened by stream bank erosion at the site. For the purpose of this study, the term infrastructure refers to both public works systems such as roads and pipe lines, as well as any man made structure, such as a shed or a fence that could be affected by continued erosion at the site in the near future (within 10 years). If you answer yes, make sure you take a photograph of the infrastructure element that is being threatened and describe it in the space provided on the data sheet.

Severity

Accurately rating the severity of an erosion site can be one of the more difficult parts of the SCA survey for individuals who have not walked many streams. There is a tendency for inexperienced individuals to overrate moderate erosion problems and to totally ignore minor erosion problems. It is important during the SCA training that survey members visit several sites with varying levels of erosion problems. In many cases, individuals need to see and walk a severely eroding stream to see how bad an erosion problem can be. Please keep in mind that if you rate the severity of an erosion problem as either a 1 or 2, it is very likely that someone will do a follow-up visit to the site. There is a lot of interest in identifying severe stream erosion problems so that these areas can be targeted for possible stream restoration and/or improved storm water management.

The severity rating for erosion sites will depend on the length of stream that appears to be unstable and how significant the erosion problem is in the stream. The most severe erosion problems occur in areas where there are soft unconsolidated sediments and the stream has down cut several feet forming an incised stream channel. Factors that should be taken into consideration in assigning your severity rating are:

* What is the length of stream impacted?
* What is the height of stream banks?
* Does erosion appear to be a problem in both the bend and run sections of the stream?
* Is there evidence of high erosion rates along the stream's banks?
* Is there evidence that the stream channel is unstable and readjusting?
* Is there unconsolidated gravel, sands and silts in the banks?
* Are the soils in the banks stratified?
* Has the stream channel eroded below the root zone of the vegetation along its banks?

Examples are:

<u>Severe rating (1):</u> A long section of stream (greater than 2000 feet) that had incised several feet, with banks on both sides of the stream that are unstable and eroding at a fast rate. Usually this occurs in areas where there are soft unconsolidated sediments (gravel, sand and/or silts) and the

stream has eroded below the root zone of the bank vegetation. An example of a very severe stream bank erosion problem is shown in Figure 3.6.2-2.

Moderate rating (3): Either a long section of stream (2000 ft) that has a moderate erosion problem, or a shorter stream reach (between 2000 and 300 feet) with very high banks (> 4 ft.), and evidence that the stream is eroding at a fast rate.

Minor rating (5): A short section of stream (< 300 ft.) where the erosion is limited to one or two meander bends or a site where an erosion problem is being caused by a pipe outfall and the area affected is fairly limited. An example of a minor erosion problem is shown in Figure 3.6.2-3.

Correctability

Minor erosion problems in open areas can often be corrected using some fairly simple bioengineering techniques. This is especially true in areas where the instability of the stream channel is caused by livestock having unlimited access to the stream. In order for most bioengineering approaches to be successful, the eroded area will need to be unshaded during most of the day. The need for substantial light levels at bioengineering sites stems from the fact that most of the vegetation used in these project such as willows, need high light levels to survive. While some shade tolerant species like mountain laurel can be used for some projects, these plants are usually slow growing.

Areas with minor erosion problems on public land, or with fairly easy access, that could be corrected using a bioengineering approach should be highlighted in the survey by filling out an unusual condition/comment data sheet in addition to an erosion site data sheet. These areas are important because they are excellent sites for community-based stream bank stabilization efforts.

The erosion problems you will see during a SCA survey in Tennessee are often due to a general instability of the stream channel resulting from land use changes in the watershed. In these cases, long reaches of stream are often affected. New techniques have been recently developed to analyze a stream's erosion patterns and correct the problem by reconstructing the stream channel into a stable form. Photographs of a stream channel before and after stream restoration work was done is shown in Figures 3.6.2-4 and 3.6.2-5. These tend to be very complicated restoration efforts costing hundreds of dollars per linear foot of stream. Factors that should be taken into consideration in assigning your correctability rating are:

* The length of stream impacted.
* The adjacent land use, and whether construction staging or access is a problem.
* Will heavy equipment be needed?
* How much earth, stone, or other material needs to be moved?
* How much funding would be needed for the project?
* Would permits, detailed survey, and detailed construction plans be needed?

Examples of this rating system are:

Best Correctability (1): A short stream reach (< 100 ft.) where the erosion problem can be corrected by simple bioengineering techniques using volunteers in one or two days.

Moderate Correctability (3): An erosion problem that could be corrected by a work crew over several weeks, using primarily a backhoe or other small piece of construction equipment. The project may involve using some small rock (< 100 lbs.) to stabilize the toe of a stream bank but most of the work would rely on vegetation and biodegradable material to stabilize the stream banks.

Worst Correctability (5): A long reach of stream (i.e., several thousand feet) that had deeply incised several feet and any attempt to actively restore the stream channel would require not only significant funding (i.e., several hundred thousand dollars) but would also involve a large amount of earth moving and disturbance to the riparian corridor.

Access

See section 3.5.

3.6.3 EXPOSED PIPES

Exposed pipes are any pipes that are either in the stream or along the stream's immediate banks that could be damaged by a high flow event. An example of an exposed pipe is shown in Figure 4.6.3-1. It does not include pipe outfalls where only the open end of the pipe is exposed. Exposed pipes do include: 1) manhole stacks in or along the edge of the stream channel; 2) pipes that are exposed along the stream's banks; 3) pipes that run under the stream's bed and have been exposed by stream down-cutting; and 4) pipes that are built over a stream but are low enough that they could be affected by occasional high storm flows. Pipes that are placed along the support beams of bridges or suspended high enough above the stream to not be affected by very large storm events should not be included in this survey unless they are leaking.

In urban areas it is very common for pipelines and other utilities to be located in the stream corridor. This is especially true for gravity sewer lines which depend on the continuous downward slope of the pipeline to move sewage to a pumping station or treatment plant. Since streams are located at the lowest points in the local landscape, engineers often build sewer lines parallel to streams to collect sewage from adjacent neighborhoods. While the pipelines are stationary, streams can migrate and over time can expose previously buried pipelines. When this occurs, the pipeline becomes vulnerable to being punctured by debris in the stream. Fluids in the pipelines can then be discharged into the stream causing a serious water quality problem.

DATA SHEET FOR EXPOSED PIPES

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Pipe is:

Indicate if the exposed pipe is across the bottom of the stream, along the stream banks or an exposed manhole stack. If these selections do not properly describe the exposed pipe's location, circle "**O**ther" and describe the location.

Type of Pipe:

Indicate it the pipe is made out of concrete, smooth metal, corrugated metal or plastic. If the pipe is made from some other material, or the pipe is incased in concrete and you do not know what type of pipe it is, circle "**O**ther," and describe the pipe in the space provided.

Pipe Diameter:

Pipe diameter refers to the inside diameter of the pipe and in the United States the measurement is usually in inches. In some exposed pipe situations you may not be able to directly measure the inside diameter of the pipe, but should be able to guess fairly closely by observing or measuring the outside diameter of the exposed pipe. Large pipes are usually made in ½ foot size (12 inches, 18 inches, 24 inches, etc.)

Length exposed:

Indicate the length of pipe that is exposed in feet.

Evidence of Discharge?

Indicate whether there is any evidence that the pipe is cracked or leaking. If there is evidence of a discharge describe the color and/or odor. A strong odor, even if you do not see any discharge coming out of the pipe, is an indication of a discharge. If the discharge appears to be a significant health or environmental problem, you should contact your supervisor or survey manager as soon as possible.

Color & Odor

Indicate the color and/or odor of any discharge. The choices provided are the same used by several state and county governments when investigating unknown discharges. Circle the most appropriate answer. If none of the choices accurately describe what you are seeing or smelling, then circle "**O**ther" and describe the discharge in your own words.

Severity

The severity rating for an exposed pipe will depend on the amount of pipe that is exposed, where the pipe is located in the stream, and how badly the erosion problem threatens the structural stability of the pipe. The primary concern is that the pipe will either break or be punctured, allowing whatever is in the pipe to leak into the stream. Exposed pipes can also create barriers to fish migration, and when this occurs a fish migration data sheet should also be completed. Factors that should be taken into consideration in assigning the severity rating are:

* What is the length of pipe exposed and where is it located?
* Has the pipe been reinforced with concrete?
* Is there evidence of leaking from the pipe?
* How likely is it that the pipe will either collapse or be punctured?

Examples of this rating system are as follows:

<u>Severe rating (1)</u>: Any pipe that is leaking will usually be given a severity rating of 1 or 2 depending on the amount and type of fluid that is coming out of the pipe. Other exposed pipe problems that could receive a 1 or 2 severity rating include: a section of pipe that is being

undermined by erosion and could collapse in the near future; a pipe running across the bed of the stream where part of the pipe is suspended above the stream bed: a long section along the edge of the stream where nearly the entire side of the pipe is exposed: and a manhole stack that is located in the center of the stream channel and there is evidence that the stack is beginning to crack and/or break apart. An example of a very severe exposed pipe problem is shown in Figure 3.6.3-2.

Moderate rating (3): A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event.

Minor rating (5): Minor exposed pipe problems include the following: a small section of the top of a pipe is exposed and the stream bank near the pipe appears to be stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe is exposed; the pipe is exposed but has been reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel.

Correctability

Once a portion of a pipe is exposed in a stream channel, there is a real threat that the pipe will be breached and whatever is in the pipe will contaminate the stream. Correction of exposed pipe problems usually involves either reinforcing the area around the pipe with concrete or stone to prevent the pipe from being punctured, moving the pipe or diverting the stream away from the pipe. Photographs of an exposed pipe taken before and after the stream was diverted to protect the pipe are shown in Figures 3.6.3- 4 and 3.6.3 - 5. These projects are usually very expensive, involving the use of heavy equipment. Factors that should be taken into consideration in assigning your Correctability rating are:

* What length of stream would be impacted by the work?
* What is the adjacent land use and would construction staging or access be a problem?
* Will heavy equipment be needed?
* How much earth, stone or other material would have to be moved?
* How much funding would be needed to do this project?
* Would permits, detailed survey and detailed construction plans be needed?

Examples of this rating scheme follow:

Best Correctability (1): A short stream reach where only a small portion of the pipe has been exposed. The stream in this area appears to have fairly stable banks and is in a place where a small amount of stone could be used to cover the exposed pipe and direct high flows in the stream away from the pipe.

Moderate Correctability (3): A section of pipe that is exposed and can be fixed by placing rock or other material around the pipe. The exposed pipe is in an area with fairly easy access. The stream is wide and has fairly low banks, so material placed in the stream to protect the pipe will not seriously affect the passage of storm flows through the site.

Worst Correctability (5): A long section of pipe is exposed in numerous areas and the bed of the stream has eroded down close to or below the bottom of the pipe. The most likely options to correct the problem would be either a major stream restoration effort to move the stream away from the pipe or relocate at least a section of the pipeline.

Access

See section 3.5.

3.6.5 PIPE OUTFALLS

Pipe outfalls include any pipes or small manmade channels that discharge into the stream through the stream corridor. An example of a typical pipe outfall site is shown in Figure 4.6.5-1. Pipe outfalls are considered a potential environmental problem in the survey because they can carry uncontrolled runoff and pollutants such as oil, heavy metals, and nutrients to a stream system. State and local governments have become interested in pipe outfalls, as they are required by recent revisions of the Clean Water Act to address non-point source pollution sources.

Any pipes or manmade channels that are designed to discharge into the stream are considered pipe outfalls and must be included in the survey. This includes pipes with openings outside of the immediate stream corridor, but which discharge into a channel which eventually enters the stream.

The team should especially be on the look out for any pipe outfalls that have a discharge coming out of it. Do not touch the discharge and try to avoid getting any of the discharge on your skin or clothes since you cannot always be sure what may be in the discharge. On your data sheets, indicate the color and smell of the discharge. Any pipe outfall discharge with a color and/or smell should be especially noted by the survey team. At the end of the day, notify your supervisor and/or the survey manager of the discharge, so that immediate follow up action can be taken if warranted. Use the Unusual Condition /Comment data sheet to better describe the discharge if you feel that the Pipe Outfall data sheets are insufficient.

If you are surveying the stream while it is raining, shortly after it has rained or while snow is melting, then you will not be able to able to determine it the pipe outfall has a dry weather discharge. If you are not sure if a discharge is coming out of a pipe outfall you should indicate "Unknown," on your data sheets.

In many cases you will not be able to determine the reason for a discharging pipe outfall during the SCA survey. You should simply indicate that a potential problem does exist so that follow up investigations can be done.

DATA SHEET FOR PIPE OUTFALL

Map, Team, Site, Date, and Photo Numbers:

Fill in the appropriate site identification information and on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Type of Outfall:

As you gain experience doing the SCA survey, you should begin to recognize the different types of outfalls that are commonly seen along a stream. The most common are storm water outfalls. The storm water pipes usually have fairly large diameter pipes (i.e., 24 inches or greater) and are usually made of concrete. Other outfall pipes you may see include sewage plant discharges, industrial discharges, overflow pipes, and agricultural drainage pipes. If you do not know the purpose of the outfall pipe, circle "**U**nknown." If you think you know the purpose of the outfall but it is not listed as a possible choice, circle "**O**ther" and fill in the appropriate answer in the space provided.

Type of Pipe:

Indicate whether the pipe outfall is an earth channel, concrete channel, concrete pipe, smooth metal pipe, corrugated metal pipe or plastic pipe. If the pipe outfall is made from some other material than the choices listed, circle "**O**ther" and record the appropriate answer in the space provided.

Location (facing downstream):

Indicate whether the pipe outfall is located on the left stream bank, right stream bank or at the head of stream channel. If the three above choices do not adequately describe the location of the pipe outfall, then circle "**O**ther" and fill in the appropriate answer in the space provided.

Pipe Diameter:

Measure the inside diameter of the pipe outfall and record the information in inches in the space provided. In the SCA survey, pipe diameter always refers to the inside diameter of the pipe opening.

Channel width:

If the pipe outfall is not a pipe but an open channel, measure the width of the channel and record the information in feet. Do not use inches. The channel width is measured across the bottom of the channel. If it is an uneven earth channel, estimate the average width of the bottom of the channel.

Evidence of Discharge:

Indicate whether there is any evidence that the pipe is cracked or leaking. If there is evidence of a discharge, record the color and if there is an odor. A strong odor, even if you do not see any discharge coming out of the pipe, is an indication of a discharge. If the discharge appears to be a significant health or environmental problem, contact your supervisor or survey manager as soon as possible.

Color & Odor

Record the color and/or odor of any discharge. The choices provided are the same used by several state and county governments when investigating unknown discharges. Circle the most appropriate answer. If none of the choices describe what you are seeing and/or smelling accurately, then circle "**O**ther" and describe the discharge in your own words.

Severity

When determining the severity rating for a pipe outfall, you should only be considering the immediate environmental problems that a specific outfall pipe is creating. The rating should be independent of whether there are other outfall pipes on the stream or whether the stream has an erosion problem. If there is an erosion problem at the outfall you should fill out an erosion site sheet. The severity rating for pipe outfalls will primarily depend on whether there is a discharge from the pipe outfall, how much of a discharge, the discharge color or smell and how much of an impact the discharge appears to be having on the stream. Factors that should be taken into consideration when assigning the severity rating are:

* Is there a discharge coming from the pipe outfall?
* Does the discharge appear to be just water or does it have a color and/or smell associated with it?
* How large is the discharge compared to the stream's usual base flow?
* Is the discharge discoloring the stream and how far can it be seen downstream?
* Is the discharge affecting the stream's biota?

Examples of the rating system are as follows:

Severe rating (1): A pipe outfall that has a strong discharge with a distinct color and/or a strong smell. The amount of discharge is large compared to the amount of normal flow in the stream that is receiving it, and the discharge appears to be having a significant impact downstream. An example of a sever pipe outfall is shown in Figure 3.6.5 - 2.

Moderate rating (3): A pipe outfall that has a small discharge coming out of it but the discharge is usually clear and has no odor associated with it. If the discharge has a color and/or odor the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor and localized.

Minor rating (5): Storm water outfall pipes or other channels and/or pipes that appear to be designed to carry storm water runoff and does not have dry weather discharge nor does it appear to be causing any erosion problems. An example of a minor pipe outfall is shown in Figure 3.6.5 - 3.

Correctability

In assigning a severity and correctability ratings for pipe outfalls, look at a single pipe outfall and the immediate problems that outfall may be causing. You should not take into consideration how many other outfall pipes there are along the stream or the whether the stream has an erosion problem. Erosion problems are evaluated separately using the Erosion Site data sheets.

Pipe outfalls with no discharge and/or smell, or pipe outfalls with minor discharges of clear water will usually be given a low correctability rating. In most cases, these pipe outfalls are not considered environment problems by themselves and nothing needs to be done at the site. Pipe outfalls with significant discharges that have a color and/or smell associated with it will get a high correctability rating. Any work to correct problems involving storm drain systems, or discharges from sewage or industrial sites, are usually a major engineering undertaking involving significant funding. Factors that should be taken into consideration in assigning your Correctability rating are:

* Is there a discharge coming from the outfall pipe and is it an environmental problem?
* If excavation needs to be done, will local land use be a problem?
* Would construction staging or access be a problem?
* How much funding would be needed to do this project?
* Would permits, detailed survey and detailed construction plans be needed?

Examples of the rating system are as follows:

Best Correctability (1): A pipe outfall that does not have a dry weather discharge or odor will usually have a correctability rating of 1. If there is a discharge but the discharge is small and appears to be only water, give it a correctability rating of 2.

Moderate Correctability (3): A pipe outfall that does have a discharge but the cause of the discharge is known and can be fixed by a public works crew in a few days.

Worst Correctability (5): A significant discharge that has a color and/or odor associated with it from storm water or other discharge pipe. You may not know the exact source of the discharge but you assume that any attempt to correct the problem will require both engineering designs and a significant amount of funding.

Access

See section 3.5.

3.6.6 FISH BARRIER

Fish migration barriers are anything in the stream that significantly interferes with the upstream movement of fish. An example of a fish migration barrier is shown in Figure 3.6.6-1. Unimpeded fish passage is important for fish species, many of which also move both up and down stream during different parts of their life cycle. Without free fish passage, some sections in a stream network can become isolated. If a disturbance occurs in an isolated stretch of stream, such as a sewage spill on a small tributary, some or all fish species may be eliminated from that isolated section of stream. With a fish blockage present and no natural way for a fish to repopulate the isolated stream section, the diversity of the fish community in an area will be reduced and the remaining biological community may be out of natural balance.

Fish blockages can be cause by man-made structures such as dams or road culverts, and by natural features such as waterfalls or beaver dams. Fish blockages occur for three main reasons. First, there is a vertical water drop such as a dam that it is too high for fish to swim over. A vertical drop of 6 inches may cause fish passage problems for some resident fish species, while anadromous fish can usually move through water drops of up to 1 foot, providing there is sufficient flow and water depth. The second reason a structure may be a fish passage problem is because the water is too shallow. This can often occur in channelized stream sections or at road crossings where the water from a small stream has been spread over a large flat area and the water is not deep enough for fish. Finally, a structure may be a fish blockage if the water is moving too fast. This can occur at road crossings where the culvert pipe has been placed at a steep angle and the water moving through the pipe has a velocity higher than a fish's swimming ability.

DATA SHEET

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information and on the top of the data sheet and on the field map. Also, record the date and film exposure numbers for the photographs taken at the site.

Fish Blockage:

Indicate on the data sheet whether you believe the structure is a Total, Partial or Temporary fish barrier. A partial fish barrier may be an area with shallow water that is deep enough for small fish to move through but which would impede the migration of larger fish. A partial fish barrier may prevent fish from migrating through the structure during base flow conditions, but will usually be deep enough for fish to pass through after a small rain event. When designating a structure a partial fish barrier, you must consider not only what the water depth may be during elevated flows but also the velocity of the water moving through a structure during the higher flows. Finally, a temporary fish blockage is usually either a beaver dam or debris dam. While these structures may totally or partially block the upstream movement of the fish, the structure is only temporary and should be gone in a few years. Tree falls across streams are usually not fish barriers because very often the fish can move through water flowing both under and over the tree

If you are not sure if a structure is a Total, Partial or Temporary fish barrier, make an educated guess as to which category best describes the fish barrier. Only circle the "**U**nknown" choice if you cannot even guess if it is a Total, Partial or Temporary fish barrier.

Type of Barrier:

Record on the data sheet if the fish barrier is a Dam, Road Crossing, Pipe Crossing, Natural Falls, Beaver Dam, or Channelized stream section. If the fish barrier is present due to a structure other than the ones listed, circle "**O**ther" and record the appropriate answer in the space provided.

Blockage because:

Indicate on the data sheet that a fish barrier exists at this site because the water drop is too high, the water is too shallow or the water is moving too fast. Only circle one answer. If a structure is a fish blockage for more than one or the three choices, circle the one you believe is the most important.

Water drop:

If a fish barrier is present because there is a structure with a water drop too high for the fish to swim through, record the height, in inches, of the water drop on the data sheets. Height of the water drop is measured from the top of the downstream water surface to the top of the structure the water is flowing over.

Water depth:

If a fish barrier is present because the water moving through the structure is too shallow for the fish, first look at the entire structure and determine where the shallowest cross-section is. Measure in inches the water depth at the deepest point in the shallowest cross-section. What you are attempting to do is find the shallowest point that a fish would have to swim through if it was trying to swim up the deepest part of the channel.

Severity

The severity rating for fish barriers will depend on the location of the barrier in the stream network and whether it is a total, partial or temporary barrier to upstream fish migrations. Fish barriers that could potentially interfere with the migration of anadromous fish to their spawning ground are usually given priority in restoration efforts in Tennessee. A fish barrier on a large stream or river (e.g., 3rd order or greater) that totally blocks the upstream movement of anadromous fish would usually get a severity rating of 1 or 2, unless a functioning fish passage device is present. If a functioning fish passage device is present, the severity rating may be downgraded to 2 or 3. The structure would usually still be given a fairly low severity rating because most fish passage devices are designed to pass only certain fish species. Also, many devices are maintained only during the anadromous fish runs in the spring. Total fish blockages on smaller first and second order streams should also receive a low to moderate severity rating (i.e., less than 3) if fish blockages are isolating a significant portion of a tributary (< 1000 ft.) from contact with the rest of the stream's fish community. Identifying small tributaries where fish populations are isolated from the main fish community is important because the isolated fish populations can become ecologically unbalanced. This can occur when there is a disturbance such as an oil spill or sediment pollution event on an isolated tributary which eliminates some or all fish species from the tributary. A severity rating of 4 or 5 will normally be given to temporary fish blockages, such as beaver dams, or in the case of fish barriers located in areas where there is very little fish habitat above the barrier. Factors that should be taken into consideration in assigning your severity rating are:

* Is the structure a total, partial or temporary fish barrier?
* Could the structure effect anadromous fish migrations? Is the structure the most downstream barrier to anadromous fish?
* Does the structure isolate a tributary's fish community from the rest of the fish in the stream network? How long a stream reach is being isolated and what is the condition of the habitat in the isolated reach?

Examples of the rating system follow.

<u>Severe rating (1):</u> A structure such as a dam or perched road culvert on a large stream or river (e.g., 3rd order or greater) that would totally block the upstream movement of anadromous fish and there is no fish passage device present. An example of a severe fish blockage is shown in Figure 3.6.6-2.

<u>Moderate rating (3</u>): A total fish blockage on a tributary that would isolate a significant stretch of stream or a partial blockage the could interfere with the migration of anadromous fish during their spring migrations.

<u>Minor rating (5):</u> A temporary fish barrier such as a beaver dam or a fish blockage at the very head of a stream with very little viable fish habitat above it. Natural fish barriers, such as waterfalls are also given a minor severity rating. A minor fish blockage is shown in Figure 3.6.6-3.

Correctability

The correct ability rating for fish barriers will depend on how hard it will be to either remove or modify a structure to allow the free upstream migration of both anadromous and resident fish species. Whenever possible the preferred option is usually to remove a fish barrier and return the area to a natural stream condition. Photographs of a perched road culvert that was replaced by a small bottomless arch to provide natural fish passage is shown in Figures 4.6.6 - 4 and 4.6.6 - 5. If removal of a fish barrier is not a practical option, the structure can sometimes be modified to allow for the passage of at least some fish species. Removal or modification of a dam or road crossing to allow fish passage will usually involve an engineering review. That is because anything that is done to improve fish passage at a dam or road crossing also has the potential of affecting up and downstream flooding. In addition to engineering review, projects at dams and road crossing usually require permits and substantial funding. For these reason, most fish blockages at road crossings and dams will have a worst (IE., 4 or 5) correctability rating. The best correctability rating (ie., 1 or 2) will usually be given at temporary fish barriers such as beaver dams or partial fish barriers that do not involve road crossings, or where a small modification to the channel could improve fish passage conditions.

Some fish barriers such as a debris jam at a road crossing are not only an environmental problem, but can also threaten the road itself. Debris clogging of road culverts is one of the main causes of road failure during large rain evens. If the water in the stream cannot pass through the culvert under the road, it will usually begin to flow over the top of the road, possibly causing the road to wash out. If you see a road crossing with a significant blockage in it, please notify your supervisor or the survey manager at the end of the day. They will notify either a public works department or the Department of Transportation of the flow blockage at the road crossing so that it can be corrected quickly. Factors that should be taken into consideration in assigning your Correctability rating are:

* Would construction staging or access be a problem?
* Will heavy equipment be needed?
* How much earth, stone or other material would need to be moved?
* How much funding would be needed to do this project?
* Would permits, detailed survey and detailed construction plans be needed?

Examples of the rating system are as follows:

<u>Best Correctability (1):</u> A temporary fish barrier such as a beaver dam or a debris jam at a road culvert. A team of volunteers in a few hours could remove the blockage if it was determined that removal was warranted.

<u>Moderate Correctability (3)</u>: A total or partial fish barrier that could be corrected with a small team in a week or less. Removal of a check dam or a small dam that is already partially breached could be assigned a moderate correctability rating.

<u>Worst Correctability (5):</u> A total fish barrier at a dam or road crossing where no fish passage device is already present. These are usually major engineering undertaking requiring substantial work and funding.

Access

See section 3.5.

3.6.7 INADEQUATE BUFFER

Forested stream buffers are very important for maintaining healthy streams. Forest buffers help shade the stream, preventing excessive solar heating, and the roots stabilize the stream banks. Forest buffers remove nutrients, sediment and other pollutants from runoff, while the leaves of trees are a major component of the stream's food web.

For the purposes of this study, a buffer is generally considered inadequate if it is less than 50 feet wide from the edge of the stream.

DATA SHEET FOR INADEQUATE BUFFER

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information and on the top of the data sheet and on the field map. Also, record the date and film exposure numbers for the photographs taken at the site.

Inadequate Buffer:

Indicate whether the buffer is inadequate on the left, right or both sides of the stream. Left and right stream banks are always determined facing downstream.

Unshaded Stream:

A natural stream buffer usually will have trees along the edge of the stream's banks that help shade the stream from excessive solar heating. In prioritizing future buffer planting, emphasis is given to stream reaches without trees along the edge of the stream. Indicate on the data sheet if the stream is unshaded and whether it is due to a lack of trees along the left bank, right bank or both stream banks. Left and right stream banks are determined facing downstream. On larger streams and rivers it is common for the trees' canopy to cover only part of the stream channel with the center portion of the stream channel to be unshaded. This is a natural condition and is not considered an environmental problem. If there are large trees on both sides of the stream then the stream is considered shaded even if the tree's branches do not completely shade the entire stream.

Buffer Width:

Determine as accurately as possible, the width of the existing stream buffer on both the left and right sides of the stream. Record your answer in feet. If the existing forest buffer on either side of the stream is greater that 100 ft. than you should simply enter > 100'. Left and right stream banks are determined looking downstream.

Length:

Determine as accurately as possible, the length of stream along both the left and right stream banks that has an inadequate buffer.

Land Use:

Indicate what the general land use in the stream's corridor is on both the left and right sides of the stream. The left and right sides of a stream are determined by facing downstream. Land use choices on the data sheets include "Crop fields, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose." In making your determination, the area closest to the stream is the area of greatest interest. If more than one land use type is present on a bank, chose the one that best describes the area's land use overall. The database will only accept one land use entry for each side of the stream. If none of the listed categories accurately describes the land use near the stream, circle "**O**ther" and enter an appropriate answer.

Has a buffer recently been established:

If the area has an inadequate buffer but it is obvious that a buffer has been planted or is being allowed to grow circle **Yes**. Otherwise circle **No**.

Are livestock present:

Indicate if livestock have regular access to the buffer. You do not have to see livestock in the buffer to answer **Yes**, you only need to see evidence that they are using the area. If the area is being used by livestock, indicate the type of livestock operation. Circle Cattle, Horses, Pigs or Other. If you circle Other you should also write in the type of livestock operation.

Severity

The severity rating for inadequate buffers will depend on the condition of the vegetation along the streams banks and the length of stream with an inadequate buffer. Factors that should be taken into consideration in assigning your severity rating are:

* What are the land use and type of vegetation in the area with an inadequate buffer?
* Is there evidence that a tree buffer is beginning to form in the inadequate buffer area?
* Is the inadequate buffer on one or both sides of the stream?
* Is the stream unshaded?
* How long is the reach of stream with an inadequate buffer?

Examples of this rating follow:

<u>Severe rating (1):</u> A significant length of stream that is completely open with no trees on either side of the stream. Both sides of the stream are maintained as either lawn, pasture or some other condition that excludes trees from the stream's banks.

<u>Moderate rating (3</u>): A section of stream without trees on one side of the stream, but an adequate forest buffer on the other side.

<u>Minor rating (5):</u> A section of stream with trees on both sides of the stream, but on one side the

stream buffer is less than 50 feet wide.

Correctability

The correctability of a stream reach with an inadequate buffer will depend primarily on the land use in the area. In most of Tennessee, if the land is left alone, trees will quickly begin to grow and a forest will eventually develop. Open areas without trees exist because they are activity maintained that way. In determining the correctability of an inadequate buffer area, first determine the practicality of establishing a buffer in the area. Do not assume it is impossible to get permission from a private land owner to establish a forest buffer along the stream. You can assume, however, that it is easier to get permission to establish a buffer on public than on private land. Factors that should be taken into consideration in assigning your Correctability rating are:

* What is the length and width of the inadequate stream buffer?
* What is the present land use?
* How much funding would be needed to do this project?

Examples of the rating system follow.

<u>Best Correctability (1):</u> A small stream reach on public land where the land along the stream does not appear to be used for any specific purpose.

<u>Moderate Correctability (3)</u>: A significant reach of stream on either public or private land that is presently used for a specific purpose, where it should be possible to accomplish the same thing on an adjacent parcel of land. For example, a large pasture with a stream running through it that is kept open so that livestock can drink water from the stream. .

<u>Worst Correctability (5):</u> A significant reach of stream where roads and buildings have been built along the stream banks and there is no place for trees to grow.

Access

See section 3.5.

3.6.8 IN/NEAR STREAM CONSTRUCTION

In or near stream construction data sheets are used to document the locations of major disturbances located in or near the stream corridor at the time of the survey. If construction is seen near the stream, indicate the location on the survey map and look at the general condition of the stream near and downstream of the construction site. Survey teams should be on alert for evidence of inadequate sediment control measures or if sediment pollution from the site has affected the stream. However, survey team members are not sediment inspectors and it is not their job to review sediment control measures at the construction site. Survey crews should avoid walking through the construction site and should never confront anyone at the construction site about problems they observed. Any problems with sediment control measures at the construction site should be noted on the data sheets and the supervisor or the survey manager notified at the end of the day, so appropriate action can be taken.

DATA SHEET FOR IN/NEAR STREAM CONSTRUCTION

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information and on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Type of activity:

Indicate the type of construction activity occurring in or near the stream. Choices include: "road construction, installation of a road crossing, utility work, logging, bank stabilization work, residential development and industrial development." If none of the choices accurately describes the activity observed, circle "**O**ther" and describe the construction activity in the space provided.

Sediment Control:

Indicate where sediment control measures at the construction site appear to be adequate. If you observe a problem with the sediment control measures at the construction site circle "**I**nadequate," and describe the problem in the space provided. You should also take a photograph of any problems you may observe. If you feel that you cannot properly evaluate sediment control measures circle "**U**nknown."

Stream Bottom with Excess Sediment:

Look at the stream bed just downstream of the construction activity and compare it to conditions upstream of the site. Is there excessive sediment deposition in the stream bed that appears to be related to the construction activity? If yes, indicate the length of stream that is affected by the sediment deposition. If possible, also photograph the sediment problem.

Company doing construction:

If you are able to identify who is involved in the construction activity from signs posted at the site or information printed on the vehicles at the site, write it down in the space provided. Do not interview anyone at the site or ask questions to obtain this information. If it is not obvious who is involved in the construction by simply observing the construction site from a distance, leave this section blank.

Location:

Describe the location of the construction activity in relation to the stream.

Severity

The severity rating for In or Near Stream Construction sites is intended to be an overall rating of how significant the survey teams believe the aquatic resource in the area will be affected by the construction activity. Factors that should be taken into consideration in assigning your severity rating are:

* How large is the construction site?
* How close to the stream is work being done?
* Does sediment control appear to be adequate?
* Is there evidence down stream that sediment from the construction site is getting into the stream?

Examples of this rating system are as follows:

<u>Severe rating (1):</u> A very large construction site with a large amount of disturbance to the stream channel and sediment control measures appear to be absent or very poorly maintained. Investigations downstream indicate that a large amount of sediment is getting into the stream channel and depositing in the stream channel.

<u>Moderate rating (3</u>): The construction site is near the stream but there appears to be very little disturbance to the steam's banks. Construction activities however do appear to be inside the streams riparian buffer. Sediment control measures appear to be adequate and investigations downstream indicate that while some sediment may be entering the stream from the construction site the amount appears to be relatively small.

<u>Minor rating (5):</u> The construction site is away from the stream and well outside the steams riparian buffer. Sediment control measures appear to be adequate and there is not evidence that sediment from the construction site is entering the stream.

Correctability & Access

Correctability and Access ratings are not needed at in or near-stream construction sites.

3.6.9 TRASH DUMPING

The trash dumping data sheets are used to record the location of places where large amounts of trash have been dumped inside the stream corridor or to note places where trash tends to accumulate. An example of a trash dumping site is shown in Figure 3.6.9 - 1. The main purposes of identifying where trash is being dumped in or near the stream is so that steps can be taken to limit access to these areas by vehicles if possible. Past work by several community groups have found that if vehicle access is restricted, the trash dumping usually ends. A second reason for noting trash dumping sites is to assist community volunteer groups looking for possible sites to do stream clean-ups. Stream clean-ups are very good community activities which encourage local residents to go out and take a closer look at the condition of their community stream.

DATA SHEET

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information and on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Type of trash:

Indicate the main type of trash present. Possible choices include "Residential, Industrial, Yard Waste, Floatable (Styrofoam peanuts, plastics, and other floating trash), Tires, and Construction Waste." If none of the choices provided adequately describes the trash present, circle "**O**ther" and describe it. Please select only one trash category. If more than one type of trash is present chose the one that best describes the trash in general.

Amount of trash:

Estimate the amount of trash present. If possible the estimate should be based on how many pick-up truck loads would be needed to remove all the trash. If unable to estimate how many pick-up truck loads are present, an estimate of the amount of trash by the size of the pile or the area covered is acceptable.

Trash confined:

Indicate whether the trash is confined to a single site or if it is spread out over a large area.

Possible cleanup site for volunteers?

Does the site look like a good place to bring community volunteers for a clean-up activity? In making your determination, consider both safety and access issues.

Land Ownership:

Indicate whether the trash dump is located on public or private land. If you know that the land is public land, such as a public park, please indicate if the owner is city, state or county in the space provided. If you know that the land is publicly owned but are not sure who owns it, enter whatever information you may have, such as the name of the park. If you do not know who owns the land circle “**U**nknown.” Do not spend extra time trying to determine whether the land is publicly or privately owned. If the answer to the question is not obvious just circle “**U**nknown,” and continue with the survey.

Severity

The severity rating for trash dumping will depend on the amount of trash present, its location and whether cleaning up the trash would present any special problems. Factors that should be taken into consideration in assigning your severity rating are:

* How much trash is present?
* What type of trash is present? Are there sharp object or possible chemicals present?
* Is it safe for volunteers to enter and pick up trash?

Examples of this rating system are as follows:

<u>Severe rating (1):</u> A large amount of trash scattered over a large area, where access is very difficult. If there are any large chemical drums present or indications of other hazardous materials, the site is given a Severity Rating of 1, no matter how much material is present.

<u>Moderate rating (3)</u>: A fairly large amount of trash that is in a small area with easy access. The trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with the assistance of a small backhoe.

<u>Minor rating (5):</u> A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access.

Correctability

The correctability rating for trash dumping areas will depend on how much trash is present and how easy it would be to clean up the problem. The correctability rating does not include long term solutions such as putting up fencing to prevent vehicles from entering an area to dump trash, however, if the survey team believes there is a simple long term solution to the trash dumping problem at a site they should use an Unusual Problem/Comment Sheet to make their suggestions. Factors that should be taken into consideration in assigning a Correctability rating are:

* How much trash is present?
* What type of trash is present? Are there sharp object or possible chemicals present?
* Is it safe for volunteers to enter and pick up trash?

Best Correctability (1): A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access. This site would make a good site for a community stream cleanup.

Moderate Correctability (3): An area with a large amount of trash in a fairly contained area that is not difficult to access. This would be a problem that may be too big for volunteers to clean up in a single day. The trash however is in large piles and a crew working for several days with the assistance of a small backhoe could clean up the site.

Worst Correctability (5):   A large amount of garbage spread over a large area with restricted or poor access. This is either the type of site where you could have a stream clean up every weekend and it would still have a trash problem or a site where hazardous chemical may be present and the site needs to be evaluated by professionals.

Access

See section 3.5.

3.6.10 UNUSUAL CONDITION OR COMMENT

The unusual condition or comment data sheets are used by survey teams to record the location of anything out of the ordinary or to provide some additional written comments on a specific problem.

DATA SHEET

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information and on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Type:

Indicate if the data sheet is being filled out to document an **Unusual Condition** or to provide **Comments** on a situation that has been encountered while surveying the stream. **Unusual conditions** may include: unusual odor, scum, excessive algae, water color/clarity, red flock, oil on surface, etc. If you encounter an unusual condition that you believe is an environmental problem and the other data sheets do not apply, than circle **Unusual Condition** and fill out rest of the data sheet including the severity, correctability and access ratings.

In cases where you encounter something that is of environmental interest but not necessarily a problem or in cases where you have already filled out a problem data sheet and want to add some additional observations on the problem the word **Comment** should be circled. You should than complete the **Describe and Observation section** of the sheet. Since this is only a comment, you should not fill in severity, correctability or access rating. It is important to note that comments sheets can not only be used to make observations about problems, but can also be used to bring attention to possible positive things that you may encounter. For example if you come upon a completed instream restoration project or see an area where a farmer is doing a good job at keeping the cattle out of the stream you may want to fill out a comment sheet to document it.

Describe:

Describe the problem or situation in the space provided. Please try to make your description as concise as possible. If you require additional space, use the back of the data sheet.

Observations:

Use the space provided to comment on either the cause of the problem or to make a comment about a specific observation. If you have a suggestion on a possible correction for the problem, make that suggestion in this space. Please try to make your statements as concise as possible. If you require additional space, use the back of the data sheet.

Severity

The severity rating for Unusual Conditions will generally follow the general guidelines for the problem severity rating system presented in Section 4.5.1. Factors that should be taken into consideration in assigning your severity rating are:

* What is the length of stream impacted and how severe is the impact on the stream biota?
* Is the problem a human health risk as well as an environmental problem?

Examples of the rating system follow:

<u>Severe rating (1):</u> Problems that appear to have a direct and wide reaching impact on the stream's aquatic resources. Within a specific problem category, a 1 rating indicates that the problem is among the worst that the field teams have seen or would expect to see in Tennessee.

<u>Moderate rating (3)</u>: Problems that appear to be having some adverse impacts at a site. While a rating of 3 would indicate that survey crews believed it was a significant problem, but they have either seen or would expect to see much worse problems in that specific category.

<u>Minor rating (5):</u> Problems that do not appear to be directly affecting the stream. A rating of 5 indicates that a problem was present and should be addressed, but compared to other problems it would be considered minor.

Correctability

The correctability rating for Unusual Condition will generally follow the general guidelines for the problem severity rating system presented in Section 3.5.1. Factors that should be taken into consideration in assigning your Correctability rating are:

* How much time and effort would be needed to correct the problem?
* Would the project need Federal, State and/or local permits?
* How much funding would be needed?

Examples of the rating system are as follows:

<u>Best Correctability (1):</u> Problems that can be corrected quickly and easily using hand labor, with a minimum amount of planning. These types of projects would usually not need any Federal, State or local government permits. It is a job that a small group of volunteers (10 people or less) could fix in less than a day without using heavy equipment.

<u>Moderate Correctability (3)</u>: Problems that may require a small piece of equipment, such as a backhoe, and require some planning to correct. This is <u>not</u> the type of project that volunteers could do by themselves, although volunteers could assist in some aspects of the project, such as final landscaping. This type of project would usually require a week or more to complete. The

project may require some local, State or Federal government notification or permits, however, environmental disturbance would be small and approval should be easy to obtain.

Worst Correctability (5): Problems which would require a large expensive effort to correct. These projects would usually require heavy equipment, significant amount of funding ($100,000.00 or more), and construction could take a month or more. The amount of disturbance would be large and the project would need to obtain a variety of Federal, State and/or local permits

Access

See section 3.5.1.

3.6.11 REPRESENTATIVE SITE

Representative site data sheets are used to document the general condition of both in-stream habitat and the condition of the adjacent stream corridor. For each of the 10 habitat parameters a rating of optimal, suboptimal, marginal or poor is assigned based on the grading criteria that is presented at the end of Appendix C. The 10 habitat parameters evaluated are:

Attachment Sites for Macroinvertebrates (listed as MACROIN in the data base)
Embeddedness (listed as EMBEDDED in the data base)
Shelter for Fish (listed as SHELTER in the data base)
Channel Alteration (listed as ALTERATION in the data base)
Sediment Deposition (listed as DEPOSITION in the data base)
Stream Velocity and Depth Combinations (listed as VELOCITY in the data base)
Channel Flow Status (listed as FLOW in the data base)
Bank Vegetation Protection (listed as VEGETATION in the data base)
Condition of Banks (listed as BANK in the data base)
Riparian Vegetative Zone Width (listed as RIPARIAN in the data base)

In addition to the habitat ratings, data is collected on the stream's wetted width and pool depths at both runs and riffles at each representative site. Depth measurements are taken along the stream thalweg (main flow path). At these sites, field crews also indicate whether the bottom sediments in the area were primarily silts, sands, gravel, cobble, boulders or bedrock.

Representative site evaluations are usually done at set intervals both along the stream's mainstream and on major tributaries. The frequency that representative site data sheets are filled out will depend on the stream system, main purpose of the survey and the needs of the survey's sponsor. In past surveys, the data sheets have been filled out at either 1/4 or1/2 mile intervals depending on the survey. In general, for an urban stream 1/4 mile spacing of representative sites has been used, and for more rural areas ½ mile intervals. Representative sites are determined at the beginning of the survey by the survey manager, and indicated with a red dot on the survey maps. The survey manager may vary the spacing of representative sites to collect information at critical survey points such as upstream and downstream of the confluence of major stream segments. When a survey team comes to a predesignated representative site, they will complete a Representative Data Sheet.

DATA SHEET FOR REPRESENTATIVE SITES

Map, Team, Site, Date and Photo Numbers:

Fill in the appropriate site identification information and on the top of the data sheet and on the field maps. Also, record the date and film exposure numbers for the photographs taken at the site.

Habitat Assessment

Using the habitat assessment guidelines in Appendix D indicate whether each of the 10 habitat parameters listed on the data sheet should be rated Optimal, Suboptimal, Marginal or Poor. You need only to check the appropriate box on the data sheet. Do not attempt to assign numerical scores to each parameter.

Wetted width:

Wetted width is the width of the stream that is covered with water. At the pool, riffle and run sections near the predesignated representative site, identify representative cross sections and measure the wetted width of each in inches.

Thalweg depth:

The thalweg is the main flow channel in a stream cross section. This is usually the area where water depth and water velocities are the highest. At the pool, riffle and run sections near the predesignated representative site, identify representative cross sections and measure the thalweg depth in inches.

Bottom type:

Looking at primarily the riffle and run sections of the stream, determine if the bottom sediments in the stream are primarily silts, sands, gravel, cobble, boulders or bedrock. Most stream bottoms are made up of a variety of different size sediments but your answer should indicate the dominant size.

4.0 DATA MANAGEMENT

4.1 DATA SHEETS

Data sheets used in the SCA survey can be found in Appendix C. During the survey, each team will carry enough data sheets for that day's work. At the end of the day, all used data sheets should be removed from the storage compartment on the clip board and checked by the team leader for completeness. Any data sheets that are incomplete or require special attention, such as a leaking sewage line or near stream construction sites that is causing a sediment pollution problem, should be set aside and discussed with either the survey crew chief or survey manager as soon as possible. Data sheets not requiring immediate attention should be placed in sequential order with the summary data sheet on top. These data sheets are clipped together and placed in a storage box at the field office until the information on the data sheets can be entered into the survey's database. Do not bring completed data sheets from the previous day into the field where they can be damaged or lost.

4.1.1 DATA ENTRY

Data entry should be done within one or two weeks of when the data is collected. If possible, the team that collected the data should enter the information from the data sheets into the project database. It is also helpful to have the photograph available during data entry to help answer any questions that may arise

Information collected during the SCA survey is entered into a separate Microsoft Access Database developed for each project. After the data entry program has been loaded and a project data base established, the survey crew can begin data entry. Data entry is usually done when the crew has some free time usually due to poor weather conditions. It is important, however, that the data be entered into the project database periodically during the survey, and that there is no more that a 2-week time lag between data collection and data entry. After each data entry cycle, the data that has been entered into the project database should be printed out and a backup copy of the database made. Backup copies of the database should be stored in a safe place.

4.1.2 DATA VERIFICATION

All data entered into the project database must be verified by the survey crew to insure that the information has been accurately entered into the database. Data entry verification is a simple process where the data in the database is checked against the original data sheets. This is usually done by one person reading aloud the information from a printout of the database and a second individual checking the original data sheet to make sure it is correct. When discrepancies occur they should be noted on the database printout and the database corrected. Once the data in the database has been verified, the original data sheets should be stored in a safe place.

4.2 CATALOGING PHOTOGRAPHS

Photographs taken during the SCA survey have proven to be a very important tool in analyzing problem sites and in the prioritizing future restoration work. The information collected by the field teams during a SCA survey is limited and the photographs can often help provide insight about problems identified in the survey.

The survey crew should develop a regular routine to collect exposed film and bring it in for developing. Film should be dropped off and picked up from a film processor at least once a week. When the photograph prints and negatives are returned to the field teams, the team should first make sure the photographs are in proper sequential order. If there are any questions about the sequential order of the photographs the team should refer back to the negatives. The field team should then determine the field identification number for each photograph and write the field identification number on the back of each photograph using a soft felt tip pen. Do not use a ball point pen or pencil because they can cause creases in the photographs. Once all the photographs have been processed, they should be placed in 3-ring binder plastic sleeves and stored in a safe place. The plastic sleeves holding the negatives should be labeled with the survey name, team number and dates the photographs were taken. After the negatives have been labeled, they should also be stored in a safe place away from the photographs.

After the field surveys have been completed, all photographs should be digitized using a scanner. In past studies two survey crew members have been able to scan two to three hundred photographs in a single day. The scanned photographs are usually stored in a temporary directory and eventually copied onto a compact disk (CD). The production of a CD containing digitized copies of all the photographs, as well as, a copy of the survey's database and final report has proven to be a very effective way of sharing the survey's information with other watershed stakeholders. The size of the files needed to store each digitized photograph depends on the scanning resolution. In order to store more than five hundred photographs on a single CD, photographs are usually scanned at 100 to 200 dpi. Photographs scanned at 100 to 200 dpi will provide a fairly clear image on a computer monitor and can also be used to produce small prints using a color printer. To produce larger blowups of the images, it will usually be necessary to rescan the original photographs at a higher resolution. In the past, the TIF file format has been used because it can be read by a variety of software packages.

After all the photographs have been scanned, they should be placed in sequential order and placed back into one a 3-ring binder. The 3-ring binders should be safely stored until they are turned over to the project manager for analysis and production of a final report. After a final report has been completed, the original photographs will be kept on file.

4.3 MAP INFORMATION

The location of environmental problems and representative sites are first recorded on field survey maps. At the end of each day field team leaders should quickly review the maps to make sure they are filled in properly. When all the streams present on a map have been surveyed, the completed field maps should be stored in a safe place. If possible the completed maps should be photocopied and stored at a separate location from the original maps. Periodically during the survey, the completed field survey maps will be entered into a GIS database.

4.3.1 GIS DATA ENTRY

Data entry of site locations into a GIS database will depend on the GIS system being used. When county governments have been the survey's sponsor, the counties have provided training to the survey crew members on how to enter site location information directly into the sponsor's GIS system. Once data entry is completed, the data will be transferred to the GIS system.

4.3.1 GIS DATA VERIFICATION

Just as field data entered into a project database must be verified (Section 4.1.2), it is important that site location data also undergoes the same process. Once the site location data has been entered into a GIS system and the location of the survey sites is ready to be displayed by the system, survey crew members should compare all site locations in the GIS system with the original field survey maps. When discrepancies are identified, they should be noted and arrangements made with the GIS system manager to correct them.

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APPENDIX A. SAMPLE PROPERTY OWNER NOTIFICATION LETTER

John Q. Public
555 5th Street
________, TN 00555
Tax Map: 0055
Parcel: 055

Dear ________,

As fellow _______ River Watershed residents, we write to invite you to join with the City of ________and other watershed partners in an effort to inventory the condition of tributary perennial streams in our watershed. This field survey is to be performed as part of the City's efforts to protect the natural resources within the ______ River Watershed. Because these tributary waterways traverse your land, your help is crucial to our success.

Since the City of ________ lies at the heart of this watershed, our future growth and present health are tightly tied to the water quality of the streams that run through the watershed. The City does not plan to grow and thrive at the further expense of water quality in the ________, and we hope you will join us in our efforts to improve the abundant river we share.

Our goal from this work is to develop a watershed plan, called a Watershed Restoration Action Strategy, for the ______ River Watershed that identifies potential projects that will help us to protect and restore healthy stream ecosystems. Projects that could be recommended include: stream bank improvements, stream habitat restoration, enhanced wooded and grassed buffers, run-off management, stream road crossings improvements, low impact (environmentally sensitive) development strategies, land or rural preservation approaches, and enhanced nutrient reduction from our wastewater treatment plant. And, most particularly, we will identify possible sources of funding for these prioritized projects.

The first step in the program is to walk the streams; observing and noting various stream characteristics including natural areas, healthy ecological steam systems, as well as areas of erosion, poor buffers, fish blockages, or pipe outfalls, and other points of interest. Water samples will be taken for testing from __ sites within the watershed; one of which may be along your stream frontage. Information regarding the overall health of the watershed will be compiled and presented at a public meeting in _____. Your participation in this meeting is welcomed and encouraged.

The Town of ______ will be performing the fieldwork for this baseline Stream Corridor Assessment. Your permission is requested to allow the City's team to visit your property as noted above by tax map and parcel. Each member of the trained team will be appropriately identified and will observe proper protocols and avoid any areas of your property which you may elect to restrict. It is anticipated that the crews will be in your area around ____________. We will notify you and invite you to accompany the team on its visit if you like.

Permission to walk your property will allow this important phase of the project to move forward. We will be sending you a right of entry permit, which we hope you will approve, either under this cover or at a date closer to the anticipated field work.

Your knowledge and current stewardship efforts are invaluable to us. We thank you for your support and hope you will join us for the watershed public meetings and events. During these meetings you will have an opportunity to meet with many of the partners participating in this effort including the Soil Conservation District, members of the planning community, the Tennessee Department of Environment and Conservation, and representatives from the development community. Please feel free to contact ____ _____ if you should have any questions, concerns or if you would like to be involved to a greater degree. ________can be reached at ___ ____ _____. You may also contact us at ____ ___ ______.

APPENDIX B. SAMPLE RIGHT OF ENTRY PERMIT

February 20, 2007

[**Recipient Name**]
[**Street Address**]
[**City, ST ZIP Code**]

Dear [**Recipient Name**]:

The [City/Town/County name] is mandated by the Environmental Protection Agency and the Tennessee Department of Environment and Conservation to monitor certain streams (or tributaries to those streams). The goal of this mandate is to protect and rehabilitate our natural water resources. In accordance with this mandate, the [City/Town/County name] seeks right of entry to the property that you [own/lease] at [address/Parcel number etc.]. This right of entry is not for entry into any building or structures on the property, it is specifically for the purpose of inspecting streams (or their tributary watercourses) listed in the Total Maximum Daily Load **(**TMDL) Monitoring Program. Representatives of [City/Town/County name] will be collecting samples from the stream and/or making visual assessments of the watercourse.

> In accordance with this request, I, [owner/lessee's name], owner/lessee of the above named property, do grant Right of Entry to the property, to representatives of [City/Town/County name] this ______ day of _________ , 20__. This right of entry shall expire 60 days from this date.

[City/Town/County name] thanks you for your cooperation in complying with this State and Federal Mandate, and assisting in making our water resources cleaner for everyone.

Sincerely,

[**Your Name**]
[**Title**]

APPENDIX C:

SAMPLE DATA SHEETS
AND
DOCUMENTATION

Continuous Stream Walk Assessment Methods Field Sheets

This tool contains the field sheets to conduct a unified stream assessment and a stream corridor assessment.

Both are continuous stream walk methods that systematically evaluate conditions and identify restoration opportunities within the stream corridor.

For more details on USA and guidance for completing the field forms, see Kitchell and Schueler, 2004.

Unified Stream Assessment (USA)

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID (*Condition-#*): **OT-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____		**GPS:** (*Unit ID*)

BANK: ☐ LT ☐ RT ☐ Head

FLOW: ☐ None ☐ Trickle ☐ Moderate ☐ Substantial ☐ Other:

TYPE:	**MATERIAL:**	**SHAPE:**	**DIMENSIONS:**	**SUBMERGED:**
☐ Closed pipe	☐ Concrete ☐ Metal ☐ PVC/Plastic ☐ Brick ☐ Other:	☐ Single ☐ Circular ☐ Double ☐ Elliptical ☐ Triple ☐ Other:	Diameter:______(in)	☐ No ☐ Partially ☐ Fully
☐ Open channel	☐ Concrete ☐ Earthen ☐ Other:	☐ Trapezoid ☐ Parabolic ☐ Other:	Depth: ______(in) Width (Top):______(in) " (Bottom):______(in)	*NOT APPLICABLE*

CONDITION:	**ODOR:** ☐ NO	**DEPOSITS/STAINS:**	**VEGGIE DENSITY:**	**PIPE BENTHIC GROWTH:** ☐ None
☐ None	☐ Gas	☐ None	☐ None	☐ Brown ☐ Orange ☐ Green
☐ Chip/Cracked	☐ Sewage	☐ Oily	☐ Normal	☐ Other:
☐ Peeling Paint	☐ Rancid/Sour	☐ Flow Line	☐ Inhibited	**POOL QUALITY:** ☐ No pool
☐ Corrosion	☐ Sulfide	☐ Paint	☐ Excessive	☐ Good ☐ Odors ☐ Colors ☐ Oils
☐ Other:	☐ Other:	☐ Other:	☐ Other:	☐ Suds ☐ Algae ☐ Floatables
				☐ Other:

FOR FLOWING ONLY	**COLOR:**	☐ Clear ☐ Brown ☐ Grey ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:
	TURBIDITY:	☐ None ☐ Slight Cloudiness ☐ Cloudy ☐ Opaque
	FLOATABLES:	☐ None ☐ Sewage (toilet paper, etc.) ☐ Petroleum (oil sheen) ☐ Other:
OTHER CONCERNS:	☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation	
	☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other:	

POTENTIAL RESTORATION CANDIDATE ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization
☐ no ☐ Storm water retrofit ☐ Other:

If yes for daylighting:
Length of vegetative cover from outfall: ___________ft Type of existing vegetation:______________________ Slope: ___________°

If yes for stormwater:
Is stormwater currently controlled? Land Use description:_________________________________
☐ Yes ☐ No ☐ Not investigated Area available:

OUTFALL SEVERITY: (*circle #*)	Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream.		Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized.	Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems.
	5	4	3	2 1

SKETCH/NOTES:

REPORTED TO AUTHORITIES: ☐ YES ☐ NO

Severe Bank Erosion **ER**

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**
SURVEY REACH: **TIME:**___:____AM/PM	**PHOTO ID** (CAMERA-PIC #): /#	
SITE ID: (*Condition-#*) **ER-**_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown

☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*) LT______ft and/or RT________ft | Bottom width _______ft
Bank Ht LT______ft and/or RT_________ft | Top width __________ft
Bank Angle LT_______° and/or RT_______° | Wetted Width _______ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown | **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY(*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5 4	3 2	1
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5 4	3 2	1

NOTES/CROSS SECTION SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

5

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) IB-_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)	

IMPACTED BANK: ☐ LT ☐ RT ☐ Both

REASON INADEQUATE: ☐ Lack of vegetation ☐ Too narrow ☐ Widespread invasive plants ☐ Recently planted ☐ Other:

LAND USE: (*Facing downstream*)	Private	Institutional	Golf Course	Park	Other Public
LT Bank	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐:

DOMINANT LAND COVER:	Paved	Bare ground	Turf/lawn	Tall grass	Shrub/scrub	Trees	Other
LT Bank	☐	☐	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐	☐	☐:

INVASIVE PLANTS: ☐ None ☐ Rare ☐ Partial coverage ☐ Extensive coverage ☐ unknown

STREAM SHADE PROVIDED? ☐ None ☐ Partial ☐ Full

WETLANDS PRESENT? ☐ No ☐ Yes ☐ Unknown

POTENTIAL RESTORATION CANDIDATE ☐ Active reforestation ☐ Greenway design ☐ Natural regeneration ☐ Invasives removal ☐ no ☐ Other:

RESTORABLE AREA

	LT	RT
	BANK	
Length (ft):	________	________
Width (ft):	________	________

REFORESTATION POTENTIAL: (*Circle #*)	Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting	Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate	Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting
	5 4	3 2	1

POTENTIAL CONFLICTS WITH REFORESTATION ☐ Widespread invasive plants ☐ Potential contamination ☐ Lack of sun ☐ Poor/unsafe access to site ☐ Existing impervious cover ☐ Severe animal impacts (deer, beaver, cattle) ☐ Other:

NOTES:

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **SC-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____		**GPS** (*Unit ID*)

TYPE: ☐ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

FOR ROAD/ RAILROAD CROSSINGS ONLY

SHAPE:	**# BARRELS:**	**MATERIAL:**	**ALIGNMENT:**	**DIMENSIONS:** (*if variable, sketch*)
☐ Arch ☐Bottomless ☐ Box ☐ Elliptical ☐ Circular ☐ Other:	☐ Single ☐ Double ☐ Triple ☐ Other:	☐ Concrete ☐ Metal ☐ Other:	☐ Flow-aligned ☐ Not flow-aligned ☐ Do not know	Barrel diameter: _________(ft) Height: _________(ft)
CONDITION: (*Evidence of…*) ☐Cracking/chipping/corrosion ☐ Downstream scour hole ☐ Sediment deposition ☐ Failing embankment ☐ Other (*describe*):			**CULVERT SLOPE:** ☐ Flat ☐ Slight ($2^o – 5^0$) ☐ Obvious ($>5^o$)	Culvert length: _________(ft) Width: _________(ft) Roadway elevation:_________(ft)

POTENTIAL RESTORATION CANDIDATE ☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit

☐ no ☐ Local stream repair ☐ Other:

IS SC ACTING AS GRADE CONTROL ☐ No ☐ Yes ☐ Unknown

If yes for fish barrier

EXTENT OF PHYSICAL BLOCKAGE:
☐ Total ☐ Partial
☐ Temporary ☐ Unknown

CAUSE:
☐ Drop too high Water Drop: ______ (in)
☐ Flow too shallow Water Depth:______ (in)
☐ Other:

BLOCKAGE SEVERITY: (*circle #*)

A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present.	A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish.	A temporary barrier such as a beaver dam or a blockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls.

5 4 3 2 1

NOTES/SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#

SITE ID: (*Condition-#*) **CM-**_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)

TYPE: ☐ Channelization ☐ Bank armoring ☐ concrete channel ☐ Floodplain encroachment ☐ Other:

MATERIAL:			**DIMENSIONS:**
☐ Concrete ☐ Gabion	Does channel have perennial flow?	☐ Yes ☐ No	Height _______________(ft)
☐ Rip Rap ☐ Earthen	Is there evidence of sediment deposition?	☐ Yes ☐ No	Bottom Width _______________(ft)
☐ Metal	Is vegetation growing in channel?	☐ Yes ☐ No	Top Width: _______________(ft)
☐ Other:	Is channel connected to floodplain?	☐ Yes ☐ No	Length: _______________(ft)

BASE FLOW CHANNEL

Depth of flow ____________(in)

Defined low flow channel? ☐ Yes ☐ No

% of channel bottom _________%

ADJACENT STREAM CORRIDOR

Available width LT________(ft) RT________(ft)

Utilities Present? ☐ Yes ☐ No

Fill in floodplain? ☐Yes ☐ No

POTENTIAL RESTORATION CANDIDATE ☐ Structural repair ☐ Base flow channel creation ☐ Natural channel design ☐ Can't tell ☐ no ☐ De-channelization ☐ Fish barrier removal ☐ Bioengineering

CHANNEL-IZATION SEVERITY: (*Circle #*)	A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel.	A moderate length (> 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel.	An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area.
	5 4	3	2 1

NOTES:

WATERSHED/SUBSHED:			**DATE:** ___/_____/___		**ASSESSED BY:**
SURVEY REACH ID:		**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#		
SITE ID: (*Condition-#*) **TR-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK** _____				**GPS:** (*Unit ID*)
TYPE: ☐ Industrial ☐ Commercial ☐ Residential	**MATERIAL:** ☐ Plastic ☐ Paper ☐ Metal ☐ Tires ☐ Construction ☐ Medical ☐ Appliances ☐ Yard Waste ☐ Automotive ☐ Other:		**SOURCE:** ☐ Unknown ☐ Flooding ☐ Illegal dump ☐ Local outfall	**LOCATION:** ☐ Stream ☐ Riparian Area ☐ Lt bank ☐ Rt bank	**LAND OWNERSHIP:** ☐ Public ☐ Unknown ☐ Private **AMOUNT** (*# Pickup truck loads*):

POTENTIAL RESTORATION CANDIDATE ☐ Stream cleanup ☐ Stream adoption segment ☐ Removal/prevention of dumping
☐ no ☐ Other:

If yes for trash or debris removal	**EQUIPMENT NEEDED :** ☐ Heavy equipment ☐ Trash bags ☐ Unknown	**DUMPSTER WITHIN 100 FT:** ☐ Yes ☐ No ☐ Unknown
	WHO CAN DO IT: ☐ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other	

CLEAN-UP POTENTIAL: (*Circle #*)	A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access	A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe.	A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials
	5 4	3	2 1

NOTES:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **UT-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

TYPE:	**MATERIAL:**	**LOCATION:**	**POTENTIAL FISH BARRIER:**	**PIPE DIMENSIONS:**
☐ Leaking sewer ☐ Exposed pipe ☐ Exposed manhole ☐ Other:	☐ Concrete ☐ Corrugated metal ☐ Smooth metal ☐ PVC ☐ Other:	☐ Floodplain ☐ Stream bank ☐ Above stream ☐ Stream bottom ☐ Other:	☐ Yes ☐ No	Diameter: _____in Length exposed: _____ft
			CONDITION: ☐ Joint failure ☐ Protective covering broken ☐ Other:	☐ Pipe corrosion/cracking ☐ Manhole cover absent

EVIDENCE OF DISCHARGE:		
	COLOR	☐ None ☐ Clear ☐ Dark Brown ☐ Lt Brown ☐ Yellowish ☐ Greenish ☐ Other:
	ODOR	☐ None ☐ Sewage ☐ Oily ☐ Sulfide ☐ Chlorine ☐ Other:
	DEPOSITS	☐ None ☐ Tampons/Toilet Paper ☐ Lime ☐ Surface oils ☐ Stains ☐ Other:

POTENTIAL RESTORATION CANDIDATE ☐ Structural repairs ☐ Pipe testing ☐ Citizen hotlines ☐ Dry weather sampling

☐ no ☐ Fish barrier removal ☐ Other:

If yes to fish barrier, Water Drop: ________ (in)

UTILITY IMPACT SEVERITY: (*Circle #*)			
Leaking= ☐ 5	Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure.	A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event.	Small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel.
	5 4	3	2 1

NOTES:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

SURVEY REACH ID: ______	**WTRSHD/SUBSHD:**	**DATE:** ___/_____/___	**ASSESSED BY:**
START **TIME:**____:____AM/PM **LMK:** ______ **LAT**____°______'______" **LONG** ____°______'______" **DESCRIPTION:**	*END* **TIME:**____:____AM/PM **LMK:** ______ **LAT**____°______'______" **LONG** ____°______'______" **DESCRIPTION:**		**GPS ID:**

RAIN IN LAST 24 HOURS ☐ Heavy rain ☐ Steady rain ☐ None ☐ Intermittent ☐ Trace

PRESENT CONDITIONS ☐ Heavy rain ☐ Steady rain ☐ Intermittent ☐ Clear ☐ Trace ☐ Overcast ☐ Partly cloudy

SURROUNDING LAND USE: ☐ Industrial ☐ Commercial ☐ Urban/Residential ☐ Suburban/Res ☐ Forested ☐ Institutional ☐ Golf course ☐ Park ☐ Crop ☐ Pasture ☐ Other:

AVERAGE CONDITIONS *(check applicable)*

BASE FLOW AS % CHANNEL WIDTH	☐ 0-25% ☐ 50%-75% ☐25-50 % ☐ 75-100%
DOMINANT SUBSTRATE	☐ Silt/clay (fine or slick) ☐ Cobble (2.5 –10") ☐ Sand (gritty) ☐ Boulder (>10") ☐ Gravel (0.1-2.5") ☐ Bed rock
WATER CLARITY	☐ Clear ☐Turbid *(suspended matter)* ☐ Stained *(clear, naturally colored)* ☐ Opaque *(milky)* ☐ Other *(chemicals, dyes)*
AQUATIC PLANTS IN STREAM	Attached: ☐ none ☐ some ☐ lots Floating: ☐ none ☐ some ☐ lots
WILDLIFE IN OR AROUND STREAM	(Evidence of) ☐ Fish ☐ Beaver ☐ Deer ☐ Snails ☐ Other:
STREAM SHADING (water surface)	☐ Mostly shaded (≥75% coverage) ☐ Halfway (≥50%) ☐ Partially shaded (≥25%) ☐ Unshaded (< 25%)
CHANNEL DYNAMICS ☐ Unknown	☐ Downcutting ☐ Widening ☐ Headcutting ☐ Aggrading ☐ Sed. deposition ☐ Bed scour ☐ Bank failure ☐ Bank scour ☐ Slope failure ☐ Channelized
CHANNEL DIMENSIONS *(FACING DOWNSTREAM)*	Height: LT bank ____________(ft) RT bank ____________(ft) Width: Bottom ____________(ft) Top ____________(ft)

REACH ACCESSIBILITY

Good: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	**Difficult.** Must cross wetland, steep slope, or sensitive areas to get to stream. Few areas to stockpile available and/or located a great distance from stream. Specialized heavy equipment required.
5 4	3	2 1

REACH SKETCH AND SITE IMPACT TRACKING

Simple planar sketch of survey reach. Track locations and IDs for all site impacts within the survey reach (OT, ER, IB,SC, UT, TR, MI) as well as any additional features deemed appropriate. Indicate direction of flow

NOTES: *(biggest problem you see in survey reach)*

REPORTED TO AUTHORITIES ☐ YES ☐ NO

OVERALL STREAM CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
IN-STREAM HABITAT *(May modify criteria based on appropriate habitat regime)*	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
VEGETATIVE PROTECTION *(score each bank, determine sides by facing downstream)*	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
BANK EROSION (facing downstream)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.	Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
FLOODPLAIN CONNECTION	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
OVERALL BUFFER AND FLOODPLAIN CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
VEGETATED BUFFER WIDTH	Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone.	Width of buffer zone 25-50 feet; human activities have impacted zone only minimally.	Width of buffer zone 10-25 feet; human activities have impacted zone a great deal.	Width of buffer zone <10 feet: little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
FLOODPLAIN VEGETATION	Predominant floodplain vegetation type is mature forest	Predominant floodplain vegetation type is young forest	Predominant floodplain vegetation type is shrub or old field	Predominant floodplain vegetation type is turf or crop land
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN HABITAT	Even mix of wetland and non-wetland habitats, evidence of standing/ponded water	Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water	Either all wetland or all non-wetland habitat, evidence of standing/ponded water	Either all wetland or all non-wetland habitat, no evidence of standing/ponded water
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN ENCROACH-MENT	No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures	Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function	Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function	Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Sub Total In-stream: _____ **/80** + Buffer/Floodplain: _____ **/80** = **Total** Survey Reach _____ **/160**

Photo Inventory

(By Camera)

Project: ______________

Group: _______________

Camera: _____________

This field sheet is to be completed AS photos are taken in the field. The intent is to organize pictures taken on each camera. Fill out one sheet per camera (add sheets as needed). Only fill in Date/Reach/Location ID when you start in a new spatial or temporal location.

Date	Stream/ Reach	Location ID	Photo #	Description

Date	Stream/ Reach	Location ID	Photo #	Description

Comments:

(BACK)

CHANNEL ALTERATION CA

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Type: Concrete, Gabion, Rip-rap, Earth Channel, Other: ______________

Bottom Width: ______________ in **Length:** ______________ ft.

Does channel have perennial flow? Yes No

Is sediment deposition occurring in the channel? Yes No

Is vegetation growing in the channel? Yes No

Is it part of a road crossing? No Above Below Both

Channelized length above road crossing ______________ ft.

Channelized length below road crossing ______________ ft.

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

CHANNEL ALTERATION CA

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Type: Concrete, Gabion, Rip-rap, Earth Channel, Other: ______________

Bottom Width: ______________ in **Length:** ______________ ft.

Does channel have perennial flow? Yes No

Is sediment deposition occurring in the channel? Yes No

Is vegetation growing in the channel? Yes No

Is it part of a road crossing? No Above Below Both

Channelized length above road crossing ______________ ft.

Channelized length below road crossing ______________ ft.

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

EROSION SITE ES

Map: ______________ Team: ______ Site: ________

Date: ___/___/___ Photo: ______ Survey: ______
MM DD YY

Type: Downcutting Widening Headcutting Unknown

Cause: Bend at steep slope, Pipe Outfall, Below Channelization, Below Road Crossing, Livestock, Land Use Change Upstream, Other: ______________________

Length: ____________________ ft. **Average exposed bank height:** ____________________ ft.

Present Land Use Left Side (looking downstream): Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ______________________

Present Land Use Right Side (looking downstream): Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ______________________

Threat to Infrastructure?: Yes No **Describe:** ______________________________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

EROSION SITE ES

Map: ______________ Team: ______ Site: ________

Date: ___/___/___ Photo: ______ Survey: ______
MM DD YY

Type: Downcutting Widening Headcutting Unknown

Cause: Bend at steep slope, Pipe Outfall, Below Channelization, Below Road Crossing, Livestock, Land Use Change Upstream, Other: ______________________

Length: ____________________ ft. **Average exposed bank height:** ____________________ ft.

Present Land Use Left Side (looking downstream): Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ______________________

Present Land Use Right Side (looking downstream): Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ______________________

Threat to Infrastructure?: Yes No **Describe:** ______________________________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

EXPOSED PIPE **EP**

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Pipe is: Exposed across bottom of stream, Exposed along stream bank, Exposed manhole, Above stream, Other: ______________________________

Type of Pipe: Concrete, Smooth Metal, Corrugated Metal, Plastic, Terra Cotta, Other: ____________________

Pipe Diameter: _____________ in. **Length exposed:** ______________ ft.

Purpose of Pipe: Sewage, Water Supply, Stormwater, Unknown, Other: ________________________

Evidence of Discharge?: Yes No

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: _______________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: _______________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

EXPOSED PIPE **EP**

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Pipe is: Exposed across bottom of stream, Exposed along stream bank, Exposed manhole, Above stream, Other: ______________________________

Type of Pipe: Concrete, Smooth Metal, Corrugated Metal, Plastic, Terra Cotta, Other: ____________________

Pipe Diameter: _____________ in. **Length exposed:** ______________ ft.

Purpose of Pipe: Sewage, Water Supply, Stormwater, Unknown, Other: ________________________

Evidence of Discharge?: Yes No

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: _______________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: _______________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

PIPE OUTFALL PO

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Type of Outfall: Stormwater, Sewage Overflow, Industrial, Pumping Station, Agricultural, Other: ________________________

Type of Pipe: Earth Channel, Concrete Channel, Concrete Pipe, Smooth Metal Pipe, Corrugated Metal, Plastic, Other: ________________________

Location (facing downstream): left bank, right bank, head of stream, Other ________________

Pipe Diameter: ____________ in. **Channel width:** ____________ ft.

Evidence of Discharge?: Yes No

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: ____________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: ____________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

PIPE OUTFALL PO

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Type of Outfall: Stormwater, Sewage Overflow, Industrial, Pumping Station, Agricultural, Other: ________________________

Type of Pipe: Earth Channel, Concrete Channel, Concrete Pipe, Smooth Metal Pipe, Corrugated Metal, Plastic, Other: ________________________

Location (facing downstream): left bank, right bank, head of stream, Other ________________

Pipe Diameter: ____________ in. **Channel width:** ____________ ft.

Evidence of Discharge?: Yes No

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: ____________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: ____________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

FISH BARRIER FB

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Fish Blockage: Total, Partial, Temporary, Unknown

Type of Barrier: Dam, Road Crossing, Pipe Crossing, Natural Falls, Beaver Dam, Channelized, Instream Pond, Debris Dam, Other: ________________________

Blockage because: Too high Too shallow Too fast

Water drop: _________________ inches (if too high)

Water depth: _________________ inches (if too shallow)

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

FISH BARRIER FB

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Fish Blockage: Total, Partial, Temporary, Unknown

Type of Barrier: Dam, Road Crossing, Pipe Crossing, Natural Falls, Beaver Dam, Channelized, Instream Pond, Debris Dam, Other: ________________________

Blockage because: Too high Too shallow Too fast

Water drop: _________________ inches (if too high)

Water depth: _________________ inches (if too shallow)

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

INADEQUATE BUFFER IB

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Buffer inadequate on: Left Right Both (looking downstream)

Is stream unshaded? Left Right Both (looking downstream) Neither

Buffer width left: _______ ft. Buffer width right: _______ ft.

Length left: ___________ ft. Length right: ___________ ft.

Present land use left side: Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ____________________

Present land use right side: Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ____________________

Has a buffer recently been established: Yes No

Are Livestock present: Yes No Type: Cattle, Horses, Pigs, Other: ____________________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)
Wetland Potential	Best	1	2	3	4	5	Worst	Unknown (-1)

(Good wetland potential = low slope, low bank height)

INADEQUATE BUFFER IB

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Buffer inadequate on: Left Right Both (looking downstream)

Is stream unshaded? Left Right Both (looking downstream) Neither

Buffer width left: _______ ft. Buffer width right: _______ ft.

Length left: ___________ ft. Length right: ___________ ft.

Present land use left side: Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ____________________

Present land use right side: Crop field, Pasture, Lawn, Paved, Shrubs & Small Trees, Forest, Multiflora Rose, Other ____________________

Has a buffer recently been established: Yes No

Are Livestock present: Yes No Type: Cattle, Horses, Pigs, Other: ____________________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)
Wetland Potential	Best	1	2	3	4	5	Worst	Unknown (-1)

(Good wetland potential = low slope, low bank height)

IN OR NEAR STREAM CONSTRUCTION IC

Map: ______________ Team: ______ Site: ________

Date: ___/___/___ Photo: ______ Survey: ______
MM DD YY

Type of activity: Road, Road Crossing, Utility, Logging, Bank Stabilization, Residential Development, Industrial Development, Other: ____________________

Sediment Control: Adequate Inadequate Unknown

If inadequate, why? ____

Is stream bottom below site laden with excess sediment? Yes No

Length of stream affected: ______________________ ft.

Company doing construction: _________________________________

Location: ____

Severity Severe 1 2 3 4 5 Minor Unknown (-1)

Contact office as soon as possible: ( )

IN OR NEAR STREAM CONSTRUCTION IC

Map: ______________ Team: ______ Site: ________

Date: ___/___/___ Photo: ______ Survey: ______
MM DD YY

Type of activity: Road, Road Crossing, Utility, Logging, Bank Stabilization, Residential Development, Industrial Development, Other: ____________________

Sediment Control: Adequate Inadequate Unknown

If inadequate, why? ____

Is stream bottom below site laden with excess sediment? Yes No

Length of stream affected: ______________________ ft.

Company doing construction: _________________________________

Location: ____

Severity Severe 1 2 3 4 5 Minor Unknown (-1)

Contact office as soon as possible: ( )

TRASH DUMPING TD

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Type of trash: Residential, Industrial, Yard Waste, Flotables, Tires, Construction,
Other: ____________________________

Amount of trash: ______________________ pick-up truck loads

Other measure: ______________________

Is trash confined to? Single site, Large Area

Possible cleanup site for volunteers? Yes No

Land Ownership: Public Private Unknown

If public, name: ________________________________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

TRASH DUMPING TD

Map: ______________ Team: ______ Site: ________

Date: ____/____/____ Photo: ______ Survey: ______
MM DD YY

Type of trash: Residential, Industrial, Yard Waste, Flotables, Tires, Construction,
Other: ____________________________

Amount of trash: ______________________ pick-up truck loads

Other measure: ______________________

Is trash confined to? Single site, Large Area

Possible cleanup site for volunteers? Yes No

Land Ownership: Public Private Unknown

If public, name: ________________________________

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

UNUSUAL CONDITION OR COMMENT UC

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: _______
MM DD YY

Type: (circle one) **Unusual Condition** **Comment**

Describe: Odor, Scum, Excessive Algae, Water Color/Clarity, Red Flock, Sewage Discharge, Oil

____

____

____

Potential Cause: ____

____

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

UNUSUAL CONDITION OR COMMENT UC

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: _______
MM DD YY

Type: (circle one) **Unusual Condition** **Comment**

Describe: Odor, Scum, Excessive Algae, Water Color/Clarity, Red Flock, Sewage Discharge, Oil

____

____

____

Potential Cause: ____

____

Severity	Severe	1	2	3	4	5	Minor	Unknown (-1)
Correctability	Best	1	2	3	4	5	Worst	Unknown (-1)
Access	Best	1	2	3	4	5	Worst	Unknown (-1)

REPRESENTATIVE SITE

RE

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: ______

MM DD YY

	Optimal	Suboptimal	Marginal	Poor
Macroinvertebrate Substrata				
Embeddedness				
Shelter for fish				
Channel Alteration				
Sediment Deposition				
Velocity and Depth				
Channel Flow				
Bank Vegetation				
Bank Condition				
Riparian Vegetation				

Wetted width: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Thalweg depth: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Bottom type: Silts, Sands, Gravel, Cobble, Boulder, Bedrock

REPRESENTATIVE SITE

RE

Map: ______________ Team: ______ Site: _________

Date: ____/____/____ Photo: ______ Survey: ______

MM DD YY

	Optimal	Suboptimal	Marginal	Poor
Macroinvertebrate Substrata				
Embeddedness				
Shelter for fish				
Channel Alteration				
Sediment Deposition				
Velocity and Depth				
Channel Flow				
Bank Vegetation				
Bank Condition				
Riparian Vegetation				

Wetted width: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Thalweg depth: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Bottom type: Silts, Sands, Gravel, Cobble, Boulder, Bedrock

HABITAT ASSESSMENT
Rocky Bottom Streams

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Attachment Sites for Macroinvertebrates (see page 67)	Well-developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; cobble predominates; boulders and gravel common.	Riffle is as wide as stream but length is less than two times width; cobble less abundant; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
2. Embeddedness (see page 67)	Fine sediment surrounds and fills in 0-25% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 25-50% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 50-75% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in more than 75% of the living spaces around and in between the gravel, cobble, and boulders.
3. Shelter for Fish (see page 67)	Snags, submerged logs, undercut banks, or other stable habitat are found in over 50% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in over 30-50% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in over 10-30% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in less than 10% of the site.
4. Channel Alteration (see page 67)	Stream straightening, dredging, artificial embankments, dams or bridge abutments absent or minimal; stream with meandering pattern.	Some stream straightening, dredging, artificial embankments or dams present, usually in area of bridge abutments; no evidence of recent channel alteration activity.	Artificial embankments present to some extent on both banks; and 40 to 80% of stream site straightened, dredged, or otherwise altered.	Banks shored with gabion or cement; over 80% of the stream site straightened and disrupted.
5. Sediment Deposition (see page 67)	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at stream obstructions and bends; moderate deposition in pools.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom affected; pools almost absent due to substantial sediment deposition.
6. Stream velocity and depth combinations (see page 67)	Slow (< 1 ft/sec)/shallow (< 1 ft); slow/deep, fast/deep; fast/shallow; all four combinations present	3 of the 4 velocity/depth combinations present; fast current areas generally predominate.	Only 2 of the 4 velocity/depth combinations are present. Score lower if last current areas are missing.	Dominated by 1 velocity/depth category (usually slow/shallow areas)
7. Channel Flow Status (see page 68)	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; <25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
8. Bank Vegetative Protection (see page 68)	More than 90% of the streambank surfaces covered by natural vegetation, including trees, shrubs, or other plants, vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by natural vegetation, but one class of plants is not well-represented; some vegetative disruption evident; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; patches of bare soil or closely cropped vegetation common; less than one half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation, disruption of streambank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
9. Condition of Banks (see page 68)	Banks stable, no evidence of erosion or bank failure; little potential for future problems.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in site have areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank collapse or failure; 60-100% of bank has erosional scars.
10. Riparian Vegetative Zone Width (see page 68)	Width of riparian zone >50 feet; no evidence of human activities (i.e., parking lots, roadbeds, clear-cuts, mowed areas, or crops) within the riparian zone.	Width of riparian zone 35-40 feet.	Width of riparian zone 20-35 feet.	Width of riparian zone <20 feet.

Use the habitat characteristic (parameter) definitions and guidance that follows when completing the habitat assessment field data form. Rocky-bottom streams (Piedmont Streams) are generally fast moving streams with beds that are made up to gravel/cobbles/boulders in any combination and that have definite riffle areas.

1. ***Attachment Sites for Macroinvertebrates*** are essentially the amount of living space or hard substrates (rocks, snags) available for aquatic insects and snails. Many insects begin their life underwater in streams and need to attach themselves to rocks, logs, branches, or other submerged substrates. The greater the variety and number of available living spaces or attachment sites, the greater the variety of insects in the stream. Optimally, there should be a predominance of cobble, and boulders and gravel should be common. The availability of suitable living spaces for macroinvertebrates decreases as cobble becomes less abundant and boulders, gravel, or bedrock become more prevalent.

2. ***Embeddedness*** refers to the extent to which rocks (gravel, cobble, and boulders) are surrounded by, covered, or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the living spaces available to macroinvertebrates and fish for shelter, spawning, and egg incubation are decreased.

   To estimate the percent of embeddedness, observe the amount of silt or finer sediments overlying and surrounding the rocks. If kicking does not dislodge the rocks or cobbles, they may be greatly embedded. It may be useful to lift a few rocks and observe how much of the rock (e.g., 1/2, 1/3) is darker due to algal growth.

3. ***Shelter for Fish*** includes the relative quantity and variety of natural structures in the stream, such as fallen trees, logs, and branches, large rocks, and undercut banks that are available to fish for hiding, sleeping, or laying eggs. A wide variety of submerged structures in the stream provide fish with many living spaces; the more living spaces in a stream, the more types of fish the stream can support.

4. ***Channel Alteration*** is basically a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened (e.g. dredged), or diverted into concrete channels, often for flood control purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when the stream runs through a concrete channel; when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams, bridges, and flow altering structures such as combined sewer overflow pipes are present; when the stream is of uniform depth due to dredging, and when other such changes have occurred.

   Signs that indicate the occurrence of dredging include straightened, deepened, and otherwise uniform stream channels, and the removal of streamside vegetation to provide access to the stream for dredging equipment.

5. ***Sediment Deposition*** is a measure of the amount of sediment that has been deposited in the stream channel and the changes to the stream bottom that have occurred as a result of the deposition. High levels of sediment deposition create an unstable and continually changing environment that is unsuitable for many aquatic organisms.

   Sediments are naturally deposited in areas where the stream flow is reduced, such as pools and bends, or where flow is obstructed. These deposits can lead to the formation of islands, shoals, or point bars (sediments that build up in the stream, usually at the beginning of a meander) or can result in the complete filling of pools. To determine whether or not these sediment deposits are new, look for vegetation growing on them; new sediments will not yet have been colonized by vegetation.

6. ***Stream Velocity and Depth Combinations*** are important to the maintenance of aquatic communities. Restrictions to normal velocity and/or the filling of pools will affect the organisms living in the stream by reducing the dissolved oxygen that is available and by slowing down the movement of food items. Streams function best when the movement of water continually replenishes the supply of oxygen and food, and does not become stagnant.

Slow velocity is generally described as water moving **less than (<) 1 foot/second**

Fast velocity is generally described as water moving **greater than (>) 1 foot/second**

Shallow water is generally described as **less than (<) 1.5 feet**

Deep water is generally described as **greater than (>) 1.5 feet**

Four general categories of velocity and depth are optimal for benthic macroinvertebrate and fish communities. The best streams will have all four velocity/depth combinations and can maintain a wide variety of aquatic life:

(1) slow, shallow
(2) slow, deep
(3) fast, deep
(4) fast, shallow

Depth can be estimated by standing in the stream at various points. If the water level comes to below the bottom of your knee cap, it can be considered shallow. If it reaches above the bottom of your knee cap, consider it deep. Also, you can use the measuring rope to measure the length of your leg to the knee cap to judge depth.

To estimate velocity, use the measuring rope to mark off 10-foot areas of stream in the same general areas where you measured depth. Drop a twig in the stream and count the number of seconds it takes for the stick to travel the 10 feet. Generally it is best to do this in run and pool areas since velocity is difficult to measure in riffles as the twig may get caught up by rocks. Divide 10 by the number of seconds to determine velocity in "feet per second." For example:

If the twig took 6 seconds to travel the 10 foot distance, then divide 6 seconds into 10 feet, which is equal to 1.4 ft/sec. In this case, the velocity would be considered fast, as it is greater than 1 ft/sec.

Since water in riffle areas tends to have the greatest velocity, you can assume that riffle velocity is faster than velocity in either the run or pool areas you measure.

7. *Channel Flow Status* is the percent of the existing channel that is filled with water. The flow status will change as the channel enlarges or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of living area for aquatic organisms is limited.

8. *Bank Vegetative Protection* measures the amount of the stream bank that is covered by natural (i.e. growing wild and not obviously planted) vegetation. The root systems of plants growing on stream banks help hold soil in place, reducing erosion. Vegetation on banks provides shade for fish and macroinvertebrates, and serves as a food source by dropping leaves and other organic matter into the stream. Ideally, a variety of vegetation should be present, including trees, shrubs, and grasses. Vegetative disruption may occur when the grasses and plants on the stream banks are mowed or grazed upon, or the trees and shrubs are cut back or cleared.

9. *Condition of Banks* measures erosion potential and whether the stream banks are eroded. Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered to have a high erosion potential. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Bank failure and the subsequent collapse of portions of the stream bank is referred to as bank sloughing.

10. *The Riparian Vegetative Zone Width* is defined here as the width of natural vegetation from the edge of the stream bank. The riparian vegetative zone is a buffer zone to pollutants entering a stream from runoff; it also controls erosion and provides stream habitat and nutrient input into the stream. A wide, relatively undisturbed riparian vegetative zone reflects a healthy stream system; narrow, far less useful riparian zones occur when roads, parking lots, fields, lawns and other artificially cultivated areas, bare soil, rocks, or buildings are near the stream bank. The presence of "old fields" (i.e., previously developed agricultural fields allowed to convert to natural conditions) should rate higher than fields in continuous or periodic use. In arid areas, the riparian vegetative zone can be measured by observing the width of the area dominated by riparian or water-loving plants, such as willows, marsh grasses, and cottonwood trees.

Project Investigation Field Sheets

This tool contains a variety of field sheets designed to aid watershed planning by collecting more information on the feasibility of potential restoration sites and developing a workable concept design to narrow down project choices to a manageable level. The following field sheets are available here, and more information and guidance for completing each of the field forms are available in the references below:

Retrofit Reconnaissance Inventory (see CWP, 2006, in press)
Stream Repair Investigation (see Schueler and Brown, 2004)
Urban Reforestation Site Assessment (see Cappiella *et al.*, 2005)
Discharge Prevention Investigations (see Brown *et al.*, 2004)
Contiguous Forest Assessment (see CWP, 2002a)
Rare, Threatened, and Endangered Species Assessment (see CWP, 2002a)

Also included are links to Additional Sensitive Area Assessments

1. **Subwatershed:**________________ **Site Number:**____________ **Site Name:** ______________________

2. **Location (Coordinates): (Latitude:_____________Longitude:______________)**

   Location (Coordinates) _______________

From County ADC/Locator Map
Indicated by coordinates and quadrants on the map pages (e.g., H3 NW)

   Street Name ____

   Subdivision or Business Name ____

   Notes:

____

____

3. **Describe existing site conditions, including drainage structures/patterns**
   - ☐ Existing Facility **Type**____
   - ☐ Unmanaged Existing Development
   - ☐ Site Identified during stream assessment (e.g., USA, RSAT, RBP)

____

____

____

____

____

____

____

____

4. **Property Ownership (public or private):** __________________

5. **Date of Preliminary Survey:** __________________

6. **Surveyors:** __________________

7. **Photo Roll and Picture #: Roll # :**_______ **Photo #:** _______

8. **Drainage Area:** ________________

9. **Describe drainage area land use:**

10. **Approximate Imperviousness (%):** ________________

11. **Retrofit Volume Computations (i.e., target and available storage):**

☐ WQ_v ☐ Cp_v ☐ Q_p

12. **Describe elements of potential retrofit:**

☐ On-line retrofit ☐ Off-line retrofit

13. Adjacent Land Use (possible conflicts):

____

____

14. Conflicts with Existing Utilities:

____

____

____

15. Construction and Maintenance Access:

____

____

____

16. Wetlands Present? ☐ **Yes** ☐ **No** ☐ **Maybe**

If yes, describe:

____

____

____

____

17. Forested Area or Other Sensitive Areas Present? ☐ **Yes** ☐ **No**

If yes, describe:

____

____

18. Other factors that may increase cost or affect feasibility:

19. Additional Notes and/or Sketch Information:
(Include key existing features and proposed design)

20. Site Candidate for Further Investigation: ☐ **Yes** ☐ **No**

Feasibility	**High**	**5**	**4**	**3**	**2**	**1**	**Low**
Benefits	**High**	**5**	**4**	**3**	**2**	**1**	**Low**

Stream Repair Investigation Form

PROJECT:	DATE: ____/____/____	ASSESSED BY:
SUBWATERSHED:	PHOTO ID (Camera-Pic#): /#	

USA RCH ID:	START LAT ____°____'____" LONG ____°____'____" LMK _____	CONCEPT NO:
	END LAT ____°____'____" LONG ____°____'____" LMK _____	

INDEX OF USA FORMS

OT:	TR:
ER:	SC:
IB:	CM:
UT:	RCH:

AVERAGE REACH DIMENSIONS (from RCH)

BANK OF CONCERN ☐ LT ☐ RT ☐ Both

Length	LT_______ft	RT________ft	Avg bankfull height	______ft
Avg Bank Ht	LT______ft	RT________ft	Avg bottom width	_______ft
Avg Bank Angle	LT______°	RT______°	Avg top width	_______ft
			Avg wetted width	_______ft

Land ownership ☐ Public ☐ Private ☐ Don't Know ☐ Other:

Available riparian corridor ☐ ≤25 ft ☐ 26 - 50 ft ☐ 51-75ft ☐ 76-100ft ☐ >100ft

CORRIDOR VEGETATION ☐ Mature wooded ☐ Scrub/shrub ☐ Grass or turf ☐ Other:

Degradation severity	**Adjusted channel**: Grade and width fairly stable, with relatively isolated of bank erosion; and poor instream habitat conditions.	**Past downcutting** evident, active stream widening, banks actively eroding at a moderate rate.	**Active Downcutting:** Tall unstable banks on both sides of the stream eroding at a fast rate; erosion contributing significant sediment loads to stream.
	5 4	3	2 1
Upstream/Downstream condition	Upstream and downstream reaches assessed as good or fair.	Either upstream or downstream reach assessed as poor with other assessed as fair/good.	Both upstream and downstream reaches assessed as poor.
	5 4	3	2 1
Construction access to stream	**Good:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	**Difficult:** Must cross wetland, steep slope, or other sensitive areas to access stream, Minimal stockpile areas and/or located a great distance from stream section. Specialized heavy equipment required
	5 4	3	2 1
Infrastructure constraints	Sewers or other infrastructure are **not** present in the project reach corridor	Sewers, other utilities or structures are present in the project reach corridor any may constrain project design	Presence of sewers and other infrastructure will greatly impact project design and may require expensive relocation.
	5 4	3	2 1
Restoration Outcome Potential	Repair expected to restore stable, vegetated streambanks using mostly soft stabilization practices, reconnect floodplain, and significantly improve habitat	Repair expected to restore streambank stability with a mix of rigid and soft streambank stabilization practices, and moderately improve stream habitat conditions	Restoration will structurally maintain stable streambanks using predominately hard streambank protection practices, maintain existing sediment transport regime, little habitat improvement
	5 4	3	2 1
Upstream land use	Older (30-40+ yrs), well-established neighborhoods or commercial areas. Little or no new development expected	A mix of older (30-40+ yrs) development and newer (<10-20 yrs) development. Some new development or redevelopment possible	Most of subwatershed has developed in last ten years, and significant future development is possible
	5 4	3	2 1
Upstream retrofit potential	Upstream retrofits expected to significantly reduce stormwater flows to project reach	Upstream stormwater retrofits expected to produce only marginal reductions in stormwater flows and pollutant loads	No upstream retrofit opportunities exist, existing hydrology will not be improved
	5 4	3	2 1
Scope of planned stream repair	**Comprehensive:** major change in planform, grade, or cross-section of channel, many practices	**Moderate**: Combination of individual stream repair practices, but only minor changes in channel dimensions	**Simple**: use of a few stream repair practices to address a problem at a defined point
	5 4	3	2 1

<table>
<tr><td>Concept Sketch: Plan View of stream with approximate locations of stream repair practices</td><td>PROPOSED STREAM REPAIR PRACTICES

☐ A. Rigid Bank stabilization
_______________linear feet
☐ B. Soft bank stabilization
_______________ linear feet
☐ C. Flow deflection
_____________# of structures
☐ D. Grade control
_____________# of structures
☐ E. Habitat structures
_____________# of structures
☐ F. Flow diversion
_____________# of structures
☐ G. Fish passage
_____________# of structures
☐ H. Comprehensive
_______________ linear feet
☐ I. Other:</td></tr>
<tr><td>Comments on Project Design (include any special supplemental design studies or permits needed)</td><td>Planning Level Cost Estimate</td></tr>
</table>

Urban Reforestation Site Assessment (URSA)

1. General Site Information

Location:

Property owner:

Current landuse:

2. Climate

USDA plant hardiness zone:

Sunlight exposure:

☐ Full sun (6 hours or more of direct sun per day)
☐ Part sun or filtered light (< 6 hours per day)
☐ Shade (< 3 hours of direct sun per day)

Micro-climate features (check if present):

☐ High wind exposure
☐ Re-reflected heat load
☐ Other:

3. Topography

Steep slopes

Are any slopes > 15% present in the proposed planting area? Y/N

If Yes, estimate slope:

Low-lying areas

Are any low-lying areas present in the proposed planting area? Y/N

Notes:

4. Vegetation

Regional forest association (or dominant species from reference site):

Current vegetative cover (check all that apply):

☐ Mowed turf
☐ Other herbaceous
☐ None
☐ Trees or shrubs

Note species to be preserved:

Are invasive plants/noxious weeds present? Y/N

If Yes, note species and % coverage at site

Adjacent vegetative cover:

Is forest present? Y/N

If Yes, note dominant species:

Are invasive plants/noxious weeds present? Y/N

If Yes, note species and % coverage at site

5. Soils

Texture:

- ☐ Clay
- ☐ Loam
- ☐ Sand

Drainage:

- ☐ Poor (< 1" per hour)
- ☐ Moderate (1" - 6" per hour)
- ☐ Excessive (> 6" per hour)

Compaction:

- ☐ None
- ☐ Moderate
- ☐ Severe

pH:

- ☐ Acid (5.0 – 6.8)
- ☐ Neutral (6.8 – 7.2)
- ☐ Alkaline (7.2 – 8.0)

Other soil features (check if present and describe:

- ☐ Active or severe soil erosion
- ☐ Potential soil contamination
- ☐ Debris and rubble in soil
- ☐ Recent construction or other soil disturbance
- ☐ Other:

Soil Quality

List results of soil tests if applicable (e.g., levels of phosphorus, salt, or organic matter in the soil). Describe any visual indicators of soil quality.

6. Hydrology

Site hydrology:

- ☐ Upland
- ☐ Riparian

  Note: For riparian planting sites where planting is proposed on both stream banks, fill this section out for each bank individually

Stormwater runoff to planting site (check all that apply):

- ☐ Bypasses site in pipe
- ☐ Upslope drainage area outfalls to site

  Note diameter of pipe outfall:
- ☐ Open channel directs flow across or around the site
- ☐ Shallow concentrated flow (e.g., evidence includes rills, gullies, sediment deposits)
- ☐ Sheetflow
- ☐ Unknown

Contributing flow length:

Slope: _____%

Length: _____ft

Dominant cover type:

- ☐ Impervious
- ☐ Pervious

Floodplain connection (riparian areas only):

Are levees present? Y/N

Bank height: _____ft

Depth to water table (optional): _____ft

Stream order: _____

Notes or Sketch:

7. Potential Planting Conflicts

Space limitations (check if present, and note height of overhead wires, signs and lighting):

- ☐ Overhead wires: _____ft
- ☐ Pavement
- ☐ Buildings
- ☐ Signs: _____ft
- ☐ Lighting: _____ft
- ☐ Sewer and drainage pipes
- ☐ Underground utilities
- ☐ Other:

Other limiting factors (check if present and describe below):

- ☐ Trash dumping/debris
  Note type of trash, volume (estimated pickup truck loads), and source if known:
- ☐ Deer, beaver or other animal impacts
- ☐ Mowing conflict (e.g., site is mowed regularly)
- ☐ Wetland present
- ☐ Insect infestation or disease
- ☐ Heavy pedestrian traffic
- ☐ Other:

Notes:

Local Ordinance Setbacks

Check local ordinances and note any required setbacks from these features.

8. Planting and Maintenance Logistics

Site access (check if present):

- ☐ Delivery access for planting materials
- ☐ Temporary storage areas for soils, mulch, etc.
- ☐ Heavy equipment access
- ☐ Volunteer parking
- ☐ Nearby facilities for volunteers

Party responsible for maintenance (if known):

Water source (check all that apply):

- ☐ Rainfall only
- ☐ Storm water runoff
- ☐ Hose hook-up nearby
  Note distance from hook-up to planting area (ft):
- ☐ Irrigation system in place
- ☐ Overbank flow from river or stream
- ☐ Fire hydrant nearby
- ☐ Other:

9. Site Sketch

Sketch the site below and include the following features at a minimum:

- ☐ Property boundary, landmark features (e.g., roads, streams) and adjacent land use/cover
- ☐ Boundary and approximate dimensions of proposed planting area
- ☐ Variations in sun exposure, microclimate and topography within planting area
- ☐ Current vegetative cover, and location of trees to be preserved and invasive species
- ☐ Location and results of soils samples (if variable)
- ☐ Flow paths to planting area and contributing flow length
- ☐ Above or below ground space limitations (e.g., utilities, buildings)
- ☐ Other limiting factors (e.g., trash dumping, pedestrian paths)
- ☐ Water source and access points
- ☐ Scale and north arrow

OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours: Last 48 hours:		
Latitude:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	

Land Use in Drainage Area (Check all that apply):

- ☐ Industrial
- ☐ Ultra-Urban Residential
- ☐ Suburban Residential
- ☐ Commercial
- ☐ Open Space
- ☐ Institutional
- Other: ____________________
- Known Industries: ____________________

Notes (e.g., origin of outfall, if known):

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ **Closed Pipe**	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: __________	☐ Circular ☐ Eliptical ☐ Box ☐ Other: _____	☐ Single ☐ Double ☐ Triple ☐ Other: _____	Diameter/Dimensions: ______________________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ **Open drainage**	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____	☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ **In-Stream**	**(applicable when collecting samples)**				
Flow Present?	☐ Yes ☐ No ***If No, Skip to Section 5***				
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial				

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		**RESULT**	**UNIT**	**EQUIPMENT**
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	_____' _____"	Ft, In	Tape measure
	Measured length	_____' _____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only
Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls
Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

1. Sample for the lab?	☐ Yes	☐ No		
2. If yes, collected from:	☐ Flow	☐ Pool		
3. Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM	☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

UPLAND CONTIGUOUS FOREST
FIELD DATA SHEET

PROJECT	**LOCATION**
STATION #	**INVESTIGATORS**
LATITUDE	**LONGITUDE**
FORM COMPLETED BY	**PICTURE #**
DATE ________ **TIME_________ AM PM**	**WEATHER**

ECOREGION/ FOREST ASSOCIATION				
# OF TREES IN PRISM & DBH	Number		DBH	
DOMINANT TREE SPECIES				
SPECIMEN OR RARE SPECIES	Rank (1-5) 5 being highest Describe			
DENSIOMETER READING (# of squares >3/4 filled/total # squares)	North ___/24 = ____%	South ___/24 = ____%	East ___/24 = ____%	West ___/24 = ____%
	Average of above readings = ____%			
WETLAND?	Soils Y N	Hydrology Y N	Plants Y N	
UNDERSTORY CHARACTERIZATION	Dense, Medium, Sparse	Dominant species:		
HABITAT COMPLEXITY	Canopy, Mid Canopy, Understory 3 present 2 present 1 present			
FORBES (herbaceous cover)	Dense, Medium, Sparse			
EVIDENCE OF DISRUPTION AND EXTENT (%)	Natural (ie. storm, disease, deer browsing) Extent (% site coverage)	Anthropogenic (ie. clearing, dirt road, timber harvesting , trash) Extent (% site coverage)		
INVASIVES	Species	Dense, Medium, Sparse	Extent (% site coverage)	
SIZE OF TRACT	Acres			
WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Residential ❑ Other _________________	**Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources		

Explanation of Contiguous Forest Field Data Sheet

Representative or random sites should be chosen for the Contiguous Forest Assessment. Enough points should be chosen to provide a good representative characterization of the land under consideration for protection. General guidance is to sample at least 2 points for less than 100 acres of forest, and at least 4 points for up to 1000 acres of forest.

PROJECT: Project name. Typically refers to the watershed being studied

LOCATION: Station location description (i.e. 100 meters NE of the corner of Rt. 5 and Boon Drive).

STATION #: A unique station identifier. Usually refers the subwatershed being studied (e.g., Scotts Level subwatershed Site #1 might be called SL-1).

INVESTIGATORS: Initials of investigators assessing the site (useful if clarification of the data sheet is needed).

LATITUDE/ LONGITUDE: Use a GPS unit to determine the latitude and longitude of the specific location. If you do not have a GPS unit, an estimate of the location should be made using aerial/orthophoto maps.

PICTURE NUMBERS: Roll and photo numbers for any pictures taken at the site.

FORM COMPLETED BY: Initials of investigator completing the form (often necessary for deciphering hand writing).

WEATHER: Describe the current weather (e.g, sunny, rainy, snowing).

DATE: Day, month and year the survey was completed.

TIME_________ AM PM: Time the survey was completed.

ECOREGION/ Forest Classification: By pre-identifying the eco-region and forest association, the investigator will have an idea of what to expect and what issues may be facing that region. Ecoregion information is available at www.natureserve.org

 # OF TREES IN PRISM and DBH: Number of trees in Prism refers to a 10 Basal Area Factor (BAF) Prism which is used to select out the larger trees at a given site. The size of the trees is quantified by DBH, or Diameter at Breast Height.

DOMINANT TREE SPECIES PRESENT: Common and/or scientific name of dominant tree species present. Be as specific as possible (i.e. chinquapin oak, loblolly pine).

SPECIMEN OR RARE SPECIES: Give each site a rank from 1 to 5 (5 being the highest) based on the presence, age, height, location, and health of rare or specimen species present. For example, the presence of old growth trees, rare plant species, or habitat for an endangered species would constitute a high score of 5. Large mature trees and good quality forest would constitute a score of 3 or 4. A site with only 1 specimen tree might receive a rank of 2, while a site with young trees and no rare species would score a 1. The ranking system may vary and should be pre-determined.

DENSIOMETER READING: A spherical densiometer is used to measure the density of the forest canopy. In other words, you are quantifying how much of the sky above you is blocked by trees. To use a densiometer correctly it must be held level about 12-18" in front of you. When looking into the densiometer you can see the trees above you and grid marks on the densiometer mirror. Count and record the number of grid squares that are more than ¾ filled with tree images as well as the total number of squares to calculate the percent coverage. A densiometer reading should be taken at each of the four compass directions. Take the average of the four readings to get a canopy density % for the site. If the canopy density is greater than 50%, the canopy is closed. If the density is less than 50%, the canopy is open. Densiometers are available through forestry supply companies. As there may be some variation between types, follow manufacturers instructions.

WETLAND: Are there wetlands present? This can be difficult to determine since the time of year and amount of recent rainfall can greatly influence your findings. Knowledgeable personnel and wetland identification guides may be necessary to help determine if wetlands are present.
Soils: Are the soils hydric? Y/N
Hydrology: Is there standing water? Y/N
Plants: Are there wetland plants? Y/N

UNDERSTORY CHARACTERIZATION: Understory refers to the trees located entirely below the general level of the canopy that receive little or no sunlight from above or the sides. Indicate if understory is dense, medium, or sparse and identify the dominant species.

HABITAT COMPLEXITY: Circle the number of different habitats (canopy, mid-canopy, and understory/shrubs) present: 3 present 2 present 1 present.

FORBES: Forbes are herbaceous groundcover, including vegetation such as ferns. Indicate if forbes are dense, medium, or sparse.

EVIDENCE OF DISRUPTION AND EXTENT: Describe any evidence of disruption, indicate whether the disruption is natural or anthropogenic and identify the extent (%) of the site affected.

INVASIVE SPECIES: (non-native plants) Invasive species can overrun native species due to lack of natural predators, and often create a monoculture. Identify and describe the type, density (dense, medium, sparse) and extent (% site coverage) of any invasive species present.

SIZE OF TRACT: (acres) Estimate the size of the tract based on topographical maps or GIS data layers.

WATERSHED FEATURES: Identify the predominant surrounding land use and indicate if evidence of local watershed nonpoint source pollution exists. Nonpoint source pollution (NPS) is pollution that cannot be connected to one specific source such as an industrial sewage treatment plant. Examples of NPS pollution may include runoff from golf courses, commercial development, or residential lawns containing fertilizers, pesticides, sediment, metals and other pollutants.

Glossary

Basal Area – The cross-sectional area of a tree at breast height (4.5 feet above ground). The basal area of all trees in a given area represents forest stand density and is measured in square feet per acre.

Biltmore Stick – A measurement tool resembling a yard stick that is used to estimate the diameter and height of a tree.

Caliper – Tree diameter measured at 2 inches above the root collar.

Canopy – The level of the tallest trees overhanging branches that result in the limitation of sunlight reaching lower levels.

Champion Tree – The largest tree of its species within the United States, the state, county or municipality as determined by the state or local Natural Resources Department or similar agency.

Contiguous Forest – Forested land without significant breaks due to roads, power lines or other clearings.

Critical Habitat Area – A critical habitat for all endangered species and its surrounding protection area.

Densiometer – A monitoring tool used to determine the amount of canopy coverage.

Dominant Trees – Trees with crowns extending above the general level of the crown cover and receiving full sunlight from above and partly from the side; typically larger than the average trees in the stand.

Forest Stand Delineation – A methodology for evaluating the existing natural features and vegetation on a site proposed for development, taking into account the environmental elements that shape or influence the structure or makeup of a plant community.

Forest Structure – A measure of vertical and horizontal structural diversity within a stand, which is related to stand age and habitat.

Natural Regeneration – The natural establishment of trees and other vegetation.

Prism – A piece of precisely angled glass used in large forested areas for estimating basal areas, volumes or number of trees per unit area.

Specimen Tree – Trees having a diameter measured at breast height (4.5 feet above the ground) of 30 inches or more, or trees having 75% or more of the diameter of the current state champion tree of that species.

Understory Trees – Trees with crowns entirely below the general level of the canopy receiving little or no sunlight from above or the sides.

RARE AND THREATENED SPECIES
FIELD DATA SHEET

PROJECT:	**LOCATION**
STATION # **TRACT#**	**STORET #**
LAT ____________LONG __________	**INVESTIGATORS**
FORM COMPLETED BY	**Picture #s**
DATE ________ **TIME_________ AM PM**	**Weather**

Rare or Threatened Species			
Extent of Population *(if known)*			
Evidence of Potential Threats to Population			
Co-occurrence of other RTE species			
Wetland?	Soils	Hydrology	Plants
RPA Protection?			
HABITAT COMPLEXITY	Canopy, Mid Canopy, Understory 3 present 2 present 1 present		
FORBES	Dense, Medium, Sparse		
Evidence of Disruption and Extent (%)	Natural (ie. storm)	Anthropogenic (ie. clearing, dirt road, timber harvesting)	Disease
Presence of Invasives			
WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Residential ❑ Other ________________	**Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources	

Notes or Sketch on Back

Table 1: Links for Additional Sensitive Areas Assessments	
Type of Assessment	*Link to Assessment Method*
Wetland Delineation	U.S. Army Corps of Engineers Wetland Delineation Manual http://www.saj.usace.army.mil/permit/documents/87manual.pdf
Functional Wetland Assessment	Methods for Evaluating Wetland Condition www.epa.gov/waterscience/criteria/wetlands/ A Hydrogeomorphic Classification for Wetlands http://el.erdc.usace.army.mil/emrrp/emris/EMRIS_PDF/wrpde4.pdf Review of Rapid Methods for Assessing Wetland Condition http://www.epa.gov/owow/wetlands/monitor/RapidMethodReview.pdf The Process of Selecting a Wetland Assessment Procedure: Steps and Considerations http://el.erdc.usace.army.mil/emrrp/emris/emrishelp6/the_process_of_selecting_a_wetland_assessment_procedure_steps_and_considerations.htm North Carolina Coastal Region Evaluation of Wetland Significance http://www.nccoastalmanagement.net/Wetlands/NCCREWSDOC.pdf Wetland Rapid Assessment Procedure http://www.sfwmd.gov/org/reg/nrm/wrap99.pdf Field Identification of Potential Freshwater Wetland Restoration Sites http://www.woonasquatucket.org/documents/ID&Nomination.pdf Spatial Wetland Assessment for Management and Planning http://www.csc.noaa.gov/lcr/text/swamp.html
Vegetative Community Survey	USGS-NPS Vegetation Mapping Program http://biology.usgs.gov/npsveg/fieldmethods/index.html Habitat Evaluation Procedures handbook http://policy.fws.gov/ESMindex.html Soil Quality Test Kit Handbook http://soils.usda.gov/sqi/files/KitGuideComplete.pdf
Rare, Threatened and Endangered Species	New York State Natural Heritage Program Rare Plant Field Techniques http://www.dec.state.ny.us/website/dfwmr/heritage/fieldtech.htm Wyoming Natural Diversity Database Plant Species of Concern Survey Form http://uwadmnweb.uwyo.edu/wyndd/Data/plant_survey_form.pdf Minnesota County Biological Survey Rare Plant Survey http://www.dnr.state.mn.us/ecological_services/mcbs/procedures_plants.html Minnesota County Biological Survey Rare Animal Survey http://www.dnr.state.mn.us/ecological_services/mcbs/procedures_animals.html
Forest Stand Delineation/Tree Inventory	USDA Forest Service Volunteer Training Manual (street tree inventory) www.umass.edu/urbantree/volmanual.pdf Urban Forest Health Monitoring Draft Field Manual www.fs.fed.us/ne/syracuse/Tools/UFHMonitoring.htm Trees Approved Technical Manual (Montgomery County, MD) www.mc-mncppc.org/environment/forest/trees/detail_trees.pdf Maryland Green Infrastructure Assessment

	http://dnrweb.dnr.state.md.us/download/bays/gia_doc.pdf

IV. QUALIFIED TESTING LABORATORIES

While MTAS is unable to recommend any specific firm over any other, the following is a list of private sector laboratories that have been identified to MTAS as being qualified to provide sampling and testing services meeting TDEC's minimum monitoring requirements:

W. Pennington Associates
Cookeville, TN
Wendell Pennington
931 526 6038
kingpenn@citlink.net

CEC
Pittsburg& Nashville TN
Jeff Doke, Chris Catron, Tim Nayhuse
615 333 7797

Dinkins Biological Consultants
Knoxville, TN
Barbara Dinkins
865 938 7739

Aquatic Resource Center
Franklin?, TN
Todd Askguard
615 781 2901

Advent Environmental
Nashville, TN
Scott Hall, Rick Lockwood
615 377 4775

VI. SAMPLE MONITORING PLANS

Metro Nashville Davidson County
E. coli TMDL Compliance
Activities for the
Harpeth River and Tributaries

May 3, 2007

TMDL Requirements and Activities

A Total Maximum Daily Load (TMDL) for E. coli in the Harpeth River Watershed was established by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control (TDEC-WPC), and was approved by the Environmental Protection Agency (EPA). Portions of the Harpeth River Watershed fall under the jurisdiction of the municipal separate storm sewer system (MS4) of Metro Nashville Davidson County. The MS4 NPDES Permit requires Metro Water Services-NPDES/Stormwater Division to perform provisions set forth within the E.Coli TMDL.

The following document addresses the minimum TMDL requirements with proposed additional activities suggested by Metro Water Services. Intensive bacteriological sampling and visual stream surveys will be conducted on stream segments in the Harpeth River Watershed which is highlighted in the following map:

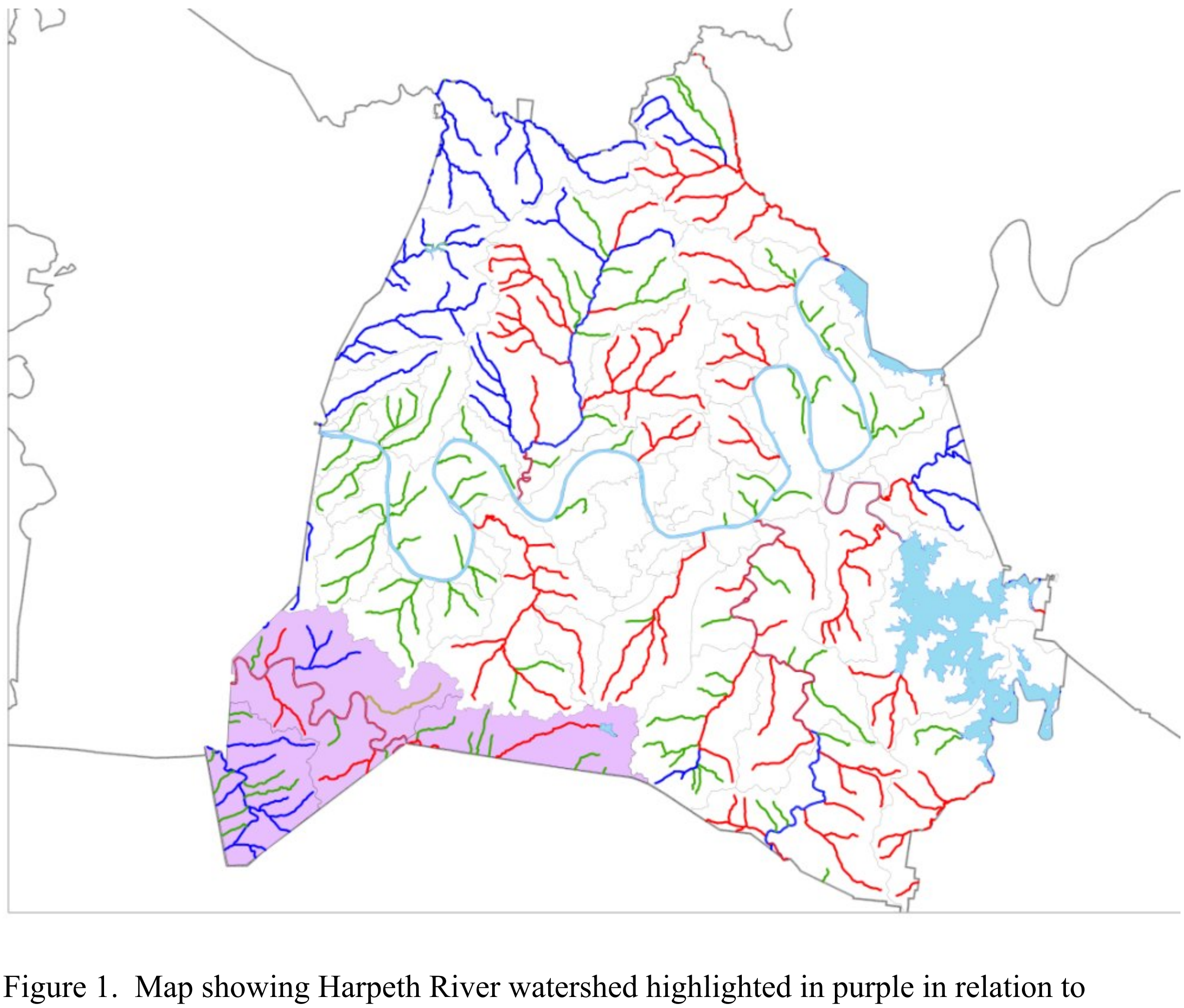

Figure 1. Map showing Harpeth River watershed highlighted in purple in relation to other impaired waters (red) in Davidson County.

Harpeth, Little Harpeth, Trace Creek

E. coli - Standard

- E. coli shall not exceed 126 CFU/100 ml as a geometric mean on a minimum of 5 samples collected within 30 days.
- E. coli in any individual sample for any lake, reservoir, State Scenic River, or Tier II or Tier III stream shall not exceed 487 CFU/100 ml.
- E. coli concentrations for individual samples shall not exceed 941 CFU/100 ml.

E. coli – Sources

- Harpeth – Discharges from MS4, highways, road, bridges, construction sites, and pasture grazing.
- Little Harpeth – Land development.
- Trace Creek – Collection system failure.

E. coli – Source Assessment

- An important part of TMDL analysis is the identification of individual sources, categories of pollutants in the watershed that affect pathogen loading and the amount of loading contributed by each of these substances

- Sources include:
    - Point Sources
        - WWTF's – none in Davidson County are located on the Harpeth.
        - MS4's
        - CAFO's – No permitted CAFO's in the Harpeth River Watershed
    - Non-Point Sources
        - Wildlife
        - Agriculture Animals
        - Failing Septic Systems and illicit discharges
        - Urban Development

E. coli – Implementation Plan

- Point Sources
    - WWTF's – All present and future discharges from industrial and municipal treatment facilities are required to be in compliance with the conditions of their NPDES

permits at all times, including elimination of bypasses and overflows.

  - MS4's – 1) All Phase I & II MS4 permits require the development of a storm water management plan that will reduce the discharges of pollutants to the maximum extent practicable and not cause or contribute to violations of State water quality standards. 2) NPDES permits for Small MS4's require the SWMP to include 6 minimum controls; Public education, Public involvement and participation, Illicit discharge detection and elimination, Construction site storm water runoff control, Post-construction storm water management in new and re-development, Pollution prevention and good housekeeping for municipal operations. 3) The SWMP must include a section describing how discharges of pollutants are going to be controlled and ensure they do not cause or contribute to instream exceedances of water quality standards. 4) MS4s must implement the WLS provisions of an applicable TMDL and describe methods to evaluate weather storm water controls are adequate to meet the WLA. 5) In order to evaluate SWMP effectiveness and demonstrate compliance with specific WLSs, MS4s must develop and implement appropriate monitoring programs. Instream monitoring, at locations selected to best represent effectiveness of BMPs, must include analytical monitoring of pollutants of concern. 6) A detailed plan describing monitoring programs must be submitted to TDEC within 12 months of approval date of the TMDL.
  - CAFO's – No permitted CAFO's in the Harpeth River Watershed

- Non-Point Sources

  Additional Monitoring:

  - Additional Monitoring and assessment activities are recommended to determine whether implementation of TMDLs, WLAs, and LAs in tributaries and upstream reaches will result in achievement of instream water quality targets for E. coli.
  - Future monitoring activities should be representative of all seasons and a full range of flow and meteorological conditions.
  - Monitoring activities should also be adequate to assess water quality using the 30-day geometric mean standard.

  Source Identification:

  - An important aspect of pathogen load reduction activities is the accurate identification of the actual sources of pollution. In cases where the sources of pathogen impairment are not readily apparent, Microbial Source Tracking is one approach to determining the source of fecal pollution and pathogens affecting a waterbody.

Evaluation of TMDL Implementation Effectiveness:

- Additional monitoring data, ground-truthing activities, and bacterial source identification actions are recommended to enable implementation of particular types of BMPs to be directed to specific areas of impaired subwatersheds.

E. coli – WLA & LA required reductions

Harpeth – WLA from MS4 >64.7 %; LA from nonpoint sources >64.7 %; Total TMDL reduction = >60.8

Little Harpeth – WLA from MS4 >43.2 %; LA from nonpoint sources >43.2 %; Total TMDL reduction = 36.8 %

Trace Creek – WLA from MS4 >64.7 %; LA from nonpoint sources >64.7 %; Total TMDL reduction = >60.8%

MWS NPDES Permit Requirements

AREA-SPECIFIC SWMP REQUIREMENTS

1. Water Quality Controls for Discharges to Impaired Waterbodies. The annual report submitted to the division must include a section describing how the SWMP will control the discharge of the pollutants of concern. This section must identify the measures and BMPs that will collectively control the discharge of the pollutants of concern. The measures should be presented in order of priority with respect to controlling the pollutants of concern.

2. Consistency with Total Maximum Daily Load (TMDL). Where a TMDL has been approved for any waterbody into which Metro discharges, Metro must follow the procedure below and report on these activities in annual reports to the division:

a. Determine whether the approved TMDL is for a pollutant likely to be found in storm water discharges from your MS4.

b. Determine whether the TMDL includes a pollutant wasteload allocation (WLA), implementation recommendations, or other performance requirements specifically for storm water discharges from your MS4.

c. Determine whether the TMDL addresses a flow regime likely to occur during periods of storm water discharge.

d. After the determinations above have been made and if it is found that the MS4 must implement specific provisions of the TMDL, Metro shall evaluate whether the implementation of existing storm water control measures is meeting the TMDL provisions, or if additional control measures are necessary.

e. Metro shall document all control measures currently being implemented or planned to be implemented, including a schedule of implementation for all planned controls. The rationale (e.g., calculations, assessments, reports and/or other evidence) should be included, showing that Metro will comply with the TMDL provisions. For control measures that are expected to be implemented and evaluated beyond the term of this permit, include a longer schedule of implementation as necessary to describe the control measure.

f. Describe a method to evaluate whether the storm water controls are adequate to meet the requirements of the TMDL.

g. If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions.

Required MWS Compliance Activities for Pathogens in the Harpeth based on the Approved TMDL

Bacteriological - *comments in italic*

Pathogen sample sets must be collected during June to September once during a five (5) year period on the streams listed in the TMDL. For Metro Water these streams include the Harpeth, Little Harpeth, and Trace creek. A sample set is defined as five (5) samples collected within a thirty (30) day period with each individual sample collected more than twelve (12) hours apart. Flow rates must be obtained when samples are collected.

- *One (1) field blank and at least one (1) duplicate must be analyzed per sampling day.*
- *Protocols and QA/QC procedures are summarized in TDECs Chemical and Bacteriological Sampling of Surface Waters March 2004.*

Visual Stream Assessment (*Stream Walks)- comments in italic*

The purpose of the visual stream assessment is to not only isolate sources of contaminants but to also provide MS4 managers a way to prioritize areas that are in need of increased scrutiny and attention. Although several documents have been approved for use by MS4's in completing this requirement, MWS will adopt the protocols set forth in Maryland's Stream Corridor Assessment Survey. All streams and tributaries impacted by the MS4, crossed by or in close proximity to water and/or sewer lines will be assessed. Those tributaries not impacted by the MS4 or water/sewer lines will be assessed for potential impacts using GIS images. All field data will be electronically stored and accessible by ArcGIS.

- *Data sheets to be filed out in the field are enclosed.*
- *Refer to Maryland's Stream Corridor Assessment Survey for detailed instructions on filling out field data sheets.*

Proposed Sample Locations

MWS will sample the following four sites for pathogen analysis and visual stream surveys:

1) The Harpeth as it enters Davidson County. (H1)
2) The Harpeth just before leaving Davidson County. (H2)
3) Trace Creek upstream of the confluence to the Harpeth. (T1)
4) Little Harpeth upstream of the confluence with the Harpeth. (LH1)

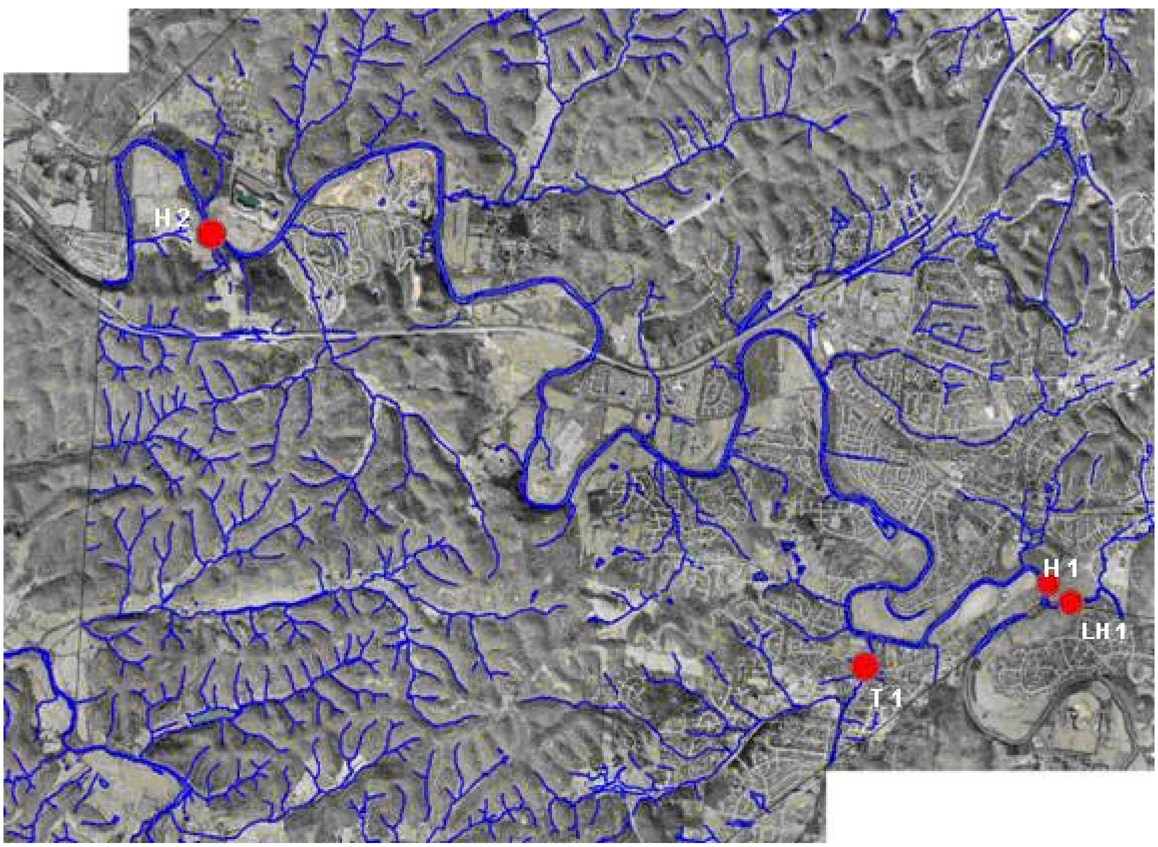

Figure 2. Map of proposed sample sites for the Harpeth River watershed.

Proposed MWS Compliance Activities

While the above protocols represent the minimal requirements set forth by the Harpeth TMDL, MWS recognizes that in order to assess improvements in waterbodies caused in part to BMP implementation and to show the stormwater program is making a difference in improving waster quality, additional sampling and monitoring efforts are required. Therefore, in addition to the above requirements MWS proposes the following additions.

Bacteriological

To examine seasonal trends, and to recognize the variety in weather conditions associated with differing seasons, MWS proposes to collect five (5) pathogen samples in a thirty (30) day period in all reaches quarterly per year, with that frequency being re-evaluated on an annual basis. This sampling procedure will satisfy the pathogen TMDL requirement listed above. Likewise, cross sectional flow rates will be collected during pathogen sampling, at all sampling stations during all sampling events. A minimum of 20 locations along a transect will be used to collect each cross sectional flow measurement. Flow rates for each transect location will be calculated based on the mean velocity during 30 second intervals.

Visual Stream Assessment (*Stream Walks)*

In addition to the requirements listed in Maryland's Stream Corridor Assessment Survey, MWS will collect pathogen samples at the mouth of all tributaries, pipes with flow and randomly throughout the reach of the stream being assessed. The purpose of this sampling effort is to detect illicit discharges or isolate potential sources of pathogens not apparent through other sampling methods.

Stream Assessment Tributary Location

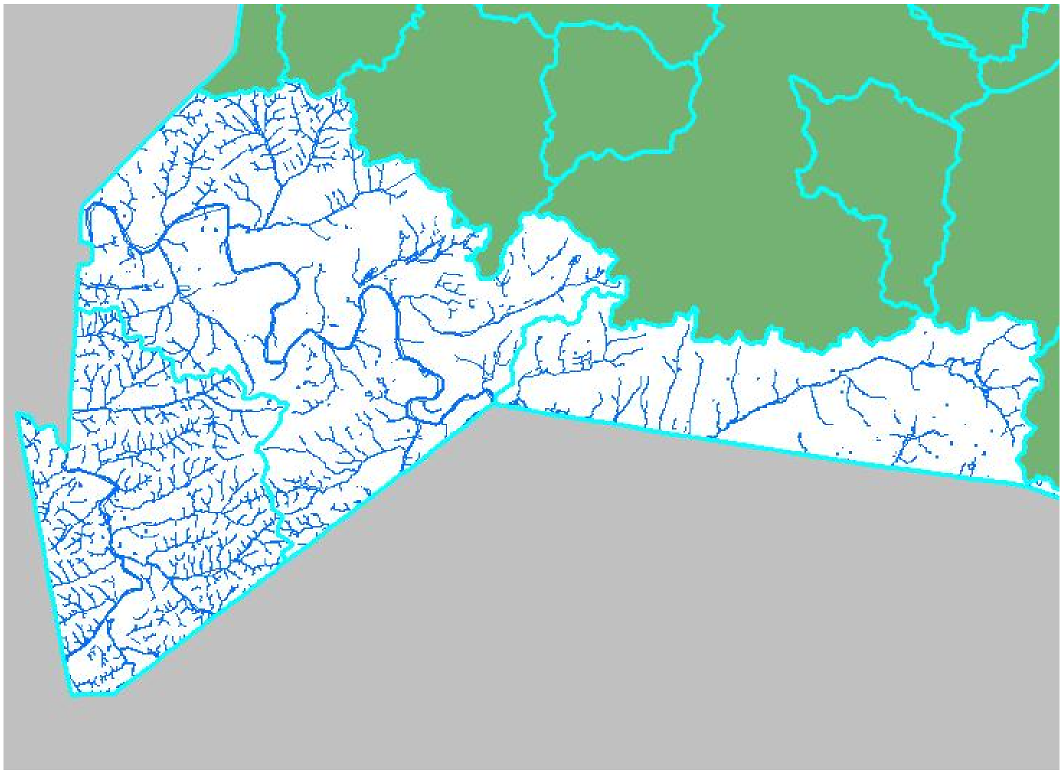

Figure 3. Map of all tributaries in the Harpeth River Watershed within Davidson County.

Data and Document Location

All data collected will be stored in the subfolder \\Hobsvwsfp01\Programs\TMDLS.

Raw data will be stored in the subfolder \\Hobsvwsfp01\Programs\TMDLS\Raw Data.

GIS data will be stored in the subfolder \\Hobsvwsfp01\Programs\TMDLS\GIS

Documents will be stored in the subfolder \\Hobsvwsfp01\Programs\TMDLS\DOCUMENTS.

This document is stored as \\Hobsvwsfp01\Programs\TMDLS\DOCUMENTS\TMDL REQUIREMENTS 4-17-07.doc.

Procedures in this document entitled TMDL REQUIREMENTS have been reviewed and approved by the following:

________________________________ Date______________

Michael Hunt
NPDES Program Manager
Metro Water Services

________________________________ Date______________

Steve Winesett, Ph.D.
Watershed Water Quality Manager
Metro Water Services

Total Maximum Daily Load

E. coli Monitoring Plan
2006 - 2011

Hamilton County Stormwater
Pollution Control Program

Permit No. TNSO75566

Authorized and Written By:	Date
Caren L. Ruffner	July 6, 2007

Manager
Hamilton County Stormwater Pollution Control Program

1250 Market Street, Suite 3050
Chattanooga – Hamilton County Development Resources Center
Chattanooga, TN 37402

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Table of Contents

Total Maximum Daily Load

E. coli Monitoring Plan

Hamilton County Stormwater Pollution Control Program
Permit No. TNSO75566

1. Background

In April 2004, Hamilton County, the City of Collegedale, the City of East Ridge, the City of Lakesite, the Town of Lookout Mountain, the City of Red Bank, the City of Ridgeside, and the City of Soddy Daisy entered into an interlocal agreement to establish one program to comply with the requirements of the Phase II Storm Water Pollution Control Program as promulgated by the United States Environmental Protection Agency (EPA). Subsequently, standard operating procedures were developed for the Hamilton County Stormwater Pollution Control Program herein after referred to as “Program.” National Pollutant Discharge Elimination System (NPDES) Permit No. TNSO75566 was issued by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control (Division) on September 30, 2004. Prior to December 31, 2005 resolutions were passed in each jurisdiction establishing the Program’s regulatory authority and requirements.

2. Purpose

The purpose of this document is to comply with monitoring requirements associated with the Total Maximum Daily Load for E. coli in the Lower Tennessee Watershed as described in NPDES Permit No. TNSO75566, Section 2. - 2.1.3.1.

3. Identification of TMDL Streams

On July 7, 2006, EPA Region 4 Approved the Total Maximum Daily Loading for E. coli in the Lower Tennessee River Watershed (HUC 0602001). Impaired waterbodies addressed in the TMDL for E. coli that are within the Program’s boundary are as follows:

Waterbody ID	Waterbody	Miles Impaired	Miles Impaired in Program Area
TN06020001007-0510	Spring Creek	9.6	5.8
TN06020001007-1000	South Chickamauga Creek	17.6	4.0
TN060200011244-0400	Gillespie Springs Branch*	1.9	0.6
TN06020001426-0100	Stringers Branch	5.8	5.4

*A TMDL could not be developed for Gillespie Spring Branch due to insufficient monitoring data.

4. Sources Assessment

Nonpoint sources of E. coli in the Municipal Separate Sewer System (MS4) are addressed in the Program's permit through best management practices such as, education and outreach programs, public participation, illicit discharge detection and elimination, land disturbing permits, post-construction water quality permits, and municipal facility stormwater pollution prevention plans.

4.1. Urban Development

As described in Section 7.2.4 of the TMDL for E. coli in the Lower Tennessee Watershed, nonpoint source loading of E. coli from urban land use can be attributed to multiple sources. These are: stormwater runoff, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. More specifically failing septic systems and animal waste are addressed below.

4.2. Failing Septic Systems

4.2.1. Stringer Branch

The TMDL reports that a population of approximately 2,270 is on septic systems in the Stringer Branch Watershed. Of this value, it is estimated virtually all of these people are located in the Program area.

4.2.2. Spring Creek

The TMDL reports that a population of approximately 693 is on septic systems in the Spring Creek Watershed. Of this value, it is estimated that a majority of these people are located in the Program area.

4.2.3. South Chickamauga Creek

The TMDL reports that a population of approximately 8,643 is on septic systems in the South Chickamauga Creek Watershed. Of this value, it is estimated that only a small number of these people are located in the Program area.

4.3. Animal Waste

Since the Program area is urbanized and keeping pets is very popular, the concentration of bacteria from pets is considered high. The Chattanooga area has a large percentage of land with established tree cover which provides habitat for wildlife such as squirrels, birds, raccoons, fox, and other small animals.

Domestic livestock contributes to the pathogen loading in streams in the Program area. Although the Program area does not contain a large number of acres used for livestock farming, many of the watersheds in the Program area have active livestock farming.

5. Monitoring

The Tennessee Department of Environment and Conservation has established the minimum monitoring frequencies for the MS4 Phase II programs including the Hamilton County Stormwater Pollution Control Program. Two monitoring methods have been identified for E. coli: bacteriological sampling and habitat assessment.

5.1. Methodology and Frequency

5.1.1. Bacteriological Analysis

The main objective of the bacteriological analysis is to quantify the pathogen loading of the stream. Sampling will be performed utilizing the Bacteriological (Pathogen) Analysis Method.

One sample set (five samples in a thirty day period) will be taken from Stringers Branch, Spring Creek and South Chickamauga Creek in a five-year period. Analysis method is identified in the State of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Quality System Standard Operating Procedures for Chemical and Bacteriological Sampling of Surface Water, March 2004.

Sampling Locations are identified in Appendix A – Maps.

5.1.2. Visual Stream Surveys and Impairment Inventory

Main objective of the survey is to identify and prioritize stream impairment sources. Survey protocols as described in Stream Corridor Assessment Survey developed by Maryland Department of Natural Resources, September, 2001, will be used with minor modification to Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6.1, 4.6.1.0 and 6.0. Section 5.1, 5.1.1, 5.1.2, 5.2, and 5.3 will not be used unless GPS equipment failure is experienced and our digital data collection system is inaccessible. Please see Appendix B for the details describing these modifications.

A stream outfall survey with the above noted modifications will be performed at the stormwater outfalls throughout Stringers Branch, Spring Creek and South Chickamauga Creek within the Program area.

5.2. Monitoring Points

5.2.1. Bacteriological

Proposed monitoring points for bacteriological sampling for the Program area are located in the same locations currently monitored by the Division:

5.2.1.1. South Chickamauga Creek at mile 15.8 at the swinging foot bridge at Audubon Acres.
(34^0 59 ' 49.1063" Lat: 85^0 11' 4.1532" Long.)

5.2.1.2. Spring Creek at mile 0.7 at the Spring Creek Road Bridge.
(35^0 0' 10.6308" Lat: 85^0 7' 46.0956" Long.)

5.2.1.3. Stringers Branch at mile 0.6, behind Austin's Garden Center on Signal Mountain Road.
(35^0 5' 8.8260" Lat: 85^0 19' 29.6580" Long.)

5.2.2. Visual Stream Assessment

A stream outfall survey will be performed at the stormwater outfalls throughout Stringers Branch, Spring Creek and South Chickamauga Creek within the Program area.

5.3. Schedule of Monitoring Plan Implementation

5.3.1. Bacteriological Sampling

Bacteriological sampling will begin in 2008. Prioritization as follows: Stringers Branch, Spring Creek and South Chickamauga Creek. The Program will complete the sampling for a minimum of one stream per year in order to have the sampling for the three E. coli TMDL streams completed by July 6, 2111.

5.3.2. Visual Stream Assessments

Stream assessments will begin in 2008. Prioritization as follows:
Stringers Branch, Spring Creek and South Chickamauga Creek. The Program will complete a minimum of one stream per year in order to have the assessments for the three E. coli TMDL streams completed by July 6, 2111.

6. References

Tennessee Department of Environment and Conservation, Division of Water Pollution Control*, NPDES Permit No. TNSO75566,* Hamilton County Phase II MS4s, 2004.

Tennessee Department of Environment and Conservation, Division of Water Pollution Control, *Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water,* 2004.

Tennessee Department of Environment and Conservation, *Total Maximum Daily Load (TMDL) for E. Coli in the Lower Tennessee River Watershed (HIC 06020001) Bledsoe, Bradley, Hamilton, Loudon, Marion, McMinn, Meigs, Rhea, Roane, and Sequatchie Counties, Tennessee,* 2006.

Tennessee Department of Environment and Conservation, *Proposed Final Version, Year 2006 303(d) List,* 2006.

Yetman, Kenneth T. *Stream Corridor Assessment Survey, SCA Survey Protocols,* Maryland Department of Natural Resources, Watershed Restoration Division, 2001.

APPENDIX A

Stringers Branch

APPENDIX A

<u>Spring Creek</u>

APPENDIX A

<u>South Chickamauga</u>

APPENDIX A

Countywide Monitoring Point Location Map

APPENDIX B

Details of Modifications
to the Maryland Department of Natural Resources "Stream Corridor Assessment Survey"

4.1 Identifying Environmental Problems
Environmental problems will be assessed at the stormwater outfalls and in the immediate areas within 100 feet upstream and downstream of the outfall.

4.2 Assigning a Site Number
A Thales™ Mobile Mapper CE unit is used to collect the Global Positioning System (GPS) location of stormwater outfalls throughout the Program Area. When the GPS information is collected, a unique identification number is automatically generated and attached to that point. Subsequently, this information is downloaded directly into the Program's geodatabase. Within the geodatabase all other information associated with a particular outfall including stream conditions found in the vicinity of the outfall are stored with a geospatial relationship.

4.3 Recording a Problem Location on a Map
The Thales Mobile Mapper Unit digitally records the point using a GPS.

4.4 Photographing a Site
A representative photo is taken of the site that will be linked to the GPS point in the geodatabase. Photolink™ Software automatically links these two files in the geodatabase using time relationship between the time the GPS point is collected and the time the Photograph is taken. If additional photographs are necessary to describe environmental problems a second camera will be used and the date time relationship will be used in a manual sense to relate the additional pictures to the problem outfall location. Additional photos will be stored in a digital folder that is linked to the outfall point. Although the folder will not be in the geodatabase, the link will provide easy access to the information.

4.5 Filling out Data Sheets
The Thales Mobile Mapper Unit supports ESRI™ ArcPad software that has the capacity to serve as a data collection device. Menus can be loaded into the device that prompt the user through a series "screens" that describe types of problems and allows the user to choose the best option or go to the next screen if it does not apply. By using ArcPad, these choices are digitally recorded and the information is related to the outfall point stored in the geodatabase. This allows the data collection process to be less human-error prone since the data does not have to be entered digitally into a database from the field data. It also saves time as the data is loaded directly into the geodatabase as this is the functionality of the ArcPad with the Mobile Mapper unit.

4.5.1 Severity, Correctability and Access Ratings

The only change to this section is in the severity rating. The change will be to reverse the rating levels. The rating will be from 1 to 5 with a 1 being a minor problem and 5 the most severe problem. This number relationship is more parallel with the correctibility and access ratings which describe a 1 rating as minor and easy respectively and a 5 rating as major and difficult respectively.

4.6.4 Channel Alteration

Channel alterations like environmental problems will be assessed at the stormwater outfalls and in the immediate areas within 100 feet upstream and downstream of the outfall.

4.6.10 Representative Site

A representative site section will not be used since stream assessments will be conducted at the stormwater outfalls and in the immediate areas within 100 feet upstream and downstream of the outfall.

6.0 Analysis and Prioritization of Outfalls

The Program's survey is required to provide a systematic survey of the streams in the Program area to assess habitat conditions and identify environmental problems at the outfalls for future restoration work by the prospective jurisdiction. The main products of the survey are: lists of environmental problems in eight separate categories, a general rating of in-stream and riparian habitat at the outfalls and maps showing the location of problem outfalls.

Data collected as part of the Program's survey is entered in the GIS system (See Section 5.0). Once the data has been entered into a GIS system, a series of maps showing the locations of the problems identified in the survey should be produced. Depending on the length of the stream surveyed and the capabilities of the GIS system, one or more maps can be produced for each of the eight problem categories. An additional map showing the location of all problem outfalls can also be produced. The maps should be detailed enough so that the location of a site can be easily identified, but not cluttered with so much information that it is difficult to either see all the sites on the map or read the field identification number for each site.

Information collected and entered into the project database should be arranged and displayed in three separate sets of tables. The first table is the Site Identification Table which is developed with the data from the problem outfalls. Tables produced from this new data set will show the following information: outfall identification number, problem type, severity rating, correctability rating, access rating, GPS location and stream segment name.

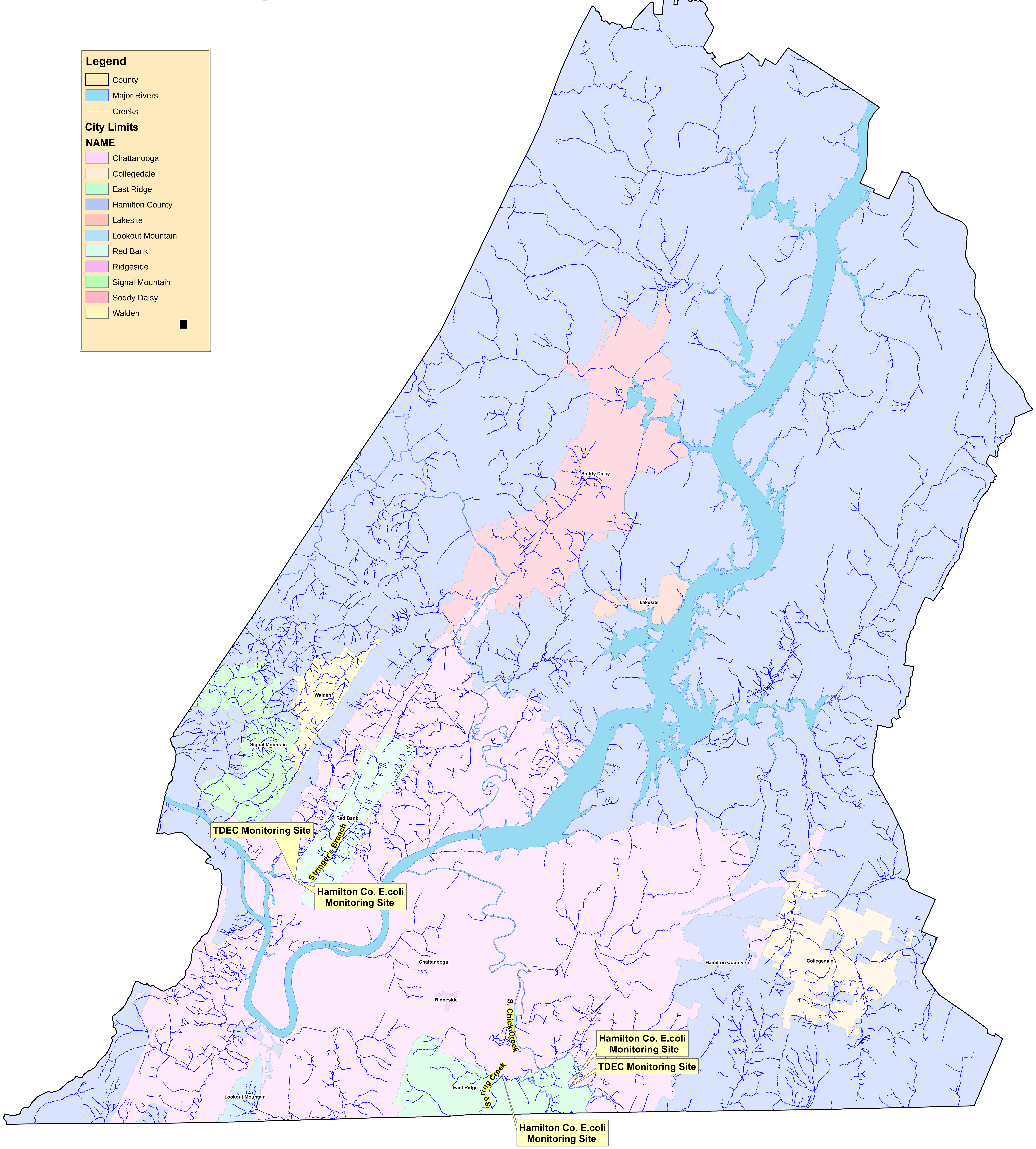
The second set of tables that are usually produced for the Program survey are the Problem Information Tables. These tables are grouped by problem type and include all of the information collected on the ArcPad digital survey. While the information in these tables can be organized in a number of different ways, usually the data is sorted in descending order by the severity, correctability and access ratings. This produces a set of tables with the sites that are considered the worst in each category at the top of the table.

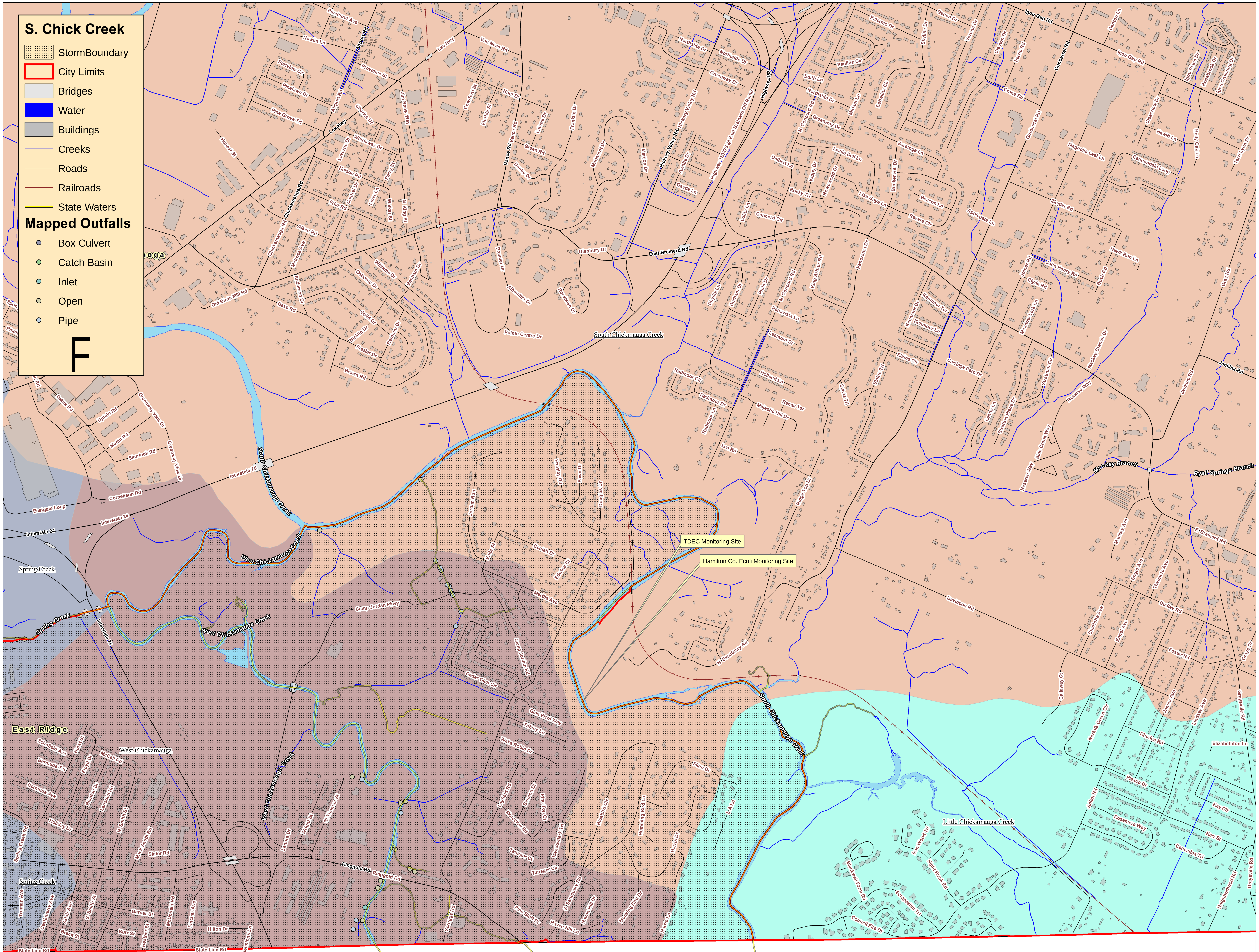
Once a working set of maps and tables have been developed, it is the responsibility of the project manager to perform the initial review of the information. During the review, the photographs, data and GIS maps are examined for all problem sites. The review is usually done with the survey team leaders and the project manager to look for possible discrepancies in the data, as well as possible trends and restoration opportunities. It is not unusual for the project manager to make a number of changes to the original survey data during the initial review. This is especially true in reviewing the severity and correctability rating of the survey teams. It is not unusual when viewing a number of different problems in the same category to adjust the rating to reflect the relative importance of specific problems. In making these changes, it is important that the database, GIS maps and original data all reflect any changes that are made.

Once the initial review is performed, it is strongly recommended that a panel of experts be brought together to review the data in specific problem categories. It is helpful if the panel is made up of not only individuals that are familiar with correcting specific types of problems, but also some of the watershed stakeholders who will be asked to help fix the problems. During the panel review, survey data and photographs will be discussed and follow-up surveys may be scheduled. The objective of the panel review is to identify any trends in the data and to begin to develop a consensus among the watershed stakeholders on what future restoration work may be needed.

Once the data has been reviewed, a final report summarizing the results of the Program's survey is written. The final report should summarize the findings of the survey and discuss any trends seen. The report should also point out possible restoration opportunities and/or follow-up work that may be needed. This report is not intended to provide an overall management strategy or plan for a watershed. Management plans are consensus documents that are written in collaboration with the stakeholders in the watershed. The Program's survey report instead provides a list of environmental problems identified at the stormwater outfalls and recommendations on possible steps that could be taken to improve environmental conditions. The Program's survey should be seen as a resource that watershed stakeholders can use in developing future watershed restoration strategies

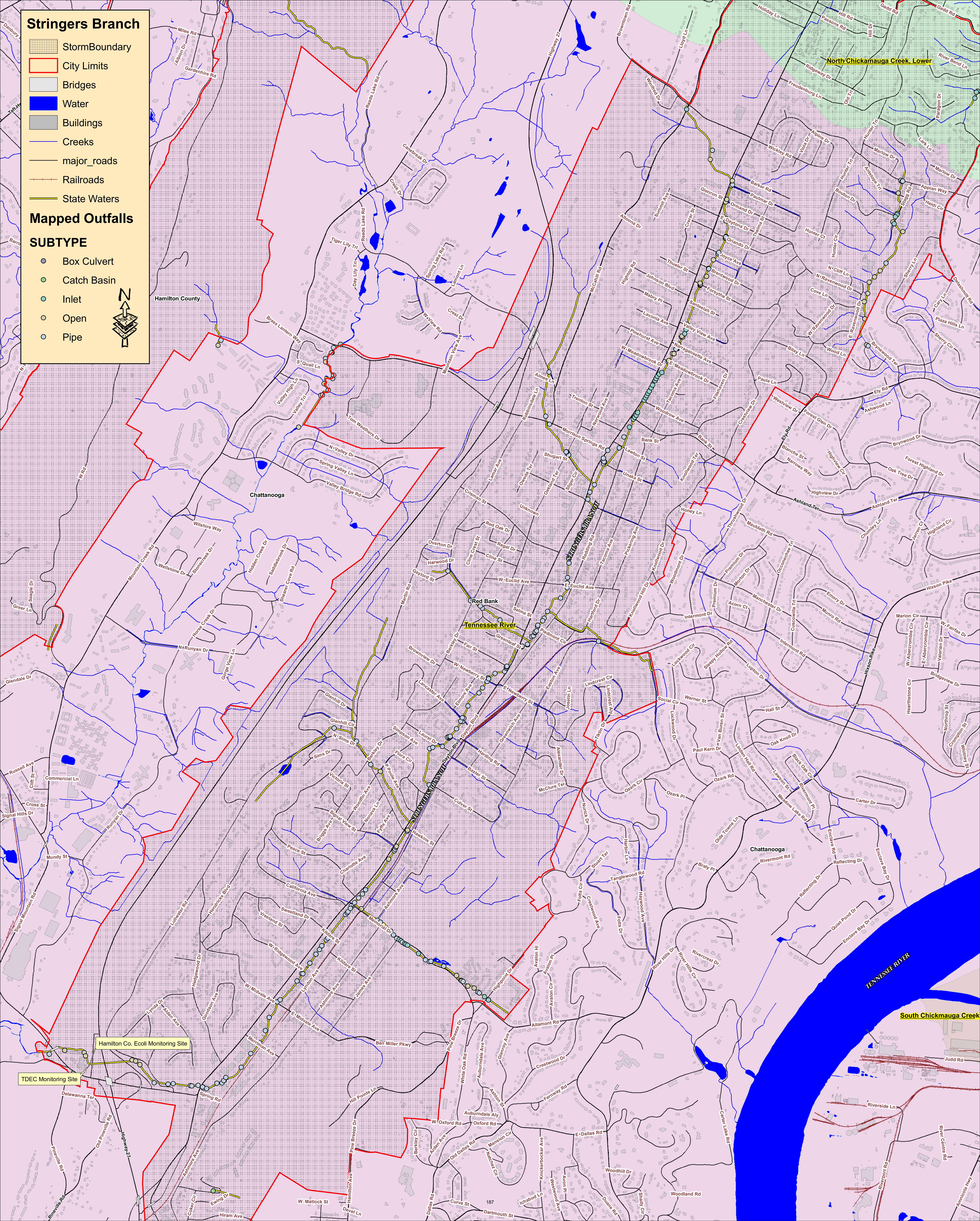
Hamilton Co. E.coli TMDL Monitoring Sites





South Chickamauga Creek

Spring Creek



Stringers Branch
StormBoundary
City Limits
Bridges
Water
Buildings
Creeks
major_roads
Railroads
State Waters
Mapped Outfalls
SUBTYPE
Box Culvert
Catch Basin
Inlet
Open
Pipe
N
Hamilton County
Chattanooga
Red Bank
Tennessee River
North Chickamauga Creek, Lower
South Chickamauga Creek
TENNESSEE RIVER
Hamilton Co. Ecoli Monitoring Site
TDEC Monitoring Site
Stringers Branch
Highway 27
Hixson Pike
Ashland Ter
Dayton Blvd

Sullivan County, Tennessee

August 2007

A Total Maximum Daily Load (TMDL) Stream Monitoring Plan For Siltation and Habitat Alteration In the South Fork Holston River Watershed (HUC 06010102)

A Five-Year Monitoring Plan for Improving the Water Quality Of the County's Planning Jurisdiction of the Waters of the State That are Listed in the TDEC 2004 - 303D List of Impaired Streams

(County's Monitoring & Assessment Period: August 2007 to July 2012)

Principal Author:
Ambre M. Torbett, AICP
Director of Planning & Zoning
(Designated Stormwater Administrator for the County)

Database and Mapping Consultant (GIS)
Russ Davis, GISP with Landmark GIS

I. BACKGROUND FOR MONITORING AND PLANNING:

On December 8, 2000, the U.S. Environmental Protection Agency (EPA) published a rule that requires certain small municipal separate storm sewer systems (MS4) to participate in the National Pollutant Discharge Elimination System (NPDES) program and obtain a stormwater permit. This rule, commonly referred to as the NPDES Phase II, extends the current permitting program to communities with a population of 10,000 or more and/or areas with a population of density of more than 1,000 people per square mile. Sullivan County is one of a number of northeast Tennessee communities required to comply with the Phase II regulations *(excerpt taken from the county's NPDES Phase II Baseline Program Report, 7.02.02).*

The Tennessee Department of Environment and Conservation (TDEC) is the NPDES permitting authority for the State of Tennessee, and has required Sullivan County, as a MS4 community, to comply with six minimum control measures detailing best management practices (BMPs), pursuant to the EPA regulations:

1. Public Education and Outreach on Stormwater Impacts;
2. Public Involvement and Participation;
3. Illicit Discharge Detection and Elimination;
4. Construction Site Stormwater Run-off Controls;
5. Post-Construction Stormwater Management in Developments; and
6. Pollution Prevention/Good Housekeeping Practices for the County's Operations.

In response to the new regulations handed down from the EPA, Sullivan County decided in 2001 to educate the staff and commissioners in "all things stormwater" such as state-organized Phase II training, local conferences as well as attending local working groups doing the same. To take that one-step further, the county decided to partner with the other local MS4 communities with the formation of the *Northeast Tennessee Stormwater Planning Group*. This group consisted of staff engineers, public works officials and the county's planner, with participation from Sullivan County; Kingsport; Bristol, TN; Elizabethton; and Johnson City. This *NE TN Stormwater Planning Group* organized and met regularly in hopes of developing a systematic approach to NPDES compliance and public education. In late 2001, the Stormwater Planning Group collectively selected Amec Earth & Environmental, Inc., an engineering consultant, to assist them in the NPDES Phase II planning project. The baseline reports were individually adopted and the MS4 permits were issued in 2003. This began the first Five-Year Phase II Permitting Cycle (2003-2008) for Phase II compliance.

In order to fulfill these obligations (BMPs) specified in the County's NPDES Permit of March 2003 and the accompanying ***Stormwater Pollution Prevention Management Program***, several policies, ordinances/resolutions, operating procedures, and activities were identified. Over the last five years of implementing these activities, some revisions to the schedule have been made as summarized in subsequent annual reports. As part of the county's permit and SWPPP program, the Health and Safety Codes Officer was designated as the main staff person to visually assess each impaired stream, keep records of such and report back to the Stormwater Administrator for the county. This task would establish a baseline for identifying sources of pollution otherwise not determined by the 303D Reports. Visual-assessments taken annually and during dry-weather have proven to be very useful for the department in managing the program, setting priorities and measures of enforcement. Non-scheduled dry-weather and wet-weather screenings are also performed on an as-needed basis or when complaints of illicit discharge or erosion occur.

In addition to the county's baseline visual assessments, the Tennessee Department of Environment & Conservation (TDEC) performs stream sampling of the impaired streams and publishes their findings and assessments every other year. On August 14, 2006, TDEC approved a report on the Siltation and Habitat Alteration with findings of the total maximum daily loads (TMDLs) for waters identified as impaired in the NPDES Phase II jurisdiction of Sullivan County, Tennessee. This means that of the many identified segments of water bodies in Sullivan County that are impaired, sixteen of them have been identified as having TMDLs over the levels considered safe and sufficient with regards to water quality due to either sediment build up and/or alterations of the natural aquatic habitats. These TMDLs may be attributed to many factors such as poor agrarian practices, general construction activities, urbanization with detrimental land-use densities or high-intense land-uses, illicit discharges directly or indirectly flowing into the waters or other unknown causes. However, only through an intense in-the-field and hands-on assessment of these impaired streams will the sources of pollution be determined. Almost every named creek in the county is impaired to some degree, but some are in very poor condition and have reached that threshold per TMDL levels.

While these approved and published reports from the EPA and TDEC have proven to be very beneficial to the regulatory agencies, they have not been sufficient for the local MS4s to use in order to truly get a handle on the most effective strategies for water quality improvement planning. That is to say, while the TDEC findings are a great resource, it is difficult to pinpoint the segments most affected by pollutants and justify land-use policy changes accordingly. Therefore, the EPA, with the oversight from the TDEC office, is now requiring the county to implement a Five-Year Monitoring Plan of these TMDL impaired streams pursuant to the new EPA's ruling. Furthermore, the EPA clarified that local Phase II MS4 communities would now be responsible for preparing and implementing two separate Stream Monitoring Plans: for both Siltation/Habitat Alteration as well as Pathogens using the 2004 List of Impaired Streams found in the 303D Report. Such plans will better serve at implementing BMP#3 - detecting and eliminating illicit discharges (illegal dumping of non-stormwater related discharges) into the impaired streams and tributaries.

II. SCHEDULE FOR MONITORING PLAN IMPLEMENTATION:

In April of 2007 the local TDEC field office informed the county's Stormwater Administrator that the two-part TMDL Stream Monitoring Plans would be due at the end of the summer – much earlier than anticipated. By two-part, shall mean one separate plan detailing the protocol and monitoring schedule to be used over the next five years for the impaired streams with a TMDL for Siltation/Habitat Alteration (see Appendix A, TMDL Map 2) and one separate plan for the impaired streams with a TMDL for Pathogens (included in next plan). Several of the impaired streams on the 2004 303-D List have been identified as having TMDLs for both pollutants (see Appendix A, TMDL Composite Map 3). While the county was fully aware of the need to visually assess these streams on an annual basis at the very least, monitoring plans including water sampling of each impaired stream was *not* scheduled nor budgeted for by the county during this permit cycle. Therefore, water sampling and certified lab analyses of these monitoring points for the TMDL streams, will not begin until the passing of the County's Fiscal Year Budget of 2008-2009, or late next summer. However, visual assessments will continue, primary stormwater outfalls will be mapped, illicit discharge and detection identification will begin (using GPS and GIS mapping) and other stormwater planning activities will continue throughout the FY 2007-2008 year and subsequent permitting cycles. The county hopes to have an accurate and comprehensive map identifying the primary stormwater outfalls in its jurisdiction in order to make more informative choices for future water sampling sites.

Of the sixteen impaired streams for siltation and habitat alteration listed in the 2006 TMDL Report, nine streams fall under the monitoring jurisdiction of the county. While some of these nine streams begin in the cities' jurisdictions, they outfall into the county's area. The impaired segments of Madd Branch, Transbarger Branch, Reedy Creek, Cedar Creek, and Beaver Creek are within the jurisdictions of Kingsport and Bristol cities. Paint Springs Branch, Dry Creek and other branches of the river have been de-listed according to the TDEC website. These creeks were listed in the 2006 TMDL report, but not recognized on the TDEC map and data set as being impaired using the 2006 303D List for siltation and habitat alteration. Therefore, time and money will be spent on the impaired streams that are more critical to water quality improvement. The following table identifies the list of impaired streams within the county's monitoring jurisdiction.

The table identifies proposed sites and dates for testing. However, please note, based upon budgetary constraints, a further refinement of such sites may result in limiting the number of sites per impaired stream, if more than one site on a stream is proposed at this time. Reduction in testing sties will be based upon further in-field research such as windshield land-use analyses and stormwater outfalls mapping.

By collecting a more refined survey of the point and non-point sources of pollution from these assessments, some testing sites can be ruled out. At this time, sites were selected based upon the knowledge at hand, using the newly developed 2006 Existing Land Use Analysis Map in conjunction with the TDEC monitoring sites map. The following is an anticipated schedule for water sampling and stream monitoring for each segment of impaired stream on the 2006 TMDL Report (which was based upon the 2004 303D List for impaired streams due to siltation and habitat alteration:

Table 1 – Sullivan County – Proposed Monitoring Sites of Impaired Streams on the 2006 TMDLs – Siltation/Habitat Alteration

	Waterbody ID	Name of Waterbody	Miles Impaired	Testing Sites (tentative location – subject to change)	Scheduled Date of the Water Sample Collection	Latitude/Longitude location
1	TN06010102006T-0100	Gammon Creek	3.8	2 sites – one near the Kpt. City-limits by their industrial park and the second site near Deck Ln. near businesses with outside storage	Fall 2008	1st site: 82.4236/36.4600 2nd site: 82.4125/36.4780
2	TN06010102006T-0200	Wagner Creek	5.5	2 sites – one by NESTCC rear of campus (new construction area and the second site by new subdivisions	Spring 2009	1st site: 82.3984/36.4848 2nd site: 82.4058/36.5160
3	TN06010102006T-0300	Candy Creek	3.2	2 sites – one at mouth of creek and second site where second segment outfalls into main segment	Fall 2009	1st site: 82.3810/36.4834 2nd site: 82.3774/36.4817
4	TN060101020012-0100	Unnamed Tributary To South Fork Holston River	2.0	1 site near urban area of Bluff City	Fall 2009	82.2475/36.4949
5	TN06010102012-0200	Paddle Creek	4.44	2 sites – one at each segment before the "y" as it comes together	Spring 2010	1st site: 82.1955/36.52027 2nd site: 82.1869/36.5034
6	TN06010102012-0300	Unnamed Trib. To South Fork Holston River	3.89	2 sites - one at each segment before the "y" as it comes together	Fall 2010	1st site: 82.1625/36.5334 2nd site: 82.1555/36.5336
7	TN06010102012-810	Big Arm Branch	5.77	1 site near higher residential densities/mhparks	Spring 2011	82.2200/36.4118
8	TN06010102042-0200	Back Creek	14.1 (partly in City of Bristol)	2 sites – at upper mouths of the stream segments near Bristol's urbanized areas	Fall 2011	1st site: 82.2884/36.5431 2nd site: 82.2901/36.5586
9	TN06010102237-1000	Muddy Creek	12.3	3 sites – one near the downtown Blountville area at 126/County Hill Rd, 2nd site near 126 near mouth of stream and 3rd site near end of creek near Muddy Creek Rd	Spring 2012	1st site: 82.3552/36.4991 2nd site: 82.3427/36.5311 3rd site: 82.3282/36.5326

*****Footnote: the 2006 303Dlist of Impaired Streams for Siltation and Habitat Alteration de-listed a stream segment on the South Fork Holston River (Kingsport area) but added additional streams. Such streams shall be monitored in the future.***

III. MAPPING THE MONITORING SITES:

The first map shown below is called the *Siltation/Habitat Alteration Impaired Streams Map* using the TDEC Impaired Streams Map using the 2006 303D List with the monitoring sites used by their agency. This was the only data available off of the State's website as provided, however the 2004 303D List had fewer number of stream segments that were impaired. Additional data layers were added to this map such as the county's jurisdiction illustrating all streams, the three proposed monitoring sites for Kingsport, (the proposed sites for Bristol will be added when their data is release) and the proposed sites scheduled for the county to monitor. The sites for the county's proposed monitoring were chosen from the nine impaired streams on the 2004 303D List by comparing their locations with the other monitoring sites. The administrator also reviewed the 1999 and the 2006 existing land use analysis maps, as prepared by the Sullivan County Planning & Zoning Department, GIS Division. By comparing the land uses along the impaired stream segments, the administrator chose proposed monitoring sites that were located in more urbanized or developing areas – ruling out areas that are known to be primarily agricultural. Only until the data is collected, analyzed, mapped and documented will the sources of pollutants be targeted more accurately. Physically walking the streams and identifying the outfalls will also aid in this process. The final map is a composite map detailing the broad picture of the county's tasks at hand. That is to say, the composite map details all blue-line streams, all urban growth boundaries of the cities, the cities' city-limits, the major road networks, the 2006 list of impaired streams for both siltation/habitat alteration and e.coli pollutants, the TDEC monitoring sites and the proposed monitoring sites of the MS4s, and the primary stormwater outfalls (bridges, creek-crossings, culverts, drainage basins). The reduced copies of these maps as inserted into the document do not show all layers of data; however the working copy of this composite map is a wall-sized version that also pinpoints these data layers more accurately. Inspection and data collection teams will be using an indexed set of the composite map in the field while collecting additional data using digital cameras and GPS devices. If the budget allows, GPS units will be upgraded for better accuracy of data collection, whereas the current device is accurate to only 1 to 3 meters. At the end of this projected five-year monitoring period, the databases and mapping of such should provide a level of information needed to determine the point and non-point sources of pollutants along these impaired streams so that the local MS4s and TDEC can further enforce regulatory measures to persons causing harm to the water bodies.

IV. METHODOLOGY FOR TMDL MONITORING - MINIMUM REQUIREMENTS FOR SAMPLING AND STREAM SURVEY ASSESSMENTS:

1. Biological stream sampling shall be performed utilizing the Semi-Quantitative Single Habitat (SQSH) Method as identified in the TDEC Division of Quality System Standard Operating Procedure for Macro-invertebrate Stream Survey, revised October 2006. At least one water sample shall be collected per proposed county monitoring site as identified on the map during the scheduled time. The standard operating procedure for these samplings shall conform to TDEC standards outlined in Bugs Standard Operating Procedure, 2006 found on the State's website. A certified laboratory in the region shall collect all samples.
2. Visual Stream Surveys and IDDE inventories shall be performed throughout the sub watersheds of the TMDL (highlighted in red on Map 1). The main objective of the stream assessments/surveys shall be the identification and prioritization of point and non-point sources of pollutants. *The Maryland Department of Natural Resources, Watershed Restoration Divisions, Survey Protocols* will be used as a guide in performing all visual stream surveys. Any changes to these procedures shall be reported in subsequent plans and annual reports and submitted to the local field office of TDEC in Johnson City, as well as the TDEC statewide stormwater coordinator. The county will train additional teams to conduct these surveys along each stream segment. The field teams will be perform the stream surveys and IDDE inventories in coordination with the water sampling schedule (as outlined in the above table) with additional research on going throughout the entire lengths of the streams to rule out other possible sources of pollutants.

Respectfully submitted:_______________________________

Ambre M. Torbett, AICP
Sullivan County, TN
Director of Planning & Zoning/Stormwater Administrator

Date:____

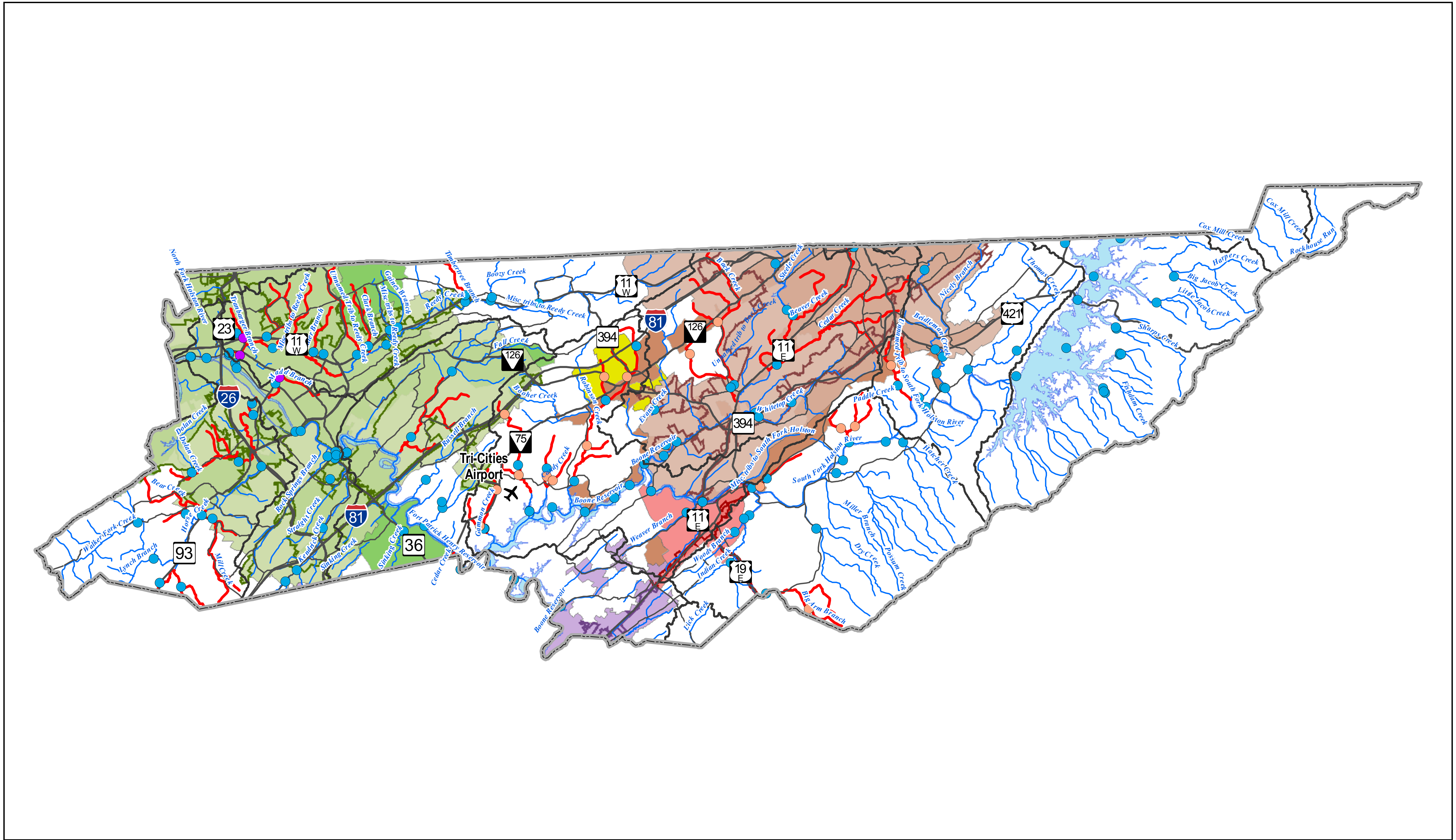
APPENDIX

1. ***Map 1 – Siltation/Habitat Alteration of Impaired Streams for Sullivan County (reduced scale)***

2. ***Map 2 – Stormwater Outfalls Survey and Assessment - Composite Map of all TMDLs, all Monitoring Sites, and 303D Listed Streams (reduced scale)***

Insert map 1

Insert map 2



Monitoring Sites

- TDEC
- Sullivan County
- Kingsport
- Bristol

- TMDL Siltation Impaired Streams
- Streams
- Watersheds

Road Classification

- Arterial
- Collector

City Limits

- Kingsport
- Bristol
- Johnson City
- Bluff City

Urban Growth Boundaries

- Kingsport
- Bristol
- Johnson City
- Bluff City

Urbanized Areas

- Kingsport
- Bristol
- Blountville

Prepared by the Sullivan County Planning & Zoning Office: GIS Division

Miles

0 3.5

Sullivan County, Tennessee

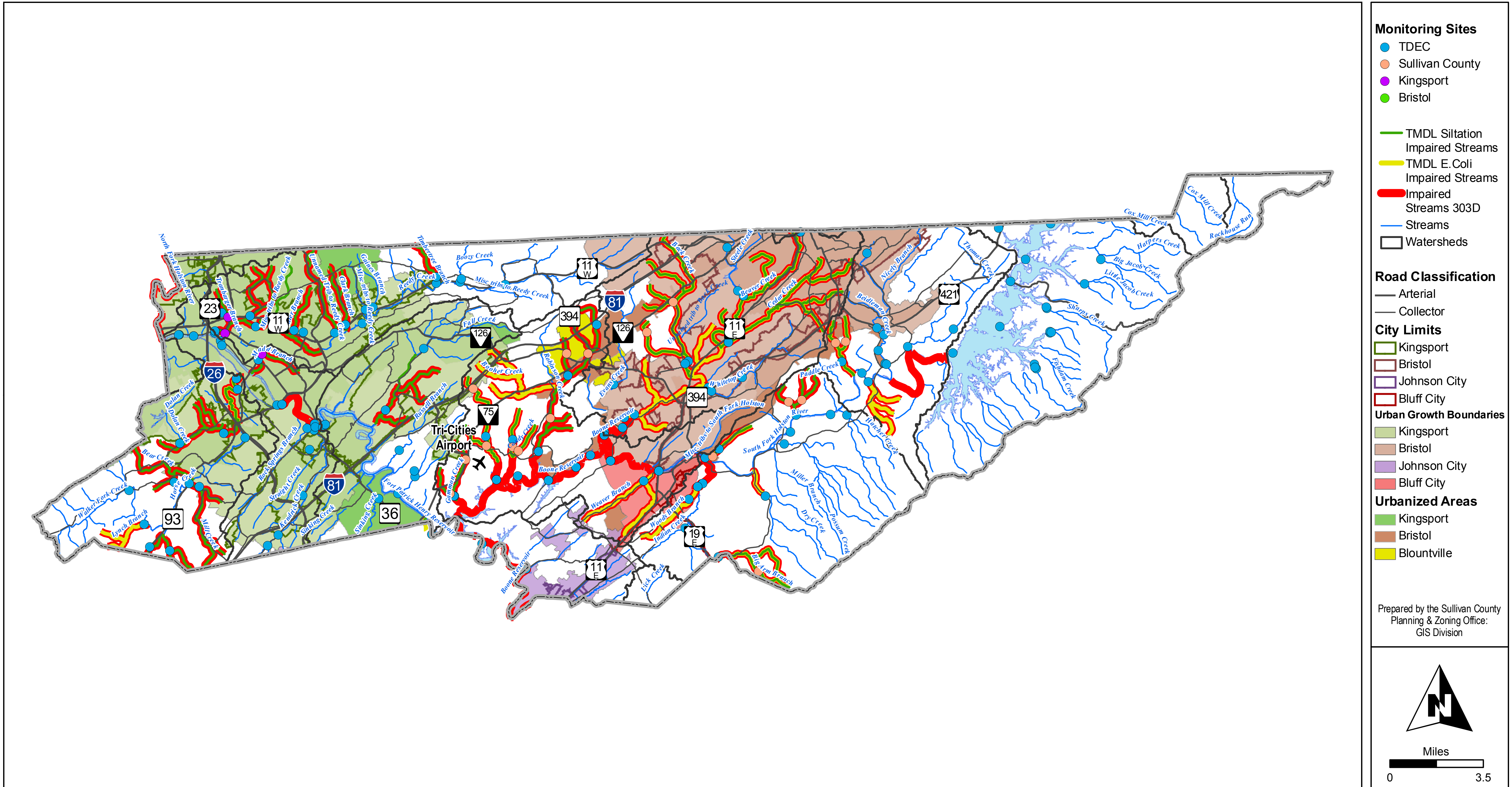
Siltation / Habitat Alteration Impaired Streams

Source: Tennessee Department of Environment and Conservation: 2006 303 (d) List

Description:
Siltation Impairment

Map ID:
Siltation Impairment 11x17

Date:
05/31/2007



Sullivan County, Tennessee

Storm Water Outfalls Survey and Assessment

Source: Tennessee Department of Environment and Conservation: 2006 303 (d) List

Description:
Storm Water Outfalls

Map ID:
Storm Water Outfalls 11x17

Date:
03/30/2007

City of Kingsport

TOTAL MAXIMUM DAILY LOAD (TMDL)

STREAM MONITORING PLAN

For

Sediment and Habitat Alteration

South Fork Holston River Watershed (HUC 06010102)

Permit No. TNS075388

303(d) Listed Stream Segments

Reedy Creek, Madd Branch, Tranbarger Branch

Submitted By:

Daniel A. Wankel
Stormwater Engineer
Kingsport, TN 37664
Phone: (423) 224-2727
Fax: (423) 224-2634
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August 7, 2007

Introduction

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not attaining water quality standards. State water quality standards consist of designated use(s) for individual water bodies, appropriate numeric and narrative water quality criteria protective of the designated uses and an anti-degradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a water body that will allow the water body to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and non-point sources in order to restore and maintain the quality of water resources (USEPA, 1991).

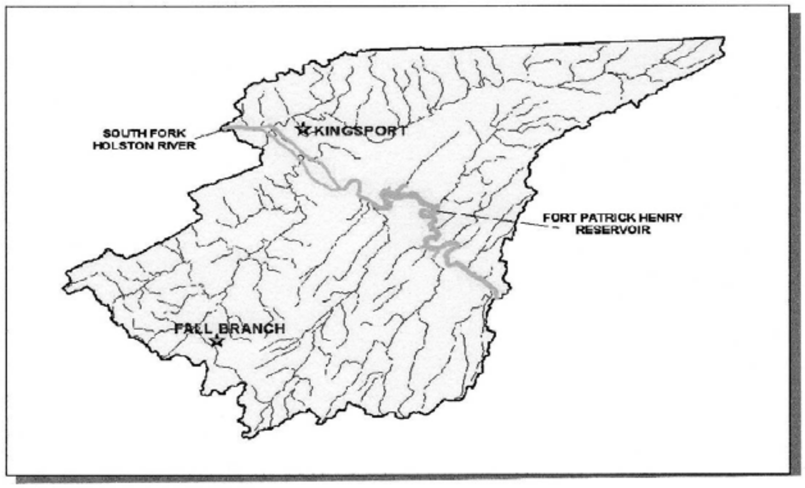
Purpose

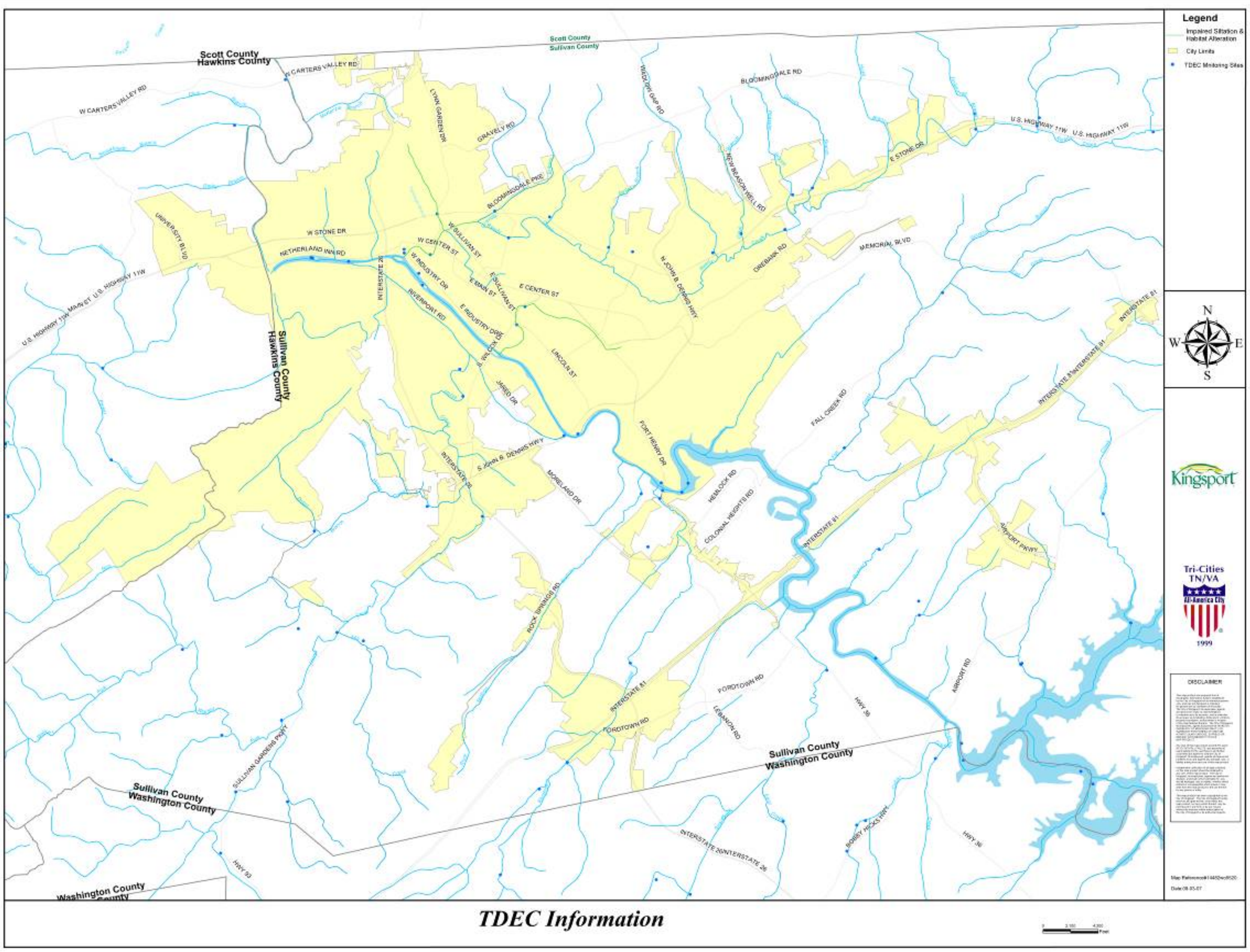
In December 2000, the Cities of Kingsport, Johnson City, Bristol and Elizabethton entered into an interlocal agreement to establish a watershed based stormwater planning group to comply with the requirements of the Phase II Stormwater Pollution Control Program as promulgated by the United States Environmental Protection Agency (EPA). Subsequently, a consultant was hired and charged with assisting the group and each community to achieve compliance collectively and individually.

The purpose of this document is to comply with monitoring requirements associated with the Total Maximum Daily Load (TMDL) for Siltation and Habitat Alteration in the South Fork Holston River Watershed as described in NPDES Permit No. TNS075388, Section 3.1.1.1.

Location

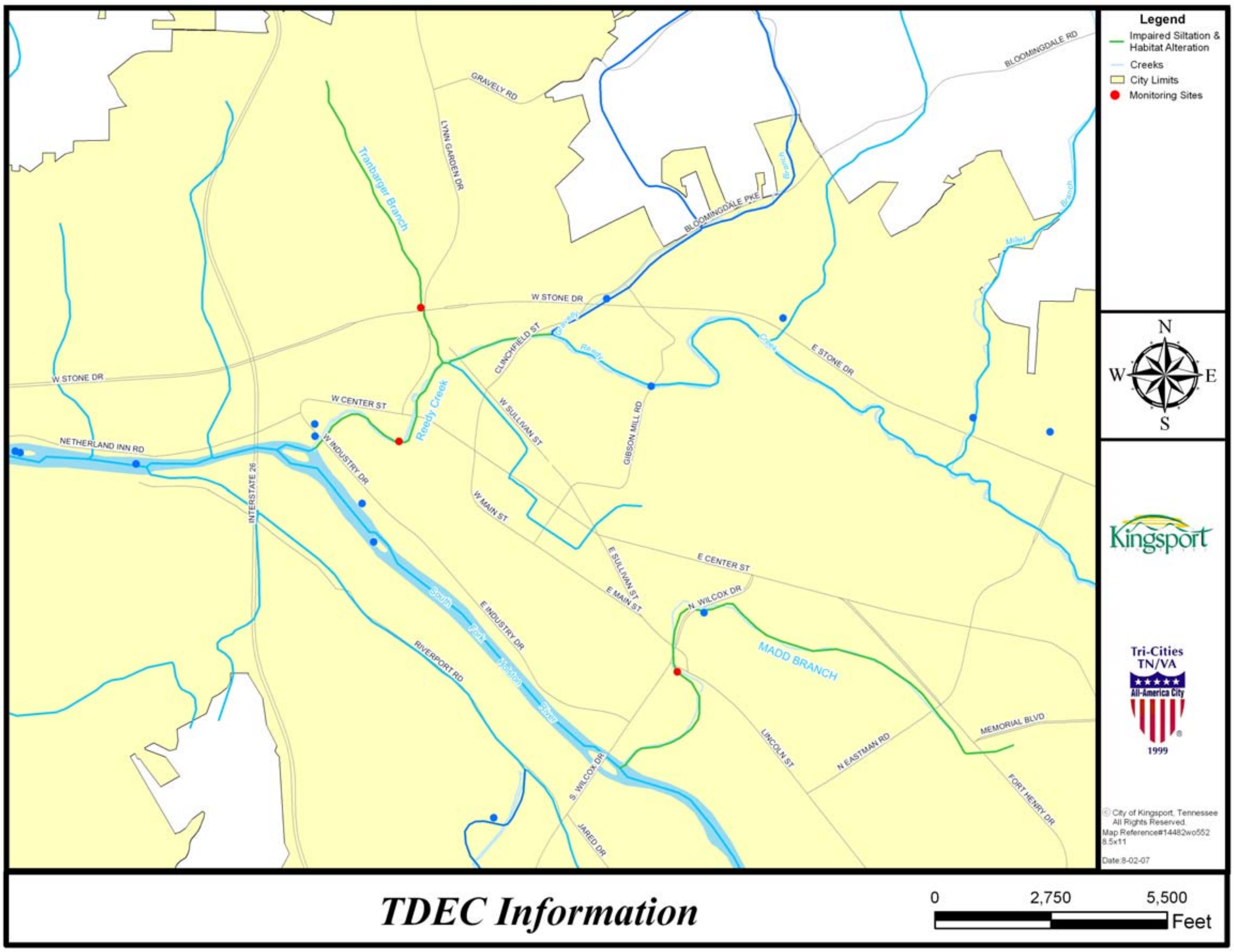
In 2004, EPA Region 4 approved the TMDL for Siltation and Habitat Alteration in the South Fork Holston River Watershed (HUC 06010102). Impaired waterbodies addressed in the TMDL that are within the City of Kingsport's boundary are as follows:





Impaired Streams/Testing Sites

Waterbody ID	Waterbody	Miles Impaired	Testing Site	Latitude	Longitude
TN06010102001-0100	Madd Branch	2.7	Mile 1.2 near day care.	36.5390	82.5464
TN06010102046-0100	Tranbarger Branch	1.4	Mile 0.3 above car wash	36.5622	82.5686
TN06010102046-1000	Reedy Creek	2.0	Mile 0.4 behind former athletic field, now skate park	36.5514	82.5772



Monitoring Plan

The City of Kingsport monitoring plan for the South Fork Holston River Siltation and Habitat Alteration TMDL will consist of the following:

1) A biological stream sampling utilizing the Semi-Quantitative Single Habitat (SQSH) method via a certified laboratory to ensuring that the State of Tennessee standard operating procedure for Macro invertebrate Stream Survey (Appendix A) is followed. Below is a list of scheduled testing to compliment TDEC's monitoring:

Segment Reference #	Segment Name	Proposed Date of Test
TN06010102046-0100	Tranbarger Branch	2010
TN06010102001-0100	Madd Branch	2008
TN06010102046-1000	Reedy Creek	2011

The plan will also incorporate other testing each year as the budget allows in order to isolate tributaries that are sources of contamination, and also the possibility of eliminating some segments listed as impaired.

2) A visual stream survey and impairment inventory will be conducted on the listed segments and their tributaries to identify and prioritize impairment sources. All sub-water sheds in the MS4 jurisdiction will be surveyed during the five year period according to the following schedule:

   - **Sub-watershed 060101020602(Madd Branch) Inspect 2008**
   - **Sub-water shed 060101020604(Tranbarger Branch) Inspect 2009**
   - **Sub-water shed 060101020604(Reedy Creek) Inspect 2010**

   The Maryland Department of Natural Resources, Watershed Restoration Divisions, Survey Protocols will be used as a guide in performing all visual stream survey. Any modifications to this protocol will be submitted along with the report.

   The City of Kingsport plans to survey all stream segments in each watershed within the City bounds, however, at a minimum, will look immediately upstream and downstream at each outfall to determine if the any pollutants are being conveyed by the system and are they causing impairment. In addition, the City will implement the terms of its MS4 Permit to the fullest extent, ensuring that all existing BMPs are being used to meet the waste load allocations (WLA) for each stream segment.