TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Siltation and Habitat Alteration

In The

Upper Duck River Watershed (HUC 06040002)

Bedford, Coffee, Franklin, Giles, Lincoln, Marshall, Maury, Moore, Rutherford, and Williamson Counties, Tennessee

FINAL

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LIST OF ABBREVIATIONS

ARS	Agricultural Research Station
BMP	Best Management Practices
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DWPC	Division of Water Pollution Control
EFO	Environmental Field Office
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NHD	National Hydrography Dataset
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NSL	National Sediment Laboratory
RM	River Mile
RMCF	Ready Mixed Concrete Facility
STATSGO	State Soil and Geographic Database
SSURGO	Soil Survey Geographic Database
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMD	Water Management Division
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

UPPER DUCK RIVER WATERSHED (HUC 06040002)

Total Maximum Daily Load for Siltation/Habitat Alteration in Waterbodies Identified on the State of Tennessee's *2004 303(d) List*

Impaired Waterbody Information:

State: Tennessee
Counties: Bedford, Coffee, Franklin, Giles, Lincoln, Marshall, Maury, Moore, Rutherford and Williamson
Watershed: Upper Duck River (HUC 06040002)
Watershed Area: 1,181 mi^2
Constituent of Concern: Siltation/Habitat Alteration
Impaired Waterbodies: *2004 303(d) List*

Waterbody ID	Impaired Waterbody	RM
TN06040002001_0300	Goose Creek	7.3
TN06040002012_0100	East Rock Creek	16.9
TN06040002012_0700	Snell Branch	4.5
TN06040002012_2000	Big Rock Creek	9.0
TN06040002012_3000	Big Rock Creek	6.0
TN06040002021_0100	Little Sinking Creek	7.6
TN06040002021_1000 & 2000	Sinking Creek	26.4
TN06040002024_0100	Davis Branch	2.2
TN06040002027_0300	Butler Creek	14.2
TN06040002027_1000	Duck River	1.6
TN06040002033_0300	Bell Buckle Creek	11.1
TN06040002038_0300	Hurricane Creek	29.4
TN06040002038_1000	Fall Creek	11.4
TN06040002039_0250	Weakley Creek	13.1
TN06040002039_0300	Alexander Creek	21.1
TN06040002039_3000	North Fork Creek	9.2
TN06040002046_1000	Wilson Creek	19.5
TN06040002047_0300	Lick Creek	8.8
TN06040002048_0100	Thick Creek	13.4
TN06040002048_1000	Caney Creek	13.1

Designated Uses:	Fish & aquatic life, irrigation, livestock watering & wildlife, and recreation. Some waterbodies in watershed also classified for domestic and/or industrial water supply.
Applicable Water Quality Standard:	Most stringent narrative criteria applicable to fish & aquatic life use classification.

Biological Integrity: The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06.

Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion and (b) is of the appropriate stream order specified for the bioregion and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods.

Interpretation of this provision for all other streams, plus large rivers, reservoirs, and wetlands, may be made using Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA/841-B-99-002) and/or other scientifically defensible methods. Effects to biological populations will be measured by comparisons to upstream conditions or to appropriately selected reference sites in the same bioregion if upstream conditions are determined to be degraded.

Habitat: The quality of instream habitat shall provide for the development of a diverse aquatic community that meets regionally based biological integrity goals. The instream habitat within each subecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.

TMDL Development

General Analysis Methodology:

- Analysis performed using the Watershed Characterization System Sediment Tool (based on Universal Soil Loss Equation (USLE)) applied to impaired HUC-12 subwatershed areas to calculate existing sediment loads.

- Target sediment loads (lbs/acre/year) are based on the average annual sediment load from biologically healthy watersheds (Level IV Ecoregion reference sites).

- TMDLs are expressed as the percent reduction in average annual sediment load required for a subwatershed containing impaired waterbodies relative to the appropriate target load.

- 5% of subwatershed target loads are reserved to account for Waste Load Allocations

(WLAs) for Ready Mixed Concrete Facilities (RMCFs) and regulated mining sites. Most loading from these sources is small compared to total loading. Since the Total Suspended Solids (TSS) component of Sewage Treatment Plant (STP) discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced from erosional processes, TSS discharges from STPs were not considered in the TMDL analysis (ref.: Sections 3.0 and 6.0).

- WLAs for Municipal Separate Storm Sewer Systems (MS4s), WLAs for National Pollution Discharge Elimination System (NPDES) regulated construction storm water discharges, and Load Allocations (LAs) for nonpoint sources are expressed as the percent reduction in average annual sediment load required for a subwatershed containing impaired waterbodies relative to the appropriate reduced target load (target load minus 5% reserved WLAs for RMCFs and mining sites).

Critical Conditions: Methodology takes into account all flow conditions.

Seasonal Variation: Methodology addresses all seasons.

Margin of Safety (MOS): Implicit (conservative modeling assumptions).

TMDL/Allocations

TMDLs, WLAs for MS4s and Construction Storm Water Sites, and LAs for Nonpoint Sources:

HUC-12 Subwatershed (06040002___)	Waterbody ID	Waterbody	Level IV Ecoregion	TMDL (Required Overall Load Reduction)	Required Load Reduction	
					WLA (MS4s and Construction SW)	LA (Nonpoint Sources)
				[%]	[%]	[%]
0203	06040002033_0300	Bell Buckle Creek	71h	4.5	9.2	9.2
0301	06040002027_0300	Butler Creek	71i	54.2	56.5	56.5
	06040002027_1000	Duck River				
0305	06040002024_0100	Davis Branch		52.3	54.7	54.7
0308	06040002038_0300	Hurricane Creek		39.6*	42.8*	42.8*
	06040002038_1000	Fall Creek				
0309	06040002021_0100	Little Sinking Creek				
	06040002021_1000 & 2000	Sinking Creek				
0401	06040002039_3000	North Fork Creek				
0402	06040002039_0300	Alexander Creek				
0404	06040002039_0250	Weakley Creek				
0502	06040002046_1000	Wilson Creek				
0503	06040002047_0300	Lick Creek				
0504	06040002048_0100	Thick Creek				
	06040002048_1000	Caney Creek				
0507	06040002001_0300	Goose Creek		32.4	35.8	35.8
0601	06040002012_0700	Snell Branch		26.8	30.5	30.5
	06040002012_2000 & 3000	Big Rock Creek				
0602	06040002012_0100	East Rock Creek		39.6*	42.8*	42.8*

*Assigned TMDLs, WLAs, and LAs. Ref.: Section 7.1.2 and Table 9.

WLAs for Mining Sites and RMCFs:

WLAs for NPDES regulated mining sites and RMCFs located in impaired subwatersheds are equal to existing permit limits for total suspended solids (TSS).

RMCFs Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed (06040002___)	**NPDES Permit No.**	**Facility Name**	**TSS Daily Max Limit**	**TSS Cut-off Conc. (SW Discharge)**
			[mg/l]	**[mg/l]**
0301	TNG110117	Sequatchie Concrete Service	50	200
	TNG110309	Bedford County Ready Mix		
0601	TNG110032	Childress Concrete Company		
	TNG110069	I.M.I TN, Inc.		

Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed (06040002___)	**NPDES Permit No.**	**Name**	**TSS Daily Max Limit**
			[mg/l]
0301	TN0066508	Vulcan Construction Materials – Shelbyville Quarry	40
	TN0022756	Rogers Group, Inc. – Shelbyville Quarry	
0401	TN0071846	Rogers Group, Inc. – Deason Quarry	
0507	TN0061395	Rogers Group, Inc. – Columbia Quarry	
0601	TN0003654	Rogers Group, Inc. – Lewisburg Quarry	
	TN0071251	Rogers Group, Inc. – Belfast Quarry	

TOTAL MAXIMUM DAILY LOAD (TMDL)
FOR SILTATION/HABITAT ALTERATION
UPPER DUCK RIVER WATERSHED (HUC 06040002)

1.0 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 waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses, and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and nonpoint sources in order to restore and maintain the quality of water resources (USEPA, 1991).

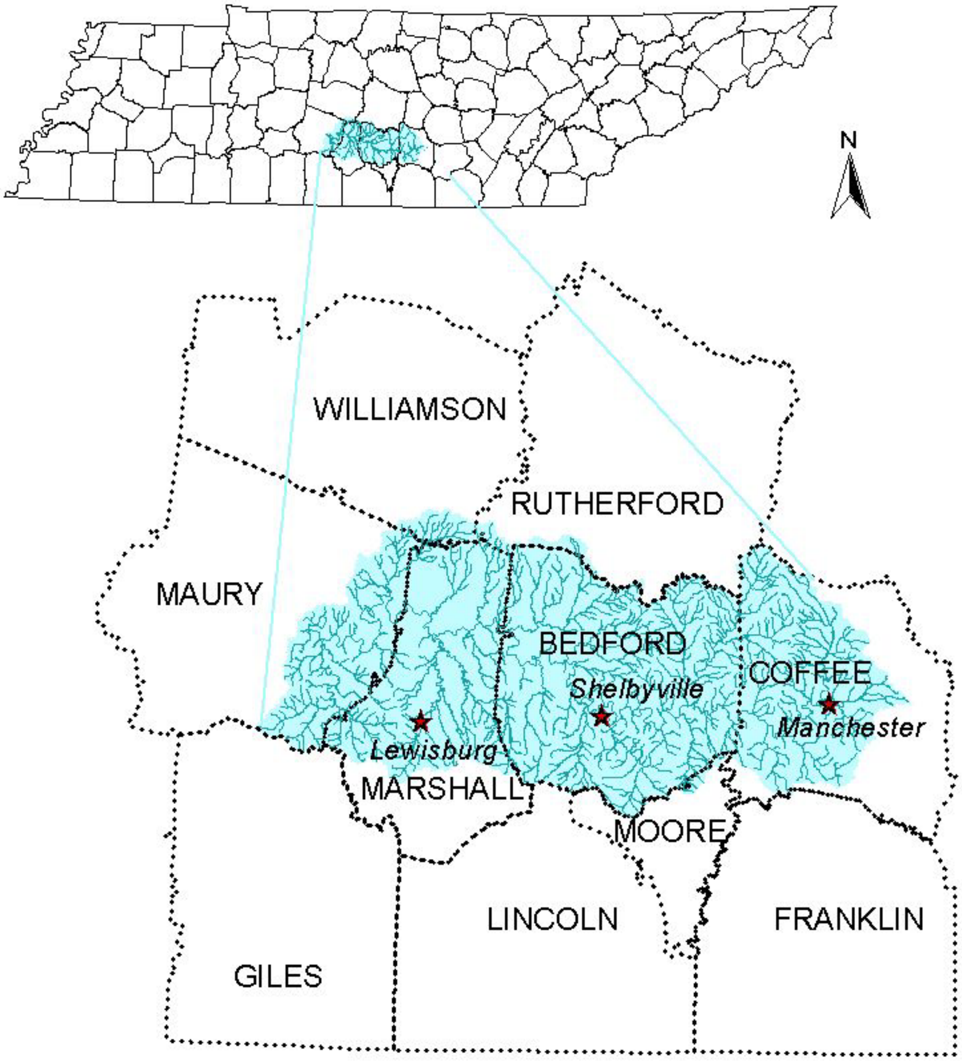
2.0 WATERSHED DESCRIPTION

The Upper Duck River Watershed, Hydrologic Unit Code (HUC) 06040002, is located in Middle Tennessee (ref.: Figure 1) in Bedford, Coffee, Franklin, Giles, Lincoln, Marshall, Maury, Moore, Rutherford, and Williamson Counties. The Upper Duck River Watershed lies within a single Level III ecoregion (Interior Plateau) and contains four Level IV subecoregions as shown in Figure 2 (USEPA, 1997):

- Western Highland Rim (71f) is characterized by dissected, rolling terrain of open hills, with elevations of 400-1000 feet. The geologic base of Mississippian-age limestone, chert, and shale is covered by soils that tend to be cherty and acidic with low to moderate fertility. Streams are relatively clear with a moderate gradient. Substrates are coarse chert, gravel and sand with areas of bedrock. The native oak-hickory forests were removed over broad areas in the mid-to late 1800's in conjunction with the iron-ore related mining and smelting of the mineral limonite, however today the region is again heavily forested. Some agriculture occurs on the flatter interfluves and in the stream and river valleys. The predominant land uses are hay, pasture, and cattle with some cultivation of corn and tobacco.

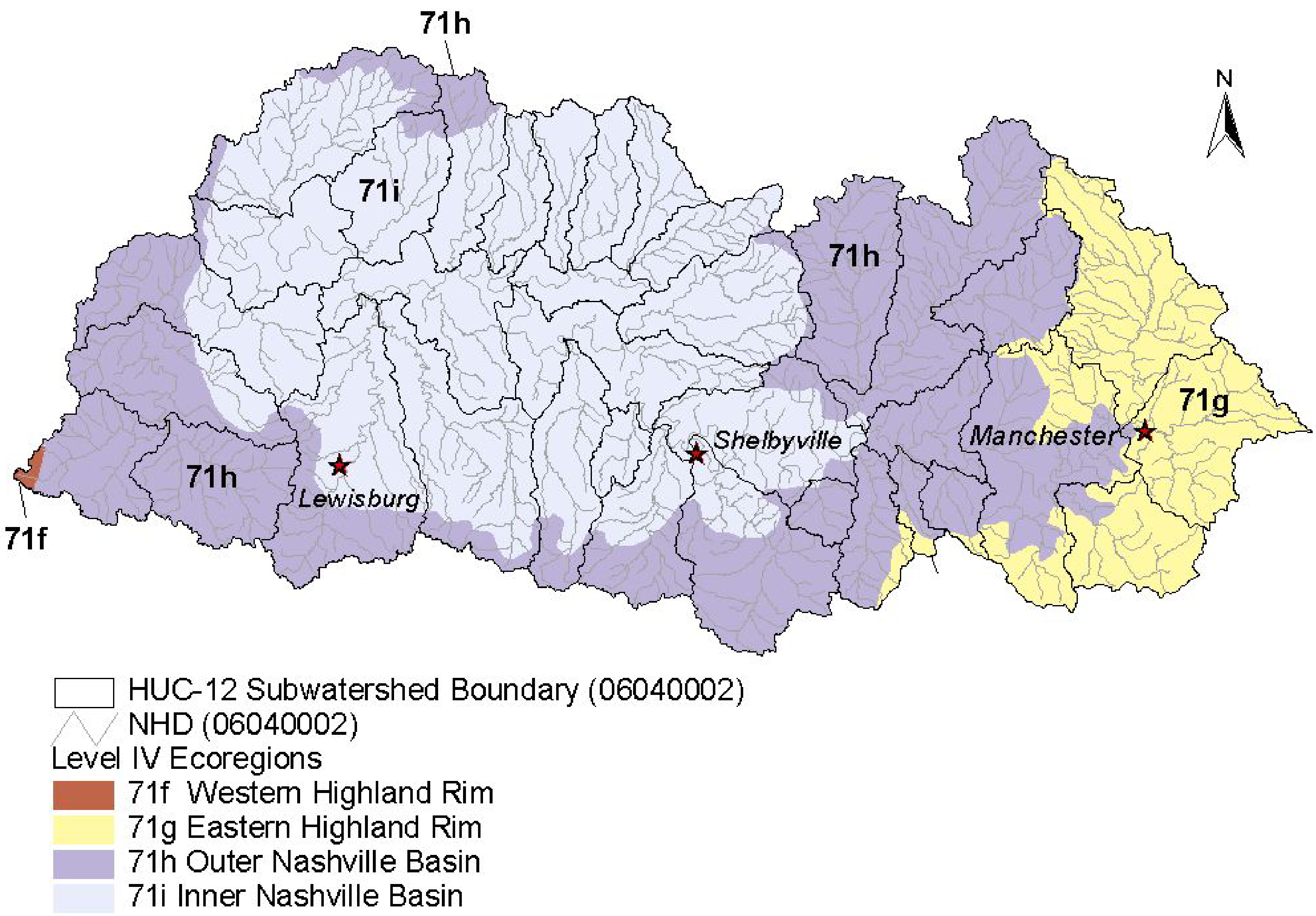
- Eastern Highland Rim (71g) has more level terrain than the Western Highland Rim (71f), with landforms characterized as tablelands of moderate relief and irregular plains. Mississippian-age limestone, chert, shale and dolomite predominate. Karst terrain sinkholes and depressions are especially noticeable between Sparta and McMinnville. Numerous springs and spring-associated fish fauna typify the region. Natural vegetation is transitional between the oak-hickory forests to the west and the mixed mesophytic forests of the Appalachian ecoregions (68, 69) to the east. Bottomland hardwoods forests were once abundant in some areas, although much of the original bottomland forest has been inundated by several large impoundments. Barrens and former prairie areas are now primarily oak thickets, pasture or cropland.

Figure 1 Location of the Upper Duck River Watershed



- Outer Nashville Basin (71h) is a more heterogeneous region than the Inner Nashville Basin (71I), with rolling and hilly topography with slightly higher elevations. The region encompasses most of the outer areas of the generally non-cherty Ordovician limestone bedrock. The higher hills and knobs are capped by the more cherty Mississippian-age formation, and some Devonian-age Chattanooga shale, remnants of the Highland Rim. The region's limestone rocks and soils are high in phosphorus, and commercial phosphate is mined. Deciduous forest with pasture and cropland are the dominant land covers. The region has areas of intense urban development with the city of Nashville occupying the northwest region. Streams are low to moderate gradient, with productive, nutrient-rich waters, resulting in algae, rooted vegetation, and occasionally high densities of fish. The Nashville Basin has a distinctive fish population, notable for species that avoid the region, as well as those that are present.

Figure 2 Level IV Ecoregions in the Upper Duck River Watershed



- Inner Nashville Basin (71i) is less hilly and lower than the Outer Nashville Basin (71h). Outcrops of the Ordovician-age limestone are common. The generally shallow soils are redder and lower in phosphorous than those of the outer basin. Streams are lower gradient than surrounding regions, often flowing over large expanses of limestone bedrock. The most characteristic hardwoods within the inner basin are a maple-oak-hickory-ash-association. The limestone cedar glades of Tennessee, a unique mixed grassland/forest cedar glades vegetation type with many endemic species, are located primarily on the limestones of the Inner Nashville Basin. The more xeric, open characteristics and shallow soils of the cedar glades also result in a distinct distribution of amphibian and reptile species. Urban, suburban, and industrial land use in the region is increasing.

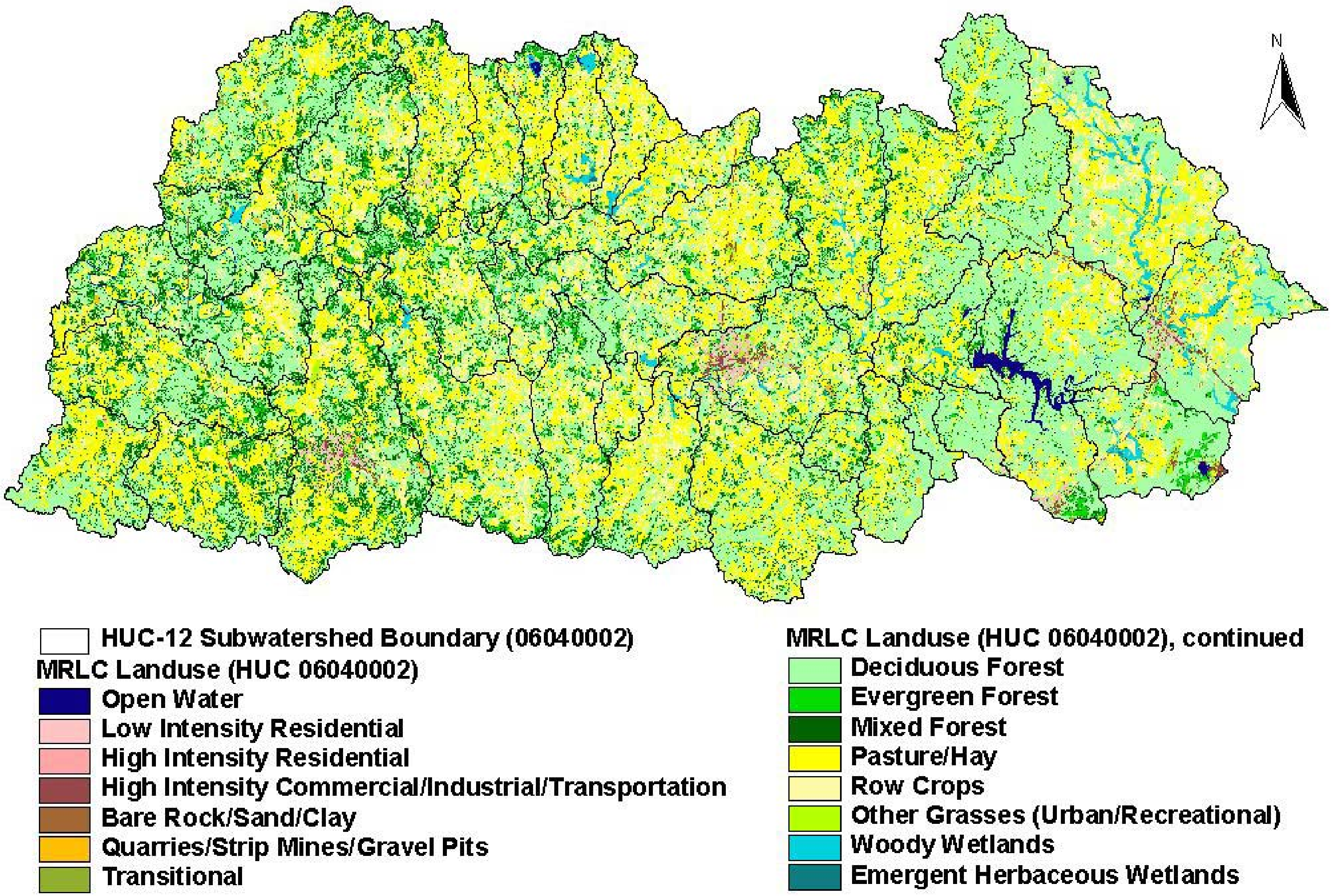
The Upper Duck River Watershed (HUC 06040002) has approximately 1,607 miles of streams and 3,260 lake acres of reservoir (based on the EPA/TDEC Assessment Database (ADB)) and drains approximately 1,181 square miles (ref.: Table 1) to the Tennessee River. Watershed land use distribution is based on the 1992 Multi-Resolution Land Characteristic (MRLC) satellite imagery databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Land use for the Upper Duck River Watershed is summarized in Table 1 and shown in Figure 3.

Table 1 Land Use Distribution - Upper Duck River Watershed

Land use	Area		
	[acres]	[mi^2]	[% of watershed]
Bare Rock/Sand/Clay	3	0.0	0.0
Deciduous Forest	296,264	462.9	39.2
Emergent Herbaceous Wetlands	420	0.7	0.1
Evergreen Forest	27,511	43.0	3.6
High Intensity Commercial/Industrial/Transportation	5,076	7.9	0.7
High Intensity Residential	1,190	1.9	0.2
Low Intensity Residential	5,806	9.1	0.8
Mixed Forest	85,377	133.4	11.3
Open Water	4,777	7.5	0.6
Other Grasses (Urban/Recreational)	3,205	5.0	0.4
Pasture/Hay	208,807	326.3	27.6
Quarries/Strip Mines/Gravel Pits	419	0.7	0.1
Row Crops	106,937	167.1	14.1
Transitional	652	1.0	0.1
Woody Wetlands	9,428	14.7	1.2
Total	**755,871**	**1,181.0**	**100.0**

Note: A spreadsheet was used for this calculation and values are approximate due to rounding.

Figure 3 MRLC Land Use in the Upper Duck River Watershed



3.0 PROBLEM DEFINITION

The State of Tennessee's *2004 303(d) List* (TDEC, 2005) identified a number of waterbodies in the Upper Duck River Watershed as not fully supporting designated use classifications due, in part, to siltation and/or habitat alteration associated with agriculture, urban runoff, land development, and bank modification. These waterbodies are summarized in Table 2 and shown in Figure 4. The designated use classifications for the Duck River, which includes the Upper Duck River and its tributaries, include fish & aquatic life, irrigation, livestock watering & wildlife, and recreation. Some waterbodies in the watershed are also classified for domestic water supply, industrial water supply, trout stream and/or naturally reproducing trout stream (TDEC, 2004).

A description of the stream assessment process in Tennessee can be found in *2006 305(b) Report, The Status of Water Quality in Tennessee* (TDEC, 2006). This document states that "biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing support of the fish & aquatic life designated use." The waterbody segments listed in Table 2 were assessed as impaired based primarily on biological surveys. The results of these assessment surveys are summarized in Table 3. The assessment information presented is excerpted from the ADB and is referenced to the waterbody IDs in Table 2. Assessment Database information may be accessed at:

http://gwidc.memphis.edu/website/dwpc/

Several examples of typical stream assessments are shown in Appendix D.

Siltation is the process by which sediments are transported by moving water and deposited on the bottom of stream, river, and lakebeds. Sediment is created by the weathering of host rock and is delivered to stream channels through various erosional processes, including sheetwash, gully and rill erosion, wind, landslides, dry gravel, and human excavation. In addition, sediments are often produced as a result of stream channel and bank erosion and channel disturbance. Movement of eroded sediments downslope from their points of origin into stream channels and through stream systems is influenced by multiple interacting factors (USEPA, 1999).

Siltation (sedimentation) is the most frequently cited cause of waterbody impairment in Tennessee, impacting over 5,800 miles of streams and rivers (TDEC, 2006). Unlike many chemical pollutants, sediments are typically present in waterbodies in natural or background amounts and are essential to normal ecological function. Excessive sediment loading, however, is a major ecosystem stressor that can adversely impact biota, either directly or through changes to physical habitat.

Excessive sediment loading has a number of adverse effects on fish & aquatic life in surface waters. As stated in excerpts from *Developing Water Quality Criteria for Suspended and Bedded Sediments (SABS) – Draft* (USEPA, 2003):

> In streams and rivers, fine inorganic sediments, especially silts and clays, affect the habitat for macroinvertebrates and fish spawning, as well as fish rearing and feeding behavior. Larger sands and gravels can scour diatoms and cause burying of invertebrates, whereas suspended sediment affects the light available for photosynthesis by plants and visual capacity of animals.

Table 2 ***2004 303(d) List*** **- Stream Impairment Due to Siltation/Habitat Alteration in the Upper Duck River Watershed**

Waterbody ID	Waterbody	Miles/ Acres	Source (Pollutant)	Cause (Pollutant)
06040002001_0300	Goose Creek	7.3	Other Habitat Alteration	Pasture Grazing
06040002012_0100	East Rock Creek	16.9	Loss of biological integrity due to siltation/Other Habitat Alterations	Pasture Grazing
06040002012_0700	Snell Branch	4.5	Loss of biological integrity due to siltation/Other Habitat Alterations	Land Development/ Channelization
06040002012_2000	Big Rock Creek	9.0	Nutrients/ Loss of biological integrity due to siltation/Low dissolved oxygen	Major Municipal Point Source/ Discharges from MS4 area
06040002012_3000	Big Rock Creek	6.0	Loss of biological integrity due to siltation/Other Habitat Alterations	Pasture Grazing
06040002021_0100	Little Sinking Creek	7.6	Loss of biological integrity due to siltation/Other Habitat Alterations	Pasture Grazing
06040002021_1000 & 2000	Sinking Creek	26.4	Loss of biological integrity due to siltation/Other Habitat Alterations	Pasture Grazing
06040002024_0100	Davis Branch	2.2	Loss of biological integrity due to siltation	Pasture Grazing
06040002027_0300	Butler Creek	14.2	Other Habitat Alterations	Pasture Grazing/Land Development
06040002027_1000	Duck River	1.6	Escherichia coli/Loss of biological integrity due to siltation	Collection System Failure/ Discharges from MS4 area
06040002033_0300	Bell Buckle Creek	11.1	Loss of biological integrity due to siltation/Other Habitat Alterations/Escherichia coli	Minor Municipal Point Source/ Livestock in Stream
06040002038_0300	Hurricane Creek	29.4	Escherichia coli/Nutrients/Loss of biological integrity due to siltation/Other Habitat Alterations	Pasture Grazing

Table 2 (Cont.) ***2004 303(d) List*** **- Stream Impairment Due to Siltation/Habitat Alteration in the Upper Duck River Watershed**

Waterbody ID	Waterbody	Miles/ Acres	Source (Pollutant)	Cause (Pollutant)
06040002038_1000	Fall Creek	11.4	Escherichia coli/Nutrients/ Loss of biological integrity due to siltation/Other Habitat Alterations	Pasture Grazing
06040002039_0250	Weakley Creek	13.1	Loss of biological integrity due to siltation/Nutrients/Escherichia coli	Agriculture
06040002039_0300	Alexander Creek	21.1	Loss of biological integrity due to siltation/ Escherichia coli	Pasture Grazing
06040002039_3000	North Fork Creek	9.2	Loss of biological integrity due to siltation/Nutrients/Escherichia coli	Agriculture
06040002046_1000	Wilson Creek	19.5	Escherichia coli/Nitrate/Other Habitat Alterations	Pasture Grazing
06040002047_0300	Lick Creek	8.8	Escherichia coli/Other Habitat Alterations	Livestock in Stream
06040002048_0100	Thick Creek	13.4	Loss of biological integrity due to siltation/Other Habitat Alterations/Escherichia coli	Pasture Grazing
06040002048_1000	Caney Creek	13.1	Nitrate/ Loss of biological integrity due to siltation	Livestock in Stream/ Removal of Riparian Vegetation

Figure 4 Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

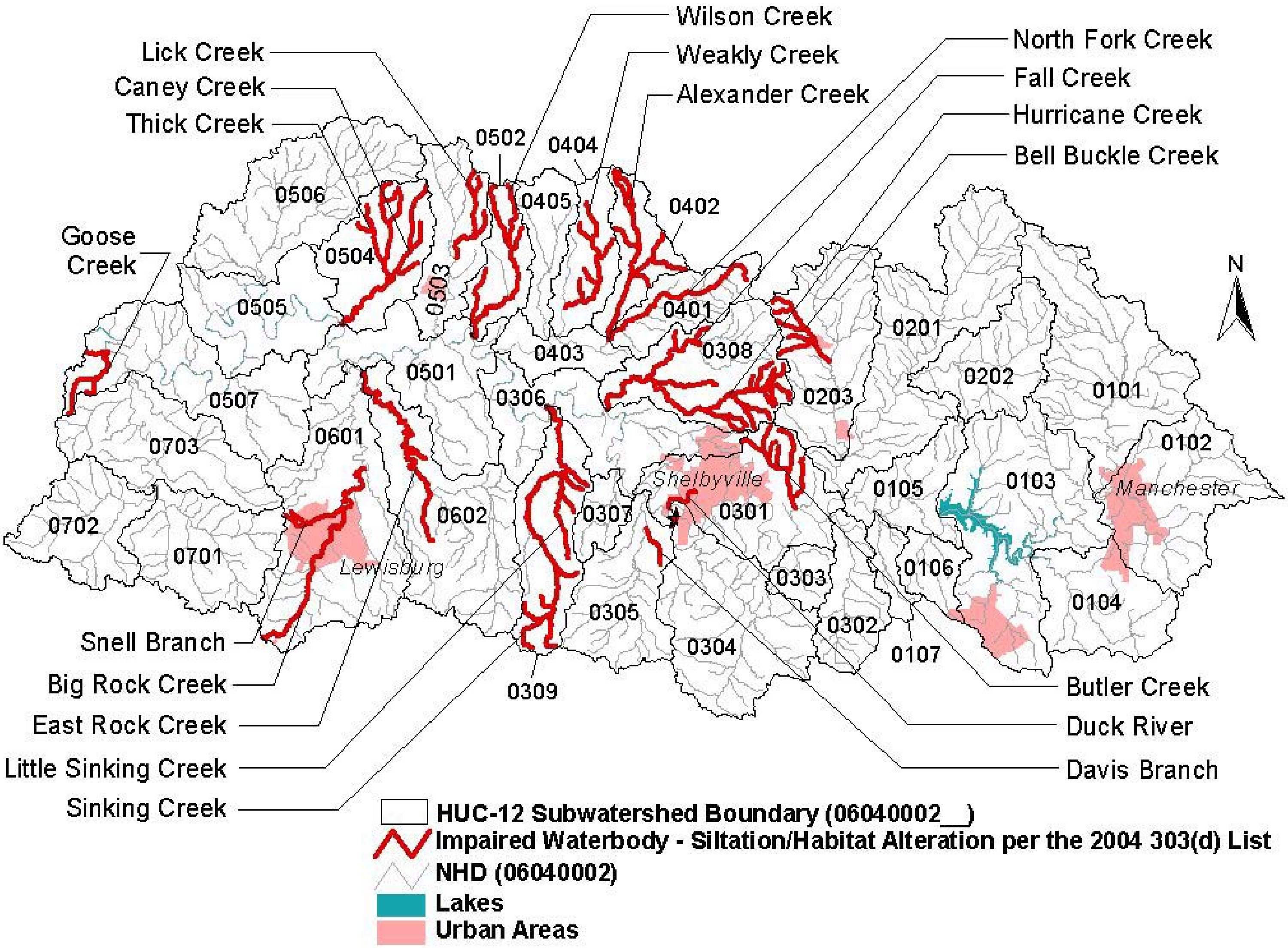


Table 3 Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration

Waterbody ID	Waterbody	Comments
06040002001_0300	Goose Creek (Duck River to headwaters)	2000 TDEC biological survey at mile 1.7 (Old Highway 50). 4 EPT families, 12 total families. Habitat score = 126.
06040002012_0100	East Rock Creek (Big Rock Creek to confluence of Mud Creek)	1999 TDEC biological survey at mile 10.3 (Highway 31A). 3 EPT families, 20 total families. Habitat score = 98. Chemical station at mile 1.8. Coliforms elevated. 1997 TVA survey at mile 1.9 (Anes Station Road). 8 EPT families, 23 total families.
06040002012_0700	Snell Branch (Big Rock Creek to headwaters)	TDEC biological station at mile 0.3 (Highway 272). 1 EPT family, 9 total families. Habitat score = 96.
06040002012_2000	Big Rock Creek (Dry Branch to Collins Hollow Road)	1999 TDEC biological survey at RM 16.8 (Hwy 431, d/s STP). 3 EPT families, 21 total families. Habitat score = 123. Chemical samples also at Highway 31A. Nutrients elevated. 1997 TVA survey at RM 11.5 (McBride Road). 4 EPT families.
06040002012_3000	Big Rock Creek (Collins Hollow Road to headwaters)	1999 TDEC biological survey at mile 19.3 (off Highway 31A, upstream of STP). 1 EPT family, 13 total families. Habitat score = 113.
06040002021_0100	Little Sinking Creek (Sinking Creek to headwaters)	TDEC 2000 probabilistic monitoring station at mile 1.0 at Sims Road. Violated proposed biocriteria for 71i. 1999 TDEC biological survey at mile 1.1 (Sims Road). 1 EPT families, 6 total families. Habitat score = 61.
06040002021_1000	Sinking Creek (Duck River to confluence of Cortner Branch)	TDEC 2000 probabilistic monitoring station at mile 1.2 at Wheel Road. Violated proposed biocriteria for 71i. 1999 TDEC biological survey at mile 8.6 (Gant Road). 1 EPT family, 12 total families. Habitat score = 99.
06040002021_2000	Sinking Creek (Corner Branch to headwaters)	TDEC 2000 probabilistic monitoring station at mile 8.9 u/s of Gant Road. Violated proposed biocriteria for 71i.
06040002024_0100	Davis Branch (Sugar Creek to headwaters)	TDEC 2000 probabilistic monitoring station at mile 0.2 at Richmond Pike. Violated proposed biocriteria for 71i.
06040002027_0300	Butler Creek (Duck River to headwaters)	TDEC biological survey at mile 0.2 (Mullins Mill Road). 6 EPT families, 22 total families. Habitat score = 109.
06040002027_1000	Duck River (Flat Creek to Highway 231)	TDEC stream survey by canoe.

Table 3 (Cont.) Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration

Waterbody ID	Waterbody	Comments
06040002033_0300	Bell Buckle Creek (Wartrace Creek to headwaters)	1999 TDEC biological station at mile 1.0 (downsteam STP). 0 EPT families, 16 total families. Habitat score = 95.
06040002038_0300	Hurricane Creek (Fall Creek to headwaters)	TDEC 2000 probabilistic monitoring station at RM 4.2 (Midland Road). Violated proposed biocriteria for 71i. Elevated fecal. 1999 TDEC biological station at RM 1.8 (Burns Road). 5 EPT families, 23 total families. Habitat score = 94.
06040002038_1000	Fall Creek (Duck River to headwaters)	TDEC 2000 probabilistic monitoring station at RM 3.0 (Gregory Mill Road). Violated proposed biocriteria for 71i. 1999 TDEC biological & 319 site at RM 1.2 (Old Unionville Road). 5 EPT families, 24 total families. Habitat score = 103. Pathogens elevated.
06040002039_0250	Weakley Creek (Unnamed tributary to headwaters)	TDEC 2000 probabilistic monitoring station at mile 5.2 at Coopertown Road. Violated proposed biocriteria for 71i. Three 319 stations in this watershed. Pathogens elevated.
06040002039_0300	Alexander Creek (North Fork Creek to headwaters)	TDEC 2000 probabilistic monitoring station at mile 4.0 u/s of Pepper Hill Road. Violated proposed biocriteria for 71i. E. coli also elevated. Dry when observed in August, 1999.
06040002039_3000	North Fork Creek (Alexander Creek to headwaters)	TDEC 2000 probabilistic monitoring station at mile 16.4 d/s of Squire Hall Road. Violated proposed biocriteria for 71i.
06040002046_1000	Wilson Creek (Duck River to headwaters)	2000 TDEC probabilistic station at mile 5.2 at Chapel Hill to Unionville Road. Site did not meet proposed biocriteria for 71i. Elevated E. coli levels. 2000 TDEC biological survey at mile 2.8 (Wright Rd). 4 EPT, 14 total families, habitat=144.
06040002047_0300	Lick Creek (Spring Creek to headwaters)	TDEC chemical station mile 1.6 (Mt Vernon Road). Coliforms elevated.
06040002048_0100	Thick Creek (Caney Creek to headwaters)	2000 TDEC probabilistic station at river mile 2.0 off Pyles Road. Site did not meet proposed biocriteria for 71i. (1 EPT genus, 14 total genera, habitat score=131, NCBI=7.59). Dominated by isopods. Fecal coliforms elevated.
06040002048_1000	Caney Creek (Duck River to headwaters)	2001 TVA biorecon at Lunns Store Rd. 3 EPT families, 1 intolerant, 17 total families. 1999 TDEC biorecons at mile 2.6 & 4.2. 5 EPT families, 20 total, habitat = 124, at mile 2.6. 1997 TVA biorecon at Lunns Store. Road. 6 EPT families, 21 total.

> Sedimentation alters the structure of the invertebrate community by causing a shift in proportions from one functional group to another. Sedimentation can lead to embeddedness, which blocks critical macroinvertebrate habitat by filling in the interstices of the cobble and other hard substrate on the stream bottom. As deposited sediment increases, changes in invertebrate community structure and diversity occur.
>
> Invertebrate drift is directly affected by increased suspended sediment load in freshwater streams. These changes generally involve a shift in dominance from ephemeroptera, plecoptera and trichoptera (EPT) taxa to other less pollution-sensitive species that can cope with sedimentation. Increases in sediment deposition that affect the growth, abundance, or species composition of the periphytic (attached) algal community will also have an effect on the macroinvertebrate grazers that feed predominantly on periphyton. ……. Effects on aquatic individuals, populations, and communities are expressed through alterations in local food webs and habitat. When sedimentation exceeds certain thresholds, ensuing effects will likely involve decline of the existing aquatic invertebrate community and subsequent colonization by pioneer species.

Historically, waterbodies in Tennessee have been assessed as not fully supporting designated uses due to siltation when the impairment was determined to be the result of excess loading of the inorganic sediment produced by erosional processes. In cases where impairment was determined to be caused by excess loading of the primarily organic particulate material found in sewage treatment plant (STP) effluent, the cause of pollution was listed as total suspended solids (TSS) or organic enrichment. In consideration of this practice, this document presents the details of TMDL development for waterbodies in the Upper Duck River Watershed listed as impaired due to siltation (excess inorganic sediment produced by erosional processes) and/or appropriate cases of habitat alteration. The TSS in STP effluent is considered to be a distinctly different pollutant and, therefore, is excluded in sediment loading calculations.

4.0 TARGET IDENTIFICATION

Several narrative criteria, applicable to siltation/habitat alteration, are established in *Rules of Tennessee Department of Environment and Conservation, Tennessee Water Quality Control Board, Division of Water Pollution Control, Chapter 1200-4-3 General Water Quality Criteria, January, 2004* (TDEC, 2004a):

> Applicable to all use classifications (Fish & Aquatic Life shown):
>
> > Solids, Floating Materials, and Deposits – There shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size and character that may be detrimental to fish & aquatic life.
> >
> > Other Pollutants – The waters shall not contain other pollutants that will be detrimental to fish or aquatic life.
>
> Applicable to the Domestic Water Supply, Industrial Water Supply, Fish & Aquatic Life, and Recreation use classifications (Fish & Aquatic Life shown):

> Turbidity or Color – There shall be no turbidity or color in such amounts or of such character that will materially affect fish & aquatic life.Applicable to the Fish & Aquatic Life use classification:
>
> Biological Integrity - The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06.
>
> Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion and (b) is of the appropriate stream order specified for the bioregion, and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods.
>
> Interpretation of this provision for all other streams, plus large rivers, reservoirs, and wetlands, may be made using Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA/841-B-99-002) and/or other scientifically defensible methods. Effects to biological populations will be measured by comparisons to upstream conditions or to appropriately selected reference sites in the same bioregion if upstream conditions are determined to be degraded.
>
> Habitat - The quality of instream habitat shall provide for the development of a diverse aquatic community that meets regionally based biological integrity goals. The instream habitat within each subecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.

These TMDLs are being established to attain full support of the fish & aquatic life designated use classification. TMDLs established to protect fish & aquatic life will protect all other use classifications for the identified waterbodies from adverse alteration due to sediment loading.

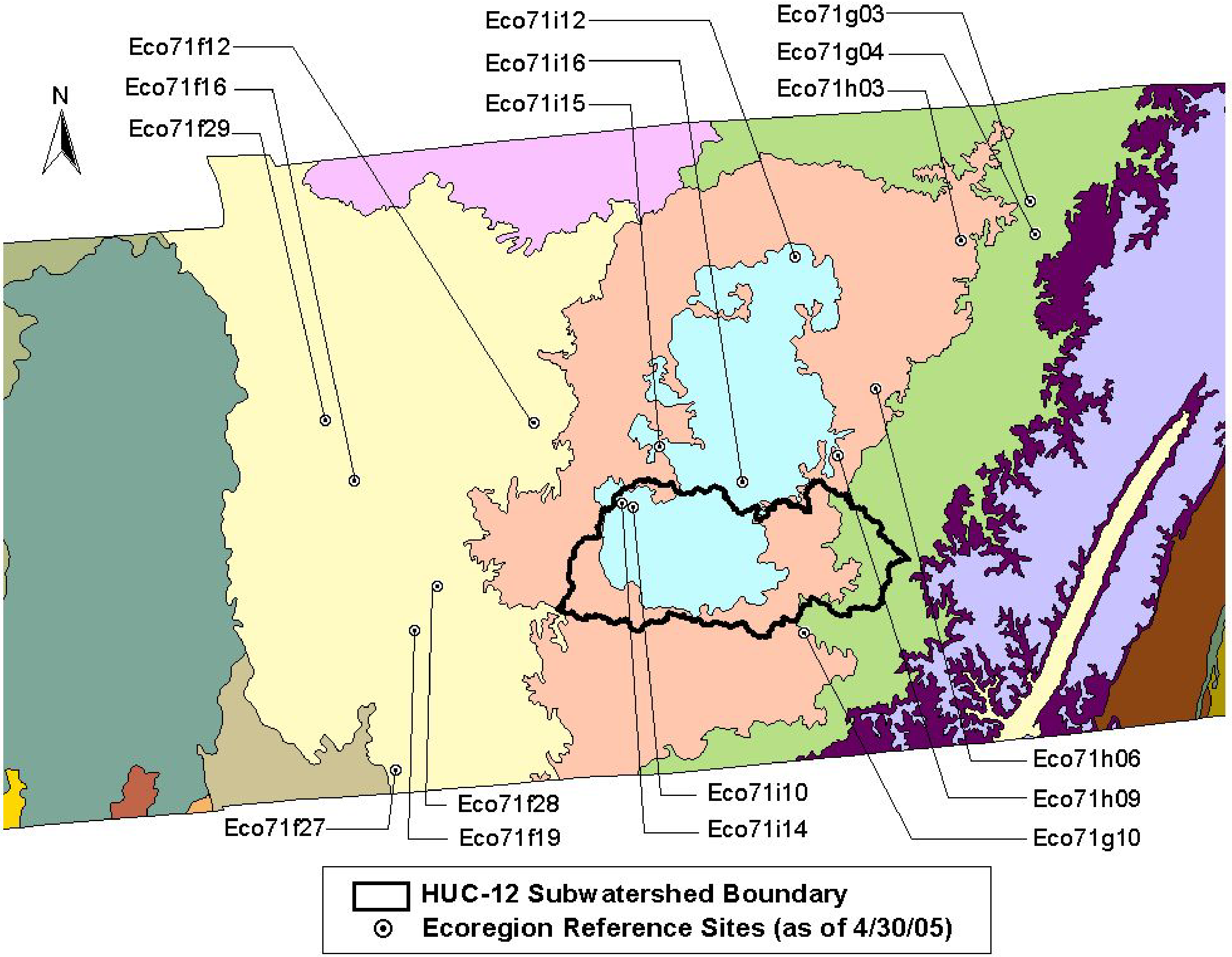
In order for a TMDL to be established, a numeric "target" protective of the uses of the water must be identified to serve as the basis for the TMDL. Where State regulation provides a numeric water quality criteria for the pollutant, the criteria is the basis for the TMDL. Where State regulation does not provide a numeric water quality criteria, as in the case of siltation/habitat alteration, a numeric interpretation of the narrative water quality standard must be determined. For the purpose of these TMDLs, the average annual sediment loading in lbs/acre/yr, from a biologically healthy watershed, located within the same Level IV ecoregion as the impaired watershed, is determined to be the appropriate numeric interpretation of the narrative water quality standard for protection of fish & aquatic life. Biologically healthy watersheds were identified from the State's ecoregion reference sites. These ecoregion reference sites have similar characteristics and conditions as the majority of streams within that ecoregion. Detailed information regarding Tennessee ecoregion reference sites can be found in *Tennessee Ecoregion Project, 1994-1999* (TDEC, 2000). In general, land use in ecoregion reference watersheds contain less pasture, cropland, and urban areas and more forested areas compared to the impaired watersheds. The biologically healthy (reference) watersheds are considered the "least impacted" in an ecoregion and, as such, sediment loading from these watersheds may serve as an appropriate target for the TMDL.

Using the methodology described in Appendix A, the Watershed Characterization System (WCS) Sediment Tool was used to calculate the average annual sediment load for each of the biologically healthy (reference) watersheds in Level IV ecoregions 71f, 71g, 71h, and 71i. The geometric mean of the average annual sediment loads of the reference watersheds in each Level IV ecoregion was selected as the most appropriate target for that ecoregion. Since the impairment of biological integrity due to sediment build-up is generally a long-term process, using an average annual load is considered appropriate. The average annual sediment loads for reference sites and corresponding TMDL target values for Level IV ecoregions 71f, 71g, 71h, and 71i are summarized in Table 4. Reference site locations are shown in Figure 5.

Table 4 Average Annual Sediment Loads of Level IV Ecoregion Reference Sites

Level 4 Ecoregion	Reference Site	Stream	Drainage Area	Average Annual Sediment Load
			(acres)	[lbs/acre/year]
71f	Eco71f12	South Harpeth Creek	6,746	1267.5
	Eco71f16	Wolf Creek	9,879	246.0
	Eco71f19	Brush Creek	5,416	846.8
	Eco71f27	Swanegan Branch	3,201	772.4
	Eco71f28	Little Swan Creek	4,730	209.9
	Eco71f29	Hurricane Creek	43,549	1,047.6
		Geometric Mean (Target Load)		**596.0**
71g	Eco71g03	Flat Creek	14,145	342.1
	Eco71g04	Spring Creek	17,090	493.6
	Eco71g10	Hurricane Creek	3,565	270.3
		Geometric Mean (Target Load)		**357.4**
71h	Eco71h03	Flynn Creek	8,318	754.7
	Eco71h06	Clear Fork	8,779	563.9
	Eco71h09	Carson Fork	7,934	516.4
		Geometric Mean (Target Load)		**603.5**
71i	Eco71i10	Flat Creek	12,200	512.2
	Eco71i12	Cedar Creek	17,852	449.8
	Eco71i14	Little Flat Creek	4,273	444.3
	Eco71i15	Harpeth River	43,239	449.5
	Eco71i16	West Fork Stones River	15,500	287.4
		Geometric Mean (Target Load)		**421.0**

Figure 5 Reference Sites in Level IV Ecoregions 71f, 71g, 71h, and 71i



5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

Using the methodology described in Appendix A, the WCS Sediment Tool was used to determine the average annual sediment load, due to precipitation-based sources, for all HUC-12 subwatersheds in the Upper Duck River Watershed (ref.: Figure 4). Existing precipitation-based sediment loads for subwatersheds with waterbodies listed on the *2004 303(d) List* as impaired for siltation/habitat alteration are summarized in Table 5.

Table 5 Existing Sediment Loads in Subwatersheds With Impaired Waterbodies

HUC-12 Subwatershed (06040002____)	Level IV Ecoregion	Existing Sediment Load
		[lbs/ac/yr]
0203	71h	632
0301	71i	919
0305		882
0308		383
0309		335
0401		334
0402		232
0404		239
0502		320
0503		390
0504		287
0507		623
0601		575
0602		394

6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of siltation in the watershed and the amount of pollutant loading contributed by each of these sources. Under the Clean Water Act, sources are broadly classified as either point or nonpoint sources. Under 40 CFR 122.2, a point source is defined as a discernable, confined and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Regulated point sources include: 1) municipal and industrial wastewater treatment facilities (WWTFs); 2) storm water discharges associated with industrial activity (which includes construction activities); and 3) certain discharges from Municipal Separate Storm Sewer Systems (MS4s). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES regulated point sources. For the purposes of these TMDLs, all sources of sediment loading not regulated by NPDES are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

6.1 Point Sources

6.1.1 NPDES Regulated Wastewater Treatment Facilities

As stated in Section 3.0, the TSS component of STP discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced from erosional processes. Therefore, TSS discharges from STPs are <u>not</u> included in the TMDLs developed for this document.

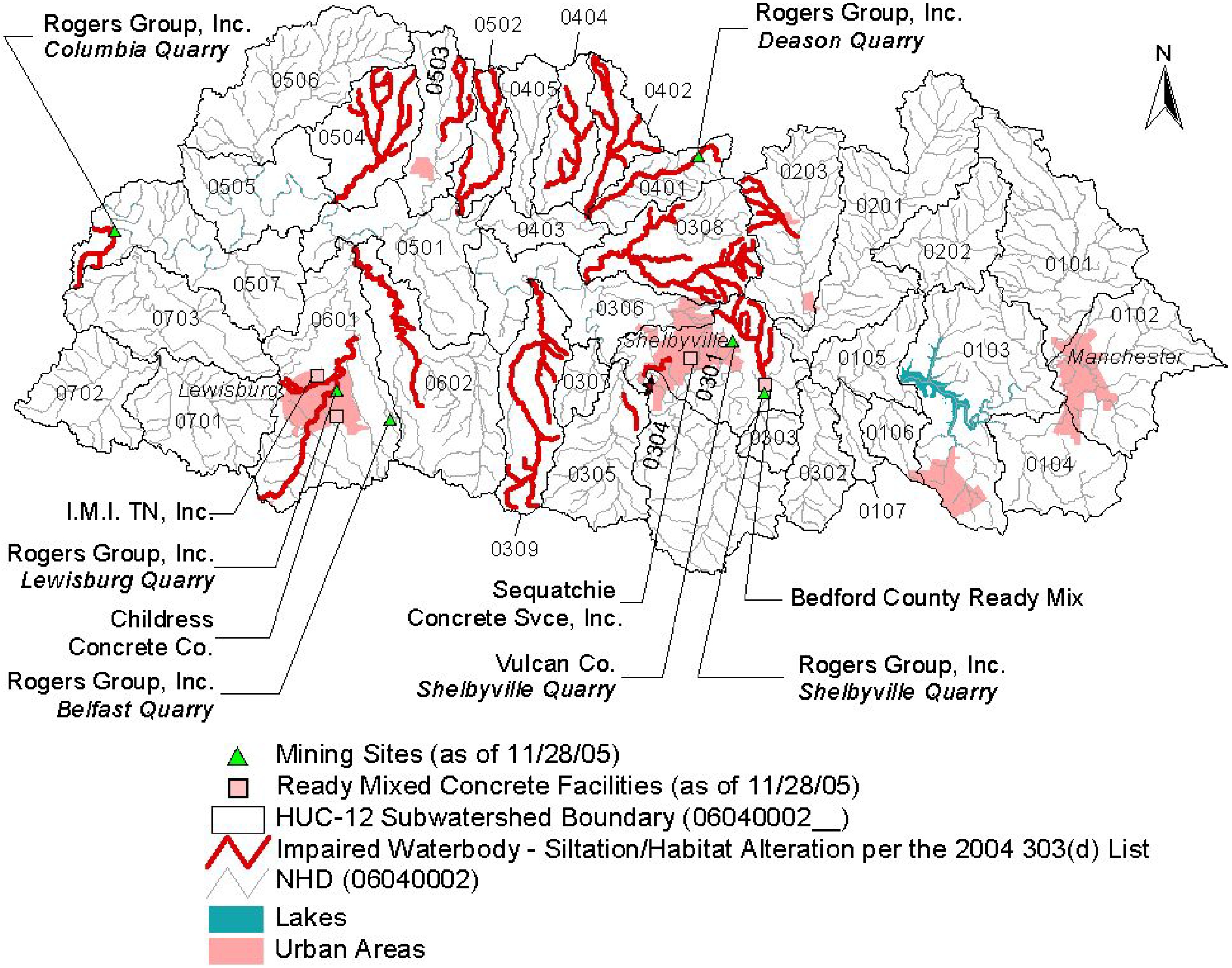
6.1.2 NPDES Regulated Ready Mixed Concrete Facilities

Discharges from regulated Ready Mixed Concrete Facilities (RMCFs) may contribute sediment to surface waters as TSS discharges (TSS discharged from RMCFs is composed of primarily inorganic material and is therefore included as a source for TMDL development). Most of these facilities obtain coverage under NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Storm Water Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2003). This permit establishes a daily maximum TSS concentration limit of 50 mg/l on process wastewater effluent and specifies monitoring procedures for storm water discharges. Facilities are also required to develop and implement storm water pollution prevention plans (SWPPPs). Discharges from RMCFs are generally intermittent, and contribute a small portion of total sediment loading to HUC-12 subwatersheds (ref.: Appendix C). In some cases, for discharges into impaired waters, sites may be required to obtain coverage under an individual NPDES permit. Of the nine permitted RMCFs in the Upper Duck River Watershed as of November 28, 2005, four are located in impaired subwatersheds. These facilities are listed in Table 6 and shown in Figure 6.

6.1.3 NPDES Regulated Mining Sites

Discharges from regulated mining activities may contribute sediment to surface waters as TSS (TSS discharged from mining sites is composed of primarily inorganic material and is therefore included as a source for TMDL development). Discharges from active mines may result from dewatering operations and/or in response to storm events, whereas discharges from permitted inactive mines are only in response to storm events. Inactive sites with successful surface reclamation contribute relatively little solids loading. Of the eight permitted mining sites in the Upper Duck River Watershed (as of November 28, 2005), six are located in impaired subwatersheds. These are listed in Table 7 and shown in Figure 6. Sediment loads (as TSS) to waterbodies from mining site discharges are very small in relation to total sediment loading (ref.: Appendix C).

Figure 6 NPDES Regulated RMCFs and Mining Sites Located in Impaired Subwatersheds



6.1.4 NPDES Regulated Construction Activities

Discharges from NPDES regulated construction activities are considered point sources of sediment loading to surface waters and occur in response to storm events. Currently, discharges of storm water from construction activities disturbing an area of one acre or more must be authorized by an NPDES permit. Most of these construction sites obtain coverage under NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activity* (TDEC, 2005a). Since construction activities at a site are of a temporary, relatively short-term nature, the number of construction sites covered by the general permit at any instant of time varies. Of the 25 permitted active construction sites in the Upper Duck River Watershed on November 28, 2005, six were in impaired subwatersheds (ref.: Figure 7).

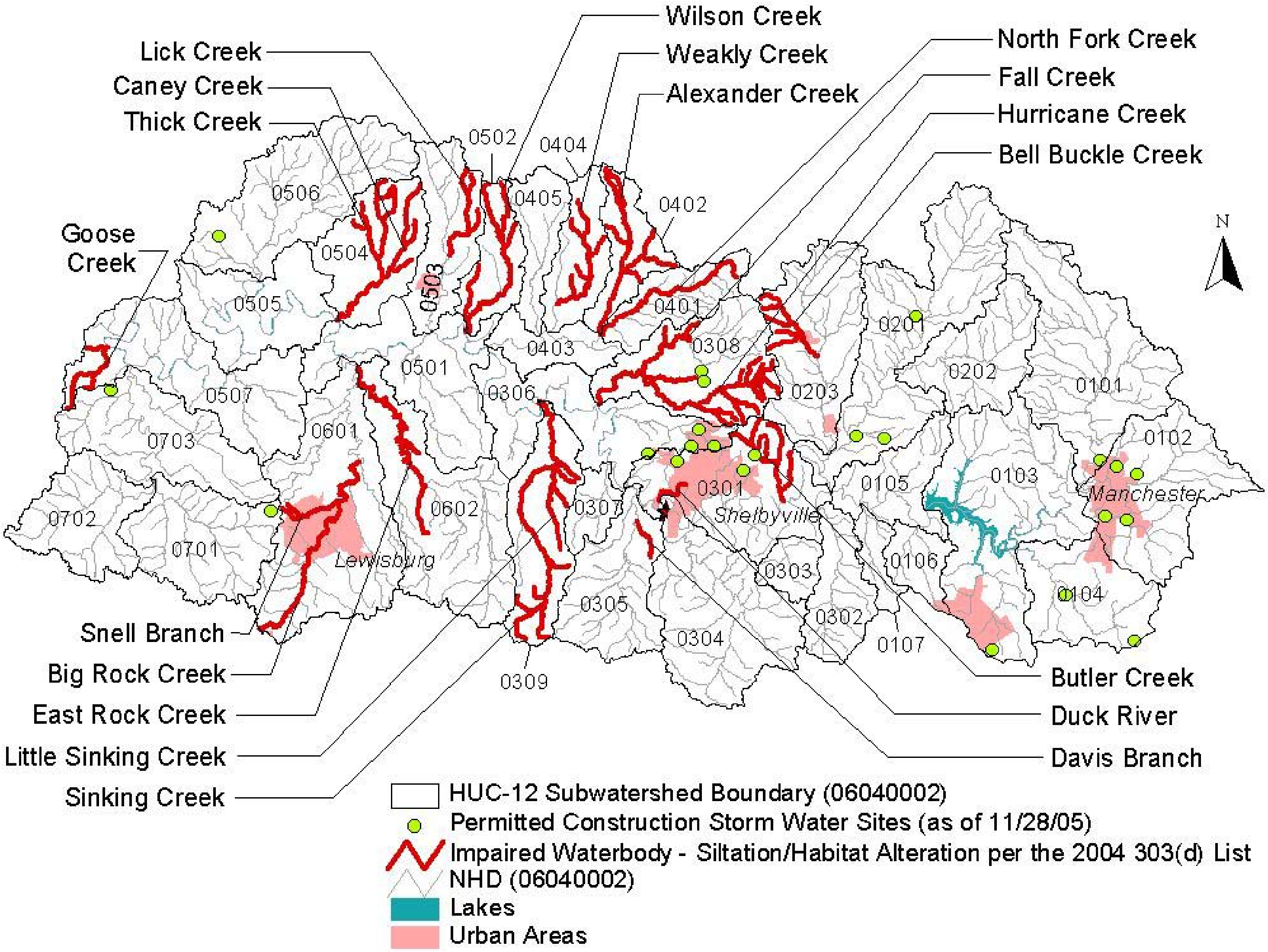
Table 6 NPDES Regulated Ready Mixed Concrete Facilities Located in Impaired Subwatersheds (as of November 28, 2005)

HUC-12 Subwatershed (06040002___)	NPDES Permit No.	Facility Name	TSS Daily Max Limit	TSS Cut-off Conc. (SW discharge)
			[mg/l]	[mg/l]
0301	TNG110117	Sequatchie Concrete Service	50	200
	TNG110309	Bedford County Ready Mix		
0601	TNG110032	Childress Concrete Company		
	TNG110069	I.M.I TN, Inc.		

Table 7 NPDES Regulated Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds (as of November 28, 2005)

HUC-12 Subwatershed (06040002___)	NPDES Permit No.	Name	TSS Daily Max Limit
			[mg/l]
0301	TN0066508	Vulcan Construction Materials – Shelbyville Quarry	40
	TN0022756	Rogers Group, Inc. – Shelbyville Quarry	
0401	TN0071846	Rogers Group, Inc. – Deason Quarry	
0507	TN0061395	Rogers Group, Inc. – Columbia Quarry	
0601	TN0003654	Rogers Group, Inc. – Lewisburg Quarry	
	TN0071251	Rogers Group, Inc. – Belfast Quarry	

Figure 7 Location of NPDES Permitted Construction Storm Water Sites in the Upper Duck River Watershed



6.1.5 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

MS4s may discharge sediment to waterbodies in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. These systems convey urban runoff from surfaces such as bare soil and wash-off of accumulated street dust and litter from impervious surfaces during rain events. Phase I of the EPA storm water program requires large and medium MS4s to obtain NPDES storm water permits. Large and medium MS4s are those located in incorporated places or counties serving populations greater than 100,000 people. At present, there are no Phase I MS4s in the Upper Duck River Watershed.

As of March 2003, regulated small MS4s in Tennessee must also obtain NPDES permits in accordance with the Phase II storm water program. A small MS4 is designated as *regulated* if: a) it is located within the boundaries of a defined urbanized area that has a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile; b) it is located outside of an urbanized area but within a jurisdiction with a population of at least 10,000 people, a population density of 1,000 people per square mile, and has the potential to cause an adverse impact on water quality; or c) it is located outside of an urbanized area but contributes substantially to the pollutant loadings of a physically interconnected MS4 regulated by the NPDES storm water program. Most regulated small MS4s in Tennessee obtain coverage under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a). There are five permitted Phase II MS4s in the Upper Duck River Watershed as follows:

NPDES Permit Number	Phase	Permittee Name
TNS077615	II	Lewisburg
TNS075531	II	Shelbyville
TNS077631	II	Tullahoma
TNS075647	II	Rutherford County
TNS075795	II	Williamson County

The Tennessee Department of Transportation (TDOT) has been issued an individual MS4 permit (TNS077585) that authorizes discharges of storm water runoff from State road and interstate highway right-of-ways that TDOT owns or maintains, discharges of storm water runoff from TDOT owned or operated facilities, and certain specified non-storm water discharges. This permit covers all eligible TDOT discharges statewide, including those located outside of urbanized areas.

Information regarding storm water permitting in Tennessee may be obtained from the TDEC website at http://www.state.tn.us/environment/wpc/stormh2o/.

6.2 Nonpoint Sources

Nonpoint sources account for the vast majority of sediment loading to surface waters. These sources include:

- Natural erosion occurring from the weathering of soils, rocks, and uncultivated land; geological abrasion; and other natural phenomena.

- Erosion from agricultural activities can be a major source of sedimentation due to the large land area involved and the land-disturbing effects of cultivation. Grazing livestock can leave areas of ground with little vegetative cover. Unconfined animals with direct access to streams can cause streambank damage.

- Urban erosion from bare soil areas under construction and washoff of accumulated street dust and litter from impervious surfaces.

- Erosion from unpaved roadways can be a significant source of sediment to rivers and streams. It occurs when soil particles are loosened and carried away from the roadway, ditch, or road bank by water, wind, or traffic. The actual road construction (including erosive road-fill soil types, shape and size of coarse surface aggregate, poor subsurface and/or surface drainage, poor road bed construction, roadway shape, and inadequate runoff discharge outlets or "turn-outs" from the roadway) may aggravate roadway erosion. In addition, external factors such as roadway shading and light exposure, traffic patterns, and road maintenance may also affect roadway erosion. Exposed soils, high runoff velocities and volumes and poor road compaction all increase the potential for erosion.

- Runoff from abandoned mines may be significant sources of solids loading. Mining activities typically involve removal of vegetation, displacement of soils, and other significant land disturbing activities.

- Soil erosion from forested land that occurs during timber harvesting and reforestation activities. Timber harvesting includes the layout of access roads, log decks, and skid trails; the construction and stabilization of these areas; and the cutting of trees. Established forest areas produce very little soil erosion.

For impaired waterbodies within the Upper Duck River Watershed, the primary sources of nonpoint sediment loads come from agriculture, roadways, and urban sources. The watershed land use distribution based on the 1992 MRLC satellite imagery databases is shown in Appendix B for impaired HUC-12 subwatersheds.

7.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations) and an appropriate margin of safety (MOS) which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma\ \text{WLAs} + \Sigma\ \text{LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

TMDL analyses are performed on a 12-digit hydrologic unit code (HUC-12) area basis for subwatersheds containing waterbodies identified as impaired due to siltation and/or habitat alteration on the *2004 303(d) List*. HUC-12 subwatershed boundaries are shown in Figure 4.

7.1 Analysis Methodology

Sediment analysis for watersheds can be conducted using methods ranging from simple, gross estimates to complex dynamic loading and receiving water models. The choice of methodology is dependent on a number of factors that include watershed size, type of impairment, type and quantity of data available, resources available, time, and cost. In consideration of these factors, the approach described in Section 7.1.1 was selected as the most appropriate for sediment TMDLs in the Upper Duck River Watershed. TMDL, WLA, and LA development for these subwatersheds are addressed in Sections 7.2, 7.3, and 7.4, respectively. This procedure was modified as noted in Section 7.1.2 for several subwatersheds.

7.1.1 WCS Sediment Tool

Sediment loading analysis for waterbodies impaired due to siltation/habitat alteration in the Upper Duck River Watershed was accomplished using the Watershed Characterization System (WCS) Sediment Tool. This ArcView geographic information system (GIS) based model is described in Appendix A and was utilized according to the following procedure:

- The Watershed Characterization System (WCS) Sediment Tool was used to determine sediment loading to Level IV ecoregion reference site watersheds. These are considered to be biologically healthy watersheds. The average annual sediment loads in lbs/acre/yr of these reference watersheds serve as target values for the Upper Duck River Watershed sediment TMDLs.

- The Sediment Tool was also used to determine the existing average annual sediment loads of impaired watersheds located in the same Level IV ecoregion. Impaired watersheds are defined as 12-digit HUCs containing one or more waterbodies identified as impaired due to siltation/habitat alteration on the State’s *2004 303(d) List* (ref: Figure 4).

- The existing average annual sediment load of each impaired HUC-12 subwatershed was compared to the average annual load of the appropriate reference (biologically healthy) watershed and an <u>overall</u> required percent reduction in loading calculated. For each impaired HUC-12 subwatershed, the TMDL is equal to this <u>overall</u> required reduction:

$$\text{TMDL} = \frac{(\text{Existing Load}) - (\text{Target Load})}{(\text{Existing Load})} \times 100$$

Although the Sediment Tool uses the best road, elevation, and land use GIS coverages available, the resulting average annual sediment loads should not be interpreted as an absolute value. The calculated loading reductions, however, are considered to be valid since they are based on the relative comparison of loads calculated using the same methodology.

Note: In several subwatersheds, the calculated existing load is lower than the calculated target load. This case is addressed in Section 7.1.2 and Appendix D.

- In each impaired subwatershed, 5% of the ecoregion-based target load was reserved to account for WLAs for NPDES permitted mining sites and RMCFs. The existing loads from these facilities are less than the five percent reserved in each impaired HUC-12 subwatershed. Any difference between these existing loads and the 5% reserved load provide for future growth and additional MOS (ref.: Appendix C).

- For each impaired HUC-12 subwatershed, WLAs for construction storm water sites, WLAs for MS4s, and LAs for nonpoint sources were considered to be the percent load reduction required to decrease the existing annual average sediment load to a level equal to 95% of the target value.

$$\mathrm{WLA}_{\mathrm{Const.\ SW}} = \mathrm{WLA}_{\mathrm{MS4}} = \mathrm{LA} = \frac{(\text{Existing Load}) - [(.95)\ (\text{Target Load})]}{(\text{Existing Load})} \times 100$$

- TMDLs, WLAs for construction storm water sites and MS4s, and LAs are expressed as a percent reduction in average annual sediment loading. WLAs for mining sites and RMCFs are equal to loads authorized by their existing permits. Since sediment loading from mining sites and RMCFs are small with respect to storm water induced sediment loading for all subwatersheds, further reductions from these facilities were not considered warranted (ref.: Appendix C).

It is expected that the reduction of sediment loading as specified by WLAs and LAs in impaired watersheds will result in the attainment of fully supporting status for all designated use classifications, with respect to siltation/habitat alteration. According to 40 CFR §130.2 (i), TMDLs can be expressed in terms of mass per time, toxicity or other appropriate measure.

Details of the analysis methodology are more fully described in Appendix A. This approach is recognized as an acceptable alternative to a maximum allowable mass load per day in the *Protocol for Developing Sediment TMDLs* (USEPA, 1999).

7.1.2 Sediment Tool Analysis Anomalies

There are nine HUC-12 subwatersheds in the Upper Duck River Watershed that have been assessed (primarily on the basis of biological surveys as stated in Section 3.0) as impaired due to siltation and/or habitat alteration, for which the results of the Sediment Tool based analysis indicate that the existing sediment load is smaller than the target load. These subwatersheds are:

060400020308	Fall Creek and Hurricane Creek
060400020309	Sinking Creek and Little Sinking Creek
060400020401	North Fork Creek
060400020402	Alexander Creek
060400020404	Weakley Creek
060400020502	Wilson Creek
060400020503	Lick Creek
060400020504	Caney Creek and Thick Creek
060400020602	East Rock Creek

These subwatersheds require a more thorough investigation to determine site-specific causes of impairment. A detailed analysis is presented in Appendix D. In consideration, however, of the assessment of waterbodies in these subwatersheds as impaired due to siltation and/or habitat alteration, TMDLs, WLAs for construction storm water sites, WLAs for MS4s, and LAs for nonpoint sources were assigned based on the predominant Level IV ecoregion in each HUC-12 subwatershed (71i for all nine subwatersheds) using the following procedure:

- Assigned TMDLs were determined to be equal to the geometric mean of the overall required load reductions (TMDLs) of other impaired HUC-12 subwatersheds predominantly in Level IV ecoregion 71i.
- Assigned WLAs for construction storm water, WLAs for MS4s, and LAs for nonpoint sources for the subwatersheds were determined to be equal to the geometric mean of the WLA & LA load reductions of other impaired HUC-12 subwatersheds predominantly in Level IV ecoregion 71i.

7.2 TMDLs for Impaired Subwatersheds

Sediment TMDLs for subwatersheds containing waterbodies identified as impaired for siltation/habitat alteration are summarized in Table 8. The determination of assigned TMDLs, WLAs for MS4s and construction SW, and LAs for HUC-12 subwatersheds where the Sediment Tool analysis resulted in existing loads lower than target loads are shown in Table 9.

7.3 Waste Load Allocations

7.3.1 Waste Load Allocations for NPDES Regulated Ready Mixed Concrete Facilities

Of the nine Ready Mixed Concrete Facilities (RMCFs) in the Upper Duck River Watershed with NPDES permits, four are located in impaired subwatersheds (ref.: Table 6). Since sediment loading from RMCFs located in impaired subwatersheds is small (ref.: Appendix C) compared to the total loading for impaired subwatersheds, the WLAs are considered to be equal to the existing permit requirements for these facilities.

7.3.2 Waste Load Allocations for NPDES Regulated Mining Activities

Of the eight mining sites in the Upper Duck River Watershed with NPDES permits, six are located in impaired subwatersheds (ref.: Table 7). Since sediment loading from mining sites located in impaired subwatersheds is small (ref.: Appendix C) compared to the total loading for impaired subwatersheds, the WLAs are considered to be equal to the existing permit requirement for these sites.

Table 8 Sediment TMDLs for Subwatersheds with Waterbodies Impaired for Siltation/Habitat Alteration

HUC-12 Subwatershed (06040002___)	Waterbody ID	Waterbody Impaired by Siltation/ Habitat Alteration	Level IV Ecoregion	Existing Sediment Load [lbs/ac/yr]	Target Load [lbs/ac/yr]	TMDL (overall required load reduction) [%]
0203	06040002033_0300	Bell Buckle Creek	71h	632	603.5	4.5
0301	06040002027_0300	Butler Creek	71i	919	421.0	54.2
	06040002027_1000	Duck River				
0305	06040002024_0100	Davis Branch		882		52.3
0308	06040002038_0300	Hurricane Creek		383		39.6*
	06040002038_1000	Fall Creek				
0309	06040002021_0100	Little Sinking Creek		335		
	06040002021_1000 & 2000	Sinking Creek				
0401	06040002039_3000	North Fork Creek		334		
0402	06040002039_0300	Alexander Creek		232		
0404	06040002039_0250	Weakley Creek		239		
0502	06040002046_1000	Wilson Creek		320		
0503	06040002047_0300	Lick Creek		390		
0504	06040002048_0100	Thick Creek		287		
	06040002048_1000	Caney Creek				
0507	06040002001_0300	Goose Creek		623		32.4
0601	06040002012_0700	Snell Branch		575		26.8
	06040002012_2000 & 3000	Big Rock Creek				
0602	06040002012_0100	East Rock Creek		394		39.6*

*Assigned TMDL. Ref.: Section 7.1.2 and Table 9.

Table 9 Determination of Assigned TMDLs, WLAs, and LAs, for Certain Impaired Subwatersheds

Level IV Ecoregion	Impaired HUC-12 Subwatershed (06040002___) [a]	Required Load Reduction		
		TMDL (required overall load reduction) [b]	WLA (Construction SW and MS4s) [c]	LAs (Nonpoint Sources)[c]
		[%]	[%]	[%]
71i	0301	54.2	56.5	56.5
	0305	52.3	54.7	54.7
	0507	32.4	35.8	35.8
	0601	26.8	30.5	30.5
	Geometric Mean	**39.6**	**42.8**	**42.8**

a. HUC-12 Subwatersheds where (existing load) > (target load)
b. See Table 8
c. See Table 10

7.3.3 Waste Load Allocations for NPDES Regulated Construction Activities

Point source discharges of storm water from construction activities (including clearing, grading, filling, excavating, or similar activities) that result in the disturbance of one acre or more of total land area must be authorized by an NPDES permit. Since these discharges have the potential to transport sediment to surface waters, WLAs are provided for this category of activities. WLAs are established for each subwatershed containing a waterbody identified on the *2004 303(d) List* as impaired due to siltation and/or habitat alteration (ref.: Table 2). WLAs are expressed as the required percent reduction in the estimated average annual sediment loading for the impaired subwatershed, relative to the estimated average annual sediment loading (minus 5%) of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (ref.: Table 10). WLAs provided to NPDES regulated construction activities will be implemented as Best Management Practices (BMPs), as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y (TDEC, 2005a). WLAs should not be construed as numeric permit limits.

7.3.4 Waste Load Allocations for NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

Municipal separate storm sewer systems (MS4s) are regulated by the State's NPDES program (ref.: Section 6.1.5). Since MS4s have the potential to discharge TSS to surface waters, WLAs are specified for these systems. WLAs are established for each HUC-12 subwatershed containing a waterbody identified on the *2004 303(d) List* as impaired due to siltation and/or habitat alteration (ref.: Table 2). WLAs are expressed as the required percent reduction in the estimated average annual sediment loading for an impaired subwatershed, relative to the estimated average annual sediment loading (minus the 5% allocated to RMCFs and regulated mining sites) of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (ref.: Table 10). WLAs apply to MS4 discharges in the impaired subwatershed for which the WLA was developed and will be implemented as Best Management Practices (BMPs) as specified in Phase I and II MS4 permits. WLAs should <u>not</u> be construed as numeric limits.

Table 10 Summary of WLAs for MS4s and Construction Storm Water Sites and LAs for Nonpoint Sources

HUC-12 Subwatershed (06040002__)	Level IV Ecoregion	Percent Reduction – Average Annual Sediment Load	
		WLAs (Construction SW and MS4s)	LAs (Nonpoint Sources)
		[%]	[%]
0203	71h	9.2	9.2
0301	71i	56.5	56.5
0305		54.7	54.7
0308		42.8*	42.8*
0309			
0401			
0402			
0404			
0502			
0503			
0504			
0507		35.8	35.8
0601		30.5	30.5
0602		42.8*	42.8*

*Assigned WLAs and LAs. Ref.: Section 7.1.2 and Table 9.

7.4 Load Allocations for Nonpoint Sources

All sources of sediment loading to surface waters not covered by the NPDES program are provided a Load Allocation (LA) in these TMDLs. LAs are established for each HUC-12 subwatershed containing a waterbody identified on the *2004 303(d) List* as impaired due to siltation and/or habitat alteration (ref. Table 2). LAs are expressed as the required percent reduction in the estimated average annual sediment loading for the impaired subwatershed, relative to the estimated average annual sediment loading (minus 5%) of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (ref.: Table 10).

7.5 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these TMDLs, an implicit MOS was incorporated through the use of conservative modeling assumptions. These include:

- Target values based on Level IV ecoregion reference sites. These sites represent the least impacted streams in the ecoregion.

- The use of the sediment delivery process that results in the most sediment transport to surface waters (Method 2 in Appendix A).

In most presently impaired subwatersheds, some amount of explicit MOS is realized due to the WLAs specified for NPDES permitted mining sites and RMCFs being less than the 5% of the target load reserved for these facilities.

7.6 Seasonal Variation

Sediment loading is expected to fluctuate according to the amount and distribution of rainfall. The determination of sediment loads on an average annual basis accounts for these differences through the rainfall erosivity index in the USLE (ref.: Appendix A). This is a statistic calculated from the annual summation of rainfall energy in every storm and its maximum 30-minute intensity.

8.0 IMPLEMENTATION PLAN

8.1 Point Sources

8.1.1 NPDES Regulated Ready Mixed Concrete Facilities

Four of the nine NPDES regulated RMCFs in the Upper Duck River Watershed are located in impaired subwatersheds (ref.: Table 6). WLAs will be implemented through NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Storm Water Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2003).

8.1.2 NPDES Regulated Mining Sites

Six of the eight NPDES regulated mining sites in the Upper Duck River Watershed are located in impaired subwatersheds (ref.: Table 7). WLAs will be implemented through the existing permit requirements for these sites.

8.1.3 NPDES Regulated Construction Storm Water

The WLAs provided to existing and future NPDES regulated construction activities will be implemented through appropriate erosion prevention and sediment controls and Best Management Practices (BMPs) as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y (TDEC, 2005a). This permit requires the development and implementation of a site-specific Storm Water Pollution Prevention Plan (SWPPP) prior to the commencement of construction activities. The SWPPP must be prepared in accordance with good engineering practices and the latest edition of the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2002) and must identify potential sources of pollution at a construction site that would affect the quality of storm water discharges and describe practices to be used to reduce pollutants in those discharges. In addition, the permit specifies a number of special requirements for discharges entering high quality waters or waters identified as impaired due to siltation. The permit does not authorize discharges that would result in a violation of a State water quality standard.

Unless otherwise stated, full compliance with the requirements of the *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y is considered to be consistent with the WLAs specified in Section 7.3.3 of this TMDL document.

8.1.4 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For existing and future regulated discharges from municipal separate storm sewer systems (MS4s), WLAs will be implemented through Phase I and II MS4 permits. These permits will require the development and implementation of a Storm Water Management Plan (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. Both the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a) and the TDOT individual MS4 permit (TNS077585) require SWMPs to include the following six minimum control measures:

1) Public education and outreach on storm water impacts;
2) Public involvement/participation;
3) Illicit discharge detection and elimination;
4) Construction site storm water runoff control;
5) Post-construction storm water management in new development and re-development;
6) Pollution prevention/good housekeeping for municipal (or TDOT) operations.

The permits also contain requirements regarding control of discharges of pollutants of concern into impaired waterbodies, implementation of provisions of approved TMDLs, and description of methods to evaluate whether storm water controls are adequate to meet the requirements of approved TMDLs.

In order to evaluate SWMP effectiveness and demonstrate compliance with specified WLAs, MS4s must develop and implement appropriate monitoring programs. An effective monitoring program could include:

- Effluent monitoring at selected outfalls that are representative of particular land uses or geographical areas that contribute to pollutant loading before and after implementation of pollutant control measures.

- Analytical monitoring of pollutants of concern in receiving waterbodies, both upstream and downstream of MS4 discharges, over an extended period of time.

- Instream biological monitoring at appropriate locations to demonstrate recovery of biological communities after implementation of storm water control measures.

The appropriate Environmental Field Office (ref.: http://tennessee.gov/environment/eac/) should be consulted for assistance in the determination of monitoring strategies, locations, frequency, and methods within 12 months after the approval date of this TMDL. Details of the monitoring plan and monitoring data should be included in the annual report required by the MS4 permit.

8.2 Nonpoint Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most nonpoint source discharges. Reductions of sediment loading from nonpoint sources (NPS) will be achieved using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired waters. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. There are links to a number of publications and information resources on EPA's Nonpoint Source Pollution website (http://www.epa.gov/owow/nps/pubs.html) relating to the implementation and evaluation of nonpoint source pollution control measures.

TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach (ref: http://www.state.tn.us/environment/wpc/watershed/). The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance. It relies on participation at the federal, state, local and nongovernmental levels to be successful.

The actions of local government agencies and watershed stakeholders should be directed to accomplish the goal of a reduction of sediment loading in the watershed. There are a number of measures that are particularly well-suited to action by local stakeholder groups. These measures include, but are not limited to:

- Detailed surveys of impaired subwatersheds to identify additional sources of sediment loading.
- Advocacy of local area ordinances and zoning that will minimize sediment loading to waterbodies, including establishment of buffer strips along streambanks, reduction of activities within riparian areas, and minimization of road and bridge construction impacts.
- Educating the public as to the detrimental effects of sediment loading to waterbodies and measures to minimize this loading.
- Advocacy of agricultural BMPs (e.g., riparian buffer, animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment protection, livestock exclusion, etc.) and practices to minimize erosion and sediment transport to streams. The Tennessee Department of Agriculture (TDA) keeps a database of BMPs implemented in Tennessee. Of the 262 BMPs in the Upper Duck River Watershed as of September 2, 2005, 112 are in sediment-impaired subwatersheds (ref.: Figure 8).

An excellent example of stakeholder involvement and action is described in the *Big Rock Creek Watershed Final Management Plan, March 2003* (NCDRP, 2003), prepared by the Center for Watershed Protection for The Nature Conservancy, Duck River Project. This development of this plan was funded, in part, under an agreement with the Tennessee Department of Agriculture, Nonpoint Source Program and a U.S. Environmental Protection Agency Assistance Agreement (#C9994674-01-0). This plan was based on an extensive evaluation of stream conditions, various investigations and analyses, and usage surveys of conservation practices in the Big Rock Creek subwatershed. The plan establishes subwatershed goals and recommendations to meet these goals. A number of restoration projects are identified and prioritized and plan implementation is divided into three phases for implementation. The plan may be accessed at:

http://www.cwp.org/watershed_services/Big_Rock_es.pdf

8.3 Evaluation of TMDL Effectiveness

The effectiveness of the TMDL will be assessed within the context of the State's rotating watershed management approach. Watershed monitoring and assessment activities will provide information by which the effectiveness of sediment loading reduction measures can be evaluated. Monitoring data, ground-truthing, and source identification actions will enable implementation of particular types of BMPs to be directed to specific areas in the subwatersheds. These TMDLs will be reevaluated during subsequent watershed cycles and revised as required to assure attainment of applicable water quality standards.

9.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed sediment TMDLs for the Upper Duck River Watershed was placed on Public Notice for a 35-day period and comments were solicited. Steps that were taken in this regard included:

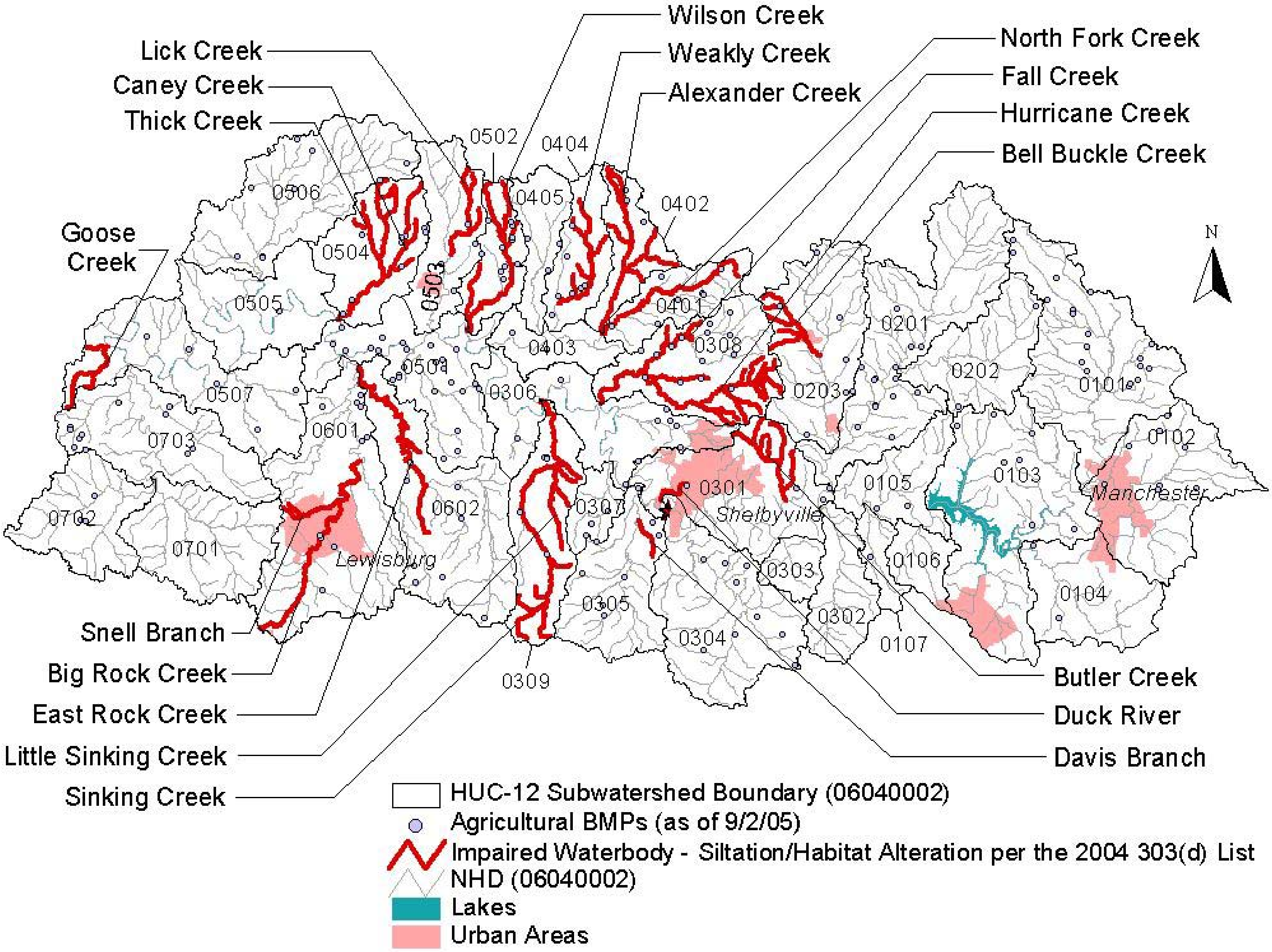
1) Notice of the proposed TMDLs was posted on the Tennessee Department of Environment and Conservation website. The notice invited public and stakeholder comments and provided a link to a downloadable version of the TMDL document.

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings, which was sent to approximately 90 interested persons or groups who had requested this information.

3) A letter was sent to following point source facilities in the Upper Duck River Watershed that are permitted to discharge treated total suspended solids (TSS) and are located in impaired subwatersheds advising them of the proposed sediment TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided on request. Letters were sent to the following facilities:

TNG110117	Sequatchie Concrete Service
TNG110309	Bedford County Ready Mix
TNG110032	Childress Concrete Company
TNG110069	I.M.I TN, Inc.
TN0066508	Vulcan Construction Materials – Shelbyville Quarry
TN0022756	Rogers Group, Inc. – Shelbyville Quarry
TN0071846	Rogers Group, Inc. – Deason Quarry
TN0061395	Rogers Group, Inc. – Columbia Quarry
TN0003654	Rogers Group, Inc. – Lewisburg Quarry
TN0071251	Rogers Group, Inc. – Belfast Quarry

Figure 8 Location of Agricultural Best Management Plans in the Upper Duck River Watershed



4) A letter was sent to identified water quality partners in the Upper Duck River Watershed advising them of the proposed sediment TMDLs and their availability on the TDEC website and inviting comments. These partners included:

   Natural Resources Conservation Service
   Tennessee Department of Agriculture
   Tennessee Valley Authority
   Tennessee Wildlife Resources Agency
   USDA – Forest Service
   USGS Water Resource Programs
   The Nature Conservancy

5) A draft copy of the proposed sediment TMDLs was sent to the following MS4s:

TNS077615	Lewisburg
TNS075531	Shelbyville
TNS077631	Tullahoma
TNS075647	Rutherford County
TNS075795	Williamson County
TNS077585	Tennessee Department of Transportation (TDOT)

10.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website: http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding these TMDLs should be directed to the following members of the Division of Water Pollution Control staff:

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APPENDIX A

Watershed Sediment Loading Model

WATERSHED SEDIMENT LOADING MODEL

Determination of target average annual sediment loading values for reference watersheds and the sediment loading analysis of waterbodies impaired for siltation/habitat alteration was accomplished utilizing the Watershed Characterization System (WCS) Sediment Tool (v.2.6). WCS is an ArcView geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. WCS consists of an initial set of spatial and tabular watershed data, stored in a database, and allows the incorporation of additional data when available. It provides a number of reporting tools and data management utilities to allow users to analyze and summarize data. Program extensions, such as the sediment tool, expand the functionality of WCS to include modeling and other more rigorous forms of data analysis (USEPA, 2001).

Sediment Analysis

The Sediment Tool is an extension of WCS that utilizes available GIS coverages (land use, soils, elevations, roads, etc), the Universal Soil Loss Equation (USLE) to calculate potential erosion, and sediment delivery equations to calculate sediment delivery to the stream network. The following tasks can be performed:

- Estimate extent and distribution of potential soil erosion in the watershed.
- Estimate potential sediment delivery to receiving waterbodies.
- Evaluate effects of land use, BMPs, and road network on erosion and sediment delivery.

The Sediment Tool can also be used to evaluate different scenarios, such as the effects of changing land uses and implementation of BMPs, by the adjustment of certain input parameters. Parameters that may be adjusted include:

- Conservation management and erosion control practices
- Changes in land use
- Implementation of Best Management Practices (BMPs)
- Addition/Deletion of roads

Sediment analyses can be performed for single or multiple watersheds.

Universal Soil Loss Equation

Erosion potential is based on the Universal Soil Loss Equation (USLE), developed by Agriculture Research Station (ARS) scientists W. Wischmeier and D. Smith. It has been the most widely accepted and utilized soil loss equation for over 30 years. The USLE is a method to predict the average annual soil loss on a field slope based on rainfall pattern, soil type, topography, crop system and management practices. The USLE only predicts the amount of soil loss resulting from sheet or rill erosion on a single slope and does not account for soil losses that might occur from gully, wind, or tillage erosion. Designed as a model for use with certain cropping and management systems, it is also applicable to non-agricultural situations (OMAFRA, 2000). While the USLE can be used to estimate long-term average annual soil loss, it cannot be applied to a specific year or a specific storm. Based on its long history of use and wide acceptance by the forestry and agricultural communities, the USLE was considered to be an adequate tool for estimating the relative long-term average annual soil erosion of watersheds and evaluating the effects of land use changes and implementation of BMP measures.

Soil loss from sheet and rill erosion is primarily due to detachment of soil particles during rain events. It is the cause of the majority of soil loss for lands associated with crop production, grazing areas, construction sites, mine sites, logging areas and unpaved roads. In the USLE, five major factors are used to calculate the soil loss for a given area. Each factor is the numerical estimate of a specific condition that affects the severity of soil erosion in that area. The USLE for estimating average annual soil erosion is expressed as:

$$A = R \times K \times LS \times C \times P$$

where:

A = average annual soil loss in tons per acre
R = rainfall erosivity index
K = soil erodibility factor
LS = topographic factor - L is for slope length and S is for slope
C = crop/vegetation and management factor
P = conservation practice factor

Evaluating the factors in USLE:

R - Rainfall Erosivity Index

The rainfall erosivity index describes the kinetic energy generated by the frequency and intensity of the rainfall. It is statistically calculated from the annual summation of rainfall energy in every storm, which correlates to the raindrop size, times its maximum 30-minute intensity. This index varies with geography.

K - Soil Erodibility Factor

This factor quantifies the cohesive or bonding character of the soil and its ability to resist detachment and transport during a rainfall event. The soil erodibility factor is a function of soil type.

LS - Topographic Factor

The topographic factor represents the effect of slope length and slope steepness on erosion. Steeper slopes produce higher overland flow velocities. Longer slopes accumulate runoff from larger areas and also result in higher flow velocities. For convenience L and S are frequently lumped into a single term.

C - Crop/Vegetation and Management Factor

The crop/vegetation and management factor represents the effect that ground cover conditions, soil conditions and general management practices have on soil erosion. It is the most computationally complicated of USLE factors and incorporates the effects of: tillage management, crop type, cropping history (rotation), and crop yield.

P - Conservation Practice Factor

The conservation practice factor represents the effects on erosion of Best Management Practices (BMPs) such as contour farming, strip cropping and terracing.

Estimates of the USLE parameters, and thus the soil erosion as computed from the USLE, are provided by the Natural Resources Conservation Service's (NRCS) National Resources Inventory (NRI) 1994. The NRI database contains information of the status, condition, and trend of soil, water and related resources collected from approximately 800,000 sampling points across the country.

The soil losses from the erosion processes described above are localized losses and not the total amount of sediment that reaches the stream. The fraction of the soil lost in the field that is eventually delivered to the stream depends on several factors. These include, the distance of the source area from the stream, the size of the drainage area, and the intensity and frequency of rainfall. Soil losses along the riparian areas will be delivered into the stream with runoff-producing rainfall.

Sediment Modeling Methodology

Using WCS and the Sediment Tool, average annual sediment loading to surface waters was modeled according to the following procedures:

1. A WCS project was setup for the watershed that is the subject of these TMDLs. Additional data layers required for sediment analysis were generated or imported into the project. These included:

    DEM (grid) - The Digital Elevation Model (DEM) layers that come with the basic WCS distribution system are shapefiles of coarse resolution (300x300m). A higher resolution DEM grid layer (30x30m) is required. The National Elevation Dataset (NED) is available from the USGS website and the coverage for the watershed (8-digit HUC) was imported into the project.

    Road - A road layer is needed as a shape file and requires additional attributes such as road type, road practice, and presence of side ditches. If these attributes are not provided, the Sediment Tool automatically assigns default values: road type - secondary paved roads, side ditches present and no road practices. This data layer was obtained from ESRI for areas in the watershed.

    Soil - The SSURGO (1:24k) soil data may be imported into the WCS project if higher-resolution soil data is required for the estimation of potential erosion. If the SSURGO soil database is not available, the system uses the STATSGO Soil data (1:250k) by default.

    MRLC Land Use - The Multi-Resolution Land Characteristic (MRLC) data set for the watershed is provided with the WCS package, but must be imported into the project.

2. Using WCS, the entire watershed was delineated into subwatersheds corresponding to USGS 12-digit Hydrologic Unit Codes (HUCs). These delineations are shown in Figure 4. Land use distribution for these delineations is summarized in Appendix B. All of the sediment analyses were performed on the basis of these drainage areas.

The following steps are accomplished using the WCS Sediment Tool:

3. For a selected watershed or subwatershed, a sediment project is set up in a new view that contains the data layers that will be subsequently used to calculate erosion and sediment delivery.

4. A stream grid for each delineated subwatershed was created by etching a stream coverage, based on National Hydrology Dataset (NHD), to the DEM grid.

5. For each 30 by 30 meter grid cell within the subwatershed, the Sediment Tool calculates the potential erosion using the USLE based on the specific cell characteristics. The model then calculates the potential sediment delivery to the stream grid network. Sediment delivery can be calculated using one of the four available sediment delivery equations:

   - Distance-based equation (Sun and McNulty, 1998)
     $Mad = M * (1-0.97 * D/L)$
     where: Mad = mass moved (tons/acre/yr)
     M = sediment mass eroded (ton)
     D = least cost distance from a cell to the nearest stream grid (ft)
     L = maximum distance the sediment may travel (ft)

   - Distance Slope-based equation (Yagow et al., 1998)
     $DR = \exp(-0.4233 * L * So)$
     $So = \exp(-16.1 * r/L+ 0.057)) - 0.6$
     where: DR = sediment delivery ration
     L = distance to the stream (m)
     r = relief to the stream (m)

   - Area-based equation (USDASCS, 1983)
     $DR = 0.417762 * A^{(-0.134958)} - 1.27097, \quad DR <= 1.0$
     where: DR = sediment delivery ratio
     A = area (sq miles)

   - WEEP-based regression equation (Swift, 2000)
     $Z = 0.9004 - 0.1341 * X^2 + X^3 - 0.0399 * Y + 0.0144 * Y^2 + 0.00308 * Y^3$
     where: Z = percent of source sediment passing to the next grid cell
     X = cumulative distance down slope ($X > 0$)
     Y = percent slope in the grid cell ($Y > 0$)

   The distance slope based equation (Yagow et al., 1998) was selected to simulate sediment delivery in the Upper Duck River Watershed.

6. The total sediment delivered upstream of each subwatershed "pour point" is calculated. The sediment analysis provides the calculations for six new parameters:

   - Source Erosion - estimated erosion from each grid cell due to the land cover
   - Road Erosion - estimated erosion from each grid cell representing a road
   - Composite Erosion - composite of the source and road erosion layers
   - Source Sediment - estimated fraction of the soil erosion from each grid cell that reaches

the stream (sediment delivery)

- Road Sediment - estimated fraction of the road erosion from each grid cell that reaches the stream
- Composite Sediment - composite of the source and erosion sediment layers

The sediment delivery can be calculated based on the composite sediment, road sediment or source sediment layer. The sources of sediment by each land use type is determined showing the types of land use, the acres of each type of land use and the tons of sediment estimated to be generated from each land use.

7. For each subwatershed of interest, the resultant sediment load calculation is expressed as a long-term average annual soil loss expressed in pounds per year calculated for the rainfall erosivity index (R). This statistic is calculated from the annual summation of rainfall energy in every storm (correlates with raindrop size) times its maximum 30-minute intensity.

   Calculated erosion, sediment loads delivered to surface waters and unit loads (per unit area) for subwatersheds that contain waters on the *2004 303(d) List* as impaired for siltation and/or habitat alteration are summarized in Tables A-1, A-2, and A-3, respectively.

Table A-1 Calculated Erosion - Subwatersheds With Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

HUC-12 Subwatershed (06040002__)	***EROSION***				
	Road [tons/yr]	**Source [tons/yr]**	**Total [tons/yr]**	**%Road**	**%Source**
0203	3,647	14,135	17,782	20.5	79.5
0301	6,093	22,622	28,715	21.2	78.8
0305	2,080	18,306	20,386	10.2	89.8
0308	1,889	11,140	13,029	14.5	85.5
0309	1,433	8,354	9,786	14.6	85.4
0401	675	4,514	5,189	13.0	87.0
0402	607	3,745	4,352	13.9	86.1
0404	838	4,226	5,064	16.5	83.5
0502	860	4,527	5,387	16.0	84.0
0503	1,675	8,742	10,417	16.1	83.9
0504	1,443	9,908	11,350	12.7	87.3
0507	4,432	22,798	27,230	16.3	83.7
0601	8,392	24,919	33,311	25.2	74.8
0602	2,938	17,862	20,799	14.1	85.9

Table A-2 Calculated Sediment Delivery to Surface Waters - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

HUC-12 Subwatershed (06040002__)	***SEDIMENT***				
	Road	**Source**	**Total**	**%Road**	**%Source**
	[tons/yr]	**[tons/yr]**	**[tons/yr]**		
0203	2,103	6,114	8,217	25.6	74.4
0301	2,810	9,760	12,569	22.4	77.6
0305	1,363	7,337	8,699	15.7	84.3
0308	821	3,987	4,808	17.1	82.9
0309	596	2,764	3,360	17.7	82.3
0401	291	1,622	1,913	15.2	84.8
0402	181	1,047	1,228	14.7	85.3
0404	259	1,135	1,394	18.6	81.4
0502	292	1,345	1,637	17.8	82.2
0503	593	2,555	3,148	18.8	81.2
0504	400	2,315	2,715	14.7	85.3
0507	1,742	7,938	9,680	18.0	82.0
0601	3,751	8,573	12,324	30.4	69.6
0602	1,107	5,778	6,885	16.1	83.9

Table A-3 Unit Loads - Subwatersheds With Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

HUC-12 Subwatershed (06040002__)	HUC-12 Subwatershed Area	***UNIT LOADS***			
		Erosion		**Sediment**	
	[acres]	**[tons/ac/yr]**	**[lbs/ac/yr]**	**[tons/ac/yr]**	**[lbs/ac/yr]**
0203	26,017	0.683	1,367	0.316	632
0301	31,477	1.049	2,098	0.459	919
0305	19,720	1.034	2,068	0.441	882
0308	25,096	0.519	1,038	0.192	383
0309	20,044	0.488	976	0.168	335
0401	11,450	0.453	906	0.167	334
0402	10,567	0.412	824	0.116	232
0404	11,657	0.434	869	0.120	239
0502	10,244	0.526	1,052	0.160	320
0503	16,161	0.645	1,289	0.195	390
0504	18,949	0.599	1,198	0.143	287
0507	31,086	0.876	1,752	0.311	623
0601	42,847	0.777	1,555	0.288	575
0602	34,925	0.596	1,191	0.197	394

APPENDIX B

MRLC Land Use of Impaired Subwatersheds and Ecoregion Reference Site Drainage Areas

Table B-1 Upper Duck River Watershed - Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06040002___)							
	0203		0301		0305		0308	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	8,350	32.1	5,555	17.6	6,820	34.6	6,918	27.6
Emergent Herbaceous Wetlands	4	0.0	0	0.0	10	0.0	5	0.0
Evergreen Forest	1,097	4.2	4,783	15.2	317	1.6	826	3.3
High Intensity Commercial/Industrial/Transportation	80	0.3	684	2.2	84	0.4	244	1.0
High Intensity Residential	18	0.1	174	0.6	0	0.0	0	0.0
Low Intensity Residential	143	0.5	1,824	5.8	40	0.2	116	0.5
Mixed Forest	3,427	13.2	6,849	21.8	1,850	9.4	2,286	9.1
Open Water	14	0.1	15	0.0	22	0.1	19	0.1
Other Grasses (Urban/Recreational)	71	0.3	1,040	3.3	4	0.0	129	0.5
Pasture/Hay	9,967	38.3	9,177	29.2	7,068	35.8	8,938	35.6
Quarries/Strip Mines/Gravel Pits	0	0.0	14	0.0	0	0.0	0	0.0
Row Crops	2,449	9.4	1,350	4.3	3,379	17.1	5,335	21.3
Transitional	0	0.0	11	0.0	0	0.0	7	0.0
Woody Wetlands	396	1.5	0	0.0	126	0.6	272	1.1
Total	**26,017**	**100.0**	**31,477**	**100.0**	**19,720**	**100.0**	**25,096**	**100.0**

Table B-1 (Cont.) Upper Duck River Watershed - Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06040002___)							
	0309		0401		0402		0404	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	8,357	41.7	2,604	22.7	2,030	19.2	2,323	19.9
Emergent Herbaceous Wetlands	0	0.0	17	0.1	14	0.1	99	0.8
Evergreen Forest	1,040	5.2	206	1.8	198	1.9	375	3.2
High Intensity Commercial/Industrial/ Transportation	16	0.1	46	0.4	3	0.0	76	0.7
High Intensity Residential	0	0.0	0	0.0	0	0.0	6	0.0
Low Intensity Residential	61	0.3	32	0.3	15	0.1	66	0.6
Mixed Forest	2,574	12.8	777	6.8	700	6.6	980	8.4
Open Water	5	0.0	4	0.0	1	0.0	38	0.3
Other Grasses (Urban/Recreational)	5	0.0	0	0.0	18	0.2	5	0.0
Pasture/Hay	4,302	21.5	4,512	39.4	4,451	42.1	3,992	34.2
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	3,684	18.4	2,974	26.0	2,884	27.3	3,019	25.9
Transitional	0	0.0	0	0.0	0	0.0	0	0.0
Woody Wetlands	1	0.0	278	2.4	254	2.4	678	5.8
Total	**20,044**	**100.0**	**11,450**	**100.0**	**10,567**	**100.0**	**11,657**	**100.0**

Table B-1 (Cont.) Upper Duck River Watershed - Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06040002___)					
	0502		0503		0504	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0
Deciduous Forest	2,414	23.6	3,342	20.7	7,166	37.8
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0
Evergreen Forest	486	4.7	854	5.3	993	5.2
High Intensity Commercial/Industrial/Transportation	11	0.1	164	1.0	28	0.1
High Intensity Residential	0	0.0	17	0.1	6	0.0
Low Intensity Residential	13	0.1	162	1.0	47	0.2
Mixed Forest	1,090	10.6	2,112	13.1	2,641	13.9
Open Water	4	0.0	7	0.0	4	0.0
Other Grasses (Urban/Recreational)	0	0.0	56	0.3	0	0.0
Pasture/Hay	4,362	42.6	6,643	41.1	4,431	23.4
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0
Row Crops	1,863	18.2	2,804	17.3	3,610	19.1
Transitional	0	0.0	0	0.0	0	0.0
Woody Wetlands	0	0.0	0	0.0	23	0.1
Total	**10,244**	**100.0**	**16,161**	**100.0**	**18,949**	**100.0**

Table B-1 (Cont.) Upper Duck River Watershed - Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06040002___)					
	0507		0601		0602	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0
Deciduous Forest	12,860	41.4	11,830	27.6	11,075	31.7
Emergent Herbaceous Wetlands	0	0.0	0	0.0	1	0.0
Evergreen Forest	1,247	4.0	2,514	5.9	1,898	5.4
High Intensity Commercial/Industrial/Transportation	86	0.3	583	1.4	56	0.2
High Intensity Residential	1	0.0	199	0.5	0	0.0
Low Intensity Residential	52	0.2	1,232	2.9	124	0.4
Mixed Forest	5,243	16.9	8,241	19.2	4,591	13.1
Open Water	307	1.0	33	0.1	20	0.1
Other Grasses (Urban/Recreational)	18	0.1	768	1.8	40	0.1
Pasture/Hay	6,215	20.0	12,438	29.0	9,921	28.4
Quarries/Strip Mines/Gravel Pits	54	0.2	121	0.3	0	0.0
Row Crops	4,785	15.4	4,832	11.3	7,015	20.1
Transitional	21	0.1	9	0.0	1	0.0
Woody Wetlands	199	0.6	47	0.1	184	0.5
Total	**31,086**	**100.0**	**42,847**	**100.0**	**34,925**	**100.0**

Table B-2 Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed									
	Eco71f12		Eco71f16		Eco71f19		Eco71f27		Eco71f28	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	4,839	71.7	9,655	97.7	4,403	81.3	1,888	59.0	4,175	88.3
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	39	0.6	21	0.2	73	1.4	909	28.4	155	3.3
High Intensity Commercial/ Industrial/Transportation	1	0.0	7	0.1	1	0.0	10	0.3	5	0.1
High Intensity Residential	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Low Intensity Residential	5	0.1	0	0.0	2	0.0	0	0.0	1	0.0
Mixed Forest	155	2.3	68	0.7	57	1.1	233	7.3	99	2.1
Open Water	2	0.0	0	0.0	1	0.0	0	0.0	1	0.0
Other Grasses (Urban/Recreational)	0	0.0	0	0.0	1	0.0	0	0.0	4	0.1
Pasture/Hay	1,242	18.4	94	1.0	251	4.6	6	0.2	166	3.5
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	461	6.8	0	0.0	493	9.1	48	1.5	99	2.1
Transitional	1	0.0	33	0.3	98	1.8	108	3.4	25	0.5
Woody Wetlands	0	0.0	0	0.0	35	0.7	0	0.0	0	0.0
Total	**6,746**	**100.0**	**9,879**	**100.0**	**5,416**	**100.0**	**3,201**	**100.0**	**4,730**	**100.0**

Table B-2 (Cont.) Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed							
	Eco71f29		Eco71g03		Eco71g04		Eco71g10	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	34,312	78.8	6,703	47.4	9,087	53.2	2,726	76.6
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	190	0.4	1,206	8.5	384	2.2	80	2.2
High Intensity Commercial/Industrial/Transportation	44	0.1	13	0.1	143	0.8	23	0.6
High Intensity Residential	0	0.0	0	0.0	4	0.0	0	0.0
Low Intensity Residential	49	0.1	90	0.6	132	0.8	3	0.1
Mixed Forest	741	1.7	2,635	18.6	1,612	9.4	169	4.8
Open Water	60	0.1	2	0.0	3	0.0	0	0.0
Other Grasses (Urban/Recreational)	42	0.1	175	1.2	33	0.2	54	1.5
Pasture/Hay	4,022	9.2	3,138	22.2	4,331	25.3	335	9.4
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	42	0.2	0	0.0
Row Crops	3,752	8.6	184	1.3	1,319	7.7	170	4.8
Transitional	289	0.7	0	0.0	0	0.0	5	0.1
Woody Wetlands	48	0.1	0	0.0	0	0.0	0	0.0
Total	**43,549**	**100.0**	**14,145**	**100.0**	**17,090**	**100.0**	**3,565**	**100.1**

Table B-2 (Cont.) Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed							
	Eco71h03		Eco71h06		Eco71h09		Eco71i10	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	6,784	81.6	7,788	88.7	6,264	79.0	4,782	39.2
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	137	1.6	137	1.6	245	3.1	677	5.5
High Intensity Commercial/Industrial/ Transportation	20	0.2	2	0.0	6	0.1	4	0.0
High Intensity Residential	14	0.2	0	0.0	0	0.0	0	0.0
Low Intensity Residential	136	1.6	2	0.0	36	0.5	10	0.1
Mixed Forest	757	9.1	604	6.9	722	9.1	2,425	19.9
Open Water	0	0.0	1	0.0	0	0.0	1	0.0
Other Grasses (Urban/Recreational)	52	0.6	0	0.0	0	0.0	8	0.1
Pasture/Hay	395	4.7	193	2.2	494	6.2	3,339	27.4
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	23	0.3	50	0.6	167	2.1	955	7.8
Transitional	0	0.0	1	0.0	0	0.0	0	0.0
Woody Wetlands	0	0.0	0	0.0	0	0.0	0	0.0
Total	**8,318**	**100.1**	**8,779**	**100.0**	**7,934**	**100.0**	**12,200**	**100.0**

Table B-2 (Cont.) Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed							
	Eco71i12		Eco71i14		Eco71i15		Eco71i16	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	4,495	25.2	1,687	39.4	11,842	27.4	5,535	35.7
Emergent Herbaceous Wetlands	0	0.0	0	0.0	12	0.0	46	0.3
Evergreen Forest	640	3.6	95	2.2	2,334	5.4	887	5.7
High Intensity Commercial/Industrial/ Transportation	96	0.5	1	0.0	125	0.3	33	0.2
High Intensity Residential	0	0.0	0	0.0	5	0.0	3	0.0
Low Intensity Residential	55	0.3	5	0.1	262	0.6	70	0.5
Mixed Forest	2,106	11.8	526	12.3	6,707	15.5	2,178	14.1
Open Water	7	0.0	0	0.0	61	0.1	7	0.0
Other Grasses (Urban/Recreational)	35	0.2	0	0.0	139	0.3	24	0.2
Pasture/Hay	6,846	38.4	1,311	30.7	14,171	32.8	3,665	23.6
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	3,571	20.0	574	13.4	7,163	16.6	2,403	15.5
Transitional	0	0.0	73	1.7	109	0.3	1	0.0
Woody Wetlands	0	0.0	0	0.0	310	0.7	647	4.2
Total	**17,852**	**100.0**	**4,273**	**99.9**	**43,239**	**100.0**	**15,500**	**100.0**

APPENDIX C

Estimate of Existing Point Source Loads for NPDES Permitted Ready Mixed Concrete Facilities and Mining Sites

Determination of Existing Point Source Sediment Loads

Existing point source sediment loads for RMCFs and mining sites located in impaired HUC-12 subwatersheds were estimated using the methodologies described below.

Ready Mixed Concrete Facilities (RMCFs)

Total loading from RMCFs is the sum of loading from process wastewater discharges and storm water runoff. Estimates of loading (ref.: Table C-1) from RMCFs located in an impaired subwatershed were determined as follows.

The existing loading from process wastewater discharge for RMCFs is based on facility design flow, the monthly average permit limit for TSS, and the area of the HUC-12 subwatershed in which the facilities are located. Loads are expressed as average annual loads per unit area and are summarized in Table C-1.

$$AAL_{RMCF} = \frac{(Q_d) \text{ x } (MAvg)\ (8.34 \text{ lb-l/gal-mg})\ (365 \text{ days/yr})}{(A_{HUC\text{-}12})}$$

where: AAL_{RMCF} = Average annual load [lb/ac/yr]
Q_d = Facility design flow [MGD]
MAvg = Monthly average concentration limit for TSS [mg/l]
$A_{HUC\text{-}12}$ = Area of impaired HUC-12 subwatershed [acres]

The existing loading from storm water runoff for RMCFs is based on an assumed runoff from the site drainage area, the daily maximum permit limit for TSS, and the area of the HUC-12 subwatershed in which each facility is located (ref.: Table C-1). Site runoff was estimated by assuming that one-half of the annual precipitation falling on the site drainage area results in runoff. Annual precipitation for the Upper Duck River Watershed is approximately 52 in/yr (Midwest Plan Service, 1985).

$$AAL_{RMCF} = \frac{(A_d)\ (DMax)\ (Precip)\ (0.2266 \text{ lb-l/ac-in-mg})\ (0.5)}{(A_{HUC\text{-}12})}$$

where: AAL_{RMCF} = Average annual load [lb/ac/yr]
A_d = Facility (site) drainage area [acres]
DMax = Daily maximum concentration limit for TSS [mg/l]
Precip = Average annual precipitation for watershed [in/yr]
$A_{HUC\text{-}12}$ = Area of impaired HUC-12 subwatershed [acres]

Table C-1 Estimate of Existing Loads - Ready Mixed Concrete Facilities

HUC-12 Subwatershed (06040002__)	Subwatershed Area	NPDES Permit No.	Process Wastewater			Storm Water Runoff			Total Annual Average Load
			Estimated Flow	Daily Maximum TSS Limit	Annual Average Load	Site Drainage Area	TSS Cut-off Conc.	Annual Average Load	
			[MGD]	[mg/l]	[lb/ac/yr]	[acres]	[mg/l]	[lb/ac/yr]	[lb/ac/yr]
0301	27,369	TNG110117	0.0001	50	0.0006	12.0	200	0.5166	0.517
		TNG110309				3.0		0.1292	0.130
0601	42,847	TNG110032			0.0004	14.6		0.4015	0.402
		TNG110069				2.5		0.0688	0.069

Mining Sites

Existing loads for permitted mining sites are based on an assumed runoff from the site drainage area, the daily maximum permit limit for TSS, and the area of the HUC-12 subwatershed in which the mining site is located (ref.: Table C-2). Site runoff was estimated by assuming that one half of the annual precipitation falling on the site area results in runoff. Annual precipitation for the Upper Duck River Watershed is approximately 52 in/yr (Midwest Plan Service, 1985).

$$AAL_{Mining} = \frac{(A_d)\ (DMax)\ (Precip.)\ (0.2266\ \text{lb-l/ac-in-mg})\ (0.5)}{(A_{HUC\text{-}12})}$$

where: AAL_{Mining} = Average annual load [lb/yr]
A_d = Facility (site) drainage area [acres]
DMax = Daily maximum concentration limit for TSS [mg/l]
Precip = Average annual precipitation for watershed [in/yr]
$A_{HUC\text{-}12}$ = Area of impaired HUC-12 subwatershed [acres]

Table C-2 Estimate of Existing Load – NPDES Permitted Mining Sites

HUC-12 Subwatershed (06040002___)	Subwatershed Area	NPDES Permit No.	Site Drainage Area	Daily Maximum TSS Limit	Annual Average Load
	[acres]		[acres]	[mg/l]	[lb/ac/yr]
0301	27,369	TN0022756	200	40	1.722
	27,369	TN0066508	95		0.822
0401	11,450	TN0071846	169		3.478
0507	31,086	TN0061395	125		0.950
0601	42,847	TN0003654	80		0.440
	42,847	TN0071251	64		0.353

Total Existing Point Source Loads for Impaired HUC-12 Subwatersheds

Estimated point source loads were summed for each impaired HUC-12 subwatershed and then compared to both existing and target subwatershed sediment loads (ref.: Table C-3).

Table C-3 Estimate of Existing Point Source Loads in Impaired HUC-12 Subwatersheds

HUC-12 Subwatershed (06040002__)	NPDES Permit No.	Facility Type	Average Annual Point Source Load	Existing Subwatershed Load	Point Source Percentage Of Existing Load	Subwatershed Target Load	Point Source Percentage of Target Load
			[lb/ac/yr]	[lb/ac/yr]	[%]	[lb/ac/yr]	[%]
0301	TN0022756	Mining	1.722				
	TN0066508	Mining	0.822				
	TNG110309	RMCF	0.130				
	TNG110117	RMCF	0.517				
	Subwatershed 0301 Total		**3.191**	919	**0.35**	421	**0.76**
0401	TN0071846	Mining	**3.478**	334	**1.04**	421	**0.83**
0507	TN0061395	Mining	**0.950**	623	**0.15**	421	**0.23**
0601	TN0003654	Mining	0.440				
	TN0071251	Mining	0.353				
	TNG110032	RMCF	0.402				
	TNG110069	RMCF	0.069				
	Subwatershed 0601 Total		**1.264**	575	**0.22**	421	**0.30**

Note: A spreadsheet was used for this calculation and values are approximate due to rounding.

APPENDIX D

Site Specific Analysis of Predicted Zero Load Reduction in Certain Impaired Subwatersheds

D1.0 Predicted Zero Load Reduction of Impaired Watersheds

As described in Appendix A, the Watershed Characterization System (WCS) Sediment Tool (v.2.6) was used to determine the existing annual average sediment load for impaired HUC-12 subwatersheds. This GIS-based tool applies the Universal Soil Loss Equation (USLE) to digitized spatial data (land use, roads, soils, elevation, etc.) to calculate erosion from land surfaces and sediment delivery to the stream network.

There are nine HUC-12 subwatersheds in the Upper Duck River watershed that have been assessed as impaired due to siltation, but the Sediment Tool analysis indicates that no sediment load reduction is required (the model-calculated sediment loads for these drainage areas are less than the TMDL target loads). Based on stream monitoring and watershed reconnaissance by Field Office and State Lab personnel, the source of impairment for each of these subwatersheds was determined to be pasture grazing, agricultural sources, or livestock in the stream.

HUC-12 Subwatershed	Impaired Waterbody	Source
060400020308	Hurricane Creek Fall Creek	Pasture Grazing Pasture Grazing
060400020309	Sinking Creek Little Sinking Creek	Pasture Grazing Pasture Grazing
060400020401	North Fork Creek	Agriculture
060400020402	Alexander Creek	Pasture Grazing
060400020404	Weakley Creek	Agriculture
060400020502	Wilson Creek	Pasture Grazing
060400020503	Lick Creek	Livestock in Stream
060400020504	Caney Creek Thick Creek	Livestock in Stream Pasture Grazing
060400020602	East Rock Creek	Pasture Grazing

In these cases, model limitations and/or site-specific factors that are not considered in the analysis may be causes of waterbody impairment. Relevant factors may include:

- The USLE-based model only takes into account erosion from land surfaces that result from precipitation. Sediment loading from streambank erosion is not considered.

- The current MRLC land use data used by the Sediment Tool was produced from satellite imagery from 1992 through 1995 and was created in a 30-meter by 30-meter cell-sized grid. One specific land use type is assigned to each grid cell causing a loss of resolution in the data. The land use has also changed in some areas of the watershed since the satellite imagery was developed. The land use shown for this watershed is typically pasture grazing, with some forested areas. In some areas, however, row crops have replaced pasture and forest, resulting in a higher actual sediment load delivered to the stream network than the Sediment Tool analysis would indicate.

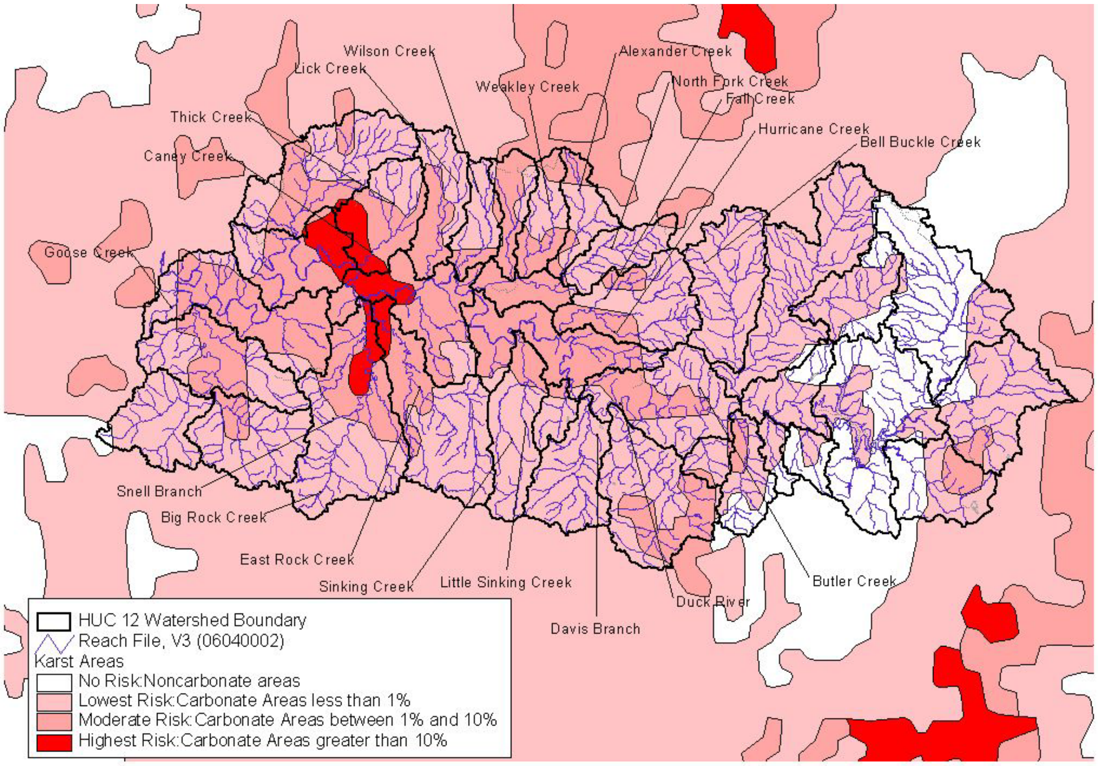
- The National Hydrography Database (NHD) stream data coverage used was created at 1:100,000 scale. Many smaller streams and headwater tributaries are not represented in this coverage and, therefore, not considered in the modeling process.
- Other localized factors, such as lack of riparian vegetation, livestock access to streams, and/or karst topography (see Section D2.0), that are not represented in the model may affect sediment loading.

Details of stream assessments and discussion of other relevant factors for each of the nine impaired subwatersheds are presented in Sections D3.0 through D11.0

D2.0 Karst Topography in the Upper Duck River Watershed

The Upper Duck River Watershed is located in a karst region of Tennessee (ref.: Figure D-1). Karst topography refers to an irregular topography that is characterized by sinkholes, streamless valleys, and streams that disappear into the underground. These are developed by the action of surface and underground water in soluble rocks such as limestone (Stokes et al., 1978).

Figure D-1 Karst Risk Regions (based on % Carbonate) in the Upper Duck Watershed



D3.0 Hurricane Creek and Fall Creek (060400020308) Subwatershed Analysis

Hurricane Creek (TN06040002038_0300) was placed on the 303(d) list of impaired streams in 2002 as impacted by pathogens, nutrients, siltation and other habitat alterations from pasture grazing. The *2004 303(d) List* indicated the stream was impaired due to Escherichia coli and nutrients, loss of biological integrity due to siltation and other habitat alterations, from pasture grazing. The land use in the areas was primarily pasture grazing.

Hurricane Creek was monitored in 2003 at RM 15.9 and at RM 6.6 by the Nashville Environmental Field Office. Notes report in that area, the stream had minimal sediment deposits (ref.: Figures D-2 and D-3) and was classified as fully supporting. However, in the lower reaches, the stream conditions were impacted by low flow and siltation. The stream assessment in 2001 by aquatic biologists from the State Lab at RM 0.2 (ref.: Figures D-4 and D-5) indicated heavy sediment deposits and suboptimal vegetative protection. A biorecon showed 1 EPT, 1 intolerant, and 12 total families. The stream assessment in 1999 by the Nashville Environmental Field Office (ref.: Figures D-6 and D-7) at RM 1.8 noted moderate sediment deposits, high siltation in the stream, some riparian loss and access to the stream by cows (a path was described from the barn to the stream). There were long, deep, still pools with algae noted (ref.: Figure D-8), due to low flow at the time of the visit. An abbreviated biorecon indicated that while there were quite a few total taxa (23), EPT (5) was low.

Fall Creek (TN06040002038_1000) was placed on the 303(d) list of impaired streams in 2002 as impacted by pathogens, nutrients, siltation and habitat alterations, from pasture grazing. The *2004 303(d) List* indicated the stream was impaired due to Escherichia coli and nutrients, loss of biological integrity due to siltation and other habitat alterations, from pasture grazing.

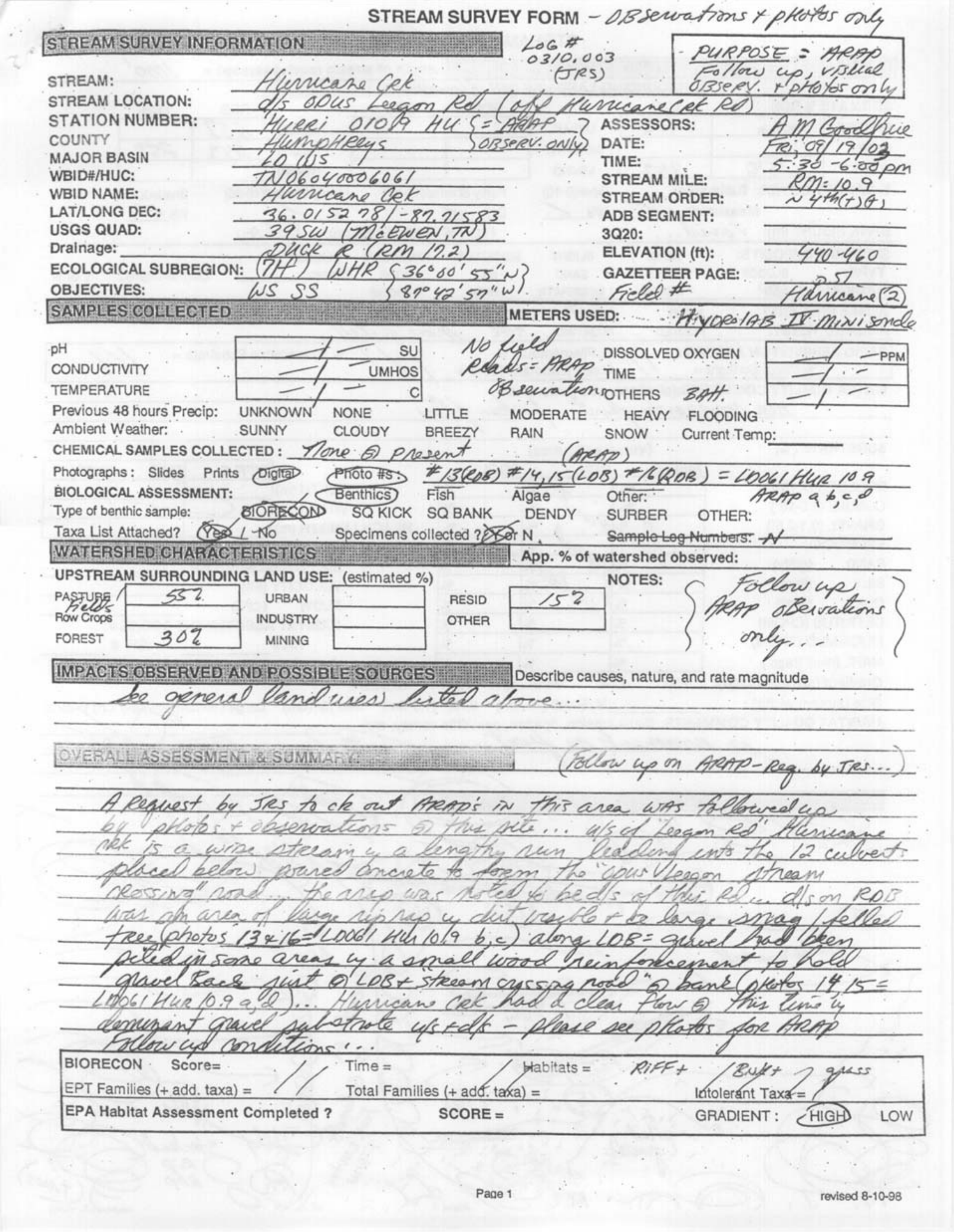
Fall Creek was monitored at RM 1.1 in 1999 by the Nashville Environmental Field Office. Notes report very low flow, moderate bank erosion, algae choking the stream, and cows alongside the stream (ref.: Figures D-9 through D-12). Fall Creek was also monitored at RM 6.1 in 2001 by aquatic biologists from the State Lab. They noted moderate sedimentation and siltation, marginal vegetative protection and a greatly decreased riparian zone (ref.: Figures D-13 through D-17). Monitoring conducted the next day at RM 1.2 showed moderate sediment and algae and slight siltation in the stream (ref.: Figures D-18 through D-20).

D4.0 Sinking Creek (060400020309) including Little Sinking Creek Subwatershed Analysis

Sinking Creek (TN06040002021_1000 and _2000) was placed on the 303(d) list of impaired streams in 2002 as impacted by siltation and habitat alterations from pasture grazing. This stream was shown on the *2004 303(d) List* as being impaired by loss of biological integrity due to siltation and other habitat alterations from pasture grazing.

Sinking Creek was monitored in 1999 by the Nashville Environmental Field Office. A biorecon at RM 8.6 showed 1 EPT, 1 intolerant, and 12 total families. Notes report the sediment deposits were moderate to excessive in areas (ref.: Figures D-21 and D-22). The banks were tall and eroded with many trees falling into the stream (ref.: Figures D-23 and D-24).

Figure D-2 Hurricane Creek field sheet, RM 15.9, p1 - September 19, 2003



STREAM SURVEY FORM - OBServations + photos only

STREAM SURVEY INFORMATION

Log #
0310.003
(JRS)

PURPOSE = ARAP
Follow up, visual
OBSERV. + photos only

STREAM: Hurricane Crk
STREAM LOCATION: d/s ODUS Leegon Rd (off Hurricane Crk Rd)
STATION NUMBER: HURRI 010.9 HU {= ARAP OBSERV. ONLY}
COUNTY: Humphreys
MAJOR BASIN: LO WS
WBID#/HUC: TN06040006061
WBID NAME: Hurricane Crk
LAT/LONG DEC: 36.015278/-87.71583
USGS QUAD: 39SW (McEWEN, TN)
Drainage: DUCK R (RM 17.2)
ECOLOGICAL SUBREGION: (7H) WHR {36°00'55"N}
OBJECTIVES: WS SS {87°42'57"W}

ASSESSORS: A M Goodfrue
DATE: FRI, 09/19/03
TIME: 5:30-6:00 pm
STREAM MILE: RM: 10.9
STREAM ORDER: ~4th(+)(?)
ADB SEGMENT:
3Q20:
ELEVATION (ft): 440-460
GAZETTEER PAGE: p.57
Field #: Hurricane (2)

SAMPLES COLLECTED

METERS USED: HydroLAB IV minisonde

No field Reads = ARAP OBservations

pH	-/-	SU
CONDUCTIVITY	-/-	UMHOS
TEMPERATURE	-/-	C

DISSOLVED OXYGEN	-/- PPM
TIME	-/-
OTHERS BAH.	-/-

Previous 48 hours Precip: UNKNOWN NONE LITTLE MODERATE HEAVY FLOODING
Ambient Weather: SUNNY CLOUDY BREEZY RAIN SNOW Current Temp:
CHEMICAL SAMPLES COLLECTED: None @ present (ARAP)
Photographs: Slides Prints [✓ Digital] [✓ Photo #s:] #13(RDB) #14,15(LDB) #16(RDB) = LD061 HUR 10.9
ARAP a,b,c,d
BIOLOGICAL ASSESSMENT: [✓ Benthics] Fish Algae Other:
Type of benthic sample: ~~BIORECON~~ SQ KICK SQ BANK DENDY SURBER OTHER:
Taxa List Attached? ~~Yes~~ / No Specimens collected ? ~~Y~~ or N. ~~Sample Log Numbers:~~ N

WATERSHED CHARACTERISTICS

App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE / fields	55%	URBAN		RESID	15%
Row Crops		INDUSTRY		OTHER	
FOREST	30%	MINING			

NOTES: {Follow up ARAP observations only...}

IMPACTS OBSERVED AND POSSIBLE SOURCES Describe causes, nature, and rate magnitude

See general land uses listed above...

OVERALL ASSESSMENT & SUMMARY (Follow up on ARAP - Req. by JRS...)

A Request by JRS to ck out ARAP's in this area was followed up by photos + observations @ this site... u/s of "Leegon Rd" Hurricane Crk is a wide stream w/ a lengthy run leading into the 12 culverts placed below poured concrete to form the "Odus Leegon stream crossing" road... the arap was noted to be d/s of this Rd... d/s on RDB was an area of large rip rap w/ dirt visible + a large snag/felled tree (photos 13 & 16 = LD061 Hur 10.9 b,c) along LDB = gravel had been piled in some areas w/ a small wood reinforcement to hold gravel back just @ LDB + stream crossing road "@ bank (photos 14, 15 = LD061 Hur 10.9 a,d)... Hurricane Crk had a clear flow @ this time w/ dominant gravel substrate u/s + d/s - please see photos for ARAP follow up conditions...

BIORECON Score= //	Time = /	Habitats = RIFF + / Run + / grass
EPT Families (+ add. taxa) = //	Total Families (+ add. taxa) =	Intolerant Taxa = /
EPA Habitat Assessment Completed ?	SCORE =	GRADIENT : [✓ HIGH] LOW

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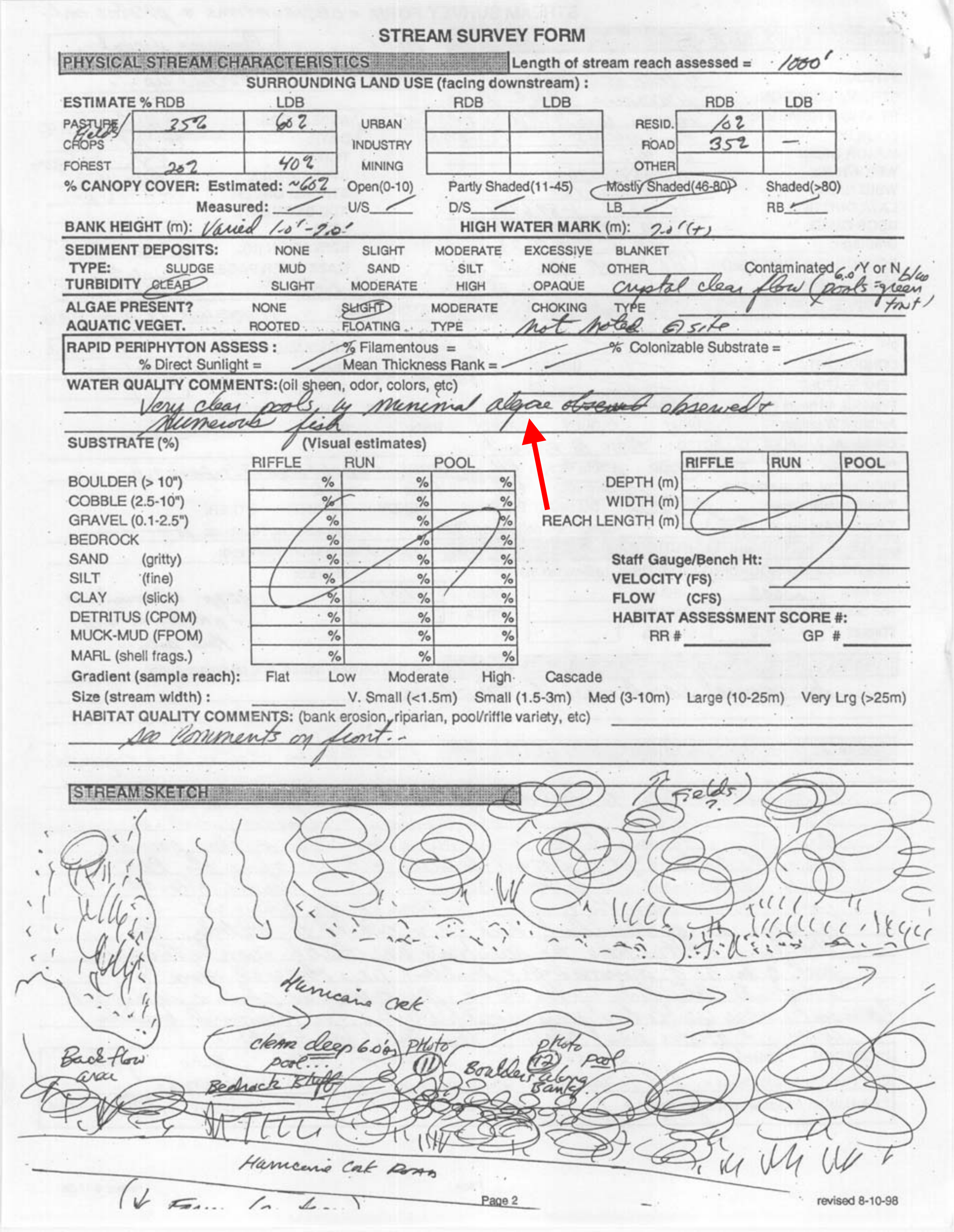
Figure D-3 Hurricane Creek field sheet, RM 15.9, p2 - September 19, 2003



STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS Length of stream reach assessed = 1000'

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE/ Fields	35%	60%	URBAN			RESID.	10%	
CROPS			INDUSTRY			ROAD	35%	—
FOREST	20%	40%	MINING			OTHER		

% CANOPY COVER: Estimated: ~60% Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)

Measured: / U/S / D/S / LB / RB /

BANK HEIGHT (m): Varied 1.0'-9.0' **HIGH WATER MARK** (m): 7.0'(+)

SEDIMENT DEPOSITS: NONE SLIGHT MODERATE EXCESSIVE BLANKET

TYPE: SLUDGE MUD SAND SILT NONE OTHER Contaminated 6.0' Y or N b/w

TURBIDITY [✓ CLEAR] SLIGHT MODERATE HIGH OPAQUE crystal clear flow (pools = green tint)

ALGAE PRESENT? NONE [✓ SLIGHT] MODERATE CHOKING TYPE

AQUATIC VEGET. ROOTED FLOATING TYPE not noted @ site

RAPID PERIPHYTON ASSESS : % Filamentous = / % Colonizable Substrate = /

% Direct Sunlight = / Mean Thickness Rank = /

WATER QUALITY COMMENTS:(oil sheen, odor, colors, etc)

Very clear pools, w/ minimal algae ~~observed~~ observed + numerous fish

SUBSTRATE (%) (Visual estimates)

	RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%
COBBLE (2.5-10")	%	%	%
GRAVEL (0.1-2.5")	%	%	%
BEDROCK	%	%	%
SAND (gritty)	%	%	%
SILT (fine)	%	%	%
CLAY (slick)	%	%	%
DETRITUS (CPOM)	%	%	%
MUCK-MUD (FPOM)	%	%	%
MARL (shell frags.)	%	%	%

	RIFFLE	RUN	POOL
DEPTH (m)			
WIDTH (m)			
REACH LENGTH (m)			

Staff Gauge/Bench Ht:

VELOCITY (FS)

FLOW (CFS)

HABITAT ASSESSMENT SCORE #:

RR # GP #

Gradient (sample reach): Flat Low Moderate High Cascade

Size (stream width) : V. Small (<1.5m) Small (1.5-3m) Med (3-10m) Large (10-25m) Very Lrg (>25m)

HABITAT QUALITY COMMENTS: (bank erosion, riparian, pool/riffle variety, etc)

see comments on front.-

STREAM SKETCH

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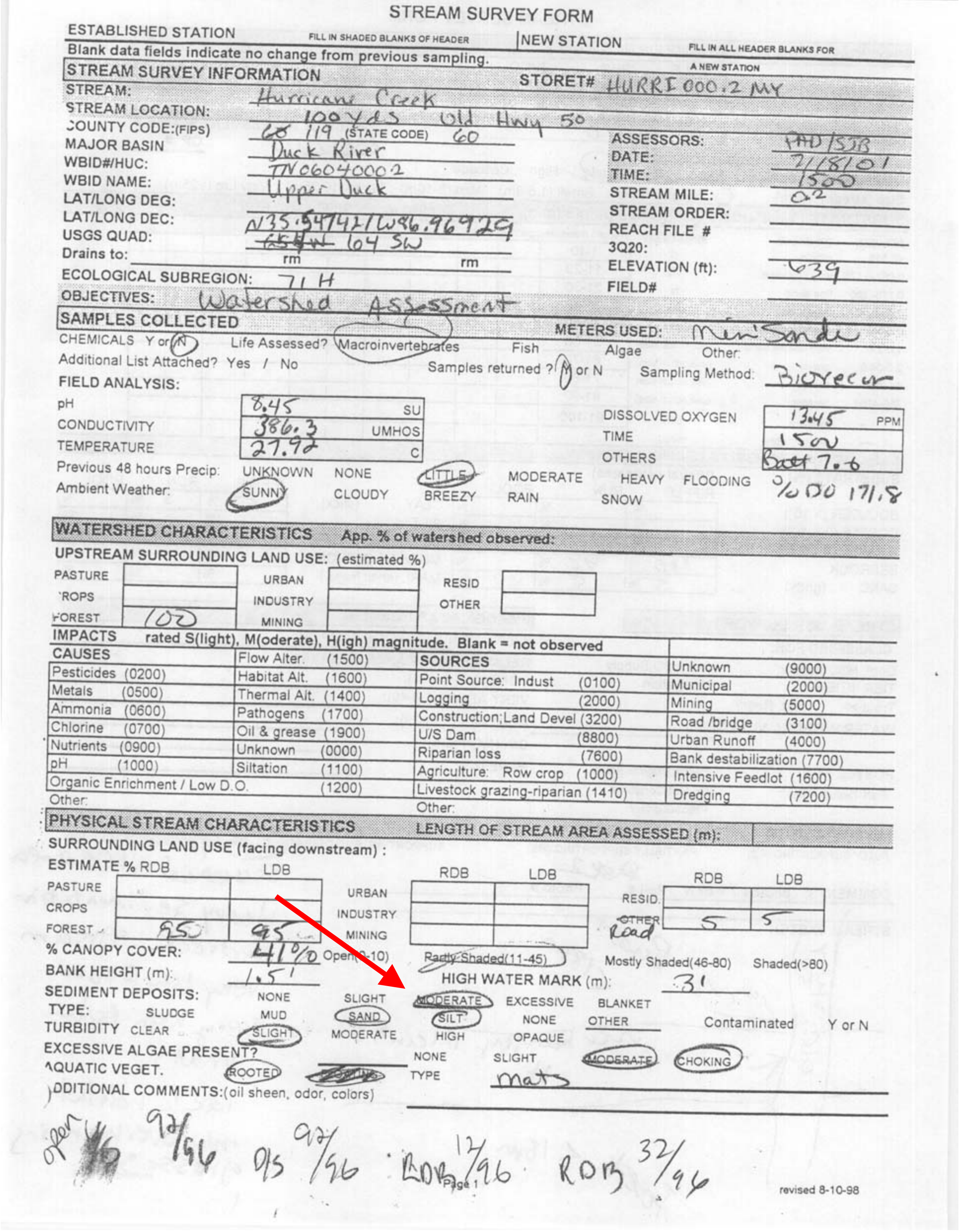
Figure D-4 Hurricane Creek field sheet, RM 0.2, p1 - July 18, 2001



STREAM SURVEY FORM

ESTABLISHED STATION FILL IN SHADED BLANKS OF HEADER | NEW STATION FILL IN ALL HEADER BLANKS FOR A NEW STATION

Blank data fields indicate no change from previous sampling.

STREAM SURVEY INFORMATION

STORET# HURRI000.2 MY

STREAM: Hurricane Creek
STREAM LOCATION: 100 yds Old Hwy 50
COUNTY CODE:(FIPS) ~~68~~ 119 (STATE CODE) 60
MAJOR BASIN Duck River
WBID#/HUC: TN06040002
WBID NAME: Upper Duck
LAT/LONG DEG:
LAT/LONG DEC: N35.54742/W86.96929
USGS QUAD: ~~65 4W~~ 64 SW
Drains to: rm rm
ECOLOGICAL SUBREGION: 71 H
OBJECTIVES: Watershed Assessment

ASSESSORS: PAD/SJB
DATE: 7/18/01
TIME: 1500
STREAM MILE: 0.2
STREAM ORDER:
REACH FILE #
3Q20:
ELEVATION (ft): 639
FIELD#

SAMPLES COLLECTED

METERS USED: MiniSonde
CHEMICALS Y or [✓ N] Life Assessed? [✓ Macroinvertebrates] Fish Algae Other:
Additional List Attached? Yes / No Samples returned ? [✓ Y] or N Sampling Method: Biorecon

FIELD ANALYSIS:

pH	8.45	SU
CONDUCTIVITY	386.3	UMHOS
TEMPERATURE	27.92	C

DISSOLVED OXYGEN	13.45 PPM
TIME	1500
OTHERS	Batt 7.6

% DO 171.8

Previous 48 hours Precip: UNKNOWN NONE [✓ LITTLE] MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY] CLOUDY BREEZY RAIN SNOW

WATERSHED CHARACTERISTICS App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE		URBAN		RESID	
CROPS		INDUSTRY		OTHER	
FOREST	100	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500)	SOURCES	
Pesticides (0200)	Habitat Alt. (1600)	Point Source: Indust (0100)	Unknown (9000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Municipal (2000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Mining (5000)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Road /bridge (3100)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600)	Urban Runoff (4000)
pH (1000)	Siltation (1100)	Agriculture: Row crop (1000)	Bank destabilization (7700)
Organic Enrichment / Low D.O.	(1200)	Livestock grazing-riparian (1410)	Intensive Feedlot (1600)
Other:		Other:	Dredging (7200)

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE			URBAN			RESID.		
CROPS			INDUSTRY			~~OTHER~~ Road	5	5
FOREST	95	95	MINING					

% CANOPY COVER: 41% Open(0-10) [✓ Partly Shaded(11-45)] Mostly Shaded(46-80) Shaded(>80)
BANK HEIGHT (m): 1.5' HIGH WATER MARK (m): 3'
SEDIMENT DEPOSITS: NONE SLIGHT [✓ MODERATE] EXCESSIVE BLANKET
TYPE: SLUDGE MUD [✓ SAND] [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR [✓ SLIGHT] MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? NONE SLIGHT [✓ MODERATE] [✓ CHOKING]
AQUATIC VEGET. [✓ ROOTED] ~~FLOATING~~ TYPE mats
ADDITIONAL COMMENTS:(oil sheen, odor, colors)

open [illegible] 92/96 0/5 92/96 LDB 12/96 RDB 32/96

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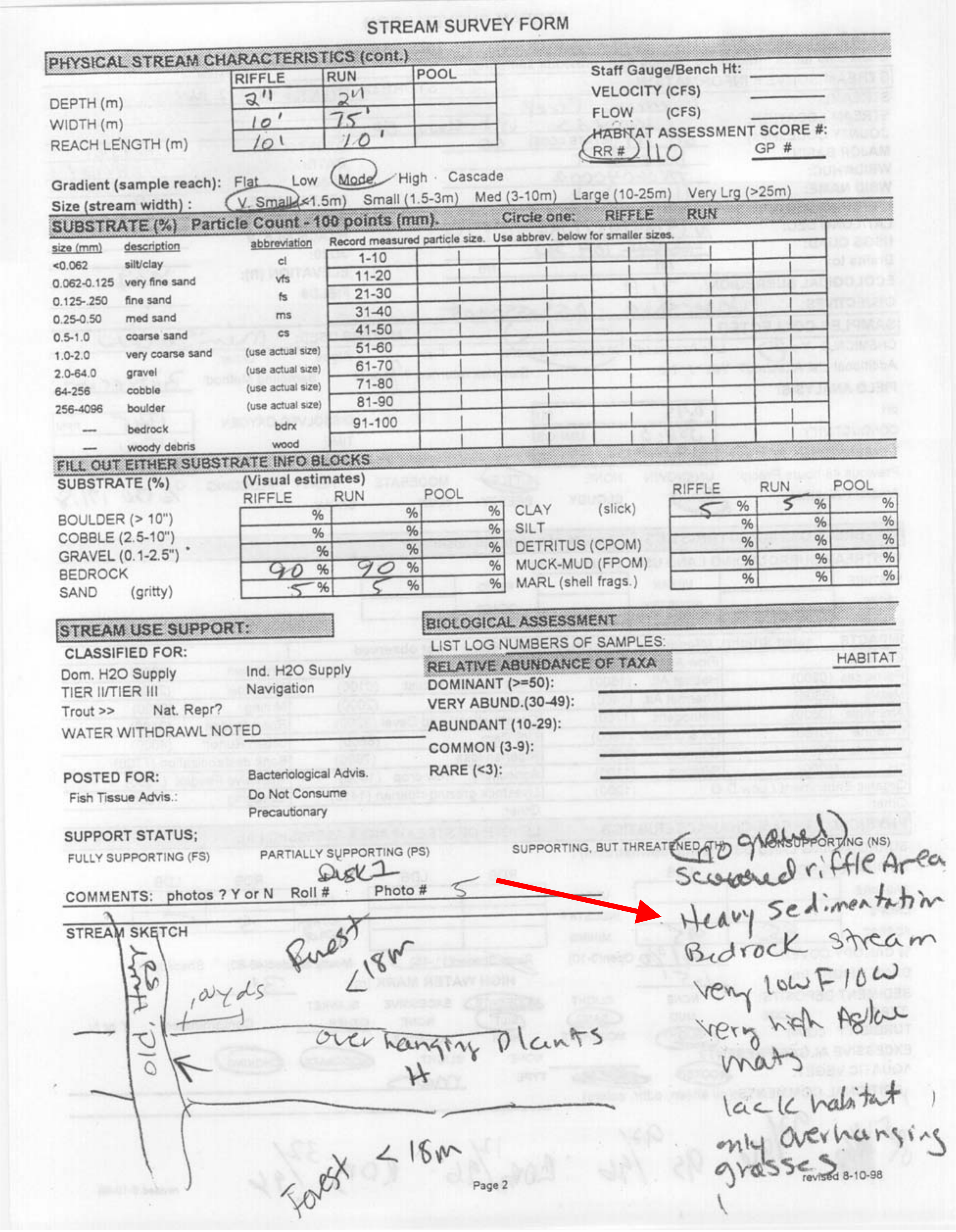
Figure D-5 Hurricane Creek field sheet, RM 0.2, p2 - July 18, 2001



STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)	2"	2"	
WIDTH (m)	10'	75'	
REACH LENGTH (m)	10'	10'	

Staff Gauge/Bench Ht: ______
VELOCITY (CFS) ______
FLOW (CFS) ______
HABITAT ASSESSMENT SCORE #:
[✓ RR #] 110 GP # ______

Gradient (sample reach): Flat Low [✓ Mode] High Cascade
Size (stream width) : [✓ V. Small (<1.5m)] Small (1.5-3m) Med (3-10m) Large (10-25m) Very Lrg (>25m)

SUBSTRATE (%) Particle Count - 100 points (mm). Circle one: RIFFLE RUN

Record measured particle size. Use abbrev. below for smaller sizes.

size (mm)	description	abbreviation	
<0.062	silt/clay	cl	1-10
0.062-0.125	very fine sand	vfs	11-20
0.125-.250	fine sand	fs	21-30
0.25-0.50	med sand	ms	31-40
0.5-1.0	coarse sand	cs	41-50
1.0-2.0	very coarse sand	(use actual size)	51-60
2.0-64.0	gravel	(use actual size)	61-70
64-256	cobble	(use actual size)	71-80
256-4096	boulder	(use actual size)	81-90
—	bedrock	bdrx	91-100
—	woody debris	wood	

FILL OUT EITHER SUBSTRATE INFO BLOCKS

SUBSTRATE (%) (Visual estimates)

	RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%
COBBLE (2.5-10")	%	%	%
GRAVEL (0.1-2.5")	%	%	%
BEDROCK	90 %	90 %	%
SAND (gritty)	5 %	5 %	%

	RIFFLE	RUN	POOL
CLAY (slick)	5 %	5 %	%
SILT	%	%	%
DETRITUS (CPOM)	%	%	%
MUCK-MUD (FPOM)	%	%	%
MARL (shell frags.)	%	%	%

STREAM USE SUPPORT:

CLASSIFIED FOR:
Dom. H2O Supply Ind. H2O Supply
TIER II/TIER III Navigation
Trout >> Nat. Repr?
WATER WITHDRAWL NOTED

POSTED FOR:
Fish Tissue Advis.: Bacteriological Advis.
Do Not Consume
Precautionary

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES:

RELATIVE ABUNDANCE OF TAXA HABITAT
DOMINANT (>=50): ______
VERY ABUND.(30-49): ______
ABUNDANT (10-29): ______
COMMON (3-9): ______
RARE (<3): ______

SUPPORT STATUS;
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

COMMENTS: photos ? Y or N Roll # Disk 1 Photo # 5

(no gravel)
Scoured riffle Area
Heavy Sedimentation
Bedrock Stream
very low Flow
very high Algae
mats
lack habitat
only overhanging
grasses

STREAM SKETCH

Forest
<18m
10 yds
old Hwy 85
overhanging plants
H
Forest <18m

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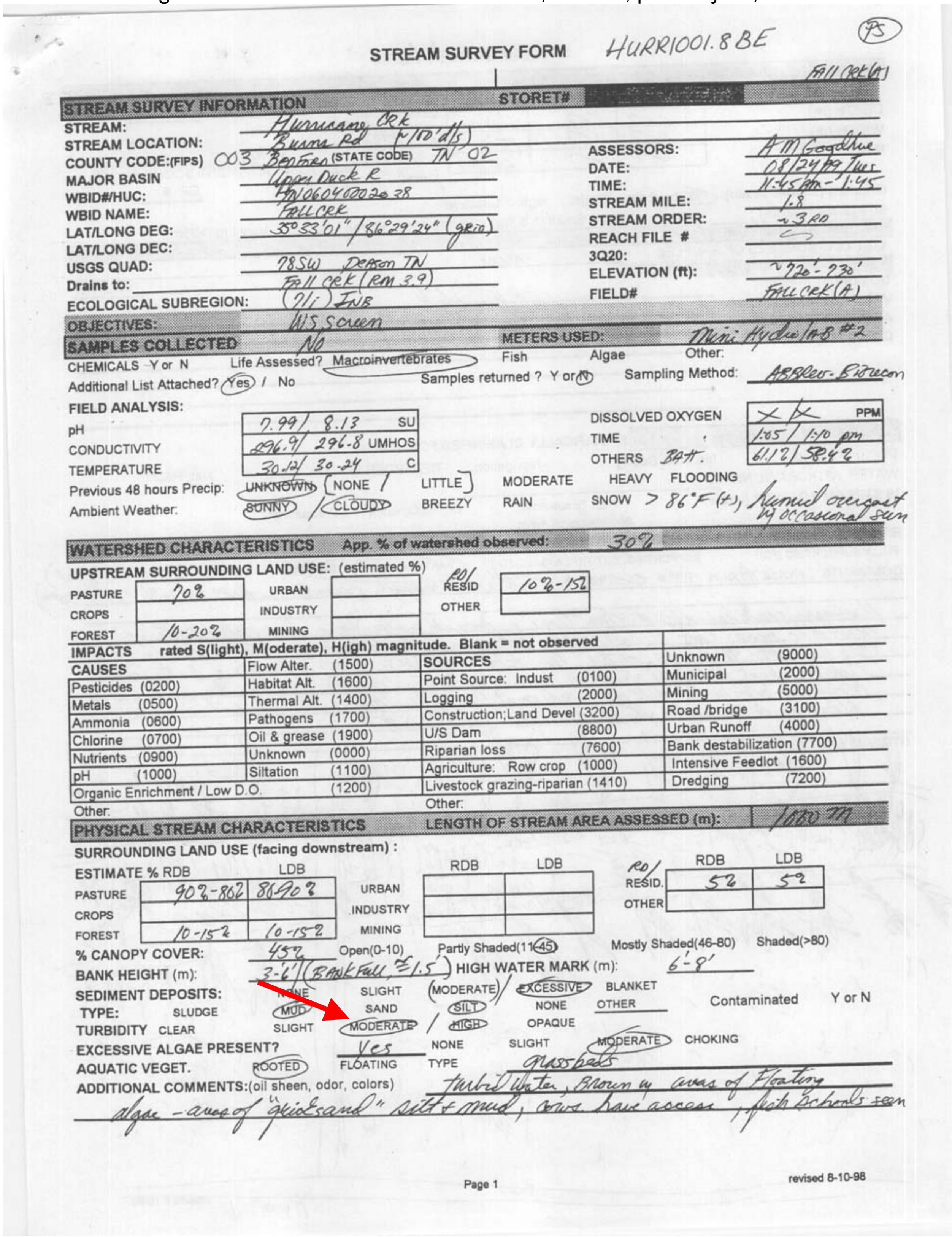
Figure D-6 Hurricane Creek field sheet, RM 1.8, p1 - July 18, 2001



PS

STREAM SURVEY FORM

HURR001.8BE

Fall Crk(A)

STREAM SURVEY INFORMATION STORET# [redacted]

STREAM: Hurricane Crk
STREAM LOCATION: Burns Rd (~10' d/s)
COUNTY CODE:(FIPS) 003 Bedford (STATE CODE) TN 02
MAJOR BASIN Upper Duck R
WBID#/HUC: TN06040002 38
WBID NAME: FALL CRK
LAT/LONG DEG: 35°33'01" / 86°29'24" (grid)
LAT/LONG DEC:
USGS QUAD: 78SW Deason TN
Drains to: Fall Crk (RM 3.9)
ECOLOGICAL SUBREGION: (71i) INB

ASSESSORS: A M Goodhue
DATE: 08/24/99 Tues
TIME: 11:45 am - 1:45
STREAM MILE: 1.8
STREAM ORDER: ~3RD
REACH FILE #: ~
3Q20:
ELEVATION (ft): ~720'-730'
FIELD# FALL CRK(A)

OBJECTIVES: WS Screen

SAMPLES COLLECTED No **METERS USED:** Mini Hydro/AB #2

CHEMICALS Y or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other:
Additional List Attached? [✓ Yes] / No Samples returned ? Y or [✓ N] Sampling Method: ABKick - Biorecon

FIELD ANALYSIS:

pH	7.99 / 8.13 SU	DISSOLVED OXYGEN	X / X PPM
CONDUCTIVITY	296.9 / 296.8 UMHOS	TIME	1:05 / 1:10 pm
TEMPERATURE	30.12 / 30.24 C	OTHERS BAH.	61.12 / 58.42

Previous 48 hours Precip: ~~UNKNOWN~~ [✓ NONE] / [✓ LITTLE] MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY] / [✓ CLOUDY] BREEZY RAIN SNOW > 86°F (+), humid overcast w/ occasional sun

WATERSHED CHARACTERISTICS App. % of watershed observed: 30%

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	70%	URBAN		RD/ RESID	10%-15%
CROPS		INDUSTRY		OTHER	
FOREST	10-20%	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500)	SOURCES	Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600)	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600)	Bank destabilization (7700)
pH (1000)	Siltation (1100)	Agriculture: Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / Low D.O. (1200)		Livestock grazing-riparian (1410)	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m): 1000 m

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	90%-80%	80-90%	URBAN			RD/ RESID.	5%	5%
CROPS			INDUSTRY			OTHER		
FOREST	10-15%	10-15%	MINING					

% CANOPY COVER: 45% Open(0-10) Partly Shaded(11-[✓ 45]) Mostly Shaded(46-80) Shaded(>80)
BANK HEIGHT (m): 3-6' (BANKFULL ≅ 1.5') HIGH WATER MARK (m): 6-8'
SEDIMENT DEPOSITS: ~~NONE~~ SLIGHT [✓ MODERATE] / [✓ EXCESSIVE] BLANKET
TYPE: SLUDGE [✓ MUD] SAND [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR SLIGHT [✓ MODERATE] / [✓ HIGH] OPAQUE
EXCESSIVE ALGAE PRESENT? Yes NONE SLIGHT [✓ MODERATE] CHOKING
AQUATIC VEGET. [✓ ROOTED] FLOATING TYPE grassbeds
ADDITIONAL COMMENTS:(oil sheen, odor, colors) Turbid Water, Brown w/ areas of Floating algae - areas of "quicksand" silt + mud, cows have access, fish schools seen

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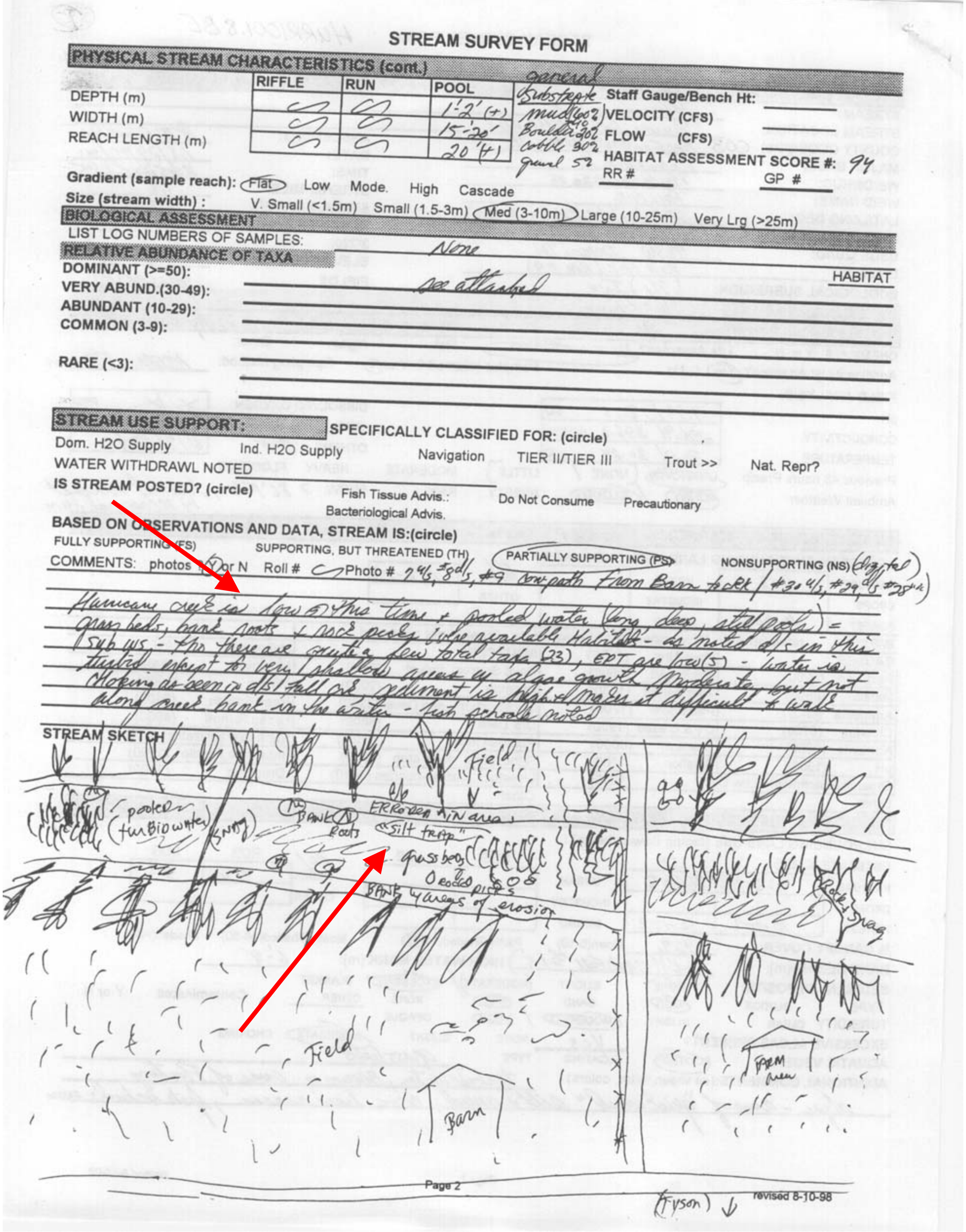
Figure D-7 Hurricane Creek field sheet, RM 1.8, p2 - July 18, 2001



STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)			1'-2' (+)
WIDTH (m)			15'-20'
REACH LENGTH (m)			20' (+)

general Substrate
mud 40% 60%
Boulder 20%
cobble 30%
gravel 5%

Staff Gauge/Bench Ht:
VELOCITY (CFS)
FLOW (CFS)
HABITAT ASSESSMENT SCORE #: 94
RR #
GP #

Gradient (sample reach): [✓ Flat] Low Mode. High Cascade

Size (stream width) : V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES: None

RELATIVE ABUNDANCE OF TAXA

HABITAT

DOMINANT (>=50):
VERY ABUND.(30-49): see attached
ABUNDANT (10-29):
COMMON (3-9):
RARE (<3):

STREAM USE SUPPORT:

SPECIFICALLY CLASSIFIED FOR: (circle)

Dom. H2O Supply Ind. H2O Supply Navigation TIER II/TIER III Trout >> Nat. Repr?

WATER WITHDRAWL NOTED

IS STREAM POSTED? (circle) Fish Tissue Advis.: Do Not Consume Precautionary
Bacteriological Advis.

BASED ON OBSERVATIONS AND DATA, STREAM IS:(circle)

FULLY SUPPORTING (FS) SUPPORTING, BUT THREATENED (TH) [✓ PARTIALLY SUPPORTING (PS)] NONSUPPORTING (NS)

COMMENTS: photos [✓ Y] or N Roll # Photo # 7 u/s, 8 d/s, #9 cow path from Barn to Crk / (digital #30 u/s, #29 d/s #28 cp)

Hurricane creek is low @ this time & pooled water (long, deep, still pools) = grass beds, bank roots & rock pools were available Habitats - as noted d/s in this sub ws. - tho there are quite a few total taxa (23), EPT are low (5) - water is turbid except for very shallow areas w/ algae growth Moderate, but not choking as seen in d/s Fall Ck, sediment is high & makes it difficult to walk along creek bank in the water - fish schools noted

STREAM SKETCH

Page 2

revised 8-10-98

Figure D-8 Photo of Hurricane Creek upstream of sample site, RM 0.2 - July 18, 2001

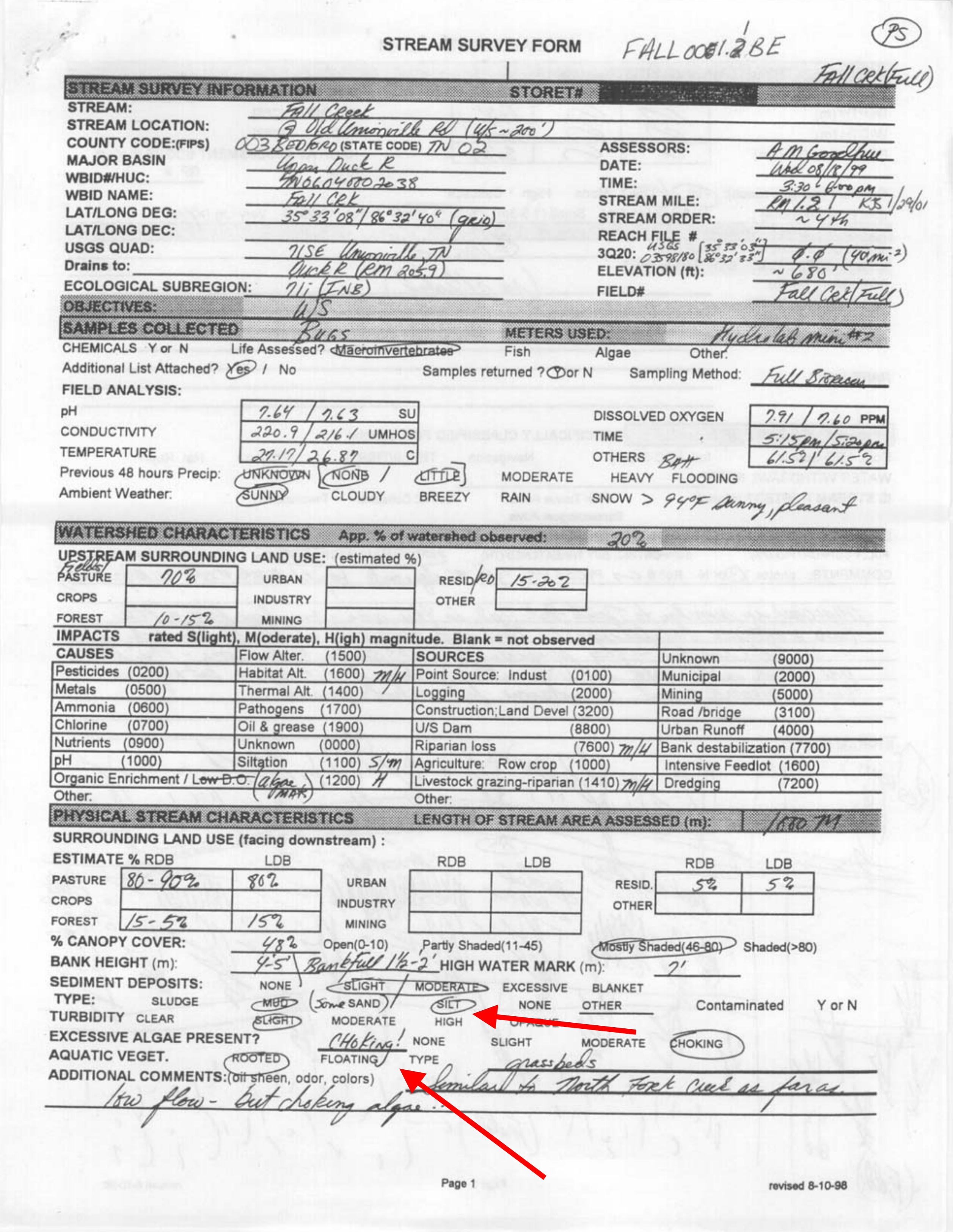
Hurricane Creek (HURRI000.2MY) upstream view.
Site located 100 yds upstream of old Hwy 50.
PAA/CAP, 07/18/01.

Sinking Creek was monitored at RM 1.2 and 8.9 by aquatic biologists from the State Lab on as a site of the probabilistic monitoring study. The stream at RM 1.2 was found have very low flow or dry on July 24, 2000 and October 17, 2000 (ref.: Figures D-25 through D-27). It contained flow on January 12, 2000, April 13, 2000, and again on May 8, 2001. These three sampling events noted slight or no siltation at this location. Land use upstream was mostly pasture.

The stream at RM 8.9 was found to be stagnant with little or no flow on July 26, 2000 and October 17, 2000. It contained flow on January 13, 2000, April 18, 2000, and again on May 9, 2001. These three sampling events noted moderate siltation at this location. Land use upstream was mostly pasture.

Little Sinking Creek (TN06040002021_0100) was placed on the 303(d) list of impaired streams in 2002 as impacted by siltation and habitat alterations from pasture grazing. Little Sinking Creek is a tributary to Sinking Creek. Sinking Creek was visited in 1999 by the Nashville Environmental Field Office. As the staff was driving up in the watershed to determine pollution sources and land use changes for Sinking Creek, they stopped at RM 3.1 on Little Sinking Creek. They noted that pasture grazing was dominant in the watershed and this site had little to no riparian area (ref.: Figure D-28).

Figure D-9 Fall Creek field sheet, RM 1.1, p1 - August 18, 1999



STREAM SURVEY FORM FALL 001.1 BE (PS)

Fall Crk (Full)

STREAM SURVEY INFORMATION **STORET#** [redacted]

STREAM: Fall Creek
STREAM LOCATION: @ Old Unionville Rd (u/s ~200')
COUNTY CODE:(FIPS) 003 BEDFORD (STATE CODE) TN 02
MAJOR BASIN Upper Duck R
WBID#/HUC: TN0604000 2038
WBID NAME: Fall Crk
LAT/LONG DEG: 35°33'08"/86°32'40" (grid)
LAT/LONG DEC:
USGS QUAD: 71SE Unionville TN
Drains to: Duck R (RM 205.9)
ECOLOGICAL SUBREGION: 71i (INB)

ASSESSORS: A M Goodhue
DATE: Wed 08/18/99
TIME: 3:30 - 6:00 pm
STREAM MILE: RM 1.2 1 KJS 1/29/01
STREAM ORDER: ~4th
REACH FILE #
3Q20: USGS 03598180 [35°33'03" 86°32'33"] 0.0 (40 mi²)
ELEVATION (ft): ~680'
FIELD# Fall Crk (Full)

OBJECTIVES: WS

SAMPLES COLLECTED Bugs **METERS USED:** Hydrolab mini #2

CHEMICALS Y or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other:
Additional List Attached? [✓ Yes] / No Samples returned ? [✓ Y] or N Sampling Method: Full Biorecon

FIELD ANALYSIS:

pH	7.64 / 7.63 SU	DISSOLVED OXYGEN	7.91 / 7.60 PPM
CONDUCTIVITY	220.9 / 216.1 UMHOS	TIME	5:15pm / 5:20pm
TEMPERATURE	27.17 / 26.87 C	OTHERS Bat	61.5% / 61.5%

Previous 48 hours Precip: UNKNOWN [✓ NONE] / [✓ LITTLE] MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY] CLOUDY BREEZY RAIN SNOW > 94°F sunny, pleasant

WATERSHED CHARACTERISTICS **App. % of watershed observed:** 20%

UPSTREAM SURROUNDING LAND USE: (estimated %)

Fields/ PASTURE	70%	URBAN		RESID/RD	15-20%
CROPS		INDUSTRY		OTHER	
FOREST	10-15%	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500)	SOURCES	Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600) M/H	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600) M/H	Bank destabilization (7700)
pH (1000)	Siltation (1100) S/M	Agriculture: Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / ~~Low D.O.~~ (algae/VMAR) (1200) H		Livestock grazing-riparian (1410) M/H	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS **LENGTH OF STREAM AREA ASSESSED (m):** 180 M

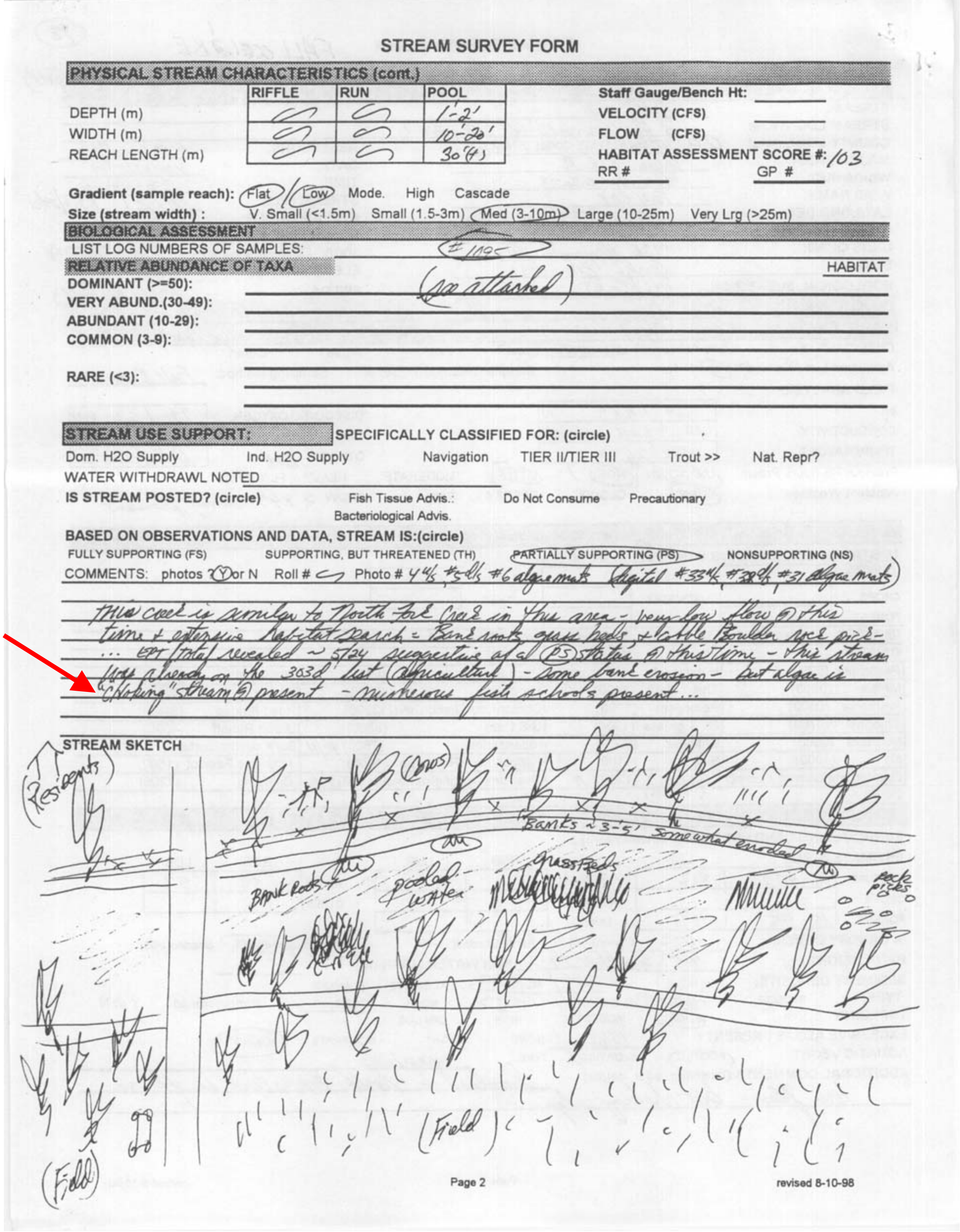
SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	80-90%	80%	URBAN			RESID.	5%	5%
CROPS			INDUSTRY			OTHER		
FOREST	15-5%	15%	MINING					

% CANOPY COVER: 48% Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)
BANK HEIGHT (m): 4-5' \ Bankfull 1½-2' **HIGH WATER MARK** (m): 7'
SEDIMENT DEPOSITS: NONE [✓ SLIGHT] / [✓ MODERATE] EXCESSIVE BLANKET
TYPE: SLUDGE [✓ MUD] (Some SAND) / [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR [✓ SLIGHT] MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? CHoKing! NONE SLIGHT MODERATE [✓ CHOKING]
AQUATIC VEGET. [✓ ROOTED] FLOATING TYPE grassbeds
ADDITIONAL COMMENTS:(~~oil sheen~~, odor, colors) Similar to North Fork Creek as far as low flow - but choking algae..

Page 1 revised 8-10-98

Figure D-10 Fall Creek field sheet, RM 1.1, p2 - August 18, 1999



STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)			1'-2'
WIDTH (m)			10'-20'
REACH LENGTH (m)			30'(4)

Staff Gauge/Bench Ht:
VELOCITY (CFS)
FLOW (CFS)
HABITAT ASSESSMENT SCORE #: 103
RR # GP #

Gradient (sample reach): [✓ Flat] / [✓ Low] Mode. High Cascade
Size (stream width) : V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES: #1095

RELATIVE ABUNDANCE OF TAXA HABITAT
DOMINANT (>=50): (see attached)
VERY ABUND.(30-49):
ABUNDANT (10-29):
COMMON (3-9):
RARE (<3):

STREAM USE SUPPORT: **SPECIFICALLY CLASSIFIED FOR: (circle)**
Dom. H2O Supply Ind. H2O Supply Navigation TIER II/TIER III Trout >> Nat. Repr?
WATER WITHDRAWL NOTED
IS STREAM POSTED? (circle) Fish Tissue Advis.: Do Not Consume Precautionary
Bacteriological Advis.

BASED ON OBSERVATIONS AND DATA, STREAM IS:(circle)
FULLY SUPPORTING (FS) SUPPORTING, BUT THREATENED (TH) [✓ PARTIALLY SUPPORTING (PS)] NONSUPPORTING (NS)

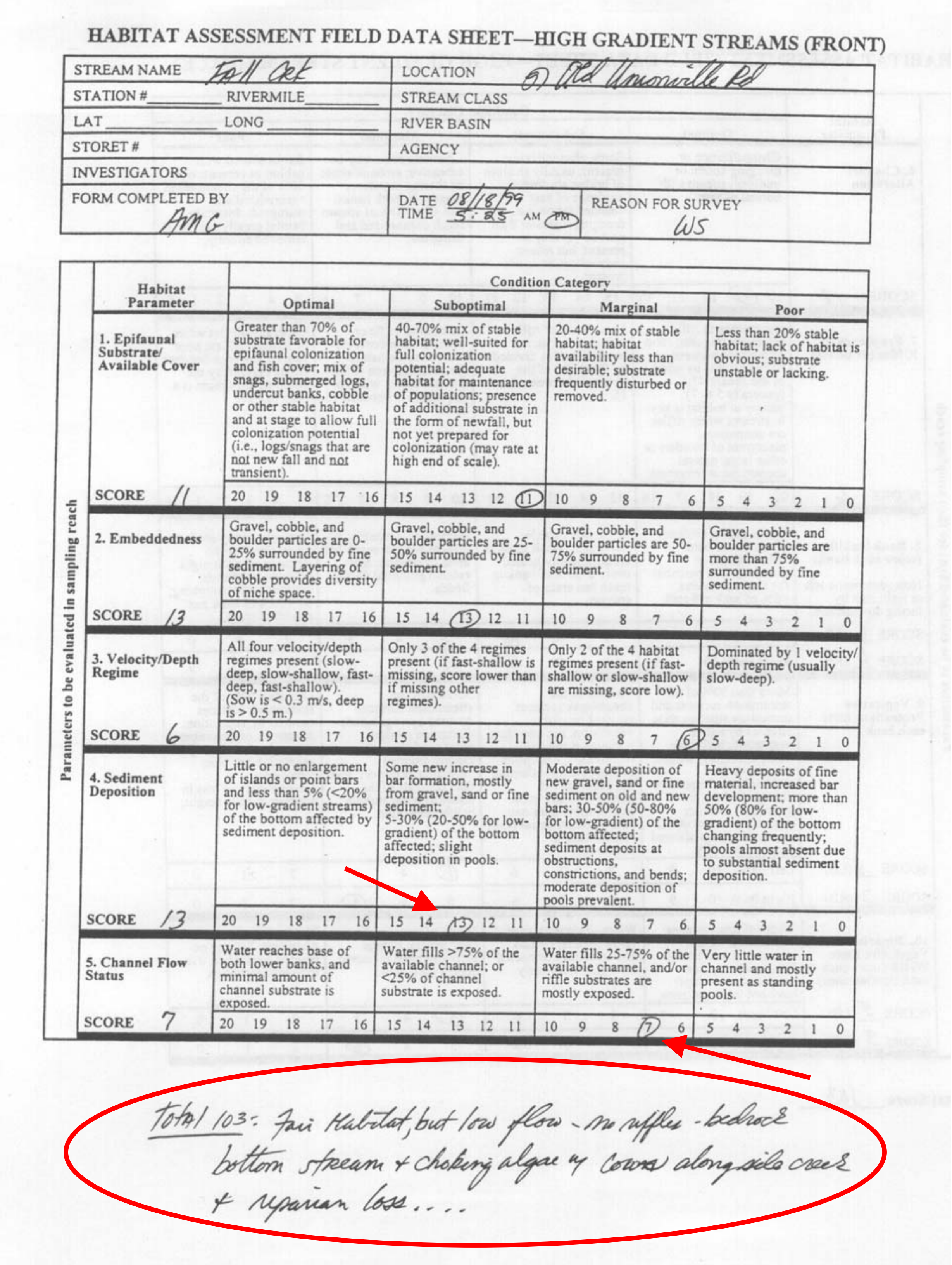
COMMENTS: photos ? [✓ Y] or N Roll # Photo # 4 u/s, #5 d/s, #6 algae mats (digital #33 u/s, #32 d/s, #31 algae mats)

this creek is similar to North Fork Creek in this area - very low flow @ this time + extensive habitat search = Bank roots, grass beds, + cobble boulder rock piles... EPT (total) revealed ~ 5/24 suggestive of a (PS) status @ this time - this stream was already on the 303d list (agriculture) - some bank erosion - but algae is "choking" stream @ present - numerous fish schools present...

STREAM SKETCH

revised 8-10-98

Figure D-11 Fall Creek Habitat Assessment, RM 1.1, front page - August 18, 1999



HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

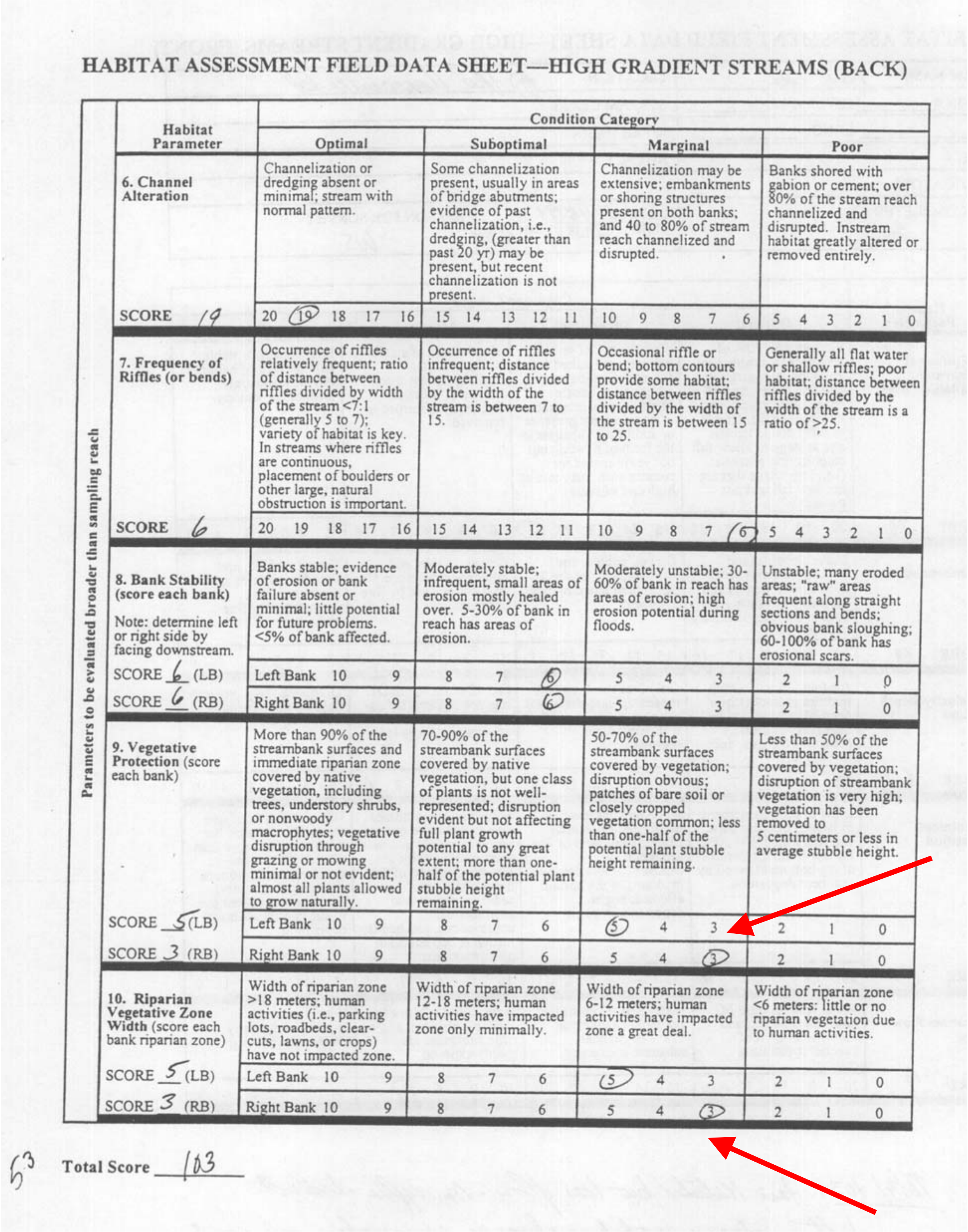
STREAM NAME Fall Crk	LOCATION @ Old Unionville Rd
STATION # ________ RIVERMILE ________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY AMG	DATE 08/18/99 TIME 5:25 AM [✓ PM] REASON FOR SURVEY WS

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	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.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <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.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1 0

Total 103: Fair Habitat, but low flow - no riffles - bedrock bottom stream + choking algae w/ cows along side creek + riparian loss....

Figure D-12 Fall Creek Habitat Assessment, RM 1.1, back page - August 18, 1999



HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

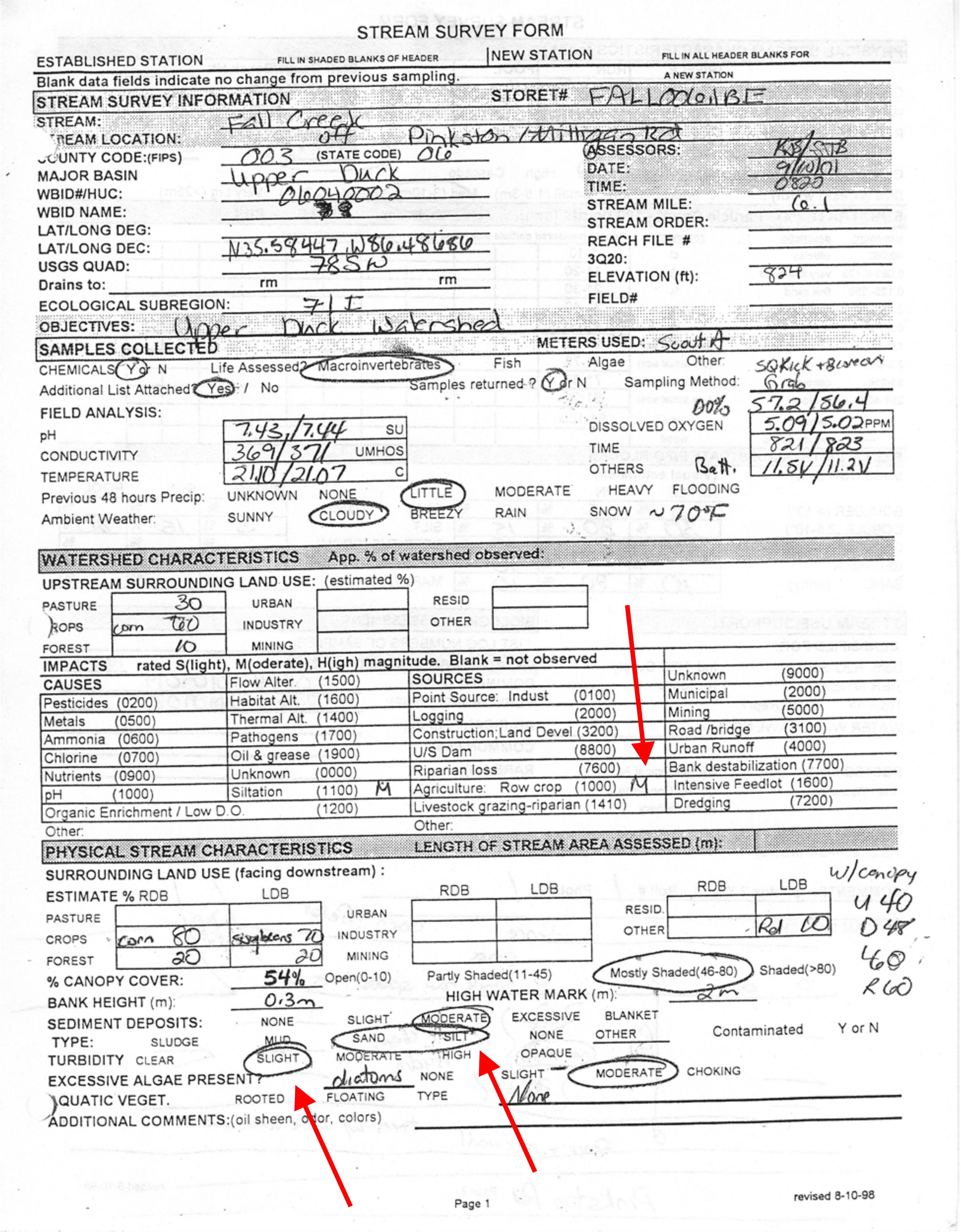
Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 [✓ 19] 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 [✓ 6]	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 6 (LB)	Left Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	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.
SCORE 5 (LB)	Left Bank 10 9	8 7 6	[✓ 5] 4 3	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 5 (LB)	Left Bank 10 9	8 7 6	[✓ 5] 4 3	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0

63

Total Score 103

Figure D-13 Fall Creek field sheet, RM 6.1, p1 - September 11, 2001



STREAM SURVEY FORM

ESTABLISHED STATION FILL IN SHADED BLANKS OF HEADER | NEW STATION FILL IN ALL HEADER BLANKS FOR A NEW STATION

Blank data fields indicate no change from previous sampling.

STREAM SURVEY INFORMATION STORET# FALL006.1BE

STREAM: Fall Creek
STREAM LOCATION: off Pinkston / Milligan Rd
COUNTY CODE:(FIPS) 003 (STATE CODE) 06
MAJOR BASIN Upper Duck
WBID#/HUC: 06040002
WBID NAME:
LAT/LONG DEG:
LAT/LONG DEC: N35.58447 W86.48686
USGS QUAD: 78 SW
Drains to: rm rm
ECOLOGICAL SUBREGION: 71 I
OBJECTIVES: Upper Duck Watershed

ASSESSORS: KB/STB
DATE: 9/10/01
TIME: 0820
STREAM MILE: 6.1
STREAM ORDER:
REACH FILE #
3Q20:
ELEVATION (ft): 824
FIELD#

SAMPLES COLLECTED METERS USED: Scout A

CHEMICALS [✓ Y] or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other: SQKick + Bioreco
Additional List Attached? [✓ Yes] / No Samples returned ? [✓ Y] or N Sampling Method: Grab

FIELD ANALYSIS:

pH 7.43 / 7.44 SU
CONDUCTIVITY 369 / 371 UMHOS
TEMPERATURE 21.10 / 21.07 C

DO% 57.2 / 86.4
DISSOLVED OXYGEN 5.09 / 5.02 PPM
TIME 821 / 823
OTHERS Batt. 11.5V / 11.2V

Previous 48 hours Precip: UNKNOWN NONE [✓ LITTLE] MODERATE HEAVY FLOODING
Ambient Weather: SUNNY [✓ CLOUDY] BREEZY RAIN SNOW ~70°F

WATERSHED CHARACTERISTICS App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	30	URBAN		RESID	
CROPS	corn 60	INDUSTRY		OTHER	
FOREST	10	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500)	SOURCES	Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600)	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600)	Bank destabilization (7700)
pH (1000)	Siltation (1100) M	Agriculture: Row crop (1000) M	Intensive Feedlot (1600)
Organic Enrichment / Low D.O. (1200)		Livestock grazing-riparian (1410)	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE			URBAN			RESID.		
CROPS	corn 80	soybeans 70	INDUSTRY			OTHER		Rd 10
FOREST	20	20	MINING					

w/canopy
U 40
D 48
L 60
R 60

% CANOPY COVER: 54% Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)
BANK HEIGHT (m): 0.3m HIGH WATER MARK (m): 2m
SEDIMENT DEPOSITS: NONE SLIGHT [✓ MODERATE] EXCESSIVE BLANKET
TYPE: SLUDGE MUD [✓ SAND] [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR [✓ SLIGHT] MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? diatoms NONE SLIGHT [✓ MODERATE] CHOKING
AQUATIC VEGET. ROOTED FLOATING TYPE None
ADDITIONAL COMMENTS:(oil sheen, odor, colors)

Page 1

revised 8-10-98

Figure D-14 Fall Creek field sheet, RM 6.1, p2 - September 11, 2001

STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)	3"	0.5ft	⅓m
WIDTH (m)	6m	10m	4m
REACH LENGTH (m)	5m	100m	8m

Staff Gauge/Bench Ht: ______
VELOCITY (CFS) ______
FLOW (CFS) ______
HABITAT ASSESSMENT SCORE #:
[✓ RR # 100] GP # ______

Gradient (sample reach): Flat Low- [✓ Mode] High Cascade
Size (stream width) : V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

SUBSTRATE (%) Particle Count - 100 points (mm). Circle one: RIFFLE RUN

Record measured particle size. Use abbrev. below for smaller sizes.

size (mm)	descriptio·	abbreviation											
<0.062	silt/clay	cl	1-10										
0.062-0.125	very fine sand	vfs	11-20										
0.125-.250	fine sand	fs	21-30										
0.25-0.50	med sand	ms	31-40										
0.5-1.0	coarse sand	cs	41-50										
1.0-2.0	very coarse sand	(use actual size)	51-60										
2.0-64.0	gravel	(use actual size)	61-70										
64-256	cobble	(use actual size)	71-80										
256-4096	boulder	(use actual size)	81-90										
---	bedrock	bdrx	91-100										
---	woody debris	wood											

FILL OUT EITHER SUBSTRATE INFO BLOCKS

SUBSTRATE (%) (Visual estimates)

	RIFFLE	RUN	POOL
BOULDER (> 10")	10 %	5 %	5 %
COBBLE (2.5-10")	30 %	30 %	15 %
GRAVEL (0.1-2.5")	40 %	30 %	10 %
BEDROCK	%	%	40 %
SAND (gritty)	10 %	20 %	10 %

	RIFFLE	RUN	POOL
CLAY (slick)	%	%	%
SILT	5 %	15 %	20 %
DETRITUS (CPOM)	%	%	%
MUCK-MUD (FPOM)	%	%	%
MARL (shell frags.)	%	%	%

STREAM USE SUPPORT:

CLASSIFIED FOR:
Dom. H2O Supply Ind. H2O Supply
TIER II/TIER III Navigation
Trout >> Nat. Repr?
WATER WITHDRAWL NOTED ______

POSTED FOR: Bacteriological Advis.
Fish Tissue Advis.: Do Not Consume
Precautionary

SUPPORT STATUS;
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES: ______

RELATIVE ABUNDANCE OF TAXA HABITAT
DOMINANT (>=50): SQKICK B0109019
VERY ABUND.(30-49): Biorecon B0109020
ABUNDANT (10-29): ______
COMMON (3-9): ______
RARE (<3): ______

COMMENTS: photos ? Y or N Roll # / Photo # /

STREAM SKETCH

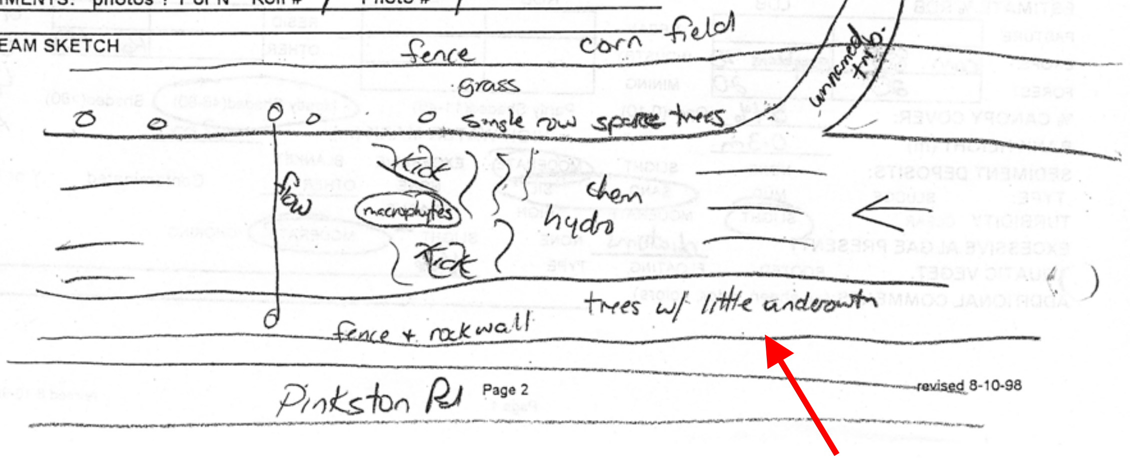
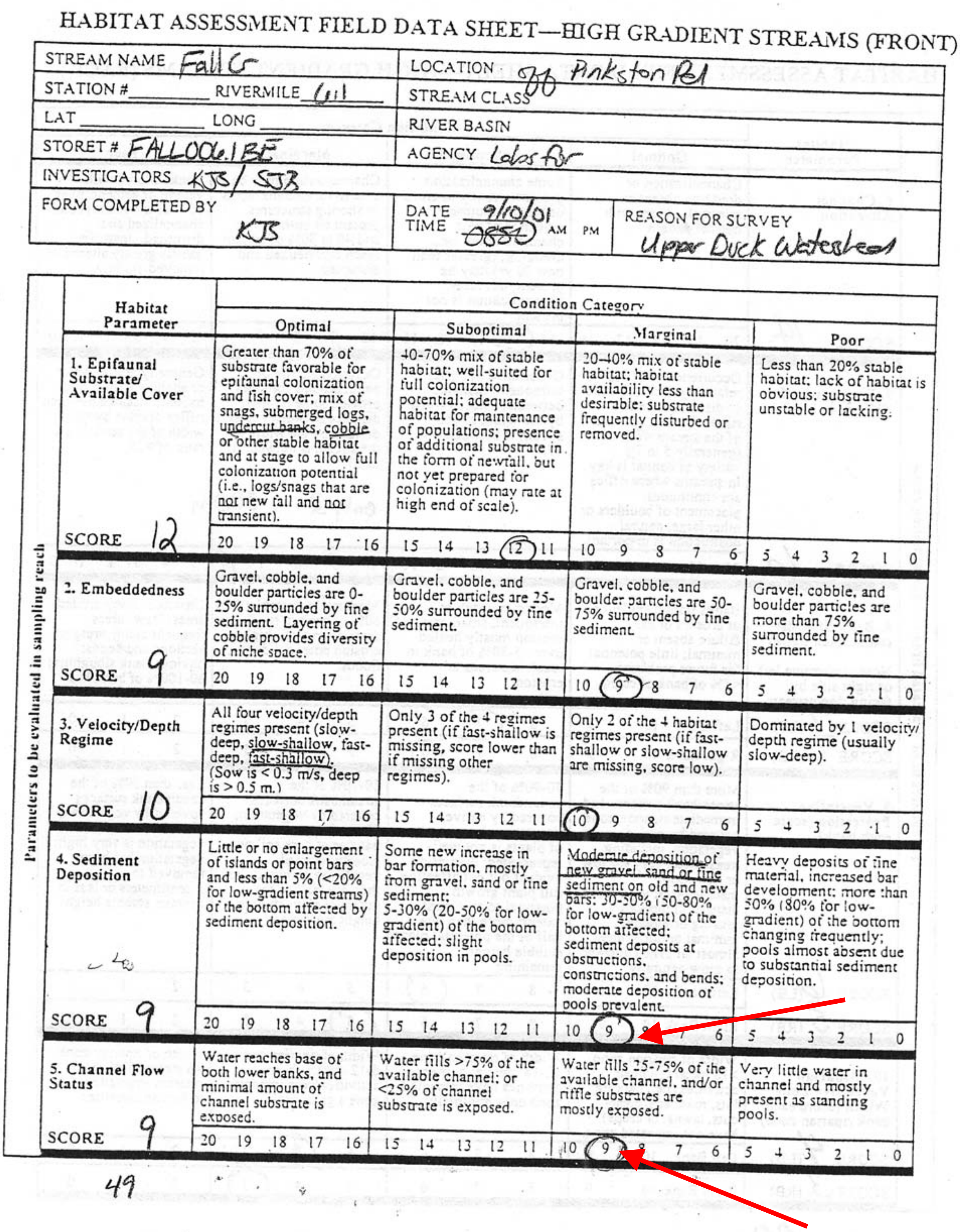


Figure D-15 Habitat Assessment, RM 6.1, front page - September 11, 2001



HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

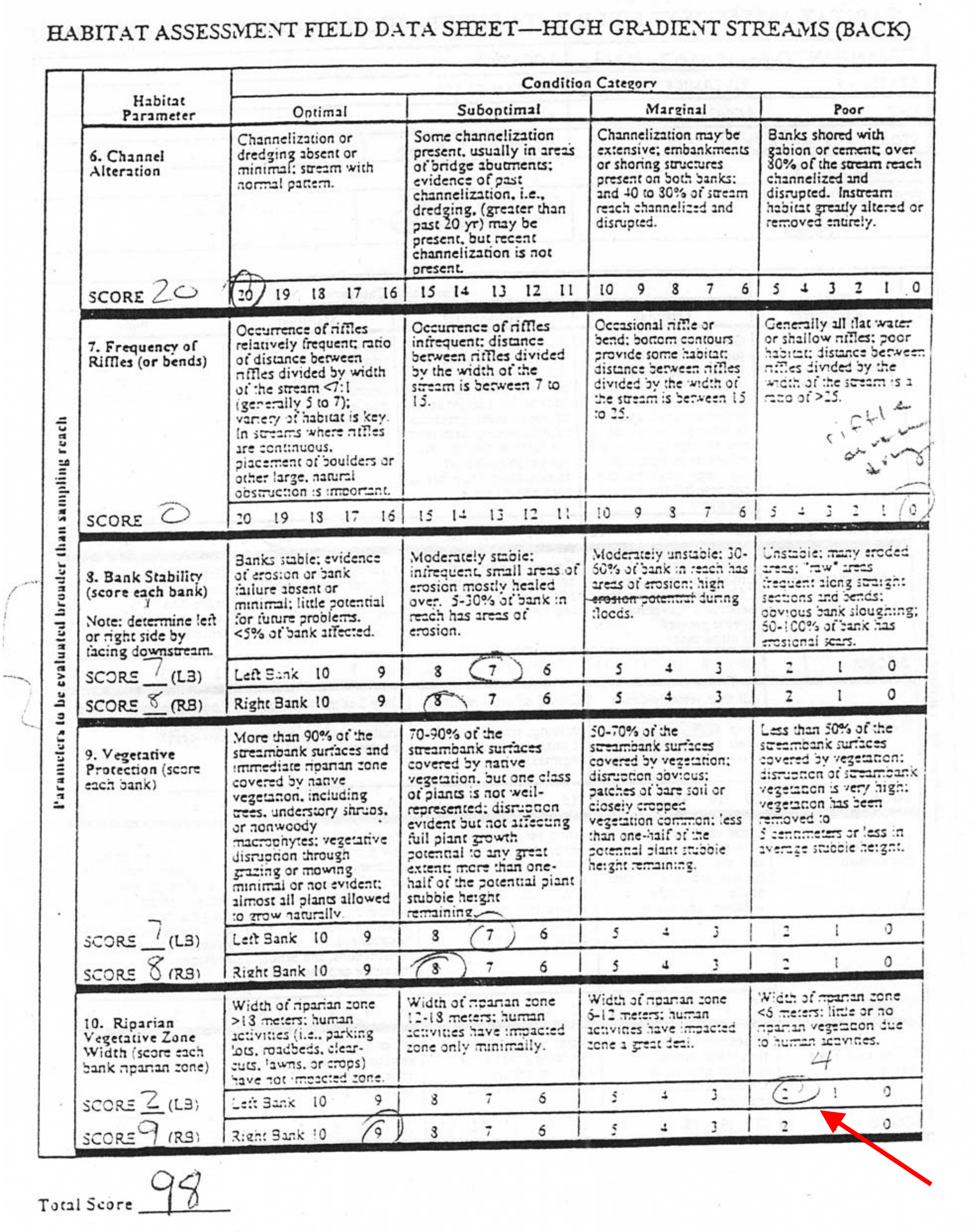
STREAM NAME Fall Cr	LOCATION off Pinkston Rd
STATION # ____ RIVERMILE 6.1	STREAM CLASS
LAT ____ LONG ____	RIVER BASIN
STORET # FALL006.1BE	AGENCY Labs for
INVESTIGATORS KJS / SJB	
FORM COMPLETED BY KJS	DATE 9/10/01 TIME 0851 [✓ AM] PM REASON FOR SURVEY Upper Duck Watershed

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	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.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition ~40	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <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.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1 0

49

Figure D-16 Fall Creek Habitat Assessment, RM 6.1, back page - September 11, 2001



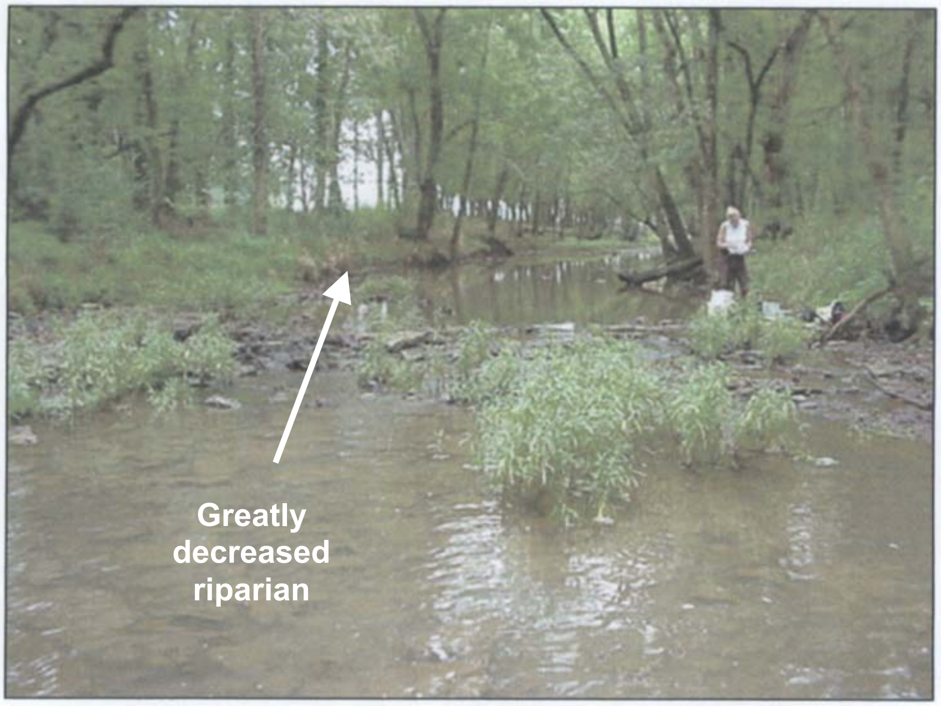
HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. riffle [illegible]
SCORE 0	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 [✓ 0]
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high ~~erosion potential~~ during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 7 (LB)	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	[✓ 8] 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	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.
SCORE 7 (LB)	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	[✓ 8] 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities. 4
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	[✓ 2] 1 0
SCORE 9 (RB)	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 0

Total Score 98

Figure D-17   Photo of Fall Creek, RM 6.1 - September 11, 2001

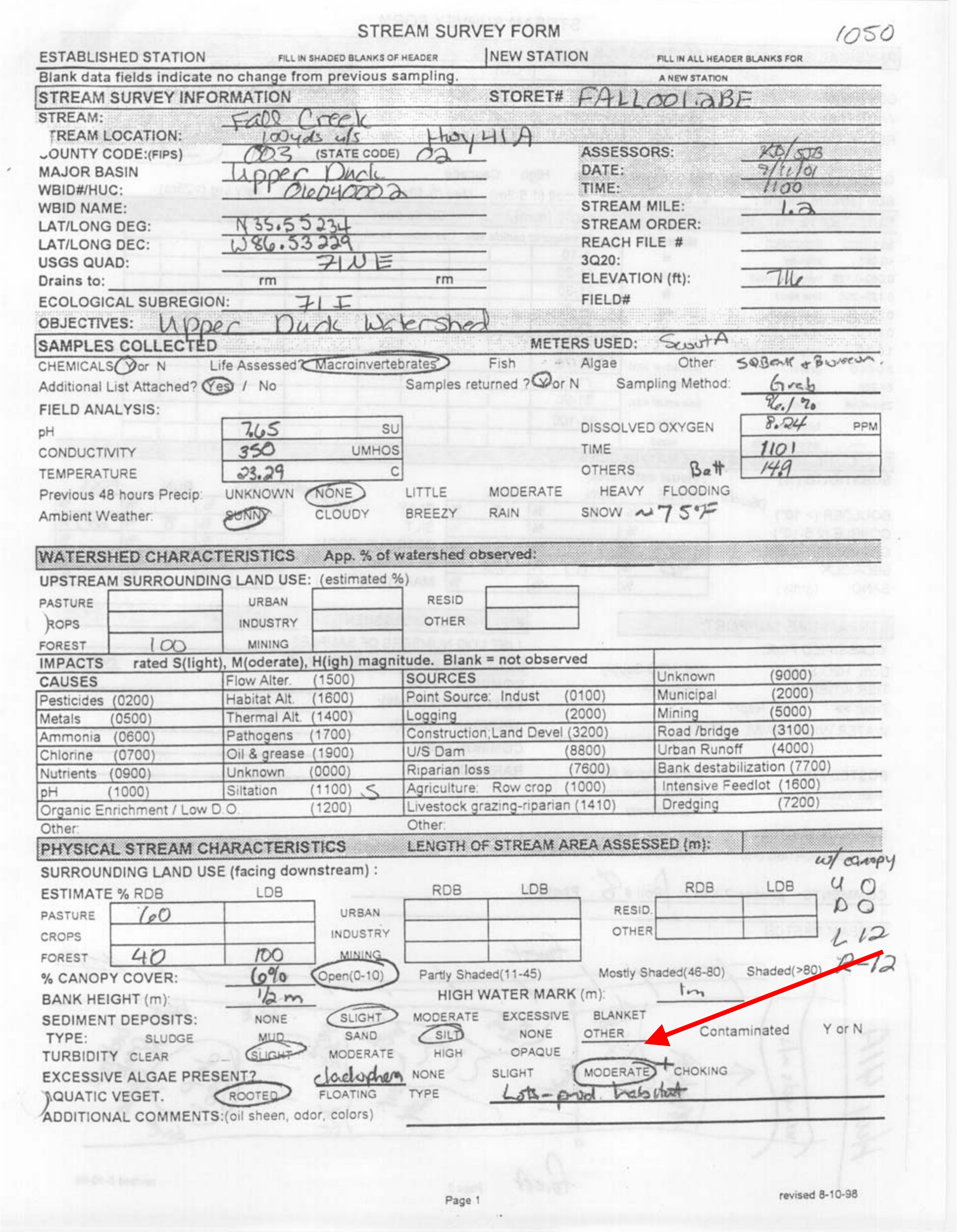


Fall Creek (FALL006.1BE) off Pinkston Rd.
View upstream of the collection area. Collected
9/10/01 @ 0920, KJS/SJB.

Little Sinking Creek was also monitored at RM 1.0 by aquatic biologists from the State Lab on as a site of the probabilistic monitoring study. The stream at RM 1.2 was found have very low flow or dry on July 26, 2000 and October 17, 2000 (ref.: Figures D-29 and D-30). It contained flow on February 07, 2000, April 18, 2000, and again on May 9, 2001. These sampling events all documented excessive sediment in the stream. Cattle had access to the stream and there was little to no riparian vegetation.

The Sinking Creek subwatershed appears to show both a sediment load from near-stream agricultural activities as well as low benthic macroinvertebrate communities due to low flow. The lack of water is most likely due to a combination of karst topography in the area (ref.: Figure D-1) and extreme drought conditions that occurred during the sampling period. The subwatershed based modeling results for the Sinking Creek watershed suggests that the average annual sediment load should not have caused impairment had the localized problem not existed. This kind of localized problem that occurs at a specific area could not be detected

Figure D-18 Fall Creek field sheet, RM 1.2, p1 - September 11, 2001



STREAM SURVEY FORM 1050

ESTABLISHED STATION FILL IN SHADED BLANKS OF HEADER | NEW STATION FILL IN ALL HEADER BLANKS FOR A NEW STATION

Blank data fields indicate no change from previous sampling.

STREAM SURVEY INFORMATION STORET# FALL001.2BE

STREAM: Fall Creek
TREAM LOCATION: 100yds u/s Hwy 41A
OUNTY CODE:(FIPS) 003 (STATE CODE) 02
MAJOR BASIN Upper Duck
WBID#/HUC: 06040002
WBID NAME:
LAT/LONG DEG: N35.55234
LAT/LONG DEC: W86.53229
USGS QUAD: 71NE
Drains to: rm rm
ECOLOGICAL SUBREGION: 71I
OBJECTIVES: Upper Duck Watershed

ASSESSORS: KD/SJB
DATE: 9/11/01
TIME: 1100
STREAM MILE: 1.2
STREAM ORDER:
REACH FILE #
3Q20:
ELEVATION (ft): 716
FIELD#

SAMPLES COLLECTED METERS USED: ScoutA

CHEMICALS [✓ Y] or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other: SQBank & Bioreon.
Additional List Attached? [✓ Yes] / No Samples returned ? [✓ Y] or N Sampling Method: Grab

FIELD ANALYSIS:

pH	7.65	SU	DISSOLVED OXYGEN	96.1% 8.24	PPM
CONDUCTIVITY	350	UMHOS	TIME	1101	
TEMPERATURE	23.29	C	OTHERS Batt	149	

Previous 48 hours Precip: UNKNOWN [✓ NONE] LITTLE MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY] CLOUDY BREEZY RAIN SNOW ~75°F

WATERSHED CHARACTERISTICS App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE		URBAN		RESID	
ROPS		INDUSTRY		OTHER	
FOREST	100	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES		SOURCES	
	Flow Alter. (1500)		Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600)	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600)	Bank destabilization (7700)
pH (1000)	Siltation (1100) S	Agriculture: Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / Low D.O. (1200)		Livestock grazing-riparian (1410)	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	60		URBAN			RESID.		
CROPS			INDUSTRY			OTHER		
FOREST	40	100	MINING					

w/ canopy
U 0
D 0
L 12
R 12

% CANOPY COVER: 6% [✓ Open(0-10)] Partly Shaded(11-45) Mostly Shaded(46-80) Shaded(>80)
BANK HEIGHT (m): 1/2 m HIGH WATER MARK (m): 1m
SEDIMENT DEPOSITS: NONE [✓ SLIGHT] MODERATE EXCESSIVE BLANKET
TYPE: SLUDGE MUD SAND [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR [✓ SLIGHT] MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? cladophora NONE SLIGHT [✓ MODERATE] + CHOKING
AQUATIC VEGET. [✓ ROOTED] FLOATING TYPE Lots - prod. habitat
ADDITIONAL COMMENTS:(oil sheen, odor, colors)

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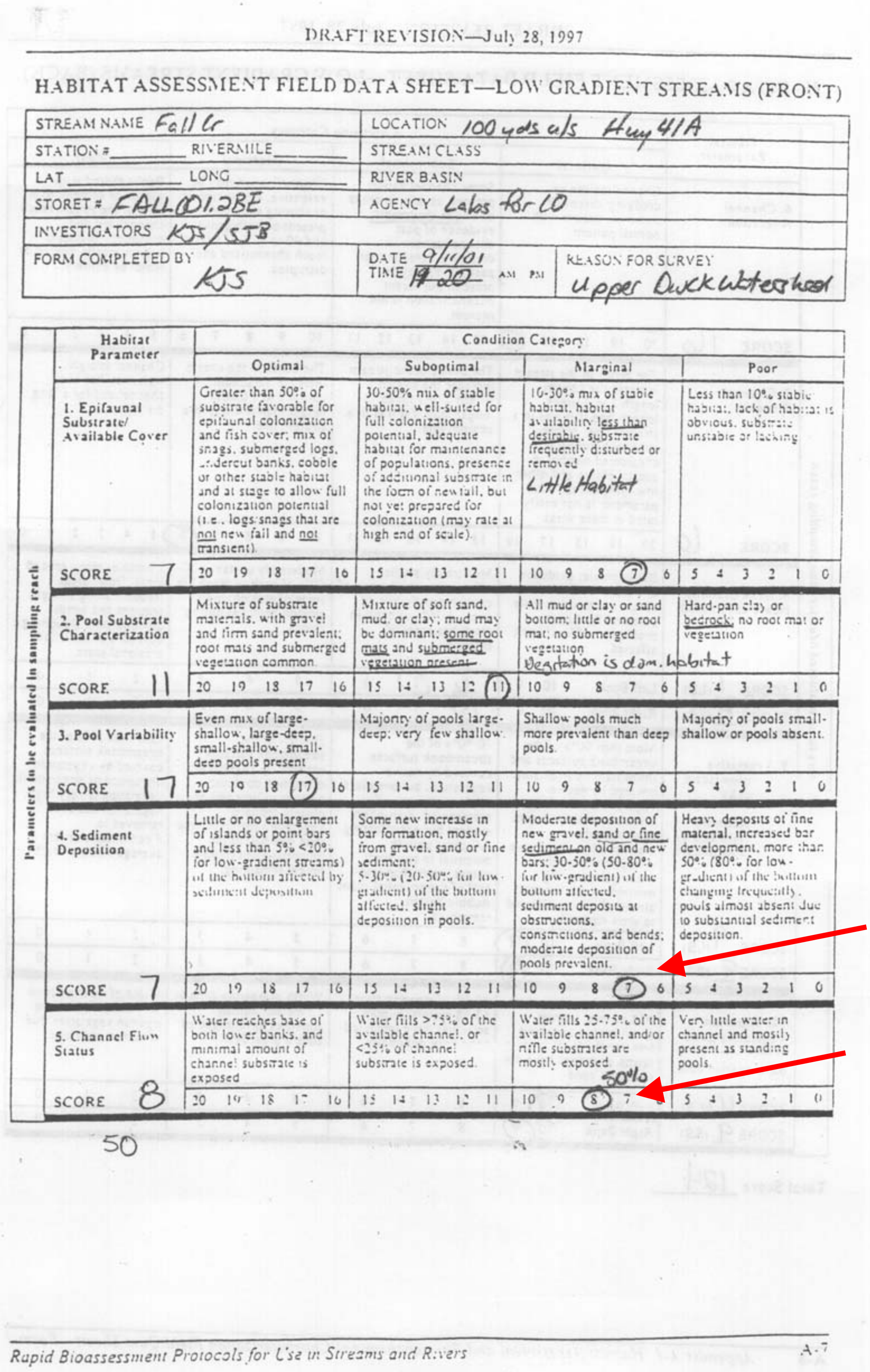
Figure D-19 Fall Creek Habitat Assessment, RM 1.2, front page - September 11, 2001



DRAFT REVISION—July 28, 1997

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Fall Cr	LOCATION 100 yds u/s Hwy 41A
STATION # ______ RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET # FALL001.2BE	AGENCY Labs for LO
INVESTIGATORS KJS/SJB	
FORM COMPLETED BY KJS	DATE 9/11/01 TIME 11 20 AM PM REASON FOR SURVEY Upper Duck Watershed

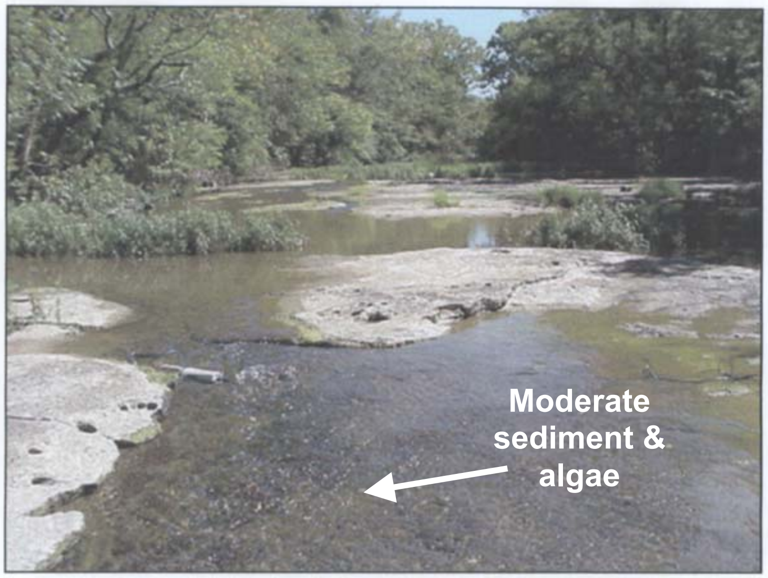
Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% 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).	30-50% 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).	10-30% mix of stable habitat, habitat availability less than desirable, substrate frequently disturbed or removed Little Habitat	Less than 10% stable habitat, lack of habitat is obvious, substrate unstable or lacking
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation Vegetation is dom. habitat	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE 17	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development, more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed	Water fills >75% of the available channel, or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed 50%	Very little water in channel and mostly present as standing pools.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1 0

50

Rapid Bioassessment Protocols for Use in Streams and Rivers A-7

Figure D-20 Photo of Fall Creek Habitat Assessment, RM 1.2 - September 11, 2001



Fall Creek (FALL001.2BE) 100 yards u/s Hwy 41A.
View u/s of the sampling area. Collected 9/11/01
@ 1115, KJS/SJB.

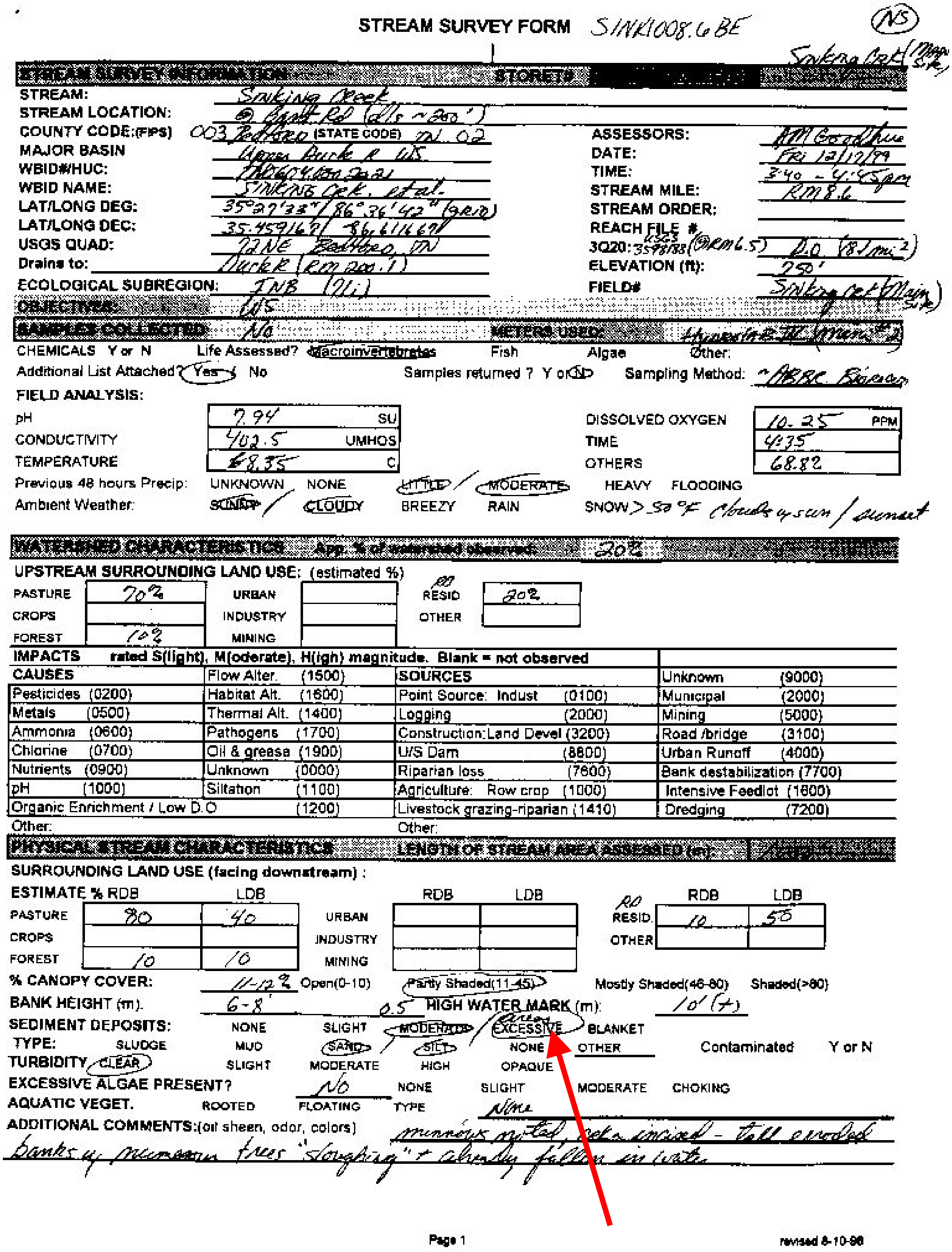
by a general purpose USLE based HUC-12 sediment loading model. Based upon our monitoring and watershed reconnaissance Sinking Creek (and especially Little Sinking Creek) needs to have agricultural best management practices, including animal exclusion and establishment of riparian vegetation, installed to correct the sediment sources observed. It appears that the majority of the sediment load is coming from Little Sinking Creek with some loading occurring from bank erosion in Sinking Creek.

D5.0 North Fork Creek (060400020401) Subwatershed Analysis

North Fork Creek (TN06040002039_3000) was placed on the *2002 303(d) List* as impacted due to siltation, nutrients, and pathogens from agricultural sources. The listing stream was shown as impaired on the *2004 303(d) List* due to loss of biological integrity due to siltation, nutrients, and Escherichia coli from agricultural sources.

Staff from the Nashville Environmental Field Office visited North Fork Creek at RM 9.4 on August 18, 1999 (ref.: Figures D-31 through D-33). This was a cursory visit to see if the stream had improved since being listed on the 1998 303(d) list. Observations confirmed it was still impaired at this time. It was noted that the flow was very low and the water was stagnant and choked with algae. The stream had poor riparian and cattle were observed in the creek upstream.

Figure D-21 Sinking Creek field sheet, p1 - December 17, 1999



STREAM SURVEY FORM SINK008.6BE (NS)

Sinking Crk (Main Site)

STREAM SURVEY INFORMATION **STORET#**

STREAM: Sinking Creek
STREAM LOCATION: @ [illegible] Rd (d/s ~200')
COUNTY CODE:(FIPS) 003 Bedford **(STATE CODE)** TN. 02
MAJOR BASIN Upper Duck R WS
WBID#HUC: TN06040002021
WBID NAME: SINKING Crk, et al.
LAT/LONG DEG: 35°27'33"/86°36'42" (grid)
LAT/LONG DEC: 35.459167/ -86.611667
USGS QUAD: 72NE [illegible], TN
Drains to: Duck R (RM 200.1)
ECOLOGICAL SUBREGION: INB (71i)
ASSESSORS: AM Goodhue
DATE: Fri 12/17/99
TIME: 3:40 - 4:45pm
STREAM MILE: RM 8.6
STREAM ORDER:
REACH FILE #
3Q20: USGS 3598788 (@RM6.5) 0.0 (81mi²)
ELEVATION (ft): 750'
FIELD# Sinking Crk (Main Site)
OBJECTIVES: WS
SAMPLES COLLECTED: No **METERS USED:** Hydrolab IV (Mini #2)

CHEMICALS Y or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other:
Additional List Attached? [✓ Yes] No Samples returned ? Y or [✓ N] Sampling Method: ~ABBC Biorecon

FIELD ANALYSIS:

pH	7.94 SU		DISSOLVED OXYGEN	10.25 PPM
CONDUCTIVITY	402.5 UMHOS		TIME	4:35
TEMPERATURE	8.35 C		OTHERS	68.82

Previous 48 hours Precip: UNKNOWN NONE [✓ LITTLE] / [✓ MODERATE] HEAVY FLOODING
Ambient Weather: [✓ SUNNY] / [✓ CLOUDY] BREEZY RAIN SNOW > 50°F cloudy w/ sun / sunset

WATERSHED CHARACTERISTICS App. % of watershed observed: 20%

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	70%	URBAN		RD RESID	20%
CROPS		INDUSTRY		OTHER	
FOREST	10%	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500)	SOURCES	Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600)	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction:Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8600)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600)	Bank destabilization (7700)
pH (1000)	Siltation (1100)	Agriculture: Row crop (1000)	Intensive Feedlot (1800)
Organic Enrichment / Low D.O	(1200)	Livestock grazing-riparian (1410)	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS **LENGTH OF STREAM AREA ASSESSED (m):**

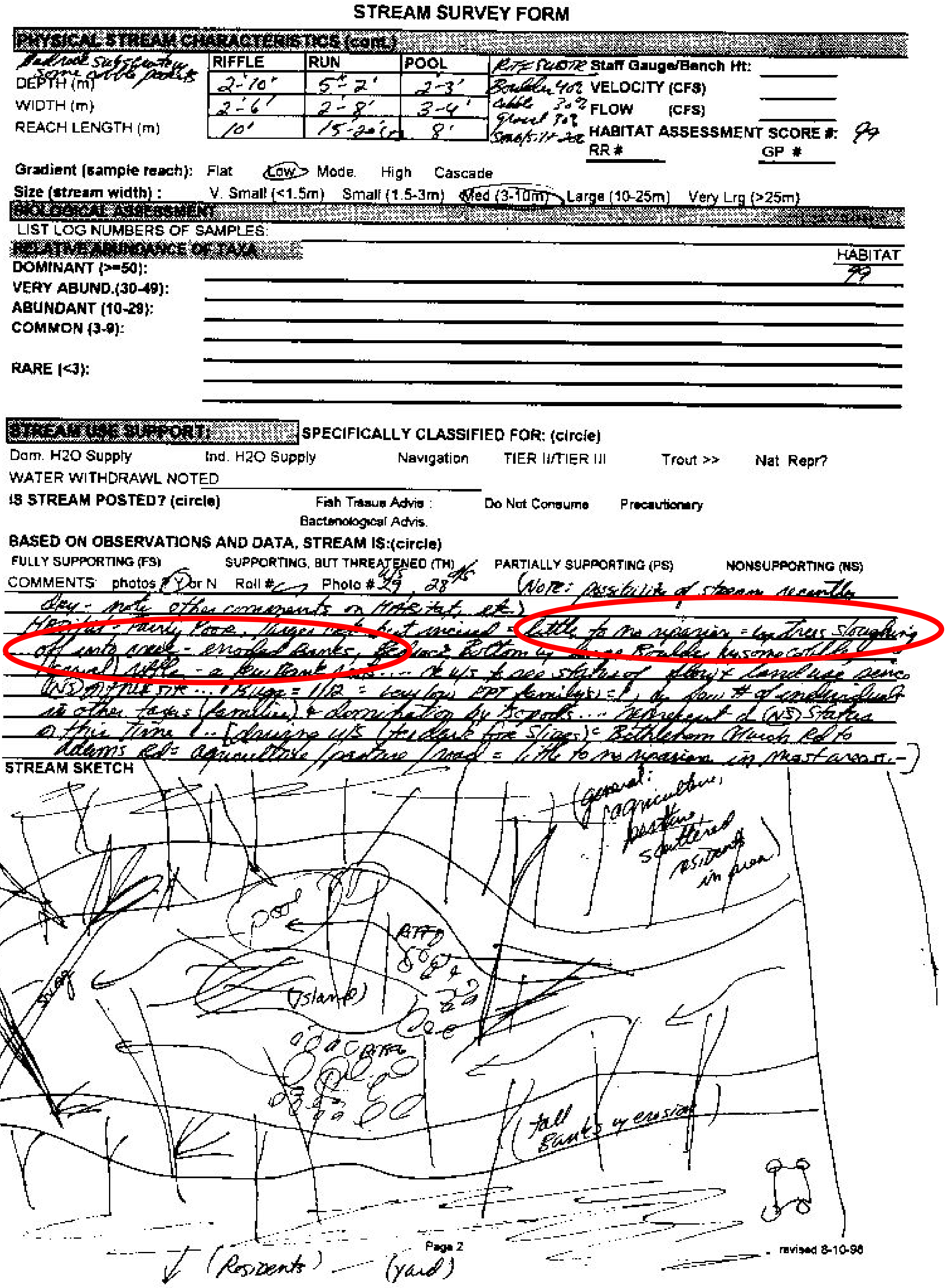
SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	80	40	URBAN			RD RESID.	10	50
CROPS			INDUSTRY			OTHER		
FOREST	10	10	MINING					

% CANOPY COVER: 11-12% Open(0-10) [✓ Partly Shaded(11-45)] Mostly Shaded(46-80) Shaded(>80)
BANK HEIGHT (m). 6-8' 0.5 **HIGH WATER MARK** (m): 10' (+)
SEDIMENT DEPOSITS: NONE SLIGHT [✓ MODERATE] / [✓ EXCESSIVE] areas BLANKET
TYPE: SLUDGE MUD [✓ SAND] / [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY [✓ CLEAR] SLIGHT MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? No NONE SLIGHT MODERATE CHOKING
AQUATIC VEGET. ROOTED FLOATING TYPE None
ADDITIONAL COMMENTS:(oil sheen, odor, colors) minnows noted, crk incised - tall eroded banks w/ numerous trees "sloughing" + already fallen in water.

Page 1 revised 8-10-98

Figure D-22 Sinking Creek field sheet, p2 - December 17, 1999



STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

Bedrock substrate w/ some cobble pockets

	RIFFLE	RUN	POOL
DEPTH (m)	2-10"	5"-2'	2-3'
WIDTH (m)	2-6'	2-8'	3-4'
REACH LENGTH (m)	10'	15-20'(r)	8'

Riffle substrate: Boulder 40% Cobble 30% Gravel 10% Sand/silt 20%

Staff Gauge/Bench Ht: _____
VELOCITY (CFS) _____
FLOW (CFS) _____
HABITAT ASSESSMENT SCORE #: 99
RR # _____ GP # _____

Gradient (sample reach): Flat [✓ Low] Mode. High Cascade

Size (stream width): V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES:

RELATIVE ABUNDANCE OF TAXA HABITAT 99

DOMINANT (>=50):
VERY ABUND.(30-49):
ABUNDANT (10-29):
COMMON (3-9):
RARE (<3):

STREAM USE SUPPORT: **SPECIFICALLY CLASSIFIED FOR: (circle)**

Dom. H2O Supply Ind. H2O Supply Navigation TIER II/TIER III Trout >> Nat Repr?

WATER WITHDRAWL NOTED

IS STREAM POSTED? (circle) Fish Tissue Advis : Do Not Consume Precautionary
Bacteriological Advis.

BASED ON OBSERVATIONS AND DATA, STREAM IS:(circle)

FULLY SUPPORTING (FS) SUPPORTING, BUT THREATENED (TH) PARTIALLY SUPPORTING (PS) NONSUPPORTING (NS)

COMMENTS: photos [✓ Y] or N Roll # — Photo # 29 u/s, 28 d/s (Note: possibility of stream recently dry - note other comments on Habitat, etc.)
Habitat - Fairly Poor, [illegible] [illegible] but overall = little to no riparian = by Trees sloughing off into creek - eroded banks, Bedrock Bottom by [illegible] Boulder, [illegible] cobble [illegible] riffle - a few [illegible] [illegible] ... d/s & u/s [illegible] status of flow & land use conc. (NS) at this site ... Biscore = 1/12 = very low EPT families = 1, & low # of individuals in other taxa (families) & domination by [illegible] ... [illegible] of (NS) status at this time ... [driving u/s (feedback from [illegible]): Bethlehem Church Rd to Adams Rd: agriculture/pasture/[illegible] = little to no riparian in most areas.-)

STREAM SKETCH

Page 2

revised 8-10-98

Figure D-23 Photo of Sinking Creek upstream - December 17, 1999

Figure D-24 Photo of Sinking Creek downstream - December 17, 1999

Figure D-25 Photo of Sinking Creek upstream - July 24, 2000

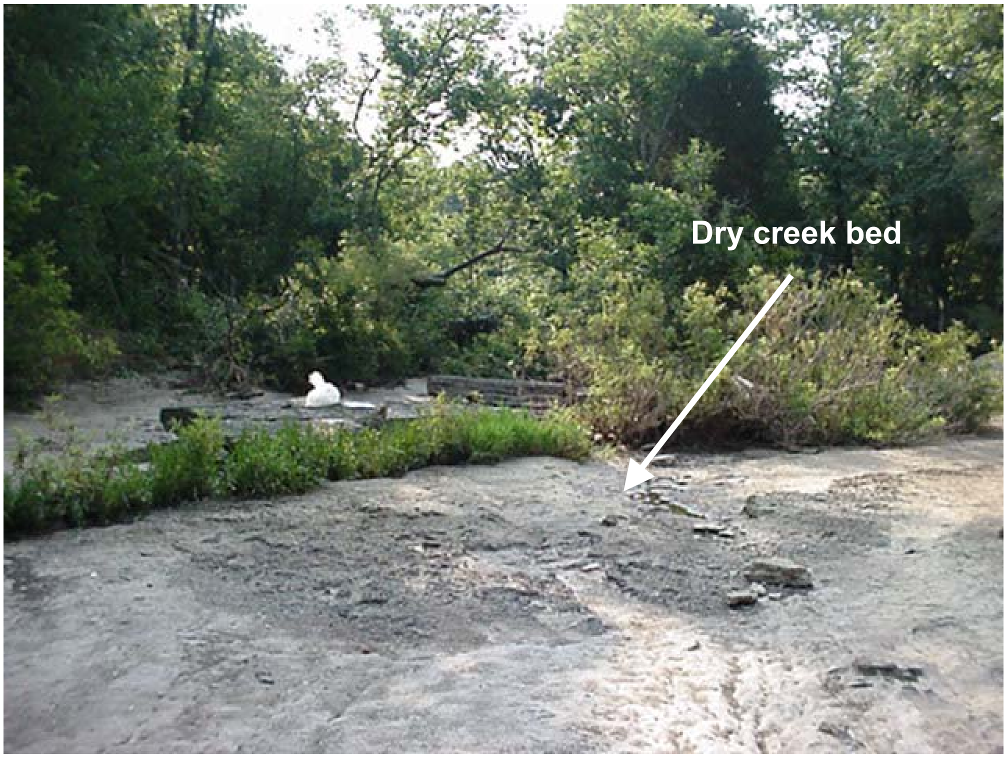


Figure D-26 Photo of Sinking Creek downstream - July 24, 2000

Figure D-27 Photo of Sinking Creek upstream - October 16, 2000

Figure D-28 Photo of Little Sinking Creek upstream - December 12, 1999

Figure D-29 Photo of Little Sinking Creek upstream - July 26, 2000

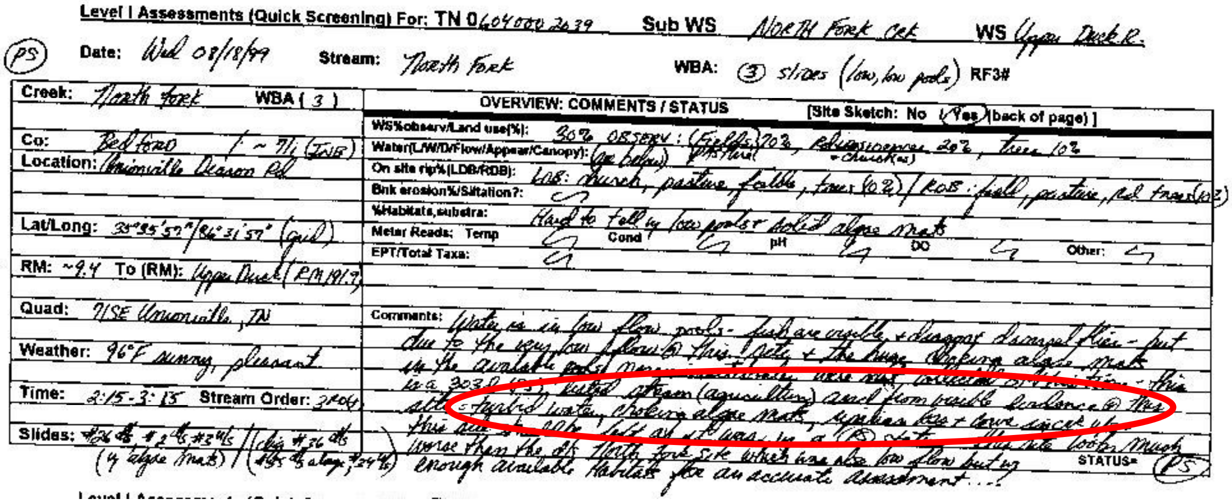
Figure D-30 Photo of Little Sinking Creek downstream - July 26, 2000

North Fork Creek was monitored at RM 7.7 and 16.4 by aquatic biologists from the State Lab on as a site of the probabilistic monitoring study. The stream at RM 7.7 was found have very low flow or dry on July 24, 2000 and October 17, 2000 (ref.: Figures D-34 through D-36). It contained flow on February 1, 2000, April 17, 2000, and again on May 8, 2001. All three sampling events noted slight to moderate siltation. Land use upstream was mostly pasture with cattle.

North Fork creek at RM 16.4 was found to have very low flow or dry on July 25, 2000 and October 16, 2000 (ref.: Figures D-37 and D-38). It contained flow on January 11, 2000, April 19, 2000, and again on May 10, 2001 (ref.: Figure D-38). All three sampling events noted moderate siltation. Land use upstream was mostly pasture with cattle.

From the monitoring data, it appears that the benthic community in North Fork Creek may be impacted from a lack of water. The lack of water is most likely due to the karst topography in the area (ref.: Figure D-1) and the extreme drought conditions noted during the sampling period. When flow did exist and the stream was monitored, the presence of sediment and some turbidity were noted. Near stream sediment sources most likely came from the surrounding agricultural land uses. A detailed and intensive watershed reconnaissance survey is recommended for further pollutant source identification. Cattle were noted in the area but the riparian conditions of these pastures were not documented.

Figure D-31 North Fork Creek field sheet, RM 9.4 - August 18, 1999



Level I Assessments (Quick Screening) For: TN 0604000 2039 **Sub WS** North Fork Crk **WS** Upper Duck R.

(PS) **Date:** Wed 08/18/99 **Stream:** North Fork **WBA:** ③ slides (low, low pools) **RF3#**

Creek: North Fork **WBA** (3)

Co: Bedford / ~ 7½ (JWB)

Location: Unionville Deason Rd

Lat/Long: 35°35'57"/86°31'57" (gul)

RM: ~9.4 **To (RM):** Upper Duck (RM 191.9)

Quad: 71SE Unionville, TN

Weather: 96°F sunny, pleasant

Time: 2:15-3:15 **Stream Order:** 3rd(4)

Slides: #26 ds #2 ds #3 u/s // (dis #36 ds) (4 algae mats) // (u/s ds algae, #24 u/s)

OVERVIEW: COMMENTS / STATUS [Site Sketch: No / [✓ Yes] (back of page)]

WS%observ/Land use(%): 30% observ: (Fields) 70% pasture, Residences 20% + church(es), trees 10%

Water(L/W/D/Flow/Appear/Canopy): (see below)

On site rip%(LDB/RDB): LDB: church, pasture, fallow, trees (02) / RDB: field, pasture, rd trees (10%)

Bnk erosion%/Siltation?:

%Habitats, substra: Hard to tell in low pools + solid algae mats

Meter Reads: Temp **Cond** **pH** **DO** **Other:**

EPT/Total Taxa:

Comments: Water is in low flow pools - fish are visible + diagonal damselflies - but due to the very low flow @ this site + the huge choking algae mats in the available pools [illegible] were not collected @ this time - this is a 303(d) listed stream (agriculture) and from visible evidence @ this site - turbid water, choking algae mats, [illegible] this site [illegible] left as it was in a (PS) state. [illegible] worse than the [illegible] North Fork site which was also low flow but w/ enough available Habitats for an accurate assessment...

STATUS= (PS)

Figure D-32 Photo of North Fork Creek RM 9.4 upstream - August 18, 1999

Figure D-33 Photo of North Fork Creek RM 9.4 downstream - August 18, 1999

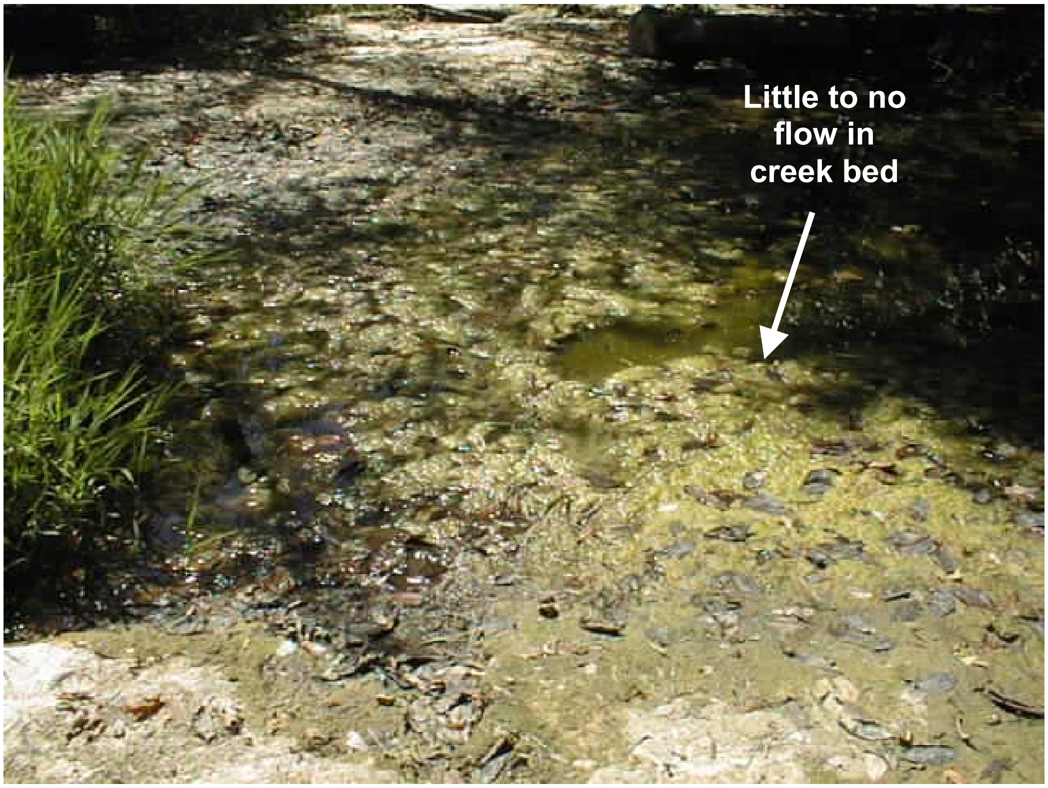


Figure D-34 Photo of North Fork Creek RM 7.7 upstream low flow - July 24, 2000


Little to no flow in creek bed

Figure D-35 Photo of North Fork Creek RM 7.7 downstream stagnant low flow - July 24, 2000


Stagnant, low flow in stream

Figure D-36 Photo of North Fork Creek RM 7.7 upstream dry - October 17, 2000

Figure D-37 Photo of North Fork Creek RM 16.4 upstream dry - July 25, 2000

Figure D-38 Photo of North Fork Creek RM 16.4 downstream dry - July 25, 2000

Figure D-39 Photo of North Fork Creek RM 16.4 upstream - May 10, 2000

D6.0 Alexander Creek (060400020402) Subwatershed Analysis

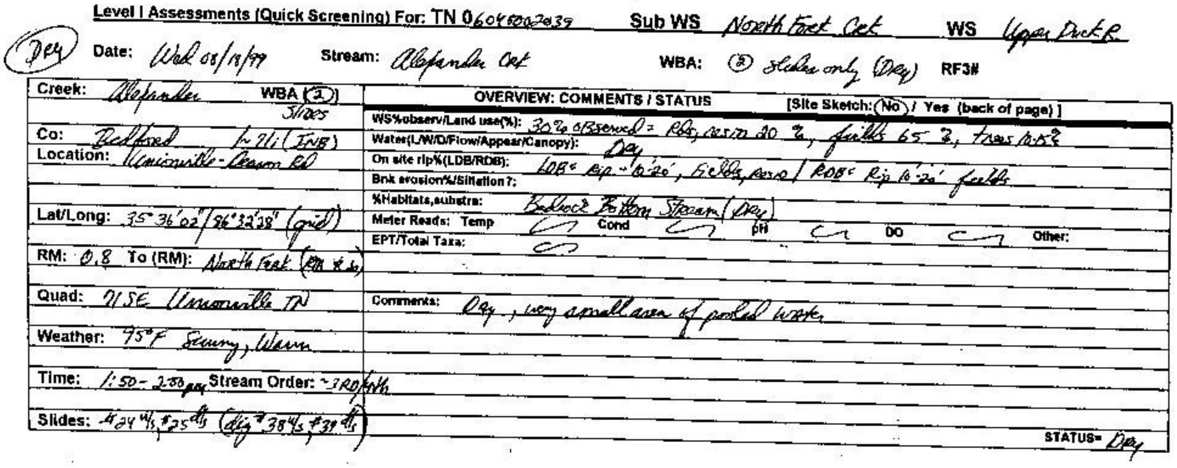
Alexander Creek (TN06040002039_0300) was placed on the *2002 303(d) List* of impaired streams as impairment by pathogens and siltation from pasture grazing. The *2004 303(d) List* indicated the stream was impaired by the loss of biological integrity due to siltation and Escherichia coli due to pasture grazing.

Alexander Creek was visited by staff from the Nashville Environmental Field Office on August 18, 1999 and observed to be dry (ref.: Figures D-40 through D-42).

Alexander Creek was revisited by aquatic biologists from the State Lab on July 24, 2000, October 17, 2000, and on September 12, 2001 and was observed to be dry (ref.: Figures D-43 through D-45). Aquatic biologists from the State Lab monitored the site on January 10, 2000, April 13, 2000, and May 10, 2001 when flow was present (ref.: Figure D-46).

From the monitoring reports, it appears that the impairment of Alexander Creek may be due to hydrologic stress of benthic macroinvertebrates. The lack of water is most likely due to the karst terrain in the area (ref.: Figure D-1). Flow likely exists during storm events but drains underground during low and normal flow conditions. When flow did exist and the stream was monitored the presence of sediment and high turbidity were noted. This likely corresponds to flows from previous rain events. The sources of deposited sediment are most likely from the surrounding agricultural land uses. A comprehensive and intensive watershed reconnaissance survey is recommended for further pollutant source identification.

Figure D-40 Alexander Creek RM 0.8 field sheet - August 18, 1999



Level I Assessments (Quick Screening) For: TN 06040002039 **Sub WS** North Fork Crk **WS** Upper Duck R.

(Dry) **Date:** Wed 08/18/99 **Stream:** Alexander Crk **WBA:** ② slides only (Dry) **RF3#**

Creek: Alexander **WBA** (2) Slides
Co: Bedford ~71i (INB)
Location: Unionville-Deason Rd
Lat/Long: 35°36'02"/86°32'28" (grid)
RM: 0.8 **To (RM):** North Fork (RM [illegible])
Quad: 71 SE Unionville TN
Weather: 75°F Sunny, Warm
Time: 1:50-2:50 pm **Stream Order:** ~3RD/4th
Slides: #24 u/s, #25 d/s (dig #38 u/s, #39 d/s)

OVERVIEW: COMMENTS / STATUS [Site Sketch: [✓ No] / Yes (back of page)]
WS%observ/Land use(%): 30% observed = Res, pasture 20 %, fields 65 %, trees 15%?
Water(L/W/D/Flow/Appear/Canopy): Dry
On site rip%(LDB/RDB): LOB = Rip ~ 10-20', fields, pasture / ROB = Rip 10-20' fields
Bnk erosion%/Siltation?:
%Habitats,substra: Bedrock Bottom Stream (Dry)
Meter Reads: Temp — **Cond** — **pH** — **DO** — **Other:**
EPT/Total Taxa: —
Comments: Dry, very small area of pooled water.
STATUS= Dry

Figure D-41 Photo of Alexander Creek RM 0.8 Upstream - August 18, 1999

Figure D-42 Photo of Alexander Creek RM 0.8 Downstream - August 18, 1999

Figure D-43 Photo of Alexander Creek RM 4.0 Upstream - July 24, 2000

Figure D-44 Photo of Alexander Creek RM 4.0 Downstream - July 24, 2000

Figure D-45 Photo of Alexander Creek RM 0.4 - October 17, 2000

Figure D-46 Photo of Alexander Creek RM 0.4 - April 13, 2000

D7.0 Weakley Creek (060400020404) Subwatershed Analysis

Weakley Creek (TN06040002039_0250) was placed on the *2002 303(d) List* as impacted due to siltation, nutrients, and pathogens from agricultural sources. The *2004 303(d) List* showed the stream as impaired due to loss of biological integrity due to siltation, nutrients and Escherichia coli due to agricultural sources.

Staff from the Nashville Environmental Field Office monitored Weakley Creek at RM 0.2 on August 18, 1999 (ref.: Figures D-47 through D-50). A biorecon showed 7 EPT, 4 intolerant, and 26 total families. These data were not high enough to rate the stream as fully supporting.

Weakley Creek was monitored at RM 5.2 by aquatic biologists from the State Lab on as a site of the probabilistic monitoring study. The stream was found dry on July 25, 2000 and October 17, 2000 (ref.: Figures D-51 through D-53). It contained flow on January 10, 2000, April 17, 2000, and again on May 8, 2001. All three sampling events noted moderate siltation. Land use upstream was mostly pasture with cattle.

Weakley Creek was also monitored by aquatic biologists from the State Lab on September 10, 2001 at RM 1.7. A semiquantitative sample showed the macroinvertebrate community was rated as fully supporting. However, it was noted that the stream had very little flow with a fractured bedrock bottom. Water appeared to flow in and out of the deep fractures. The flow upstream of the site was ponded and slow moving (ref.: Figure D-54). The monitoring showed moderate silt and high turbidity.

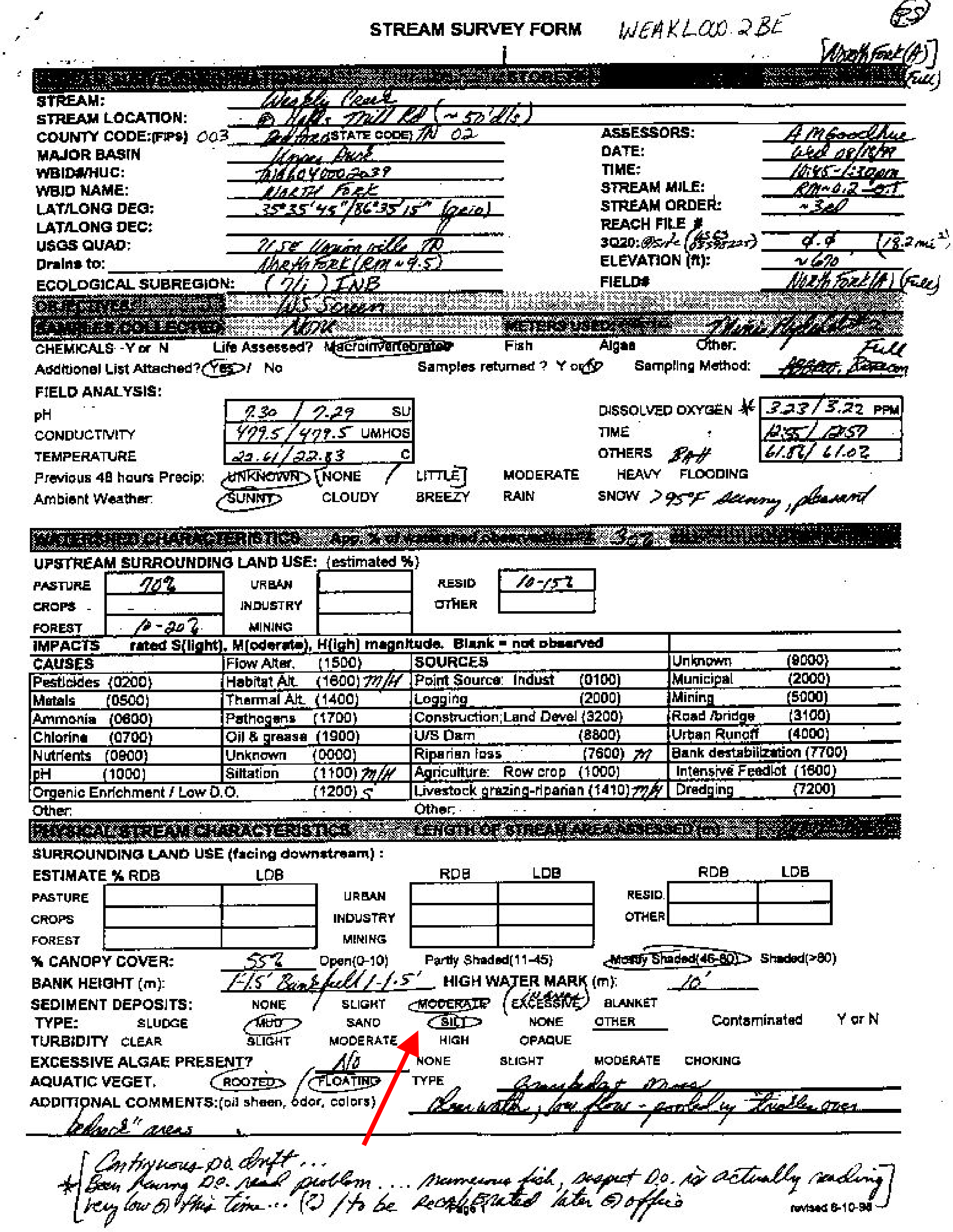
From the monitoring data, it appears that the benthic community in Weakley Creek may be impacted from a lack of water. The lack of water is most likely due to the karst topography in the area (ref.: Figure D-1) and extreme drought conditions during the sampling period. When flow did exist and the stream was monitored, the presence of sediment and some turbidity were noted. Near stream sediment sources most likely came from the surrounding agricultural land uses. A detailed and intensive watershed reconnaissance survey is recommended for further pollutant source identification. Cattle were noted in the area but the riparian conditions of these pastures were not documented.

D8.0 Wilson Creek (060400020502) Subwatershed Analysis

Wilson Creek (TN06040002046_1000) was placed on the *2002 303(d) List* as impacted due to habitat alteration, nitrates, and pathogens from agricultural sources. The *2004 303(d) List* showed the stream as impaired by Escherichia coli, nitrates and other habitat alterations due to pasture grazing.

Staff from the Nashville Environmental Field Office visited Wilson Creek at RM 2.9 on January 10, 2000. A biorecon showed 5 EPT, 5 intolerant, and 14 total families. Notes report the presence of moderate sediment deposits from the upper watershed. However, it was noted that even though at this time there was flow in the stream it was likely that there was little to no flow previously. The impacts noted may have been due to recent unusually low flow conditions.

Figure D-47 Weakley Creek RM 0.2 field sheet, p1 - August 18, 1999



STREAM SURVEY FORM WEAKL000.2BE (ES)

[North Fork(A)] (Full)

STREAM: Weakly Creek
STREAM LOCATION: @ Hills Mill Rd (~50' d/s)
COUNTY CODE:(FIPS) 003 Bedford (STATE CODE) TN 02
MAJOR BASIN: Upper Duck
WBID#/HUC: TN06040002039
WBID NAME: North Fork
LAT/LONG DEG: 35°35'45"/86°35'15" (geo)
LAT/LONG DEC:
USGS QUAD: 71 SE Unionville TN
Drains to: North Fork (RM ~9.5)
ECOLOGICAL SUBREGION: (71i) INB

ASSESSORS: A McGoodhue
DATE: Wed 08/18/99
TIME: 10:45-1:30pm
STREAM MILE: RM~0.2 est
STREAM ORDER: ~3rd
REACH FILE #
3Q20: @site (USGS 03598227) 0.0 (18.2 mi²)
ELEVATION (ft): ~670
FIELD# North Fork(A) (Full)

OBJECTIVES: US Screen
SAMPLES COLLECTED: None METERS USED: Mini Hydrolab
CHEMICALS -Y or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other: Full
Additional List Attached? [✓ Yes] / No Samples returned ? Y or [✓ N] Sampling Method: Assess, Recon

FIELD ANALYSIS:

pH	7.30 / 7.29 SU	DISSOLVED OXYGEN *	3.23 / 3.22 PPM
CONDUCTIVITY	479.5 / 479.5 UMHOS	TIME	12:55 / 12:57
TEMPERATURE	22.61 / 22.83 C	OTHERS BP#	61.86 / 61.02

Previous 48 hours Precip: [✓ UNKNOWN] [NONE / LITTLE] MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY] CLOUDY BREEZY RAIN SNOW >95°F sunny, pleasant

WATERSHED CHARACTERISTICS - App. % of watershed observed/visited: 30%

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	70%	URBAN		RESID	10-15%
CROPS	–	INDUSTRY		OTHER	
FOREST	10-20%	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500)	SOURCES	Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600) m/H	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600) m	Bank destabilization (7700)
pH (1000)	Siltation (1100) m/H	Agriculture: Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / Low D.O.	(1200) S	Livestock grazing-riparian (1410) m/H	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS - LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE			URBAN			RESID.		
CROPS			INDUSTRY			OTHER		
FOREST			MINING					

% CANOPY COVER: 55% Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)
BANK HEIGHT (m): 1-1.5' Bankfull 1-1.5' HIGH WATER MARK (m): 10'
SEDIMENT DEPOSITS: NONE / SLIGHT [✓ MODERATE] (in areas EXCESSIVE) BLANKET
TYPE: SLUDGE [✓ MUD] SAND [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR SLIGHT MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? N/O NONE SLIGHT MODERATE CHOKING
AQUATIC VEGET. [✓ ROOTED] / [✓ FLOATING] TYPE [illegible] moss
ADDITIONAL COMMENTS:(oil sheen, odor, colors) Clear water, low flow - pooled by "trickles over bedrock" areas

* [Continuous D.O. drift...
Been having D.O. read problem ... numerous fish, suspect D.O. is actually reading
very low @ this time... (?) / to be recalibrated later @ office]

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Figure D-48 Weakley Creek RM 0.2 field sheet, p2 - August 18, 1999

STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)	∽	∽	1-2'
WIDTH (m)	∽	∽	15-10'
REACH LENGTH (m)	∽	∽	20 ft

Staff Gauge/Bench Ht: ______
VELOCITY (CFS) ______
FLOW (CFS) ______
HABITAT ASSESSMENT SCORE #: 115
RR # ______ **GP #** ______

Gradient (sample reach): Flat Low Mode. High Cascade

Size (stream width) : V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

BIOLOGICAL ASSESSMENT:

LIST LOG NUMBERS OF SAMPLES: no voucher specimens collected

RELATIVE ABUNDANCE OF TAXA: HABITAT

DOMINANT (>=50):
VERY ABUND.(30-49): See attached
ABUNDANT (10-29):
COMMON (3-9):
RARE (<3):

STREAM USE SUPPORT: SPECIFICALLY CLASSIFIED FOR: (circle)

Dom. H2O Supply Ind. H2O Supply Navigation TIER II/TIER III Trout >> Nat. Repr?

WATER WITHDRAWL NOTED ______

IS STREAM POSTED? (circle) Fish Tissue Advis.: Do Not Consume Precautionary
Bacteriological Advis.

BASED ON OBSERVATIONS AND DATA, STREAM IS:(circle)

FULLY SUPPORTING (FS) SUPPORTING, BUT THREATENED (TH) [✓ PARTIALLY SUPPORTING (PS)] NONSUPPORTING (NS)

COMMENTS: photos ? [✓ Y] or N Roll # Photo # 22 4/6 43 d/h (dig 40% #37 d/h)

This trib to North Fork is very similar to North Fork w/ a little more [illegible] substrate(?) similar habitats found - rootpicks, bank [illegible], moss + grassbeds - tho quite a few macroinvertebrates were found, the EPT total (7/16) appears to represent the (PS) status @ this time - no [illegible], [illegible], or [illegible] were found - 5 EPT family taxa were found @ this site than @ North Fork (dk) + 6 total family taxa [illegible] @ this site also - numerous fish schools seen / to determine where in this gray area between [illegible] supporting status & partially supporting status the creek stands - a more in depth SS needs to be done [illegible] compared to Full site (FS) now considering HABITAT [illegible]

STREAM SKETCH

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Figure D-49 Photo of Weakley Creek RM 0.2 Upstream - August 18, 1999

Figure D-50 Photo of Weakley Creek RM 0.2 Downstream - August 18, 1999

Figure D-51 Photo of Weakley Creek RM 5.2 Upstream - July 25, 2000

Figure D-52 Photo of Weakley Creek RM 5.2 Downstream - July 25, 2000

Figure D-53 Photo of Weakley Creek RM 5.2 Upstream - October 17, 2000

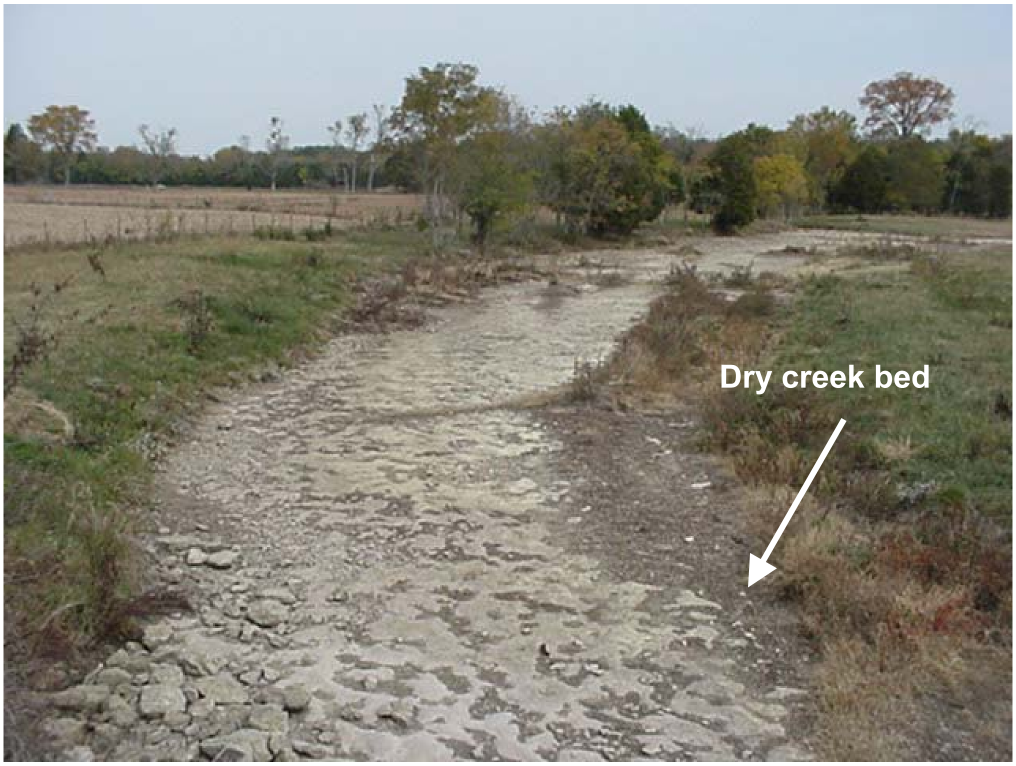


Figure D-54 Photo of Weakley Creek RM 1.7 Upstream - September 10, 2001

Wilson Creek was also monitored at RM 5.2 by aquatic biologists from the State Lab on as a site of the probabilistic monitoring study. The stream was found have very low flow or dry on July 25, 2000. It contained flow on all other sampling events. All three sampling events noted excessive siltation (ref.: Figure D-55). It was also noted that dairy cattle were present and had been in the stream to water (ref.: Figures D-56 through D-58). The riparian areas were thin to poor. The impacts from low flow are likely due to a combination of possible karst areas (ref.: Figure 1) as well as extreme drought conditions that occurred during the sampling period.

D9.0 Lick Creek (060400020503) Subwatershed Analysis

Lick Creek (TN06040002047_0300) was placed on the 303(d) list of impaired streams in 2002 as impacted by pathogens and other habitat alterations from livestock in the stream. The *2004 303(d) List* showed the stream as impaired by Escherichia coli and other habitat alterations from livestock in the stream.

Lick Creek was monitored at RM 1.8 in 1999 and again in 2001 by the Nashville Environmental Field Office. In the quick screening conducted on July 9, 1999, large floating mats of algae were noted on dark brown water. Additionally, the water was low, with still, dark pools. Notes from the monitoring visit on September 17, 2001 (ref.: Figures D-59 through D-63) report the presence of moderate sediment deposits, slight turbidity, siltation and algae, along with suboptimal vegetative protection and riparian zone. The impacts are from a combination of low flow that is likely due to possible karst areas (ref.: Figure D-1) and uncontrolled access to the streams by cows.

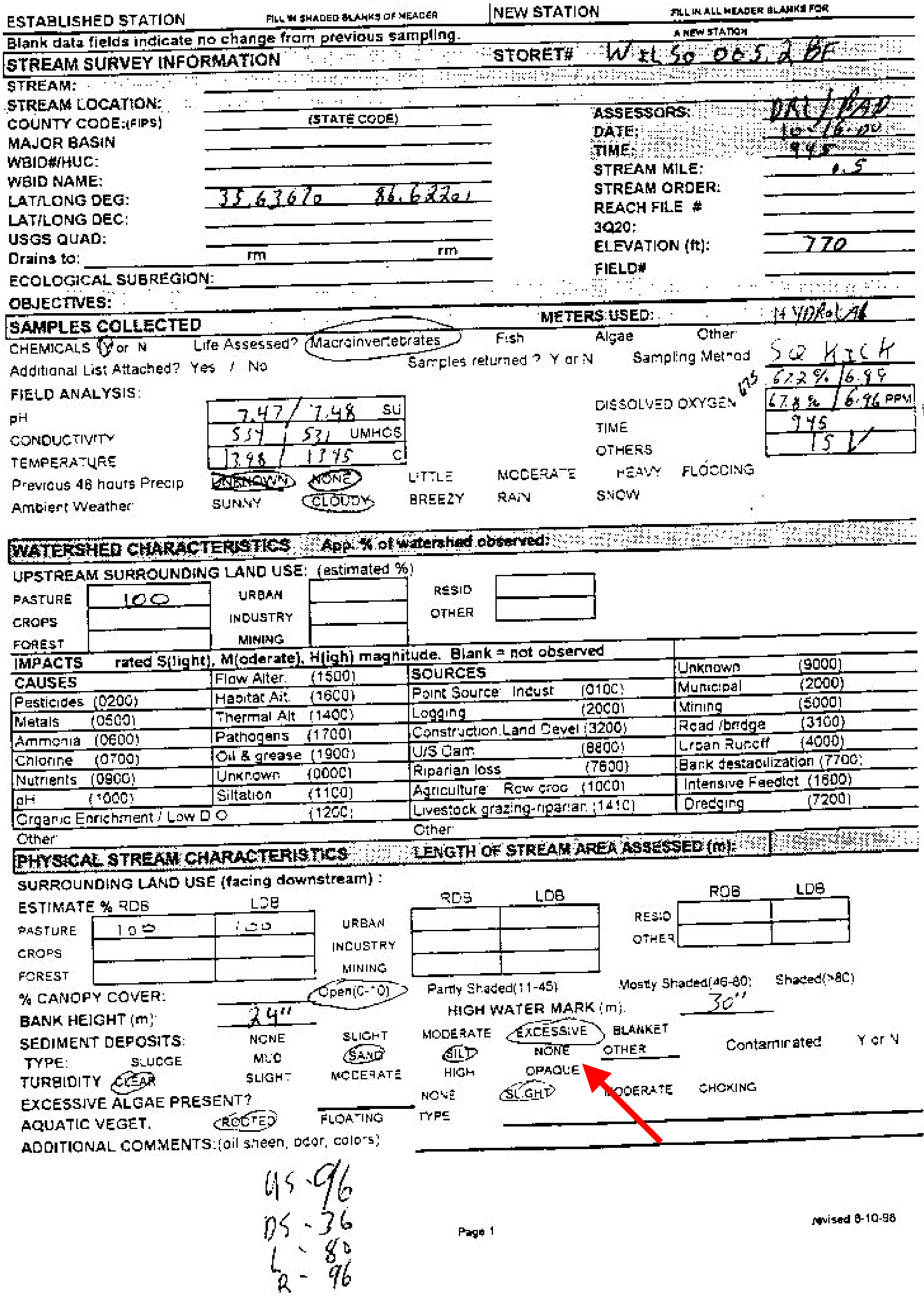
D10.0 Caney Creek and Thick Creek (060400020504) Subwatershed Analysis

Caney Creek (TN06040002048_1000) was placed on the 303(d) list of impaired streams in 2002 as impacted by nitrates and siltation from riparian loss and pasture grazing. The *2004 303(d) List* indicated that the stream was impaired due to nitrates and loss of biological integrity due to siltation. Causes listed included Livestock in the Stream and Removal of Riparian Vegetation.

Caney Creek was monitored in 1999 by the Nashville Environmental Field Office. A biorecon at RM 2.6 showed 5 EPT, 2 intolerant, and 20 total families. Notes report the presence of sediment deposits from the upper watershed. It was noted that there were new subdivision developments going in on the right bank downstream (ref.: Figure D-64). The stream was moderately turbid at this time giving the water a dark brown color (ref.: Figures D-65 through D-67).

The upper portions of the watershed were visited during the sampling period to look for possible sources of sediment (ref.: Figure D-68). Photographs of RM 4.2 showed heavy agricultural influence and a potential sediment source. The land use in the area was primarily pasture grazing. Stream banks were exposed and muddy with poor vegetation or cover. Cattle were observed loafing in the stream and along or on the stream banks. (ref.: Figures D-69 and D-70).

Figure D-55 Wilson Creek field sheet, p1 - October 16, 2000



ESTABLISHED STATION — FILL IN SHADED BLANKS OF HEADER | NEW STATION — FILL IN ALL HEADER BLANKS FOR A NEW STATION

Blank data fields indicate no change from previous sampling.

STREAM SURVEY INFORMATION STORET# Wil So 005.2 BF

STREAM:
STREAM LOCATION:
COUNTY CODE:(FIPS) (STATE CODE)
MAJOR BASIN
WBID#/HUC:
WBID NAME:
LAT/LONG DEG: 35.63670 86.62201
LAT/LONG DEC:
USGS QUAD:
Drains to: rm rm
ECOLOGICAL SUBREGION:
OBJECTIVES:

ASSESSORS: DRC/BAD
DATE: 10-16-00
TIME: 945
STREAM MILE: 0.5
STREAM ORDER:
REACH FILE #
3Q20:
ELEVATION (ft): 770
FIELD#
METERS USED: HYDROLAB

SAMPLES COLLECTED

CHEMICALS [✓ Y] or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other
Additional List Attached? Yes / No Samples returned ? Y or N Sampling Method SQ KICK

FIELD ANALYSIS:

pH	7.47 / 7.48	SU
CONDUCTIVITY	554 / 531	UMHOS
TEMPERATURE	13.98 / 13.95	C

DISSOLVED OXYGEN 675	67.2% / 6.99 67.8% / 6.96	PPM
TIME	945	
OTHERS	15 V	

10.92

Previous 48 hours Precip ~~UNKNOWN~~ [✓ NONE] LITTLE MODERATE HEAVY FLOODING
Ambient Weather SUNNY [✓ CLOUDY] BREEZY RAIN SNOW

WATERSHED CHARACTERISTICS App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	100	URBAN		RESID	
CROPS		INDUSTRY		OTHER	
FOREST		MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES		SOURCES	
Pesticides (0200)	Habitat Alt. (1600)	Point Source Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600)	Bank destabilization (7700)
pH (1000)	Siltation (1100)	Agriculture Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / Low D O (1200)		Livestock grazing-riparian (1410)	Dredging (7200)
Other		Other	

Flow Alter. (1500)
Unknown (9000)

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	100	100	URBAN			RESID		
CROPS			INDUSTRY			OTHER		
FOREST			MINING					

% CANOPY COVER: [✓ Open(0-10)] Partly Shaded(11-45) Mostly Shaded(46-80) Shaded(>80)
BANK HEIGHT (m): 24" HIGH WATER MARK (m): 30"
SEDIMENT DEPOSITS: NONE SLIGHT MODERATE [✓ EXCESSIVE] BLANKET
TYPE: SLUDGE MUD [✓ SAND] [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY [✓ CLEAR] SLIGHT MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? NONE [✓ SLIGHT] MODERATE CHOKING
AQUATIC VEGET. [✓ ROOTED] FLOATING TYPE
ADDITIONAL COMMENTS:(oil sheen, odor, colors)

US - 96
DS - 36
L - 80
R - 96

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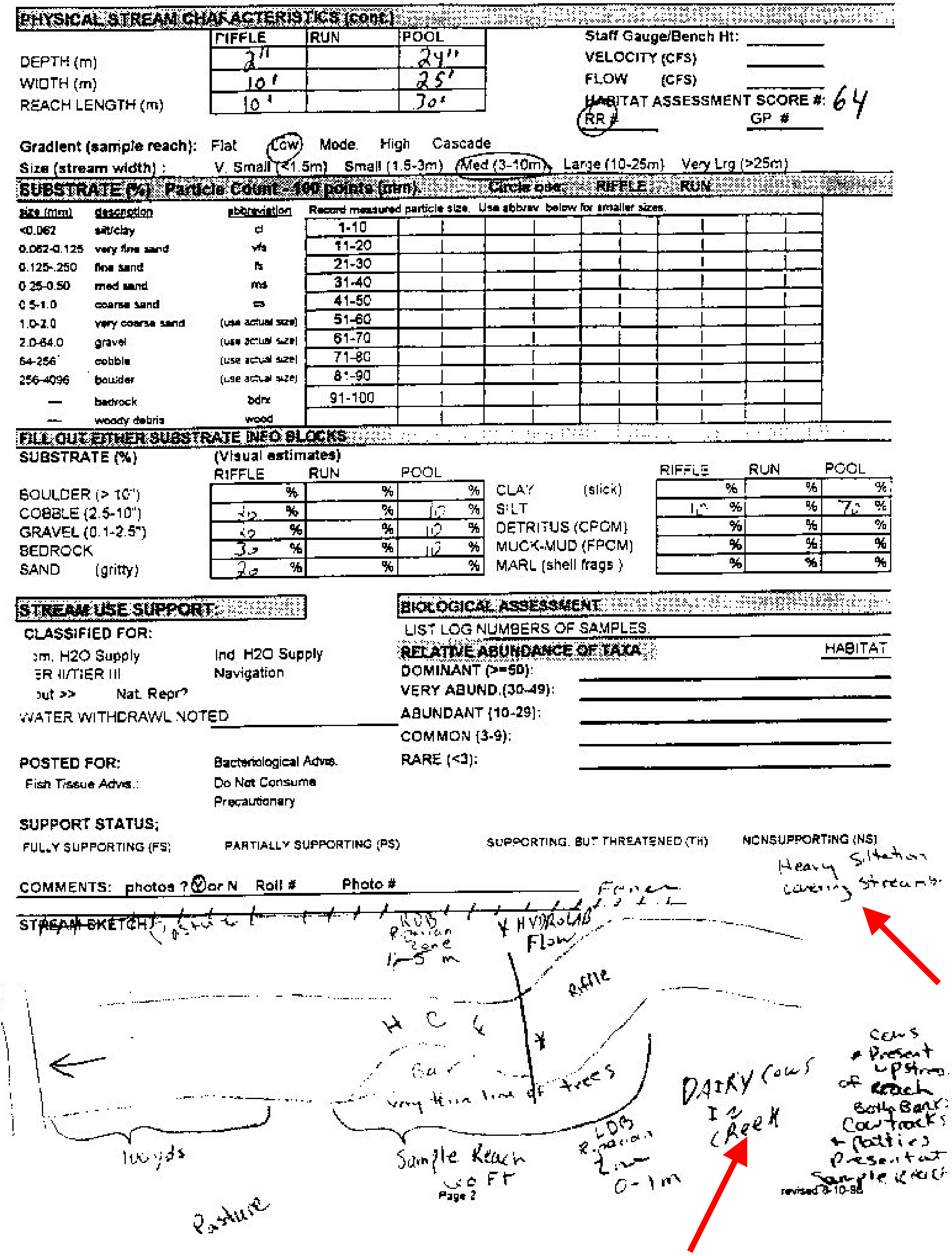
revised 8-10-98

Figure D-56 Wilson Creek field sheet, p2 - October 16, 2002



PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)	2"		24"
WIDTH (m)	10'		25'
REACH LENGTH (m)	10'		30'

Staff Gauge/Bench Ht: ____
VELOCITY (CFS) ____
FLOW (CFS) ____
HABITAT ASSESSMENT SCORE #: 64
[✓ RR #] ____ GP # ____

Gradient (sample reach): Flat [✓ Low] Mode. High Cascade
Size (stream width) : V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

SUBSTRATE (%) Particle Count - 100 points (mm). Circle one: RIFFLE RUN

size (mm)	description	abbreviation
<0.062	silt/clay	cl
0.062-0.125	very fine sand	vfs
0.125-.250	fine sand	fs
0.25-0.50	med sand	ms
0.5-1.0	coarse sand	cs
1.0-2.0	very coarse sand	(use actual size)
2.0-64.0	gravel	(use actual size)
64-256	cobble	(use actual size)
256-4096	boulder	(use actual size)
—	bedrock	bdrx
—	woody debris	wood

Record measured particle size. Use abbrev below for smaller sizes.

1-10											
11-20											
21-30											
31-40											
41-50											
51-60											
61-70											
71-80											
81-90											
91-100											

FILL OUT EITHER SUBSTRATE INFO BLOCKS

SUBSTRATE (%) **(Visual estimates)**

	RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%
COBBLE (2.5-10")	40 %	%	10 %
GRAVEL (0.1-2.5")	10 %	%	10 %
BEDROCK	30 %	%	10 %
SAND (gritty)	20 %	%	%

	RIFFLE	RUN	POOL
CLAY (slick)	%	%	%
SILT	10 %	%	70 %
DETRITUS (CPOM)	%	%	%
MUCK-MUD (FPOM)	%	%	%
MARL (shell frags)	%	%	%

STREAM USE SUPPORT:

CLASSIFIED FOR:
ɔm. H2O Supply Ind H2O Supply
ɜR II/TIER III Navigation
ɔut >> Nat. Repr?
WATER WITHDRAWL NOTED ____

POSTED FOR: Bacteriological Advs.
Fish Tissue Advs.: Do Not Consume
Precautionary

SUPPORT STATUS;
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES.

RELATIVE ABUNDANCE OF TAXA HABITAT
DOMINANT (>=50): ____
VERY ABUND.(30-49): ____
ABUNDANT (10-29): ____
COMMON (3-9): ____
RARE (<3): ____

COMMENTS: photos ? [✓ Y] or N Roll # Photo #

Heavy Siltation covering stream.

~~STREAM SKETCH:~~

Pasture
Riparian Zone 1-5 m
HYDROLAB
Fence
Flow
Riffle
HCG
Bar
Very thin line of trees
100 yds
Sample Reach 60 FT
LDB Riparian Zone 0-1m
DAIRY Cows In CReeK
Cows Present upstream of Reach
Both Banks Cowtracks + Patties Present at Sample Reach
Pasture

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Figure D-57 Photo of Wilson Creek - October 16, 2000

Figure D-58 Photo of Wilson Creek - May 10, 2000

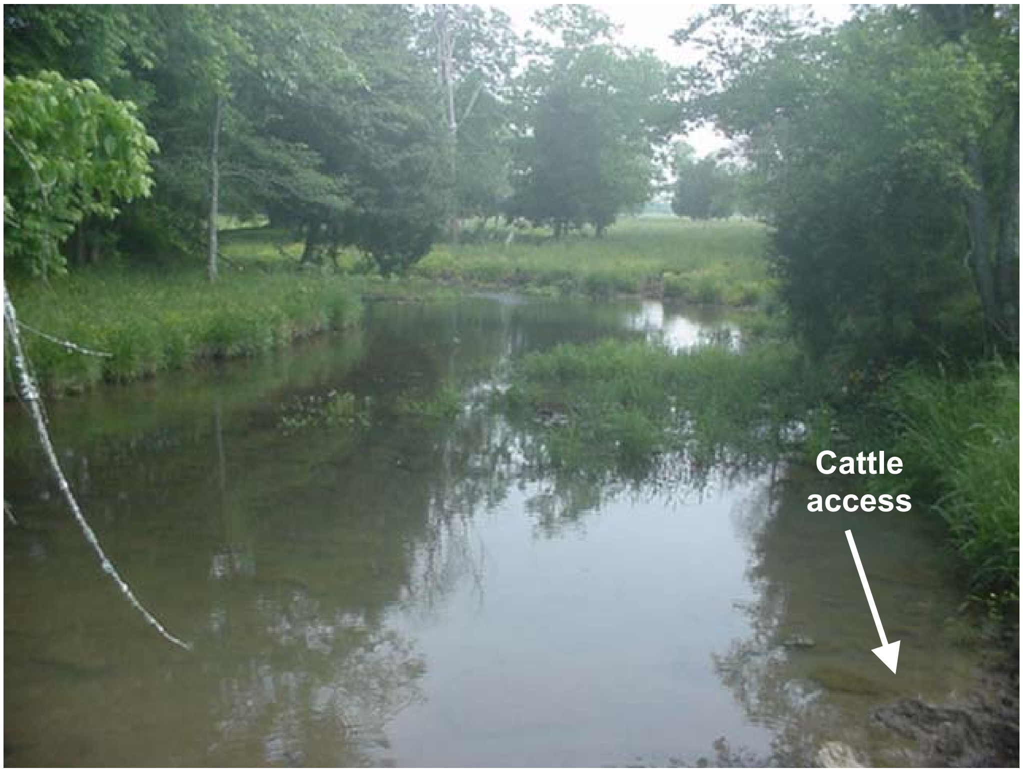
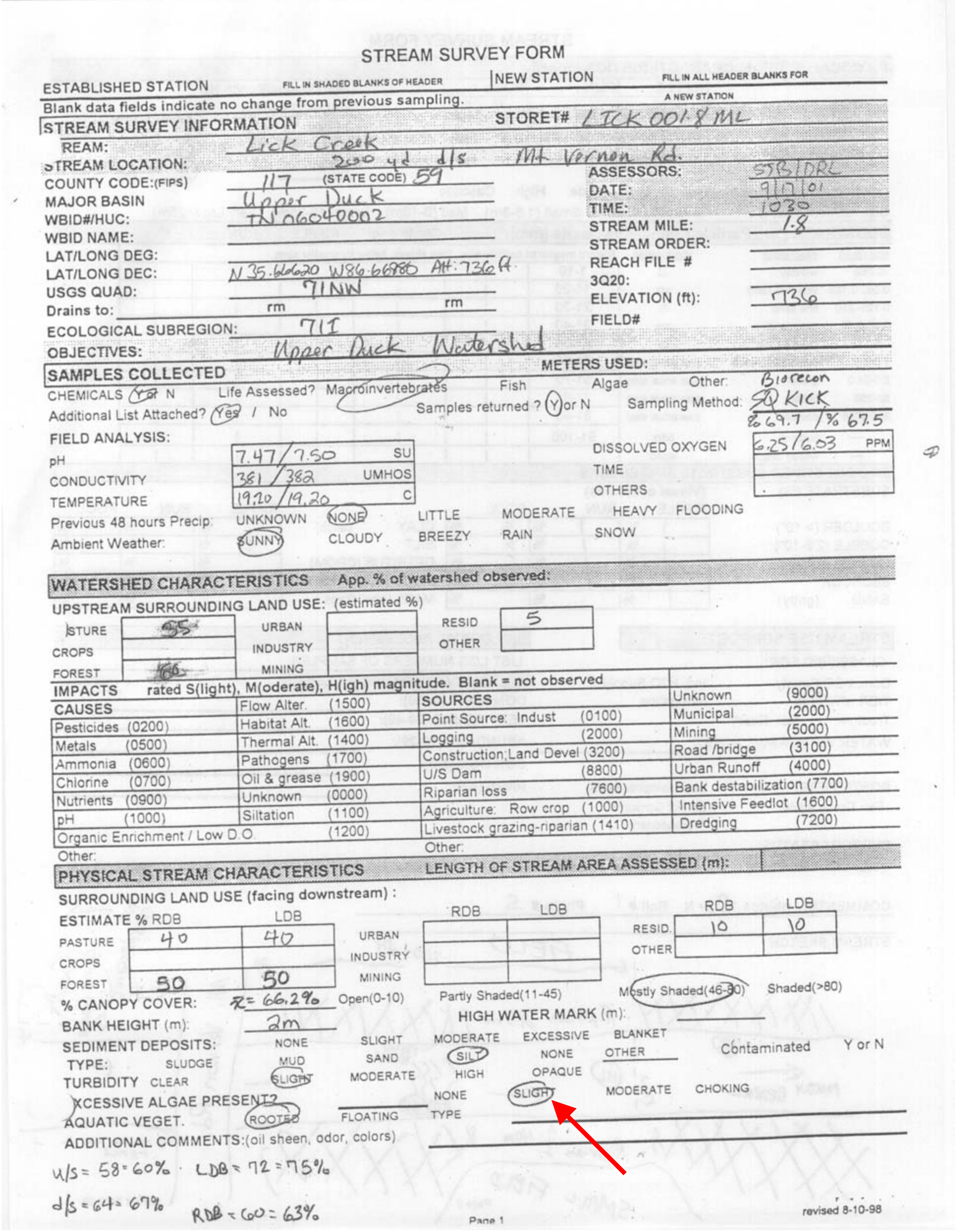


Figure D-59 Lick Creek field sheet, p1 - September 17, 2001



STREAM SURVEY FORM

ESTABLISHED STATION FILL IN SHADED BLANKS OF HEADER | NEW STATION FILL IN ALL HEADER BLANKS FOR A NEW STATION

Blank data fields indicate no change from previous sampling.

STREAM SURVEY INFORMATION

STORET# LICK 001.8 ML

REAM: Lick Creek
STREAM LOCATION: 200 yd d/s Mt Vernon Rd.
COUNTY CODE:(FIPS) 117 (STATE CODE) 59
MAJOR BASIN Upper Duck
WBID#/HUC: TN 06040002
WBID NAME:
LAT/LONG DEG:
LAT/LONG DEC: N 35.66620 W86.66980 Alt: 736 ft.
USGS QUAD: 71 NW
Drains to: rm rm
ECOLOGICAL SUBREGION: 71I
OBJECTIVES: Upper Duck Watershed

ASSESSORS: SJB/DRL
DATE: 9/17/01
TIME: 1030
STREAM MILE: 1.8
STREAM ORDER:
REACH FILE #
3Q20:
ELEVATION (ft): 736
FIELD#

SAMPLES COLLECTED

METERS USED:

CHEMICALS [✓ Y] or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other: Biorecon
Additional List Attached? [✓ Yes] / No Samples returned ? [✓ Y] or N Sampling Method: SQ KICK

FIELD ANALYSIS:

%69.7 / % 67.5

pH	7.47 / 7.50	SU
CONDUCTIVITY	381 / 382	UMHOS
TEMPERATURE	19.20 / 19.20	C

DISSOLVED OXYGEN	6.25 / 6.03	PPM
TIME		
OTHERS		

Previous 48 hours Precip: UNKNOWN [✓ NONE] LITTLE MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY] CLOUDY BREEZY RAIN SNOW

WATERSHED CHARACTERISTICS App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	55	URBAN		RESID	5
CROPS		INDUSTRY		OTHER	
FOREST	66	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES		SOURCES	
Pesticides (0200)	Flow Alter. (1500)	Point Source: Indust (0100)	Unknown (9000)
Metals (0500)	Habitat Alt. (1600)	Logging (2000)	Municipal (2000)
Ammonia (0600)	Thermal Alt. (1400)	Construction;Land Devel (3200)	Mining (5000)
Chlorine (0700)	Pathogens (1700)	U/S Dam (8800)	Road /bridge (3100)
Nutrients (0900)	Oil & grease (1900)	Riparian loss (7600)	Urban Runoff (4000)
pH (1000)	Unknown (0000)	Agriculture: Row crop (1000)	Bank destabilization (7700)
	Siltation (1100)	Livestock grazing-riparian (1410)	Intensive Feedlot (1600)
Organic Enrichment / Low D.O. (1200)			Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	40	40	URBAN			RESID.	10	10
CROPS			INDUSTRY			OTHER		
FOREST	50	50	MINING					

% CANOPY COVER: x̄= 66.2% Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)
BANK HEIGHT (m): 2m HIGH WATER MARK (m):
SEDIMENT DEPOSITS: NONE SLIGHT MODERATE EXCESSIVE BLANKET Contaminated Y or N
TYPE: SLUDGE MUD SAND [✓ SILT] NONE OTHER
TURBIDITY CLEAR [✓ SLIGHT] MODERATE HIGH OPAQUE
EXCESSIVE ALGAE PRESENT? NONE [✓ SLIGHT] MODERATE CHOKING
AQUATIC VEGET. [✓ ROOTED] FLOATING TYPE
ADDITIONAL COMMENTS:(oil sheen, odor, colors)

u/s = 58 = 60% LDB = 72 = 75%
d/s = 64 = 67% RDB = 60 = 63%

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Figure D-60 Lick Creek field sheet, p2 - September 17, 2001

STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)			4-6"
WIDTH (m)			3m
REACH LENGTH (m)			110m

Staff Gauge/Bench Ht:
VELOCITY (CFS)
FLOW (CFS) 0.188
HABITAT ASSESSMENT SCORE #:
RR #
GP # 107

Gradient (sample reach): Flat [✓ Low] Mode. High Cascade

Size (stream width) : V. Small (<1.5m) Small (1.5-3m) Med (3-10m) Large (10-25m) Very Lrg (>25m)

SUBSTRATE (%) Particle Count - 100 points (mm). Circle one: RIFFLE RUN

size (mm)	description	abbreviation	Record measured particle size. Use abbrev. below for smaller sizes.										
<0.062	silt/clay	cl	1-10										
0.062-0.125	very fine sand	vfs	11-20										
0.125-.250	fine sand	fs	21-30										
0.25-0.50	med sand	ms	31-40										
0.5-1.0	coarse sand	cs	41-50										
1.0-2.0	very coarse sand	(use actual size)	51-60										
2.0-64.0	gravel	(use actual size)	61-70										
64-256	cobble	(use actual size)	71-80										
256-4096	boulder	(use actual size)	81-90										
---	bedrock	bdrx	91-100										
---	woody debris	wood											

FILL OUT EITHER SUBSTRATE INFO BLOCKS

SUBSTRATE (%) (Visual estimates)

	RIFFLE	RUN	POOL		RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	5 %	CLAY (slick)	%	%	%
COBBLE (2.5-10")	%	%	5 %	SILT	5 %	%	%
GRAVEL (0.1-2.5")	%	%	- %	DETRITUS (CPOM)	%	%	%
BEDROCK	%	%	85 %	MUCK-MUD (FPOM)	%	%	%
SAND (gritty)	%	%	%	MARL (shell frags.)	%	%	%

STREAM USE SUPPORT:

CLASSIFIED FOR:
Dom. H2O Supply Ind. H2O Supply
TIER II/TIER III Navigation
Trout >> Nat. Repr?
WATER WITHDRAWL NOTED

POSTED FOR:
Fish Tissue Advis.: Bacteriological Advis.
Do Not Consume
Precautionary

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES:

RELATIVE ABUNDANCE OF TAXA HABITAT
DOMINANT (>=50):
VERY ABUND.(30-49):
ABUNDANT (10-29):
COMMON (3-9):
RARE (<3):

SUPPORT STATUS;
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

COMMENTS: photos ? [✓ Y] or N Roll # 1 Photo # 5

STREAM SKETCH

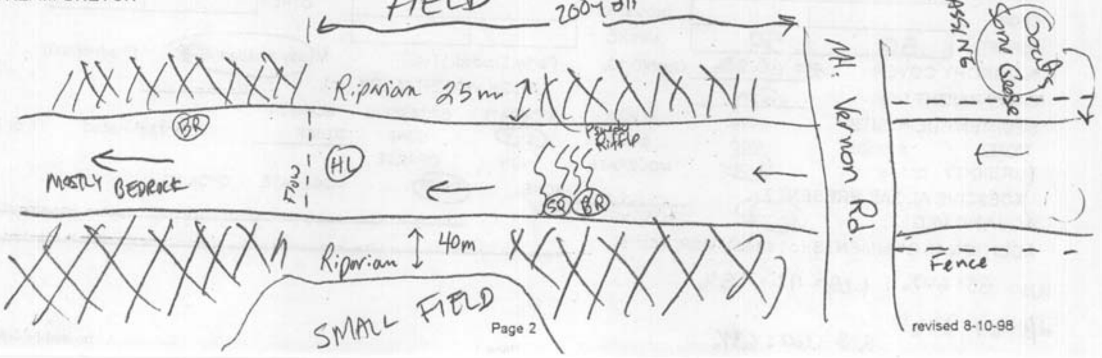

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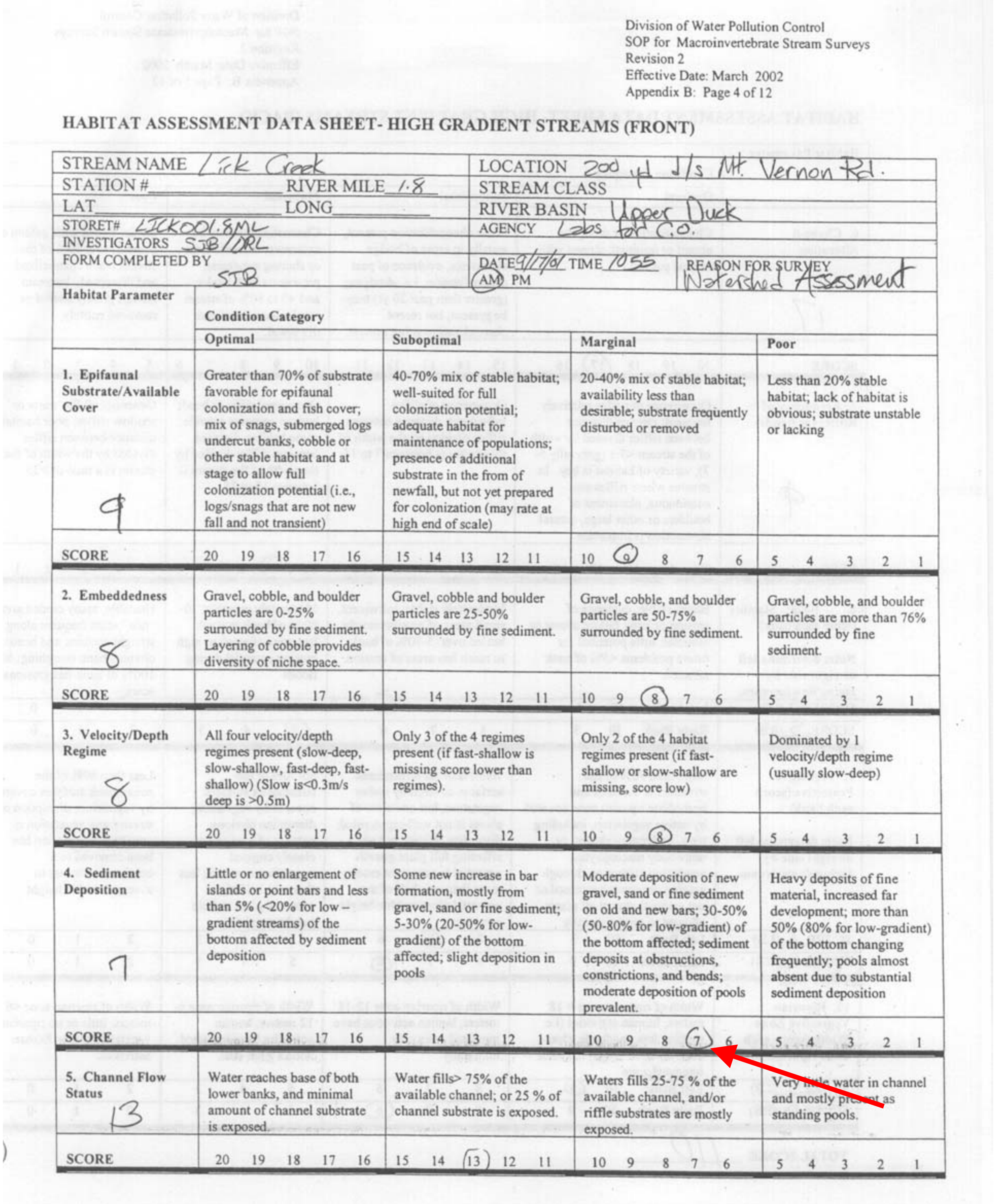
Figure D-61 Lick Creek Habitat Assessment, front page - September 17, 2001



Division of Water Pollution Control
SOP for Macroinvertebrate Stream Surveys
Revision 2
Effective Date: March 2002
Appendix B: Page 4 of 12

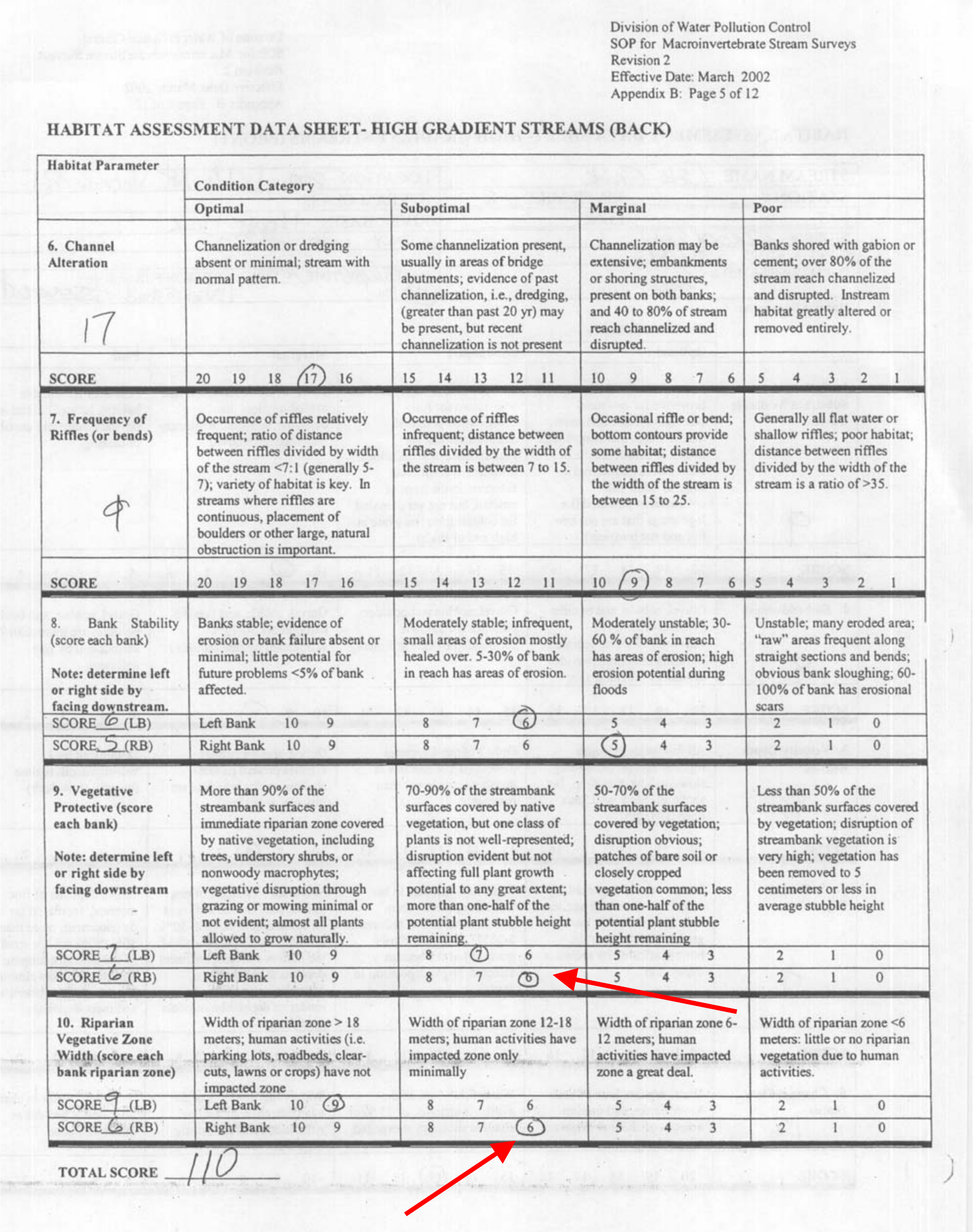
HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Lick Creek
STATION #______ RIVER MILE 1.8
LAT______ LONG______
STORET# LICK001.8ML
INVESTIGATORS SJB/DRL
FORM COMPLETED BY SJB

LOCATION 200 yd d/s Mt. Vernon Rd.
STREAM CLASS
RIVER BASIN Upper Duck
AGENCY Labs for C.O.
DATE 9/17/01 TIME 1055 [✓ AM] PM
REASON FOR SURVEY Watershed Assessment

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover 9	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 from of newfall, but not yet prepared for colonization (may rate at high end of scale)	20-40% mix of stable habitat; availability less than desirable; substrate frequently disturbed or removed	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1
2. Embeddedness 8	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 76% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
3. Velocity/Depth Regime 8	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow) (Slow is<0.3m/s deep is >0.5m)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower than regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime (usually slow-deep)
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1
4. Sediment Deposition 7	Little or no enlargement of islands or point bars and less than 5% (<20% for low – gradient streams) of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased far development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1
5. Channel Flow Status 13	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills> 75% of the available channel; or 25 % of channel substrate is exposed.	Waters 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.
SCORE	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1

Figure D-62 Lick Creek Habitat Assessment, back page - September 17, 2001



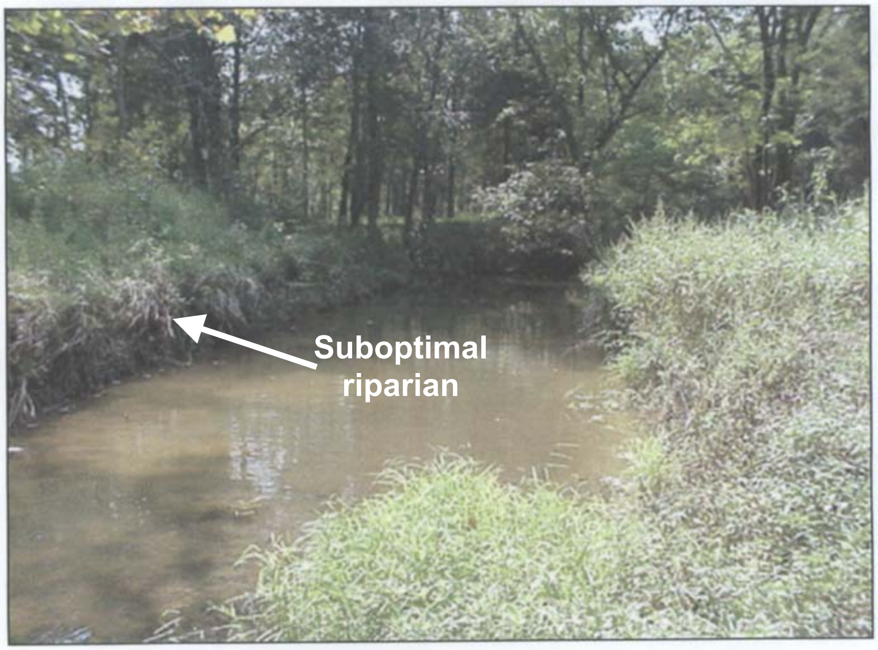
Division of Water Pollution Control
SOP for Macroinvertebrate Stream Surveys
Revision 2
Effective Date: March 2002
Appendix B: Page 5 of 12

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration 17	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present	Channelization may be extensive; embankments or shoring structures, present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends) 9	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5-7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >35.
SCORE	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank) **Note: determine left or right side by facing downstream.**	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded area; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars
SCORE 6 (LB)	Left Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
SCORE 5 (RB)	Right Bank 10 9	8 7 6	[✓ 5] 4 3	2 1 0
9. Vegetative Protective (score each bank) **Note: determine left or right side 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
SCORE 7 (LB)	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 9 (LB)	Left Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0

TOTAL SCORE 110

Figure D-63 Photo of Lick Creek - September 17, 2001

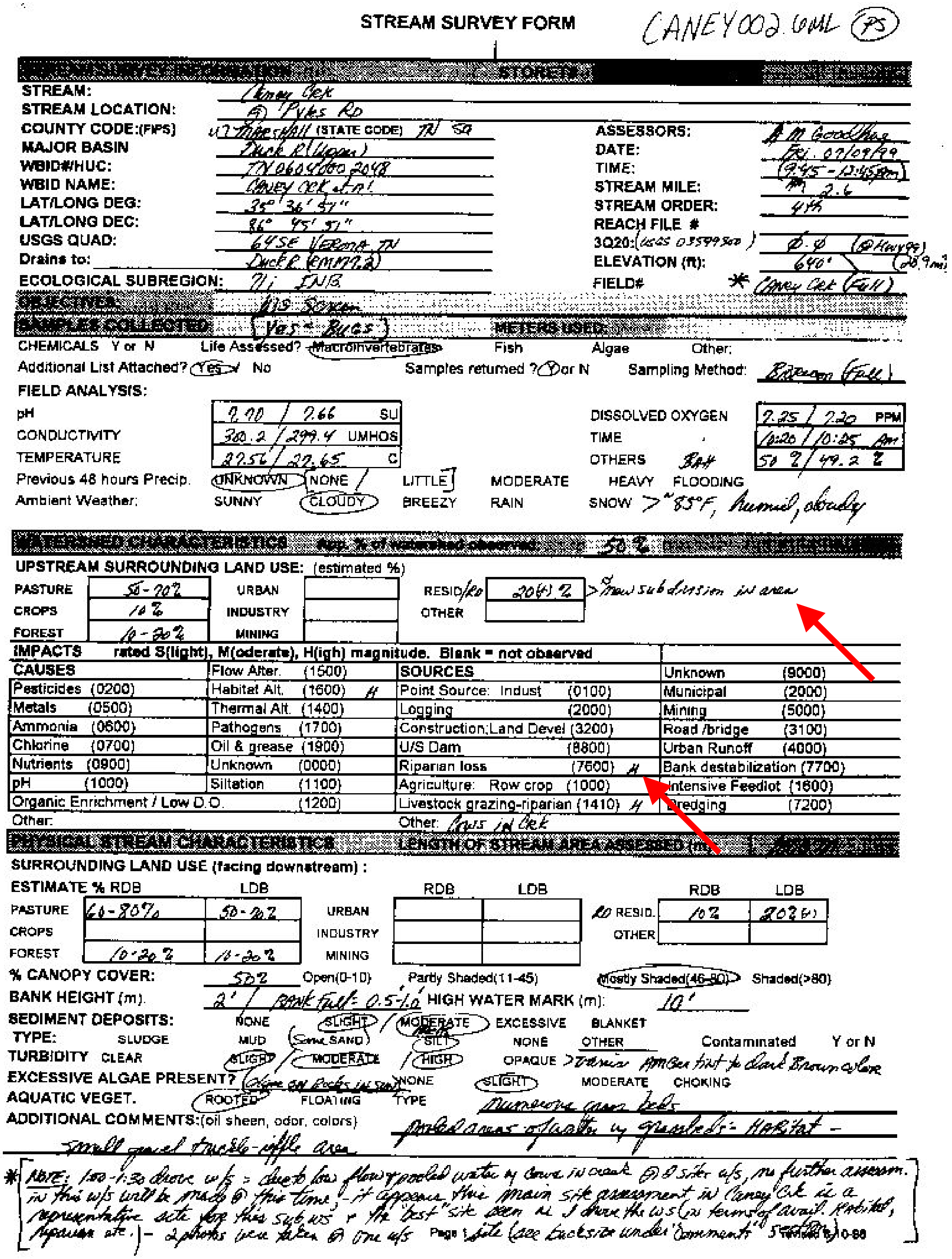


Lick Creek (LICK001.8ML) 200 d/s of Mt. Vernon Road.
9/17/01 at 1030

Thick Creek (TN06040002048_0100) was placed on the 303(d) list of impaired streams in 2002 as impacted by siltation and other habitat alterations from pasture grazing. The stream's listing continued on the *2004 303(d) List* as impaired for Escherichia coli and other habitat alterations, from livestock in the stream.

Thick Creek was monitored at RM 2.0 in 2001 by the Nashville Environmental Field Office. Notes report the presence of moderate sediment deposits, slight siltation and moderate amounts of algae, with suboptimal vegetative protection. The stream was slightly turbid at this time giving the water a dark brown color (ref.: Figures D-71 through D-73).

Figure D-64 Caney Creek field sheet, p1 - July 9, 1999



STREAM SURVEY FORM CANEY002.UML (PS)

STORET #:

STREAM: Caney Crk
STREAM LOCATION: @ Pykes Rd
COUNTY CODE:(FIPS) 117 Marshall (STATE CODE) TN 59
MAJOR BASIN: Duck R (Upper)
WBID#/HUC: TN06040002 2048
WBID NAME: Caney Crk et al
LAT/LONG DEG: 35° 36' 57"
LAT/LONG DEC: 86° 45' 57"
USGS QUAD: 64 SE Verona TN
Drains to: Duck R (RM 172.2)
ECOLOGICAL SUBREGION: 71i INB

ASSESSORS: AM Goodhue
DATE: Fri. 07/09/99
TIME: (9:45 - 12:45 pm)
STREAM MILE: RM 2.6
STREAM ORDER: 4th
REACH FILE #
3Q20:(USGS 03599500) 0.0 (@ Hwy 99) (20.9 mi²)
ELEVATION (ft): 640'
FIELD# * Caney Crk (Fall)

OBJECTIVES: WS Screen

SAMPLES COLLECTED: (Yes - Bugs) METERS USED:

CHEMICALS Y or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other:
Additional List Attached? [✓ Yes] ✓ No Samples returned ? [✓ Y] or N Sampling Method: Biorecon (Fall)

FIELD ANALYSIS:

pH	7.70 / 7.66 SU	DISSOLVED OXYGEN	7.25 / 7.20 PPM
CONDUCTIVITY	300.2 / 299.4 UMHOS	TIME	10:20 / 10:25 Am
TEMPERATURE	22.56 / 22.65 C	OTHERS Sat	51 % / 49.2 %

Previous 48 hours Precip. [✓ UNKNOWN] [✓ NONE] / LITTLE MODERATE HEAVY FLOODING
Ambient Weather: SUNNY [✓ CLOUDY] BREEZY RAIN SNOW > ~85°F, humid, cloudy

WATERSHED CHARACTERISTICS App. % of watershed observed: 50 %

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	50-70%	URBAN		RESID/RO	20(+) % > new subdivision in area
CROPS	10%	INDUSTRY		OTHER	
FOREST	10-20%	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES		SOURCES	
	Flow Alter. (1500)		Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600) H	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600) H	Bank destabilization (7700)
pH (1000)	Siltation (1100)	Agriculture: Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / Low D.O. (1200)		Livestock grazing-riparian (1410) H	Dredging (7200)
Other:		Other: Cows in Crk	

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	60-80%	50-70%	URBAN			RO RESID.	10%	20%(+)
CROPS			INDUSTRY			OTHER		
FOREST	10-20%	10-20%	MINING					

% CANOPY COVER: 50% Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)
BANK HEIGHT (m). 2' / Bank full: 0.5-1.0 HIGH WATER MARK (m): 10'
SEDIMENT DEPOSITS: NONE [✓ SLIGHT] / [✓ MODERATE] EXCESSIVE BLANKET
TYPE: SLUDGE MUD [✓ Some SAND] [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR [✓ SLIGHT] / [✓ MODERATE] / [✓ HIGH] OPAQUE > Tannic Amber tint to dark Brown color
EXCESSIVE ALGAE PRESENT? Algae on Rocks in sun NONE [✓ SLIGHT] MODERATE CHOKING
AQUATIC VEGET. [✓ ROOTED] FLOATING TYPE numerous grass beds
ADDITIONAL COMMENTS:(oil sheen, odor, colors) pooled areas of water w/ gravel bars - Habitat - small gravel trickle-riffle area

* [NOTE: 100-1:30 drove w/s - due to low flow & pooled water w/ cows in creek @ 3 sites u/s, no further assessm. in this w/s will be made @ this time, - it appears this main site assessment in Caney Crk is a representative site for this sub w/s & the "best" site seen as I drove the w/s (in terms of avail. habitat, riparian etc.) - 2 photos were taken @ one u/s site (see backside under "comments" section)

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Figure D-65 Caney Creek field sheet, p2 - July 9, 1999

STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)	2"-1"	Areas of pooled	
WIDTH (m)	3'	water ~ 75' long, 20-	
REACH LENGTH (m)	10'	30' wide, 6"-2' deep	

Riff substrate
5% cobble
60% gravel
35% sand

Staff Gauge/Bench Ht: ______
VELOCITY (CFS) ______
FLOW (CFS) ______
HABITAT ASSESSMENT SCORE #: 124
RR # ______ GP # ______

Gradient (sample reach): [✓ Flat] Low Mode. High Cascade
Size (stream width): V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES: #1086

RELATIVE ABUNDANCE OF TAXA HABITAT

DOMINANT (>=50): See list attached
VERY ABUND.(30-49):
ABUNDANT (10-29):
COMMON (3-9):
RARE (<3):

STREAM USE SUPPORT: **SPECIFICALLY CLASSIFIED FOR: (circle)**

Dom. H2O Supply Ind. H2O Supply Navigation TIER II/TIER III Trout >> Nat. Repr?

WATER WITHDRAWL NOTED ______

IS STREAM POSTED? (circle) Fish Tissue Advis.: Do Not Consume Precautionary
Bacteriological Advis.

BASED ON OBSERVATIONS AND DATA, STREAM IS:(circle)

FULLY SUPPORTING (FS) SUPPORTING, BUT THREATENED (TH) [✓ PARTIALLY SUPPORTING (PS)] NONSUPPORTING (NS)

COMMENTS: photos ? Y or N Roll # 7 Photo # 20 u/s, 21 d/s (Bugs: 112 u/s, 111 d/s) Note: numerous minnows seen

Note: u/s @ Thick Rd = 35°33'00" / 86°44'20" = #22 u/s, 23 d/s (#110 u/s, 109 d/s) = bugs in cell

Although Caney Ck is virtually areas of pooled water w/ a bedrock bottom + numerous gravelbars, there was a few minute trickle-riffle w/ a gravel substrate - the macro-invertebrates (+ EPT Ht & S/m) revealed a lack of Trichoptera + Ephemeroptera families - no mayflies or caddis, there was an abundance of one family of stoneflies... damsel flies + dragon flies were seen in adult form but only occasionally. Those found - similar streams - in pooled water similar to Caney Ck have yielded more families in the same amount of habitat - @ this time bugs appear to represent a (PS) status for FA

STREAM SKETCH

revised 8-10-98

Figure D-66 Photo of Caney Creek RM 2.6 Upstream - July 9, 1999

Figure D-67 Photo of Caney Creek RM 2.6 Downstream - July 9, 1999

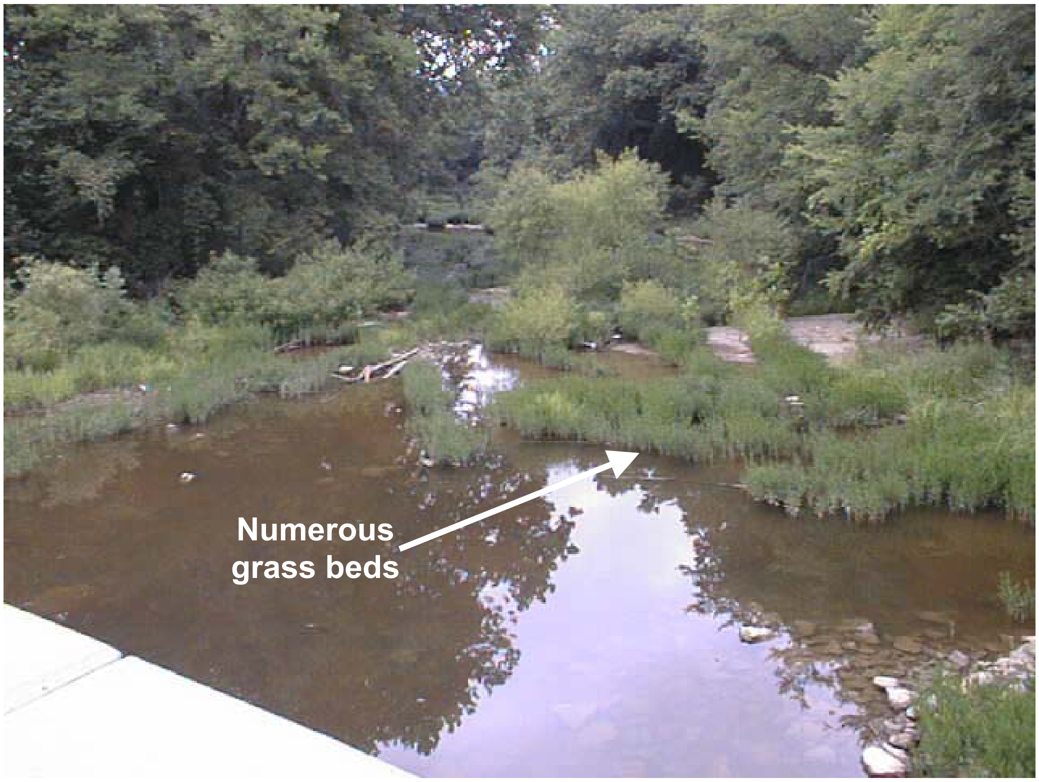
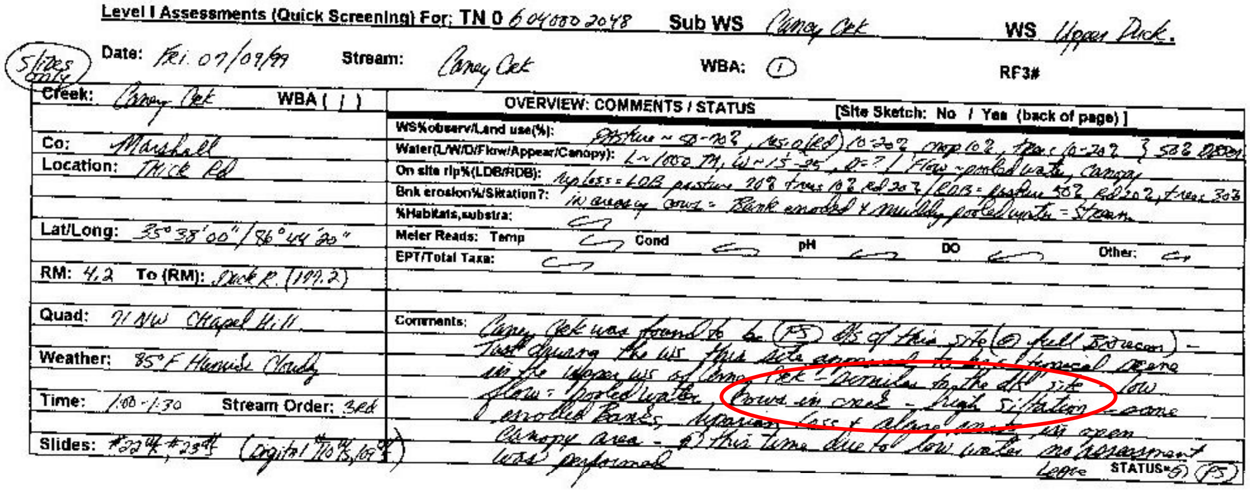


Figure D-68 Upper Caney Creek field sheet - July 9,1999



Level I Assessments (Quick Screening) For: TN 0 604000 2048 **Sub WS** Caney Crk **WS** Upper Duck.

Slides only

Date: Fri. 07/09/99 **Stream:** Caney Crk **WBA:** ① **RF3#**

Creek: Caney Crk **WBA (** 1 **)**

Co: Marshall

Location: Thick Rd

Lat/Long: 35°38'00"/86°44'20"

RM: 4.2 **To (RM):** Duck R. (199.2)

Quad: 71 NW Chapel Hill

Weather: 85°F Humid Cloudy

Time: 1:00-1:30 **Stream Order:** 3rd

Slides: #22nd, #23rd (digital #10th, 10th)

OVERVIEW: COMMENTS / STATUS [Site Sketch: No / Yes (back of page)]

WS%observ/Land use(%): Pasture ~ 50-70%, Res. o(Rd) 10-20%, crop 10%, trees 10-20% } 50% observ

Water(L/W/D/Flow/Appear/Canopy): L~1000 M, W~1.5-2.5', D=? / Flow ~pooled water, canopy

On site rip%(LDB/RDB): rip loss = LDB pasture 70% trees 10% Rd 20% / RDB = pasture 50% Rd 20%, trees 30%

Bnk erosion%/Siltation?: in areas w/ cows = Bank eroded & muddy pooled water = stream

%Habitats,substra: —

Meter Reads: Temp — **Cond** — **pH** — **DO** — **Other:** —

EPT/Total Taxa: —

Comments: Caney Crk was found to be (PS) d/s of this site (@ full Biorecon) — Just during the ws this site appeared to be typical of one in the upper ws of Caney Crk - similar to the d/s site. low flow = pooled water, Cows in creek - high siltation - some eroded banks, riparian loss & along road, in open canopy area - @ this time due to low water no assessment was performed.

Leave **STATUS=** (S) (PS)

Figure D-69 Photo of Caney Creek RM 4.2 Upstream - July 9, 1999

Cattle loafing in stream

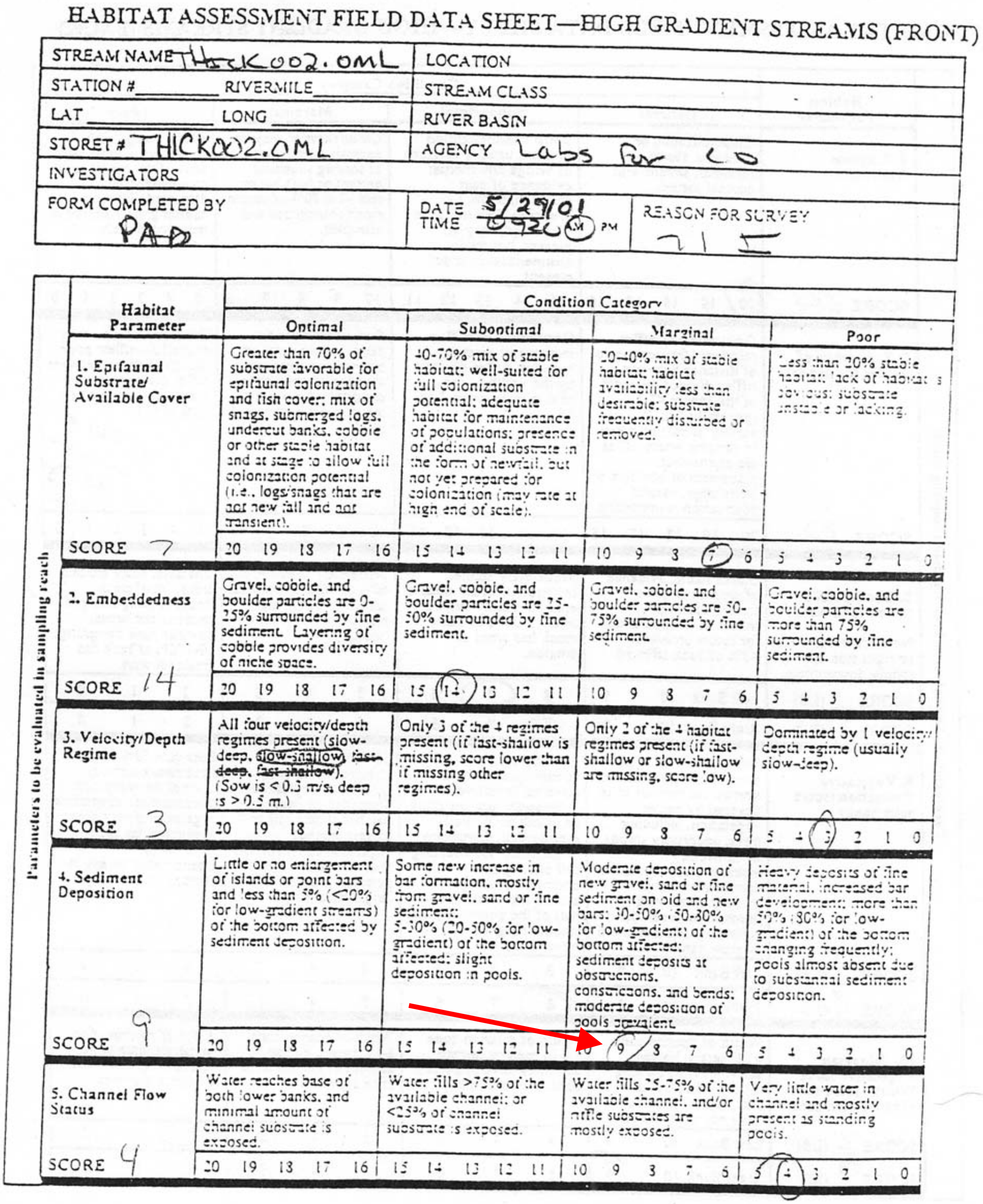
Figure D-70 Photo of Caney Creek RM 4.2 Downstream - July 9, 1999

D11.0 East Rock Creek (060400020602) Subwatershed Analysis

East Rock Creek (TN06040002012_0100) was placed on the 303(d) list of impaired streams in 2002 as impacted by siltation and other habitat alterations from pasture grazing. The *2004 303(d) List* indicated that the stream was impaired by loss of biological integrity due to siltation and other habitat alterations from pasture grazing.

East Rock Creek was monitored at RM 10.3 in 1999 by the Nashville Environmental Field Office and at RM 1.8 in 2001 by aquatic biologists from the State Lab. Notes from the assessment on December 8, 1999 (ref.: D-74 through D-77) indicate that the stream was highly turbid with floating algae mats, giving the water a dark brown color, with mud and moderate to excessive siltation noted. Notes from the assessment on July 24, 2001 (ref.: Figures D-78 through D-82) indicate that the stream vegetative protection had been disrupted, with very little riparian vegetative zone. Few trees were noted on the banks, which were deemed unstable, and no undergrowth was observed. Cows had full access to the stream. The impacts are from a combination of low flow that is likely due to possible karst areas (ref.: Figure D-1) and uncontrolled access to the streams by cows.

Figure D-71 Thick Creek Habitat Assessment Sheet, front page - May 29, 2001



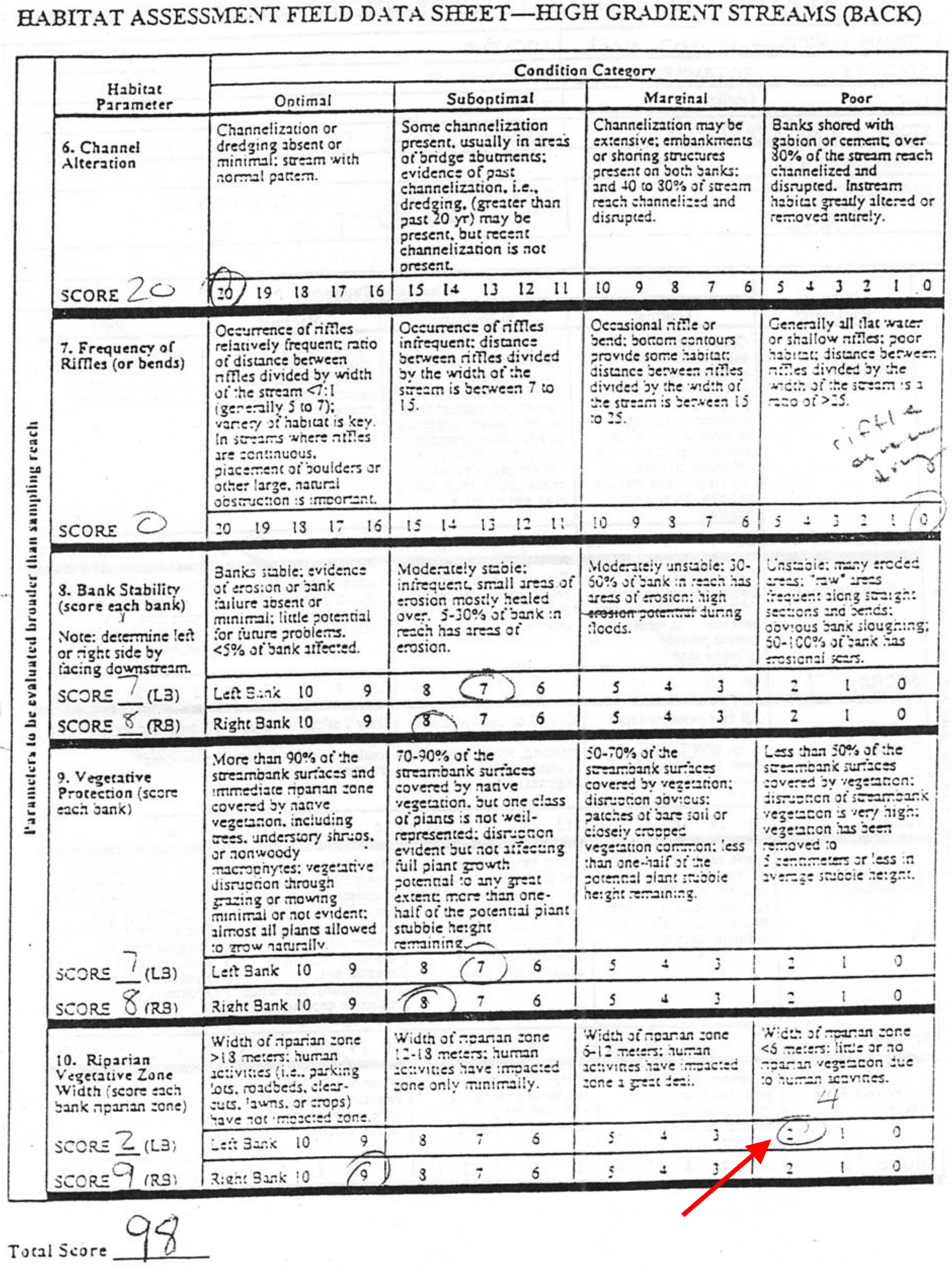
HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Thick002.OML	LOCATION
STATION # ______ RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN
STORET # THICK002.OML	AGENCY Labs for LO
INVESTIGATORS	
FORM COMPLETED BY PAD	DATE 5/29/01 TIME 0920 [✓ AM] PM
	REASON FOR SURVEY 71 I

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	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.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 [✓ 7] 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 14	20 19 18 17 16	15 [✓ 14] 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, [✓ slow-shallow], ~~fast-deep, fast-shallow~~). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 [✓ 3] 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <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.
SCORE 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 [✓ 4] 3 2 1 0

Figure D-72 Thick Creek Habitat Assessment Sheet, back page - May 29, 2001



HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

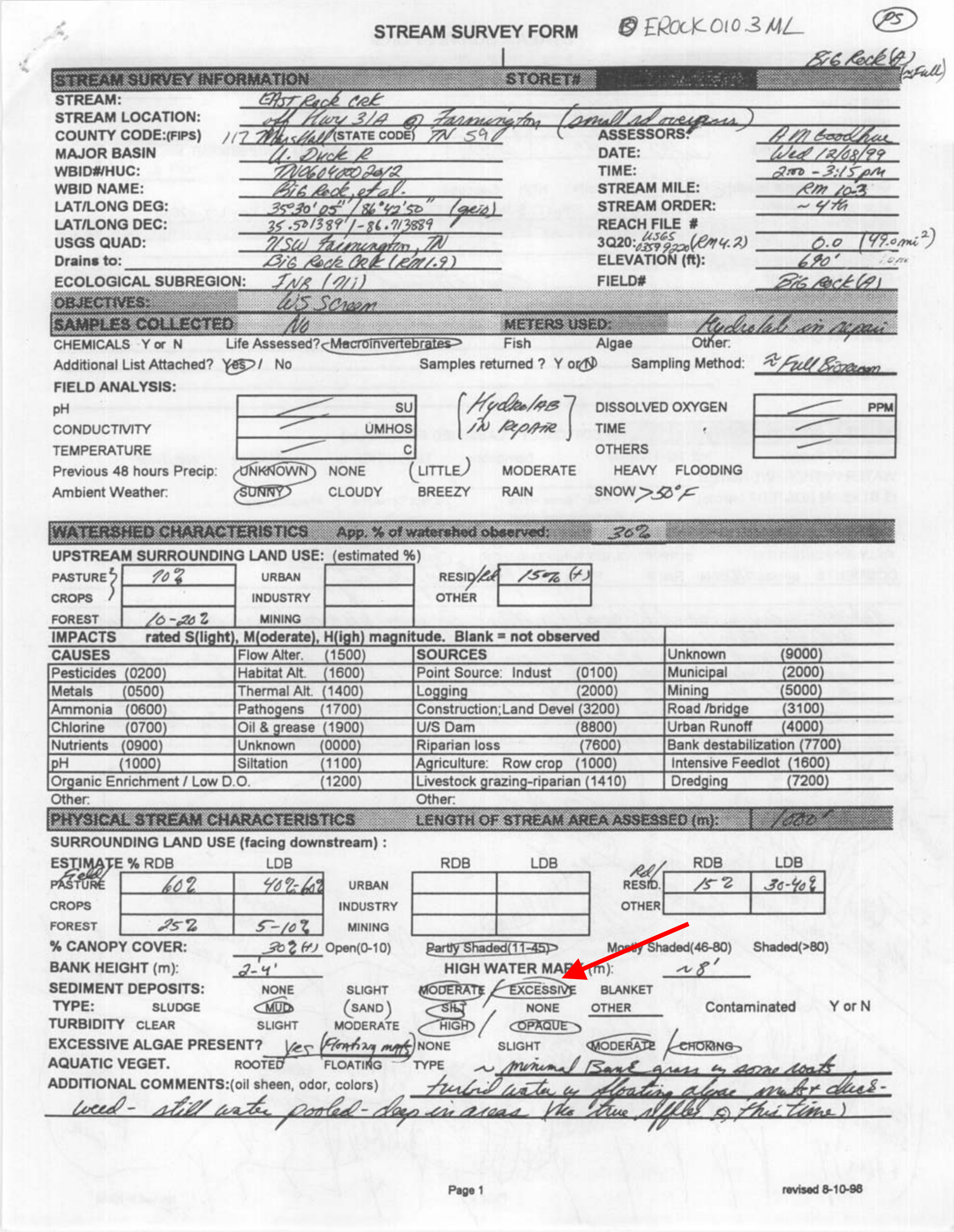
Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 20	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. riffle [illegible] dry
SCORE 0	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 [✓ 0]
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high ~~erosion potential~~ during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 7 (LB)	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	[✓ 8] 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	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.
SCORE 7 (LB)	Left Bank 10 9	8 [✓ 7] 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	[✓ 8] 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities. 4
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	[✓ 2] 1 0
SCORE 9 (RB)	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0

Total Score 98

Figure D-73 Photo of Thick Creek RM 2.0 upstream - May 29, 2001

Thick Creek (THICK002.0ML) upstream of sample site located 100 yds u/s Pyles Rd. PAD/BGL, 5/29/01.

Figure D-74 East Rock Creek field sheet, p1 - December 8, 1999



STREAM SURVEY FORM ⑧ EROCK010.3ML (PS)

Big Rock (A) (~Full)

STREAM SURVEY INFORMATION **STORET#** [redacted]

STREAM: EAST Rock Crk
STREAM LOCATION: off Hwy 31A @ Farmington (small rd overpass)
COUNTY CODE:(FIPS) 117 Marshall (STATE CODE) TN 59
MAJOR BASIN U. Duck R
WBID#/HUC: TN06040002012
WBID NAME: Big Rock, et al.
LAT/LONG DEG: 35°30'05" / 86°42'50" (geio)
LAT/LONG DEC: 35.501389 / -86.713889
USGS QUAD: 71SW Farmington, TN
Drains to: Big Rock Crk (RM 1.9)
ECOLOGICAL SUBREGION: 71NB (71i)

ASSESSORS: RM Goodhue
DATE: Wed 12/08/99
TIME: 2:00 - 3:15 pm
STREAM MILE: RM 10.3
STREAM ORDER: ~4th
REACH FILE #
3Q20: USGS 03599220 (RM 4.2) 0.0 (49.0 mi²)
ELEVATION (ft): 690'
FIELD# Big Rock (A)

OBJECTIVES: WS Screen

SAMPLES COLLECTED No **METERS USED:** Hydrolab in repair

CHEMICALS Y or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other:

Additional List Attached? [✓ Yes] / No Samples returned ? Y or [✓ N] Sampling Method: ~Full Biosurvey

FIELD ANALYSIS:

pH	— SU	[Hydrolab in repair]	DISSOLVED OXYGEN	— PPM
CONDUCTIVITY	— UMHOS		TIME	—
TEMPERATURE	— C		OTHERS	—

Previous 48 hours Precip: [✓ UNKNOWN] NONE [✓ LITTLE] MODERATE HEAVY FLOODING

Ambient Weather: [✓ SUNNY] CLOUDY BREEZY RAIN SNOW >50°F

WATERSHED CHARACTERISTICS **App. % of watershed observed:** 30%

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE }	90%	URBAN		RESID/rd	15% (+)
CROPS }		INDUSTRY		OTHER	
FOREST	10-20%	MINING			

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500)	**SOURCES**	Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600)	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700)	Construction;Land Devel (3200)	Road /bridge (3100)
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000)
Nutrients (0900)	Unknown (0000)	Riparian loss (7600)	Bank destabilization (7700)
pH (1000)	Siltation (1100)	Agriculture: Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / Low D.O. (1200)		Livestock grazing-riparian (1410)	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS **LENGTH OF STREAM AREA ASSESSED (m):** 1000'

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
Field/PASTURE	60%	40%-60%	URBAN			Rd/RESID.	15%	30-40%
CROPS			INDUSTRY			OTHER		
FOREST	25%	5-10%	MINING					

% CANOPY COVER: 30% (+) Open(0-10) [✓ Partly Shaded(11-45)] Mostly Shaded(46-80) Shaded(>80)

BANK HEIGHT (m): 2-4' HIGH WATER MARK (m): ~8'

SEDIMENT DEPOSITS: NONE SLIGHT [✓ MODERATE] / [✓ EXCESSIVE] BLANKET

TYPE: SLUDGE [✓ MUD] [✓ SAND] [✓ SILT] NONE OTHER Contaminated Y or N

TURBIDITY CLEAR SLIGHT MODERATE [✓ HIGH] / [✓ OPAQUE]

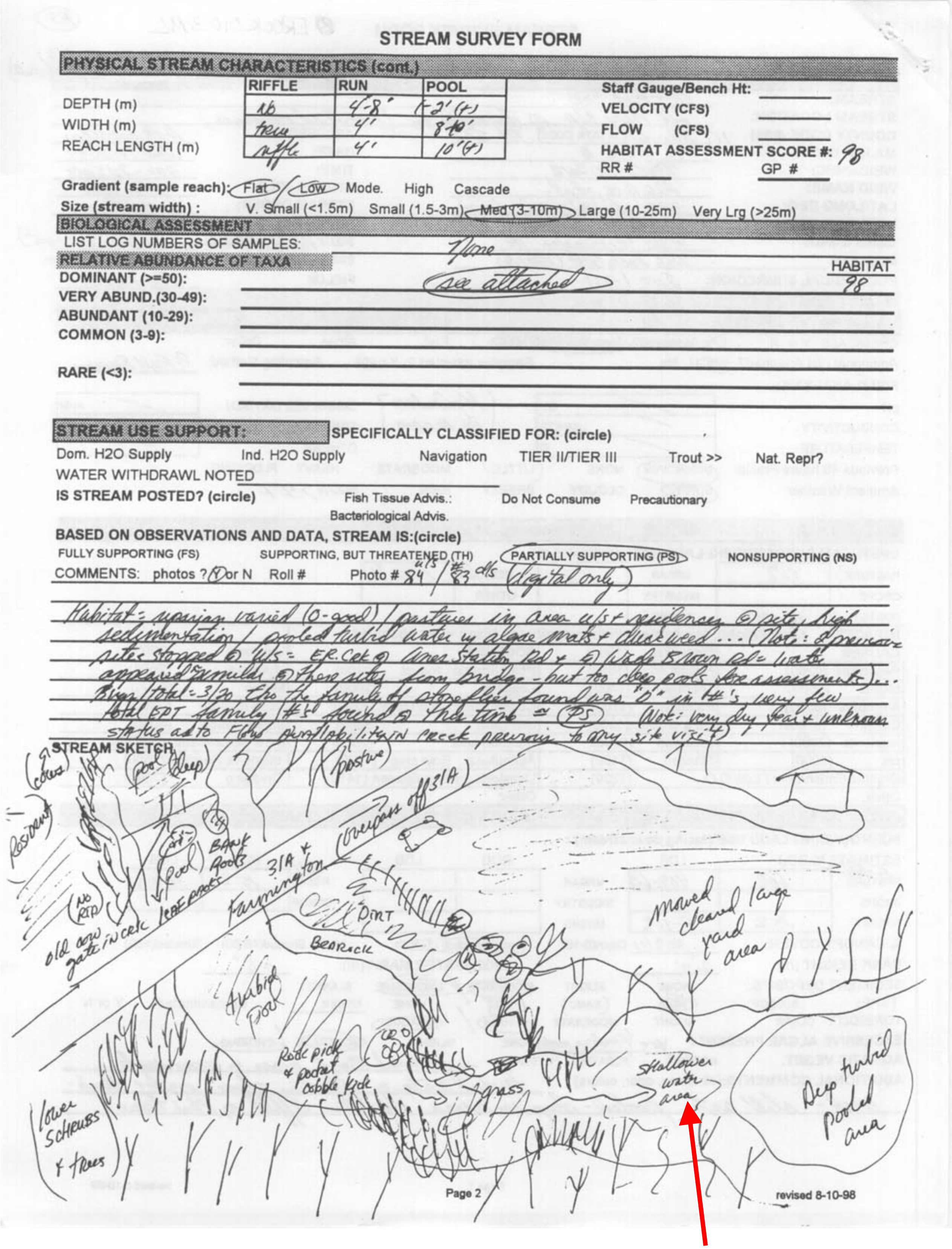
EXCESSIVE ALGAE PRESENT? Yes (Floating mats) NONE SLIGHT [✓ MODERATE] / [✓ CHOKING]

AQUATIC VEGET. ROOTED FLOATING TYPE ~minimal Bank grass in some spots

ADDITIONAL COMMENTS:(oil sheen, odor, colors) turbid water w/ floating algae mats & duckweed - still water pooled - deep in areas (No true riffles @ this time)

Page 1 revised 8-10-98

Figure D-75 East Rock Creek field sheet, p2 - December 8, 1999



STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)	no	4-8"	1-2' (+)
WIDTH (m)	few	4'	8-10'
REACH LENGTH (m)	riffle	4'	10' (+)

Staff Gauge/Bench Ht:
VELOCITY (CFS)
FLOW (CFS)
HABITAT ASSESSMENT SCORE #: 98
RR # GP #

Gradient (sample reach): [✓ Flat] / [✓ Low] Mode. High Cascade

Size (stream width): V. Small (<1.5m) Small (1.5-3m) [✓ Med (3-10m)] Large (10-25m) Very Lrg (>25m)

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES: None

RELATIVE ABUNDANCE OF TAXA

HABITAT 98

DOMINANT (>=50): see attached
VERY ABUND.(30-49):
ABUNDANT (10-29):
COMMON (3-9):
RARE (<3):

STREAM USE SUPPORT: SPECIFICALLY CLASSIFIED FOR: (circle)

Dom. H2O Supply Ind. H2O Supply Navigation TIER II/TIER III Trout >> Nat. Repr?

WATER WITHDRAWL NOTED

IS STREAM POSTED? (circle) Fish Tissue Advis.: Do Not Consume Precautionary
Bacteriological Advis.

BASED ON OBSERVATIONS AND DATA, STREAM IS:(circle)

FULLY SUPPORTING (FS) SUPPORTING, BUT THREATENED (TH) [✓ PARTIALLY SUPPORTING (PS)] NONSUPPORTING (NS)

COMMENTS: photos ? [✓ Y] or N Roll # Photo # u/s 84 / #83 d/s (digital only)

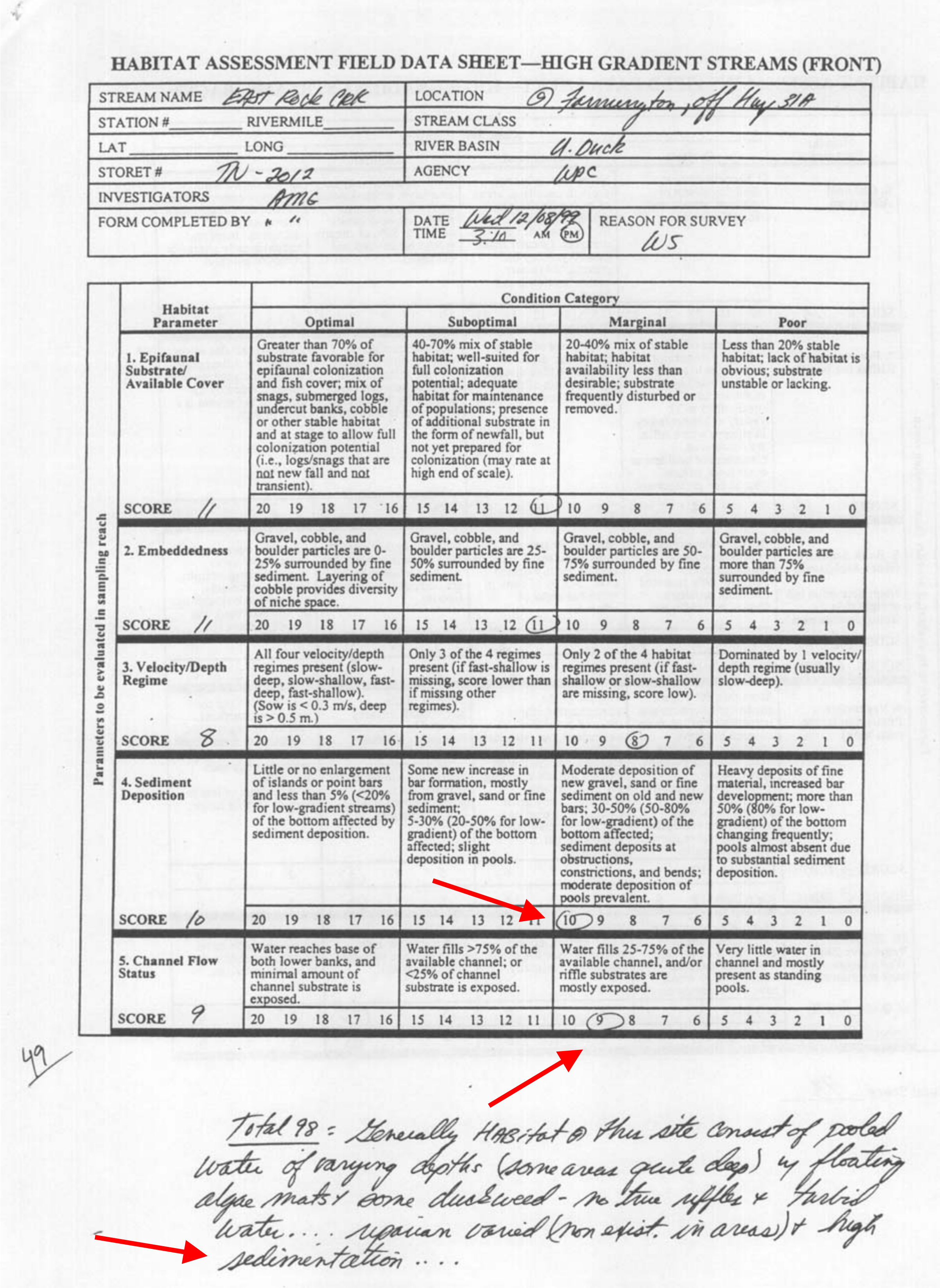
Habitat = riparian varied (0-good) / pastures in area u/s + residences @ site, high sedimentation / pooled turbid water w/ algae mats + duckweed ... (Note: 2 previous sites stopped @ u/s = ER. Cek @ Ames Station Rd + @ Wade Brown Rd = water appeared similar @ these sites from bridge - but too deep pools for assessments)... Bio / total = 3/20 tho the family of stoneflies found was "0" in #'s, very few total EPT family (#5) found @ this time ≈ (PS) (Note: very dry year + unknown status as to Flow permeability in creek previous to any site visit)

STREAM SKETCH

Page 2

revised 8-10-98

Figure D-76 East Rock Creek Habitat Assessment, front page - December 8, 1999



HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME East Rock Crk	LOCATION @ Farmington, off Hwy 31A
STATION # ______ RIVERMILE ______	STREAM CLASS
LAT ______ LONG ______	RIVER BASIN U. Duck
STORET # TN - 2012	AGENCY WPC
INVESTIGATORS AMG	
FORM COMPLETED BY " "	DATE Wed 12/08/99 TIME 3:10 AM [✓ PM] — REASON FOR SURVEY WS

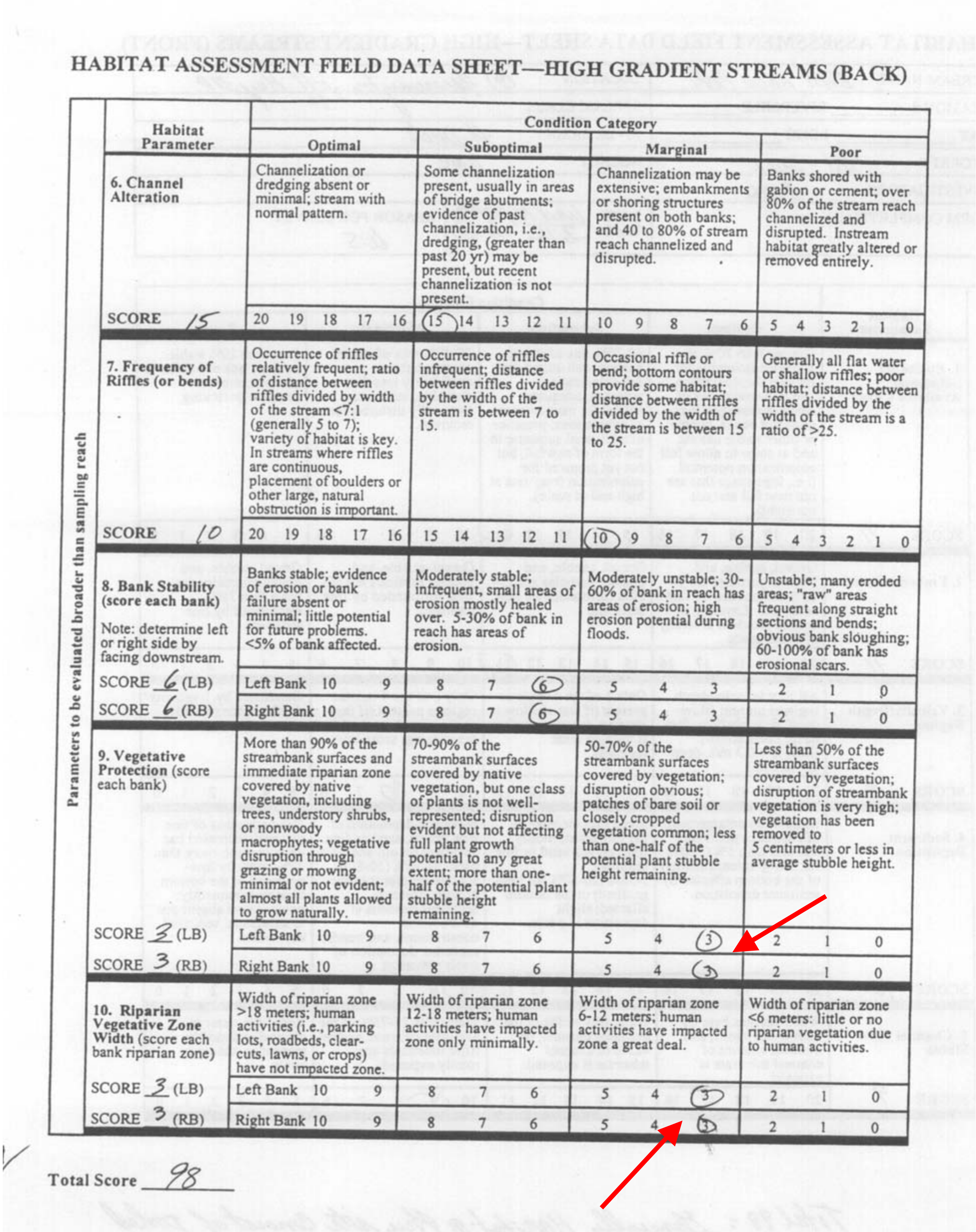
Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	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.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 [✓ 8] 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <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.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1 0

49

Total 98 = Generally Habitat @ this site consist of pooled water of varying depths (some areas quite deep) w/ floating algae mats + some duckweed - no true riffles + turbid water.... riparian varied (non exist. in areas) + high sedimentation....

Figure D-77 East Rock Creek Habitat Assessment, back page - December 8, 1999



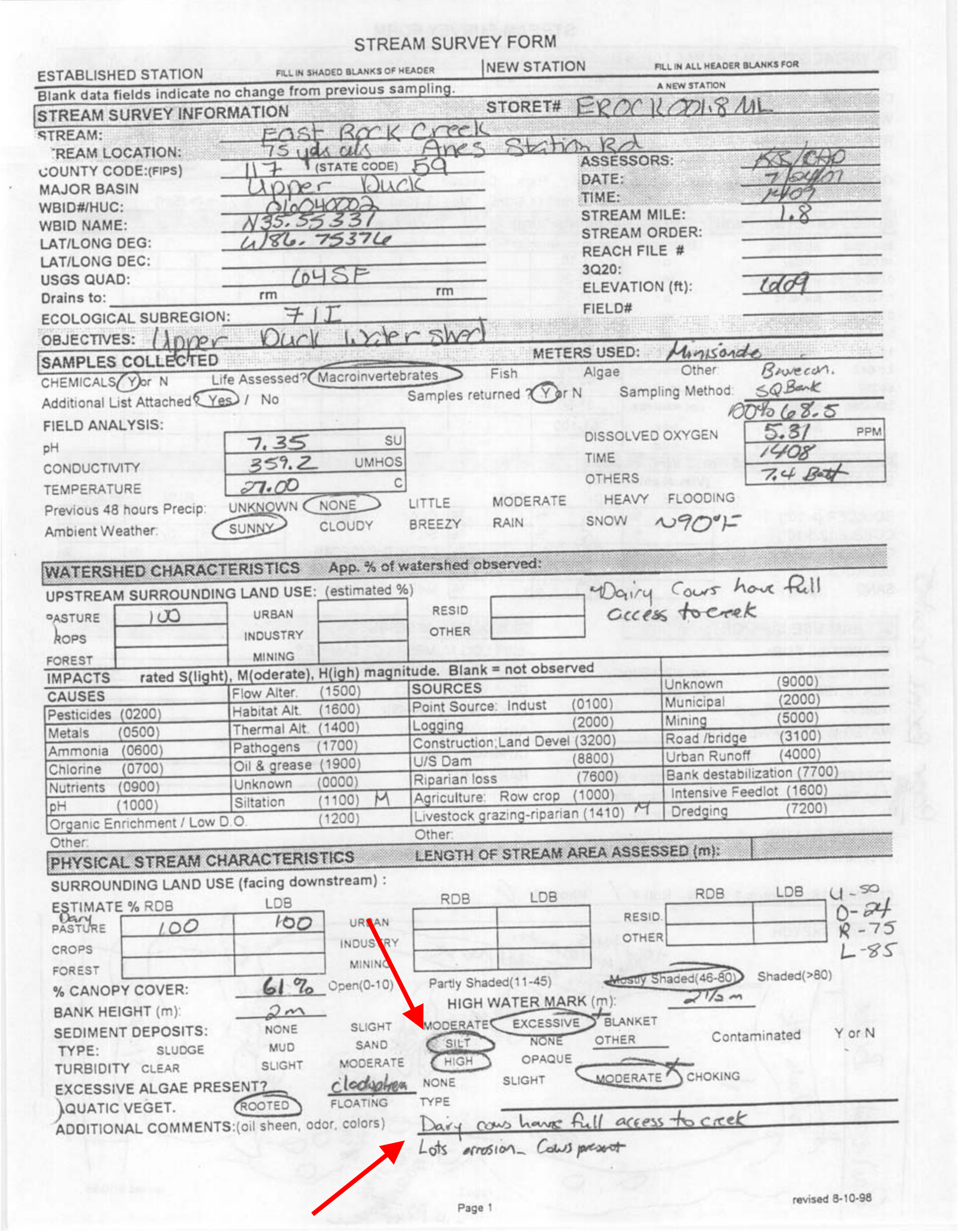
HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 15	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 6 (LB)	Left Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	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.
SCORE 3 (LB)	Left Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 3 (LB)	Left Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0

Total Score 98

Figure D-78 East Rock Creek field sheet, p1 - July 24, 2001



STREAM SURVEY FORM

ESTABLISHED STATION FILL IN SHADED BLANKS OF HEADER | NEW STATION FILL IN ALL HEADER BLANKS FOR A NEW STATION

Blank data fields indicate no change from previous sampling.

STREAM SURVEY INFORMATION STORET# EROCK001.8 ML

STREAM: East Rock Creek
STREAM LOCATION: 75 yds u/s Ames Station Rd
COUNTY CODE:(FIPS) 117 (STATE CODE) 59
MAJOR BASIN Upper Duck
WBID#/HUC: 06040002
WBID NAME: N35.55331
LAT/LONG DEG: W86.75376
LAT/LONG DEC:
USGS QUAD: 64SE
Drains to: rm rm
ECOLOGICAL SUBREGION: 71I
OBJECTIVES: Upper Duck Watershed

ASSESSORS: KB/CAO
DATE: 7/24/01
TIME: 1409
STREAM MILE: 1.8
STREAM ORDER:
REACH FILE #
3Q20:
ELEVATION (ft): 609
FIELD#

SAMPLES COLLECTED METERS USED: Minisonde

CHEMICALS [✓ Y] or N Life Assessed? [✓ Macroinvertebrates] Fish Algae Other: Biorecon.
Additional List Attached? [✓ Yes] / No Samples returned ? [✓ Y] or N Sampling Method: SQ Bank

FIELD ANALYSIS:

pH	7.35	SU
CONDUCTIVITY	359.2	UMHOS
TEMPERATURE	27.00	C

100% 68.5

DISSOLVED OXYGEN	5.31	PPM
TIME	1408	
OTHERS	7.4 Batt	

Previous 48 hours Precip: UNKNOWN [✓ NONE] LITTLE MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY] CLOUDY BREEZY RAIN SNOW ~90°F

WATERSHED CHARACTERISTICS App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	100	URBAN		RESID	
CROPS		INDUSTRY		OTHER	
FOREST		MINING			

*Dairy Cows have full access to creek

IMPACTS rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES		Flow Alter. (1500)		SOURCES		Unknown (9000)	
Pesticides (0200)		Habitat Alt. (1600)		Point Source: Indust (0100)		Municipal (2000)	
Metals (0500)		Thermal Alt. (1400)		Logging (2000)		Mining (5000)	
Ammonia (0600)		Pathogens (1700)		Construction;Land Devel (3200)		Road /bridge (3100)	
Chlorine (0700)		Oil & grease (1900)		U/S Dam (8800)		Urban Runoff (4000)	
Nutrients (0900)		Unknown (0000)		Riparian loss (7600)		Bank destabilization (7700)	
pH (1000)		Siltation (1100)	M	Agriculture: Row crop (1000)		Intensive Feedlot (1600)	
Organic Enrichment / Low D.O. (1200)				Livestock grazing-riparian (1410)	M	Dredging (7200)	
Other:				Other:			

PHYSICAL STREAM CHARACTERISTICS LENGTH OF STREAM AREA ASSESSED (m):

SURROUNDING LAND USE (facing downstream) :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
Dairy PASTURE	100	100	URBAN			RESID.		
CROPS			INDUSTRY			OTHER		
FOREST			MINING					

U-50
D-24
R-75
L-85

% CANOPY COVER: 61% Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)
BANK HEIGHT (m): 2m HIGH WATER MARK (m): 2½ m
SEDIMENT DEPOSITS: NONE SLIGHT MODERATE [✓ EXCESSIVE] BLANKET
TYPE: SLUDGE MUD SAND [✓ SILT] NONE OTHER Contaminated Y or N
TURBIDITY CLEAR SLIGHT MODERATE [✓ HIGH] OPAQUE
EXCESSIVE ALGAE PRESENT? cladophora NONE SLIGHT [✓ MODERATE] CHOKING
AQUATIC VEGET. [✓ ROOTED] FLOATING TYPE
ADDITIONAL COMMENTS:(oil sheen, odor, colors) Dairy cows have full access to creek
Lots errosion_ Cows present

Page 1

revised 8-10-98

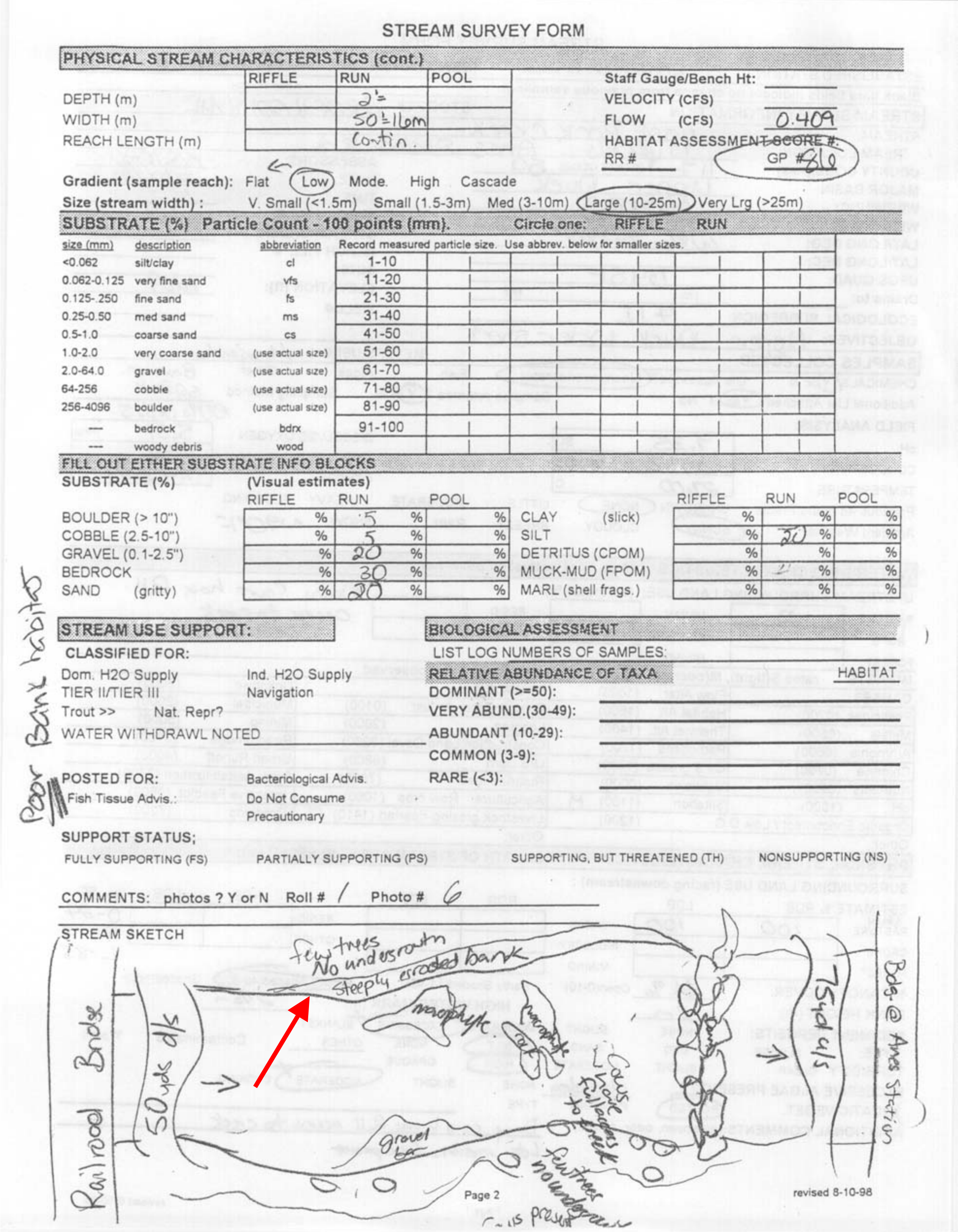


Figure D-79 East Rock Creek field sheet, p2 - July 24, 2001

STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)		2'±	
WIDTH (m)		50'±16m	
REACH LENGTH (m)		Contin.	

Staff Gauge/Bench Ht: ______
VELOCITY (CFS) ______
FLOW (CFS) 0.409
HABITAT ASSESSMENT SCORE #:
RR # ______ GP # 86

Gradient (sample reach): Flat [✓ Low] Mode. High Cascade
Size (stream width) : V. Small (<1.5m) Small (1.5-3m) Med (3-10m) [✓ Large (10-25m)] Very Lrg (>25m)

SUBSTRATE (%) Particle Count - 100 points (mm). Circle one: RIFFLE RUN

size (mm)	description	abbreviation	Record measured particle size. Use abbrev. below for smaller sizes.	
<0.062	silt/clay	cl	1-10	
0.062-0.125	very fine sand	vfs	11-20	
0.125-.250	fine sand	fs	21-30	
0.25-0.50	med sand	ms	31-40	
0.5-1.0	coarse sand	cs	41-50	
1.0-2.0	very coarse sand	(use actual size)	51-60	
2.0-64.0	gravel	(use actual size)	61-70	
64-256	cobble	(use actual size)	71-80	
256-4096	boulder	(use actual size)	81-90	
---	bedrock	bdrx	91-100	
---	woody debris	wood		

FILL OUT EITHER SUBSTRATE INFO BLOCKS

SUBSTRATE (%) (Visual estimates)

	RIFFLE	RUN	POOL		RIFFLE	RUN	POOL
BOULDER (> 10")	%	5 %	%	CLAY (slick)	%	%	%
COBBLE (2.5-10")	%	5 %	%	SILT	%	20 %	%
GRAVEL (0.1-2.5")	%	20 %	%	DETRITUS (CPOM)	%	%	%
BEDROCK	%	30 %	%	MUCK-MUD (FPOM)	%	2 %	%
SAND (gritty)	%	20 %	%	MARL (shell frags.)	%	%	%

Poor Bank habitat

STREAM USE SUPPORT:

CLASSIFIED FOR:
Dom. H2O Supply Ind. H2O Supply
TIER II/TIER III Navigation
Trout >> Nat. Repr?
WATER WITHDRAWAL NOTED

POSTED FOR:
Fish Tissue Advis.: Bacteriological Advis.
Do Not Consume
Precautionary

BIOLOGICAL ASSESSMENT

LIST LOG NUMBERS OF SAMPLES: ______

RELATIVE ABUNDANCE OF TAXA HABITAT
DOMINANT (>=50): ______
VERY ABUND.(30-49): ______
ABUNDANT (10-29): ______
COMMON (3-9): ______
RARE (<3): ______

SUPPORT STATUS;
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

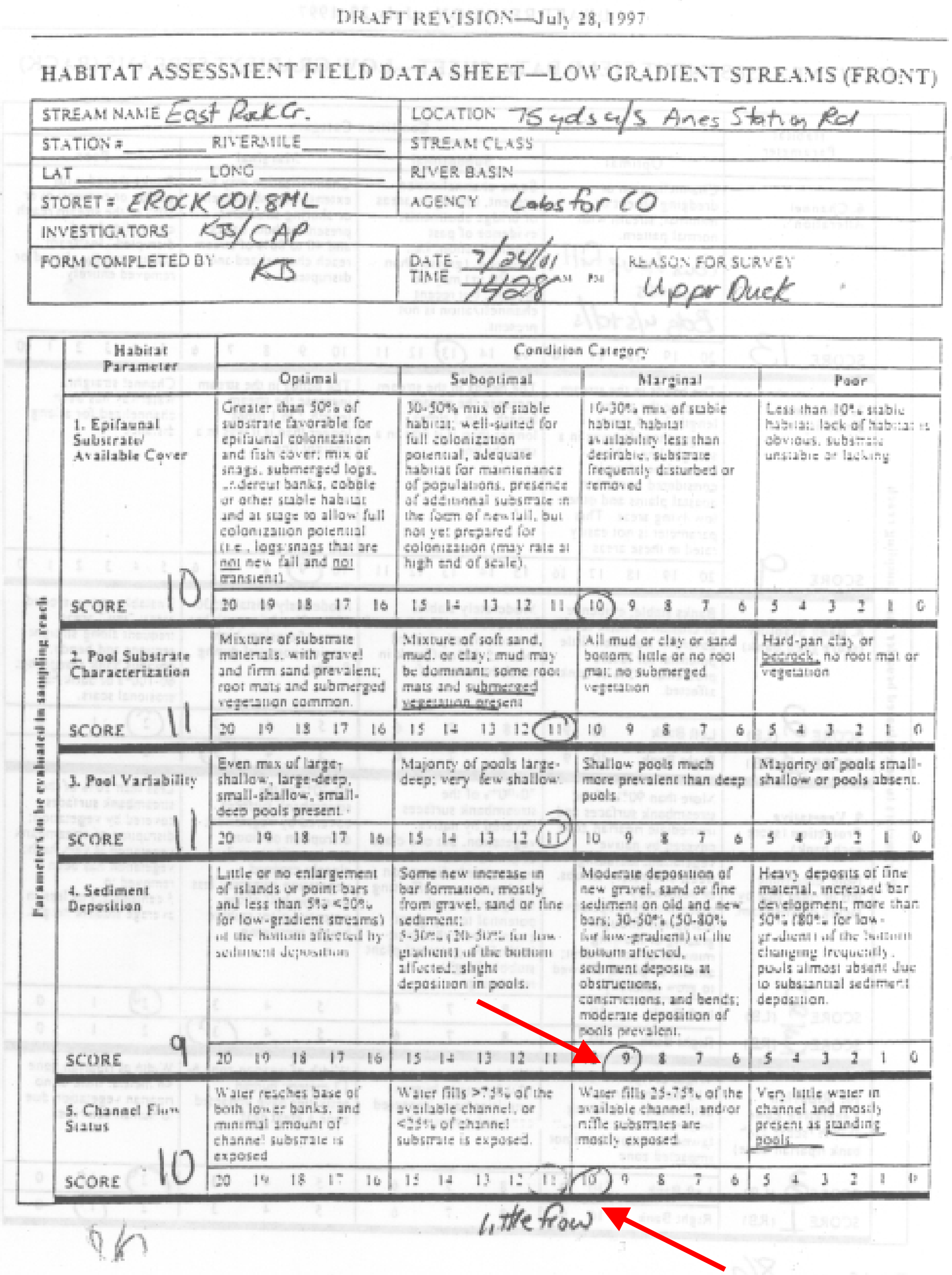
COMMENTS: photos ? Y or N Roll # 1 Photo # 6

STREAM SKETCH

Page 2

revised 8-10-98

Figure D-80 East Rock Creek Habitat Assessment, front page - July 24, 2001



DRAFT REVISION—July 28, 1997

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

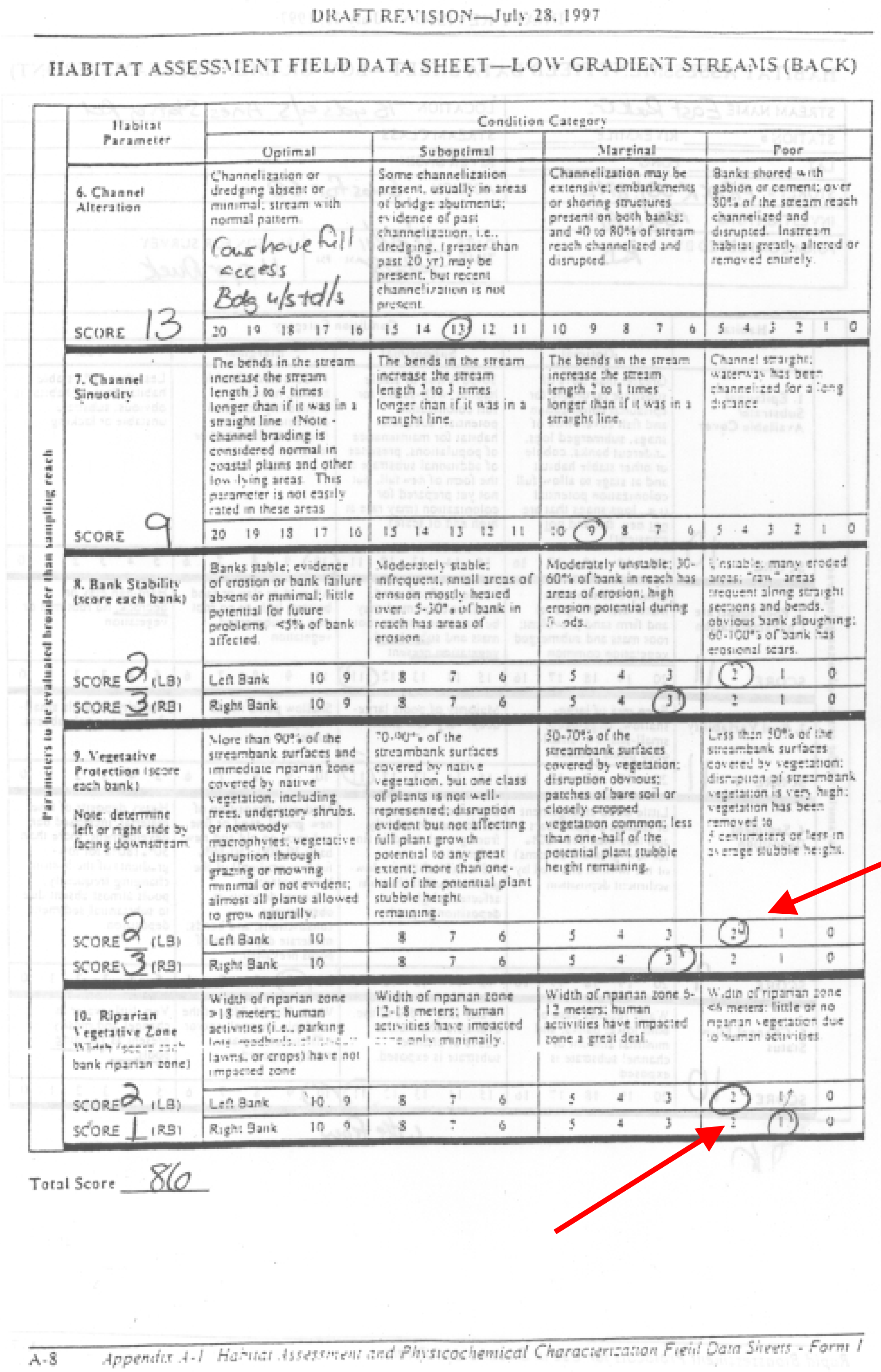
STREAM NAME East RckCr.	LOCATION 75 yds u/s Anes Station Rd
STATION # ________ RIVERMILE ________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET # EROCK 001.8ML	AGENCY Labs for CO
INVESTIGATORS KJS/CAP	
FORM COMPLETED BY KJS	DATE 7/24/01 TIME 1428 AM PM REASON FOR SURVEY Upper Duck

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% 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).	30-50% 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).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present	All mud or clay or sand bottom; little or no root mat; no submerged vegetation	Hard-pan clay or bedrock; no root mat or vegetation
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE 11	20 19 18 17 16	15 14 13 12 [✓ 11]	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed	Water fills >75% of the available channel; or <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.
SCORE 10	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0

little flow

Figure D-81 East Rock Creek Habitat Assessment, back page - July 24, 2001



DRAFT REVISION—July 28, 1997

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

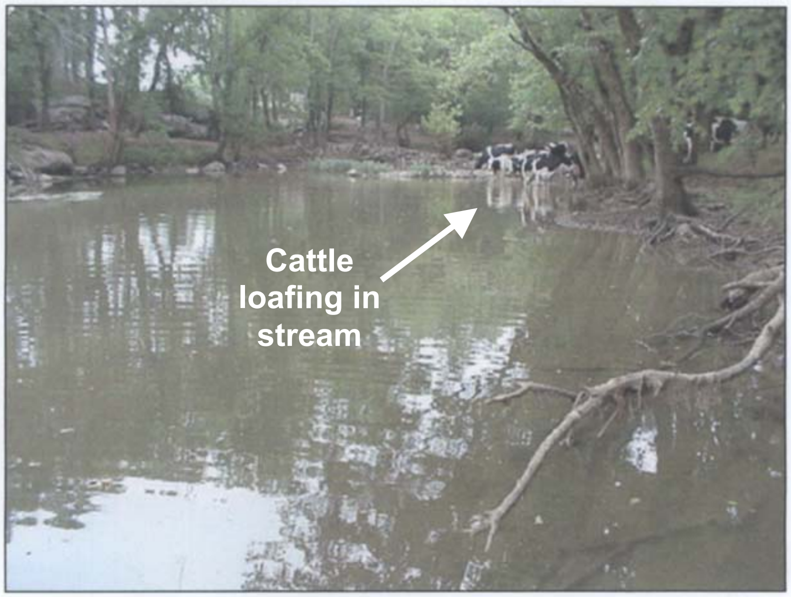
Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern. Cows have full access Bdg u/s+d/s	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 [✓ 9] 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	[✓ 2] 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side 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.
SCORE 2 (LB)	Left Bank 10	8 7 6	5 4 3	[✓ 2] 1 0
SCORE 3 (RB)	Right Bank 10	8 7 6	5 4 [✓ 3]	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	[✓ 2] 1 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 [✓ 1] 0

Total Score 86

A-8 Appendix A-1 Habitat Assessment and Physicochemical Characterization Field Data Sheets - Form 1

Figure D-82 Photo of East Rock Creek at RM 1.8 - July 24, 2004



East Rock Creek (EROCK001.8ML) 100 yards u/s Anes Station Rd. View upstream of the sample area. Col. KJS/CAP 7/24/04 @ 1403.

Note: This photo highlights the poor riparian vegetative zone, as indicated in the stream assessment above. The stream is adjacent to a roadway, with poor canopy and no fencing so that cattle have full access to the stream.

APPENDIX E

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR SILTATION & HABITAT ALTERATION IN THE UPPER DUCK RIVER WATERSHED (HUC 06040002), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Loads (TMDLs) for siltation and habitat alteration in the Upper Duck River Watershed located in middle Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

A number of waterbodies in the Upper Duck River Watershed are listed on Tennessee's final 2004 303(d) list as not supporting designated use classifications due, in part, to siltation and habitat alteration associated with land development, urban runoff, and agricultural sources. The TMDLs utilize Tennessee's general water quality criteria, ecoregion reference site data, land use data, digital elevation data, a sediment loading and delivery model, and an appropriate Margin of Safety (MOS) to establish reductions in sediment loading which will result in reduced in-stream concentrations and the attainment of water quality standards. The TMDLs require reductions in sediment loading of approximately 4% to 54% in the listed waterbodies.

The proposed siltation/habitat alteration TMDLs may be downloaded from the Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/proposed.php. *(note: this was subsequently changed to* http://www.state.tn.us/environment/wpc/tmdl/proposed.shtml)

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Mary Wyatt, Watershed Management Section
Telephone: 615-532-0714
e-mail: Mary.Wyatt@state.tn.us

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656
e-mail: Sherry.Wang@state.tn.us

Persons wishing to comment on the TMDLs are invited to submit their comments in writing no later than April 24th, 2006 to:

**Division of Water Pollution Control
Watershed Management Section
6th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534**

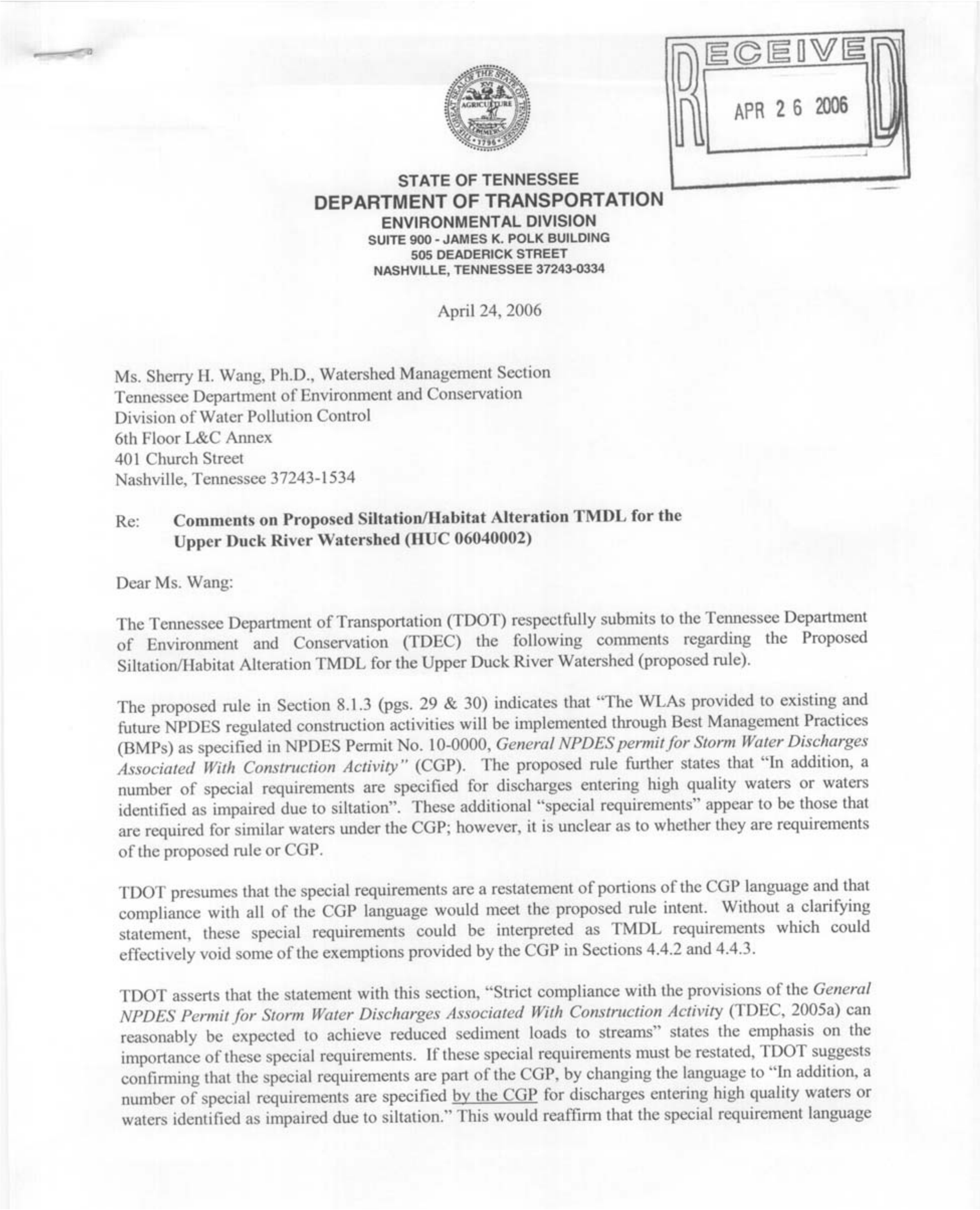
All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6th Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.

APPENDIX F

Public Comments Received

Letter from TDOT dated April 24, 2006:



RECEIVED
APR 26 2006

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL DIVISION
SUITE 900 - JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-0334

April 24, 2006

Ms. Sherry H. Wang, Ph.D., Watershed Management Section
Tennessee Department of Environment and Conservation
Division of Water Pollution Control
6th Floor L&C Annex
401 Church Street
Nashville, Tennessee 37243-1534

Re: **Comments on Proposed Siltation/Habitat Alteration TMDL for the Upper Duck River Watershed (HUC 06040002)**

Dear Ms. Wang:

The Tennessee Department of Transportation (TDOT) respectfully submits to the Tennessee Department of Environment and Conservation (TDEC) the following comments regarding the Proposed Siltation/Habitat Alteration TMDL for the Upper Duck River Watershed (proposed rule).

The proposed rule in Section 8.1.3 (pgs. 29 & 30) indicates that "The WLAs provided to existing and future NPDES regulated construction activities will be implemented through Best Management Practices (BMPs) as specified in NPDES Permit No. 10-0000, *General NPDES permit for Storm Water Discharges Associated With Construction Activity*" (CGP). The proposed rule further states that "In addition, a number of special requirements are specified for discharges entering high quality waters or waters identified as impaired due to siltation". These additional "special requirements" appear to be those that are required for similar waters under the CGP; however, it is unclear as to whether they are requirements of the proposed rule or CGP.

TDOT presumes that the special requirements are a restatement of portions of the CGP language and that compliance with all of the CGP language would meet the proposed rule intent. Without a clarifying statement, these special requirements could be interpreted as TMDL requirements which could effectively void some of the exemptions provided by the CGP in Sections 4.4.2 and 4.4.3.

TDOT asserts that the statement with this section, "Strict compliance with the provisions of the *General NPDES Permit for Storm Water Discharges Associated With Construction Activity* (TDEC, 2005a) can reasonably be expected to achieve reduced sediment loads to streams" states the emphasis on the importance of these special requirements. If these special requirements must be restated, TDOT suggests confirming that the special requirements are part of the CGP, by changing the language to "In addition, a number of special requirements are specified by the CGP for discharges entering high quality waters or waters identified as impaired due to siltation." This would reaffirm that the special requirement language

was taken from the CGP and that compliance with that permit will determine permit eligibility as it relates to NPDES Regulated Construction Storm Water in TMDL watersheds.

TDOT's proposed Municipal Separate Storm Sewer System (MS4) permit includes sampling of runoff to test pre- and post-implementation of BMPs before they are introduced as a storm water management tool. TDOTs proposed Storm Water Management Plan (SWMP) and monitoring plan shall be submitted back to the Nashville Central Office for approval. In Section 8.1.4 (pg. 31), TDOT suggests indicating in the TMDL that TDOT's SWMP and associated sampling/monitoring plan will be submitted to and approved by the Nashville Central Office of TDEC within the SWMP and not the local Environmental Field Office within 12 months of the approval date of this TMDL.

TDOT greatly appreciates this opportunity to comment and TDEC's consideration of our comments on the proposed rulemaking. Feel free to call me at (731) 935-0325 if you have any questions regarding TDOT's comments.

Sincerely,

Mr. Jody K. Knox
TDOT Project Compliance Coordinator
Environmental Division

DJD:JLH:ALD:jkk

cc: Mr. Doug Delaney, ED Director (via email)
Mr. John Hewitt, TDOT Permits Office Manager (via email)
Ms. Angie Duncan, Storm Water and Project Compliance Section Manager (via email)
Ms. Deedee Kathman, TDOT Ecology Section (via email)
Chrono. File
Reading file

APPENDIX G

Response to Public Comments

Response to TDOT letter dated April 24, 2006:

Issue No. 1 (summarized)

The special requirements detailed in Section 8.1.3 of the TMDL appear to restate requirements of the NPDES Permit No. 10-0000, *General NPDES Permit for Storm Water Discharges Associated with Construction Activity* (TDEC, 2005a), thereby eliminating the possible applicability of some of the exemptions provided in the general permit.

Response to Issue No. 1

Section 8.1.3 was revised to clarify that unless otherwise stated, full compliance with the requirements of the *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y is considered to be consistent with the WLAs specified in Section 7.3.3 of this TMDL document.

Issue No. 2 (summarized)

Since TDOT's proposed Municipal Separate Storm Sewer System (MS4) permit specifies that TDOT's proposed Storm Water Management Plan (SWMP) and monitoring plan shall be submitted to the Nashville Central Office for approval, TDOT would prefer the TMDL language not require TDOT to submit a detailed plan describing the monitoring program to the appropriate Environmental Field Office (EFO) of the Division of Water Pollution Control within 12 months of the approval date of the TMDL.

Response to Issue No. 2

The local EFO staff is best suited to evaluating the detailed plans describing the monitoring program. Therefore, the requirement for submitting a detailed plan to the appropriate Environmental Field Office (EFO) of the Division of Water Pollution Control within 12 months of the approval date of the TMDL remains as previously stated.