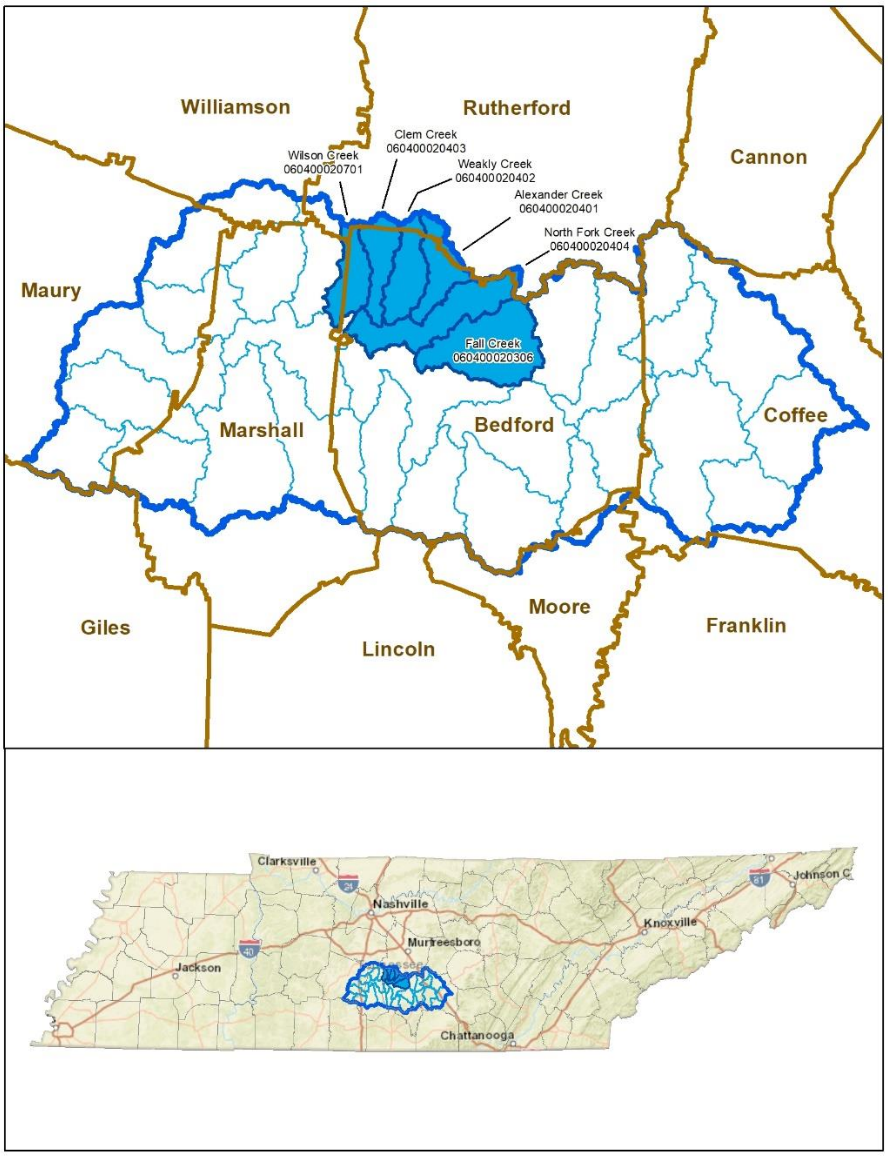
Tennessee

Upper Duck River Sub-watersheds National Water Quality Initiative (NWQI) Watershed Assessment

Hydrologic Unit Code (HUC8)) – 060400020401-Alexander Creek, 060400020402-Weakly, 060400020403-Clem Creek, 060400020404-North Fork Creek, 060400020306-Fall Creek, 060400020701-Wilson Creek[1]



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Natural Resources Conservation Service
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Nashville, Tennessee 37203

In Partnership with

Tennessee Department of Environment and Conservation Division of Water Pollution Control –
Watershed Planning Water Pollution Control
Tennessee Department of Agriculture
Bedford County Soil Conservation District
Rutherford County Soil Conservation
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I. Background and Purpose of the Assessment

The Upper Duck River Watershed (HUC 06040002) has approximately 1,607 miles of streams and drains approximately 1,181 square miles. The river is one of the most biologically diverse rivers in North America. It has a variety of aquatic species and has one of the largest diverse populations of freshwater mussel species in the world. The Duck River watershed provides habitat for 35 species listed as federally endangered, threatened, candidate or species of concern. The Duck River is one of the longest rivers contained within Tennessee. The river is primarily free flowing other than one impoundment in the headwaters, Normandy Dam.[2] The main channel of the Duck River is a popular recreational area for kayaking, canoeing, and fishing. The river has received much public attention and interest due to its biodiversity, beauty and recreational opportunities.

A portion of the main stem of the Duck River, approximately 37 miles, has been designated as scenic river and mussel sanctuary. The Duck River designated scenic section, beginning at Iron Bridge Road near Columbia and extending upstream to the Maury and Marshall County line, has over 500 documented species including aquatic plants, fish and invertebrates. The river specifically contains 39 mussel and 84 fish species which is more species of fish than in all of Europe.[3]

Many of the threatened species have been impacted due to past and current land use. The implementation of improved agricultural practices, environmental regulations, and better land use planning has improved water quality on a large portion of the Duck watershed. The area which is currently contributing to poor water quality is located in the headwaters consisting of agricultural land. The National Water Quality Initiative (NWQI) project area will include six 12-digit HUC watersheds. These watersheds flow into the mainstem of the Duck River downstream of Shelbyville, Tennessee.

In addition to the Duck River being important for species habitat and recreational activities, it is the primary water source for 250,000 people living in Middle Tennessee, providing a total of 24.3 million gallons per day (Mgal/d). Municipal water use increased 46 percent from 1981 to 2000 (from 18.0 to 26.3 Mgal/d). USGS conducted a survey on future municipal water demands estimated for the Bedford, Coffee, Marshall, and Maury-southern Williamson Counties in the upper Duck River watershed in central Tennessee through 2030. The survey indicated that water demand for municipal use may continue to increase through 2030 due to the recent intensive and anticipated growth in the residential and commercial sectors.[4]

The six watersheds selected as priority area are located above the designated scenic river and mussel sanctuary and multiple water source intakes. The integrity and protection of the scenic river and species diversity within the mainstem are impacted by the water quality condition of the watersheds in the priority area. These watersheds drain approximately 86,705 acres and approximately 52,023 acres are considered as agricultural land.[1] (See page 13 Land Use). The four priority areas flow through Bedford and Rutherford Counties. The only community or city within the watershed is Unionville, with a population under 2,000.[1]

060400020401-Alexander Creek
060400020402-Weakly Creek
060400020403-Clem Creek
060400020404-North Fork Creek
060400020306-Fall Creek
060400020701-Wilson Creek

HUC12	NAME	COUNTY	Percent of

			Watershed in Each County
060400020401	Alexander Creek	Rutherford	25
060400020401	Alexander Creek	Bedford	75
060400020402	Weakly Creek	Rutherford	9
060400020402	Weakly Creek	Bedford	90
060400020403	Clem Creek	Rutherford	13
060400020403	Clem Creek	Bedford	87
060400020404	North Fork Creek	Rutherford	3
060400020404	North Fork Creek	Bedford	97
060400020306	Fall Creek	Bedford	100
060400020701	Wilson	Bedford	70
060400020701	Wilson	Marshall	30

Table 1. County percentage in Watershed

Tennessee Rivers Assessment Project. The Tennessee Rivers Assessment is part of a national program operating under the guidance of the National Park Service's Rivers and Trails Conservation Assistance Program. The assessment is an inventory of river resources and should not be confused with "assessment" as defined by the Environmental Protection Agency. A better description can be found in the Tennessee Rivers Assessment Summary Report,[2] which is available from the Department of Environment and Conservation and on the web at: http://www.state.tn.us/environment/wpc/publications/riv/

STREAM	NSQ	RB	RF
Alexander Creek	3		
North Fork Creek	3	3	2
Weakly Creek	3		
Wilson Creek	3		
Fall Creek	3	3	

Table 2. Priority Watershed listed in TN Rivers Assessment

Categories: NSQ, Natural and Scenic Qualities
RB, Recreational Boating
RF, Recreational Fishing

Scores:
1. Statewide or Greater Significance; Excellent Fishery
2. Regional Significance; Good Fishery
3. Local Significance; Fair Fishery
4. Not a Significant Resource; Not Assessed

The Heritage Program in the TDEC Division of Natural Heritage maintains a database of rare species that is shared by partners at The Nature Conservancy (TNC), Tennessee Wildlife Resources Agency (TWRA), the US Fish and Wildlife Service (USFWS), and the Tennessee Valley Authority (TVA). The information is used to: 1) track the occurrences of rare species to accomplish the goals of site conservation planning and protection of biological diversity, 2) identify the need for and status of recovery plans, and 3) conduct environmental reviews in compliance with the federal Endangered Species Act. The table below represents the species occurrence within the priority areas.[3]

CATEGORY	SCIENTIFIC_NAME	COMMON_NAME	FEDERAL	STATE	EO_RANK
Amphibian	*Ambystoma barbouri*	Streamside Salamander	--	E	Verified extant (viability not assessed)
Flowering Plant	*Amsonia tabernaemontana var. gattingeri*	Limestone Blue Star	--	S	Historical
Flowering Plant	*Anemone caroliniana*	Carolina Anemone	--	E	Verified extant (viability not assessed)
Flowering Plant	*Astragalus tennesseensis*	Tennessee Milk-vetch	--	S	Verified extant (viability not assessed)
Insect	*Gomphus sandrius*	Tennessee Clubtail	--	Rare, Not Listed	Excellent, good, or fair estimated viability
Mollusc	*Pleuronaia dolabelloides*	Slabside Pearlymussel	LE	E	Historical
Flowering Plant	*Polygala boykinii*	Boykin's Milkwort	--	T	Fair estimated viability
Fish	*Etheostoma luteovinctum*	Redband Darter	--	D	Historical
Fish	*Etheostoma striatulum*	Striated Darter	--	T	Verified extant (viability not assessed)
Flowering Plant	*Phemeranthus calcaricus*	Limestone Fame-flower	--	S	Good estimated viability
Flowering Plant	*Paysonia densipila*	Duck River Bladderpod	--	S	Historical
Flowering Plant	*Schoenolirion croceum*	Yellow Sunnybell	--	T	Verified extant (viability not assessed)

Table 3. Threatened and Endangered Species- TDEC Natural Heritage Database[5]

SCIENTIFIC_NAME	COMMON_NAME	HABITAT
Ambystoma barbouri	Streamside Salamander	Seasonally flowing karst streams; middle Tennessee.
Amsonia tabernaemontana	Limestone Blue Star	Glades, Barrens, And Rocky River Bars
Anemone caroliniana	Carolina Anemone	Glades and Cedar Woodlands
Astragalus tennesseensis	Tennessee Milk-vetch	Glades
Gomphus sandrius	Tennessee Clubtail	Slow streams with bare bedrock shores; Central Basin; upper Duck River and middle Cumberland River watersheds.
Pleuronaia dolabelloides	Slabside Pearlymussel	Lg creeks to mod sized rivers, in riffles/shoals of sand, fine gravel, and cobble substrates with mod current
Polygala boykinii	Boykin's Milkwort	Glades
Etheostoma luteovinctum	Redband Darter	Limestone streams; Nashville Basin & portions of Highland Rim.
Etheostoma striatulum	Striated Darter	Bedrock pools of headwaters and creeks with large slab-rock cover; upper Duck River watershed.
Phemeranthus calcaricus	Limestone Fame-flower	Glades
Paysonia densipila	Duck River Bladderpod	Cultivated Fields
Schoenolirion croceum	Yellow Sunnybell	Wet Areas in Glades

Table 4. Threatened and Endangered Species- TDEC Natural Heritage Database-Habitat needs [5]

Tennessee's Water Quality Standards are set to determine the health of water resources. All streams in Tennessee are classified for at least 2 of the 7 potential designated uses. Designated Uses are goals for the water resource. Although it may, not be currently used for that activity, it should be protected for the future. The designated use classifications for the Upper Duck River and its tributaries include fish and aquatic life, irrigation, livestock watering and wildlife, and recreation. Some waterbodies in the watershed are also classified for industrial water supply, domestic water supply, and/or navigation (Normandy Lake).

Tennessee's water quality standards are to meet the designated use. The standards follow a set of criteria for various parameters that describe the minimum condition waters must meet to safely protect human health and environment and determine necessary measures to protect or meet the criteria. Waters that show water quality criteria violations of a significant magnitude, frequency, and duration are listed as impaired.

Surface water quality concerns in these six watersheds are related to impacts from silt, nutrients, habitat alterations and pathogens related to agriculture. Approximately 57 miles of stream within the priority watersheds are listed as impaired due to agriculture.[6] The six priority watersheds have been monitored and found not to meet the criteria of their designated use.[7] The impairments of the specific segments will be identified in Section III – Water Quality and Hydrological Characterization.

Implementation of conservation practices through NWQI will reduce agricultural-related impairments and pollutant sources within the Upper Duck priority watersheds will help meet the State of Tennessee designated use standards. After implementation, water contact will be safer for humans engaging in recreation. Reduction of sediment and re-vegetating streambanks and riparian areas will provide improved habitat for a diverse fishery and aquatic habitat. More wildlife and wading birds will be attracted to the waters as additional riparian and terrestrial vegetation become available. Utilities cost of the treatment of drinking water supply will be reduced with the improvement of water quality.

Education and outreach opportunities are available to work toward improving conservation practices on cropland, pasture/grazing situations, overstocking issues, and provide education on appropriate grazing management. The objective for the next five years is to promote and implement conservation practices that will help reduce the impact agriculture is having on water quality within the six selected HUC12s.

NRCS service centers and the Soil and Water Conservation Districts will provide conservation assistance within the HUC12 priority watersheds. Local Soil and Water Conservation District Boards are active and promote field days as well as conservation practices. As stated previously, the Upper Duck is one of the most biodiverse rivers in the world, thus there are many agencies and nonprofit groups that are supportive of outreach, education and the implementation of conservation to protect the resources of the Upper Duck River.

It is recognized that non-agricultural sources (failing septic systems) may still exist, but it is possible to improve the water quality in priority sections by lowering nutrient levels, pathogen and siltation levels from livestock grazing, access to streams and cropland. Although NRCS cannot provide financial assistance to treat non-agricultural pollutant sources/habitat disruption, the agency can provide financial and technical assistance to land-users to treat agriculturally related pollutant sources. Agriculturally oriented educational opportunities to raise awareness of health concerns in the priority watershed will provide residents an opportunity to learn the benefits of reducing pollutant delivery (both agricultural and non-agricultural) to the streams.

II. Priority Watershed Characterizations

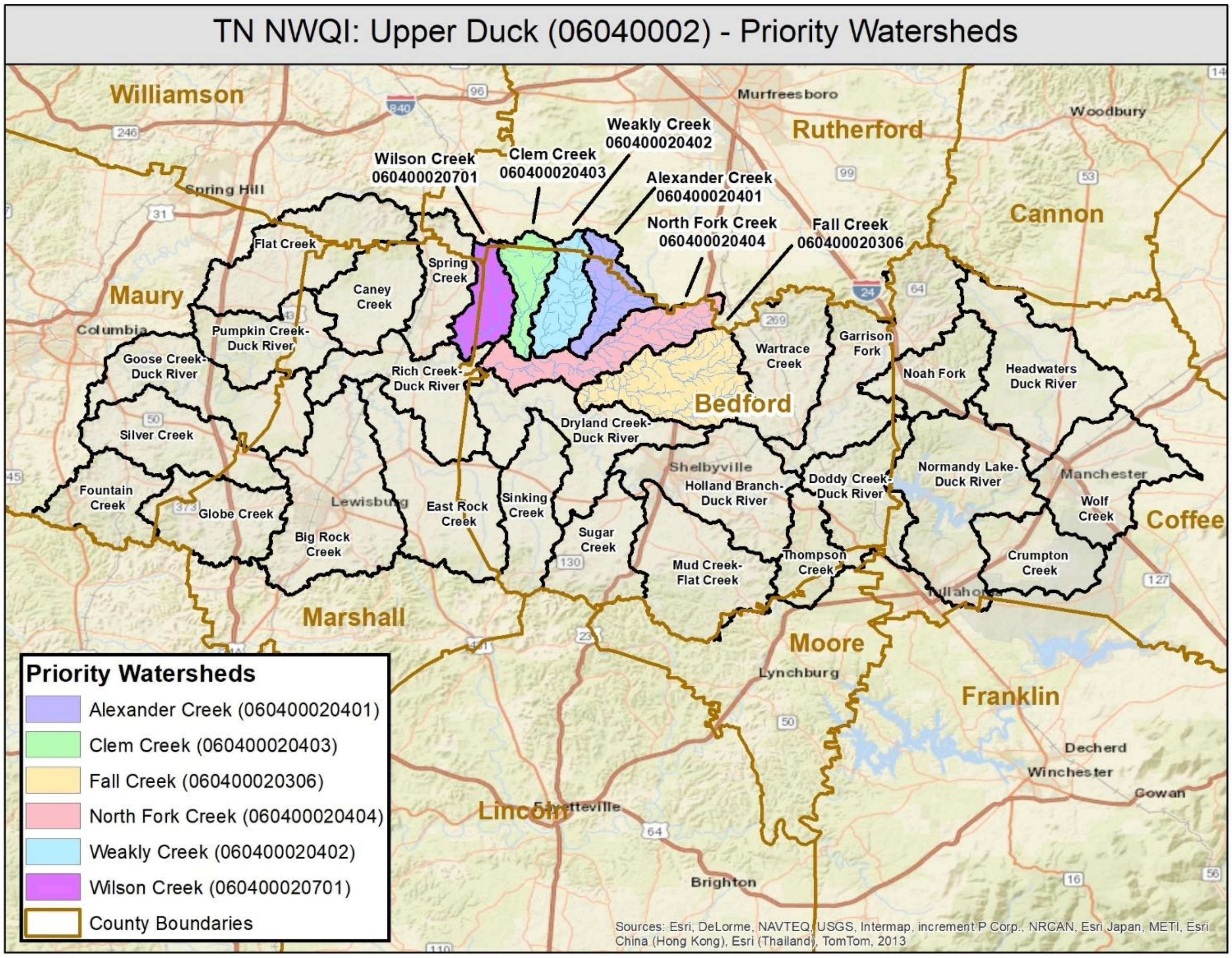

Figure 1: Map NWQI Priority 12 Digit HUC in Cordell Hull[1]

Priority Watershed Descriptions

Clem Creek, Weakly Creek, Alexander flow into North Fork Creek Watershed, which flows into the Duck River. Fall Creek and Wilson Creek flow directly into the Duck River. The confluence of these watersheds into the Duck River is downstream of Shelbyville, TN and above Henry Horton State Park and Lillard's mill. Duck River flows through Henry Horton State Park an 1,140 acre well developed park that is a popular fishing area for largemouth, smallmouth and redeye. Lillard's Mill. built in 1928, is a low head dam, that is a popular recreational area and is known for diversity of species found below this dam.

Primary water quality resource concerns are closely tied to water quality affecting fish and aquatic life, irrigation, livestock, watering and wildlife, and recreation. The pollutant factors impairing the uses include pathogens, nutrients, siltation, and habitat alteration. The Tennessee Department of Environment and Conservation (TDEC) has identified 57 miles of impaired stream within the scope of the NWQI area of the Upper Duck.[6]

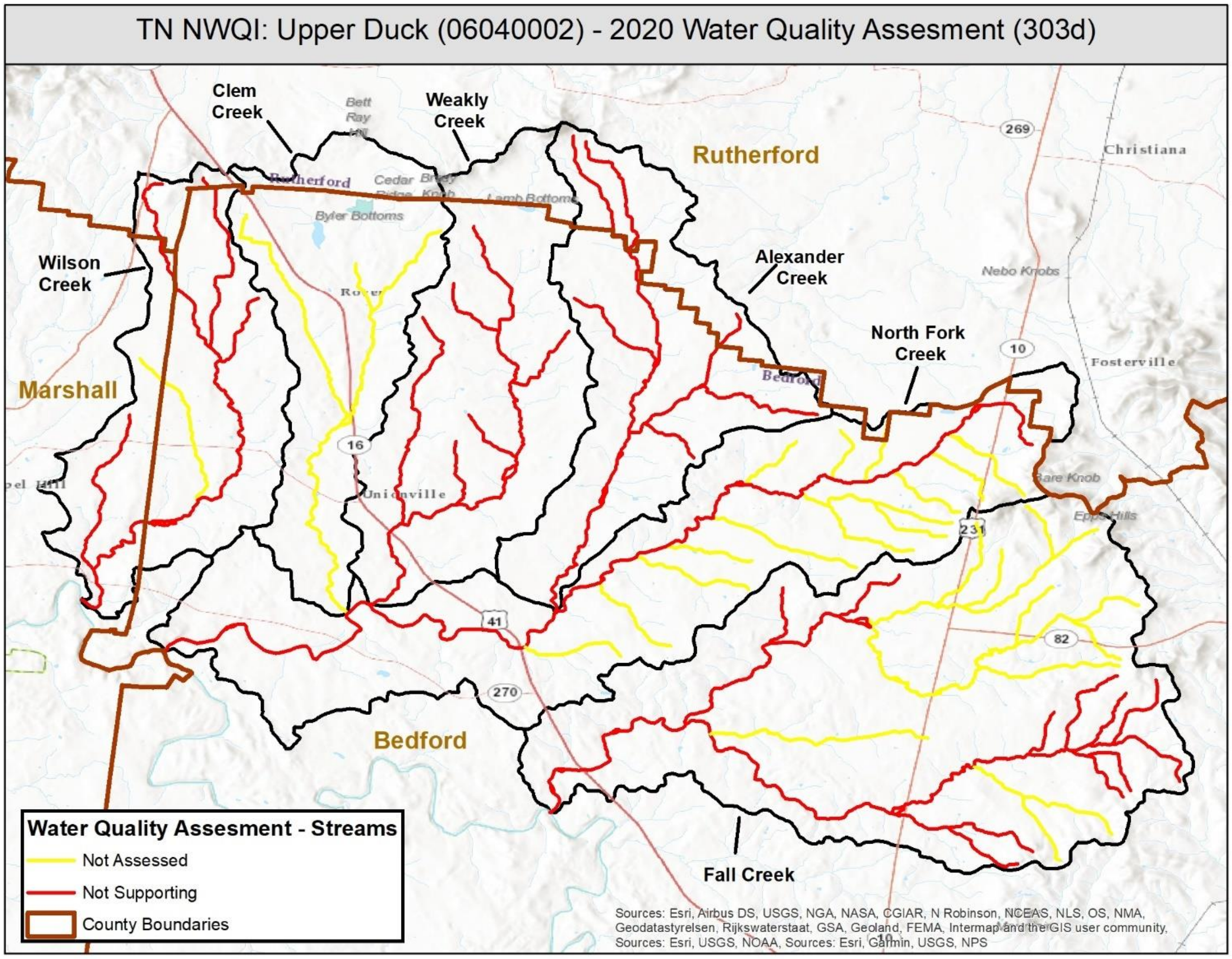

Figure 2: Map of Impaired Streams[6, 9]

Ecoregions

Ecoregions are defined as relatively homogeneous areas of similar geography, topography, climate and soils that support similar plant and animal life. Ecoregions serve as a spatial framework for the assessment, management, and monitoring of ecosystems and ecosystem components. Ecoregion studies include the selection of regional stream reference sites, identifying high quality waters, and developing ecoregion-specific chemical and biological water quality criteria.

There is one Level III Ecoregions and twenty-five Level IV sub-ecoregions in Tennessee. The Upper Duck River Watershed (HUC-06040002)) is located in Middle Tennessee primarily in Bedford County. The Upper Duck Watershed lies within one Level III ecoregion, the Nashville Basin, and contains four Level IV ecoregions as shown in Figure 2 (USEPA, 1997)[6]. The priority watersheds are located within one Level IV ecoregion.[8]

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. [8]

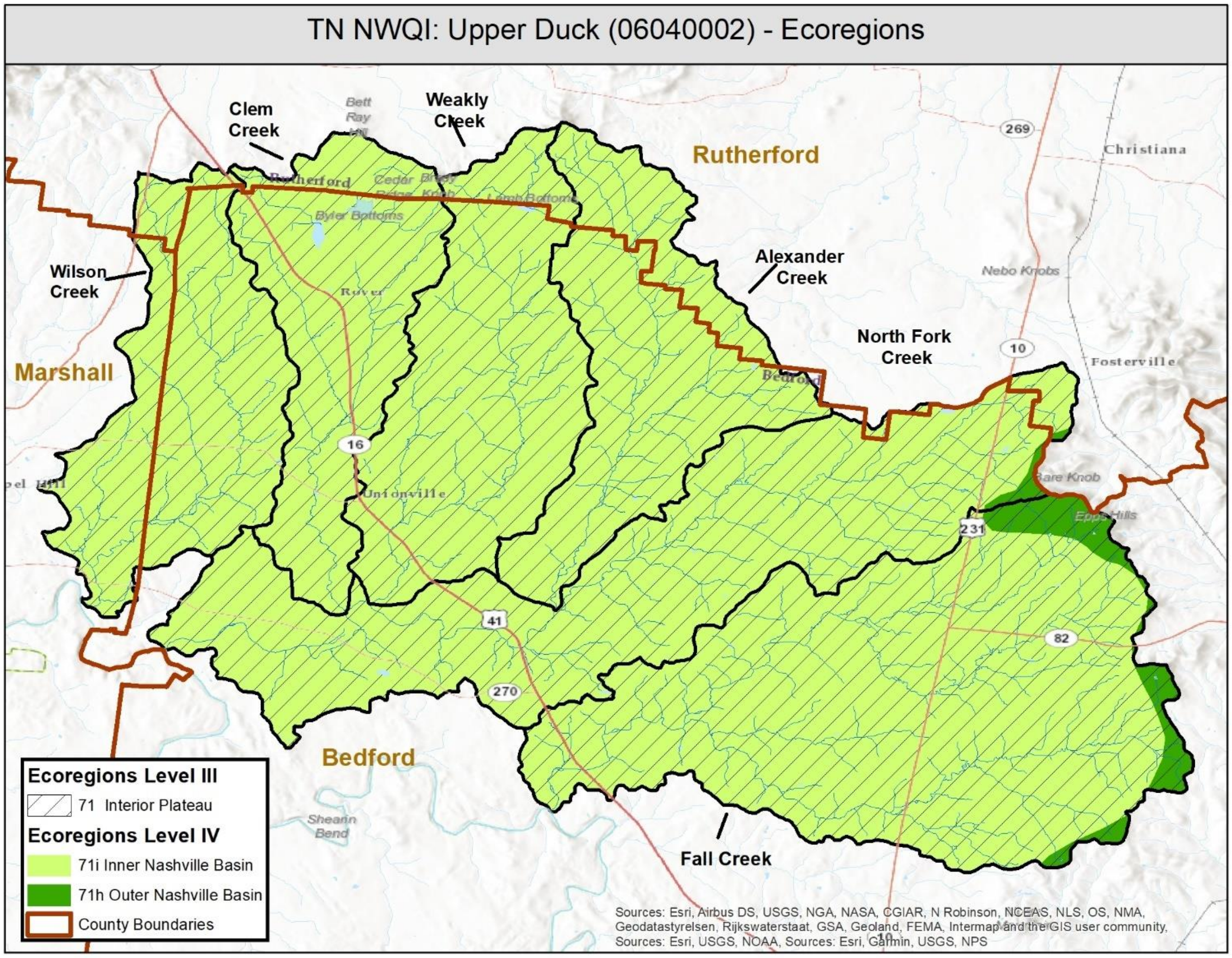

Figure 3: Ecoregions[8]

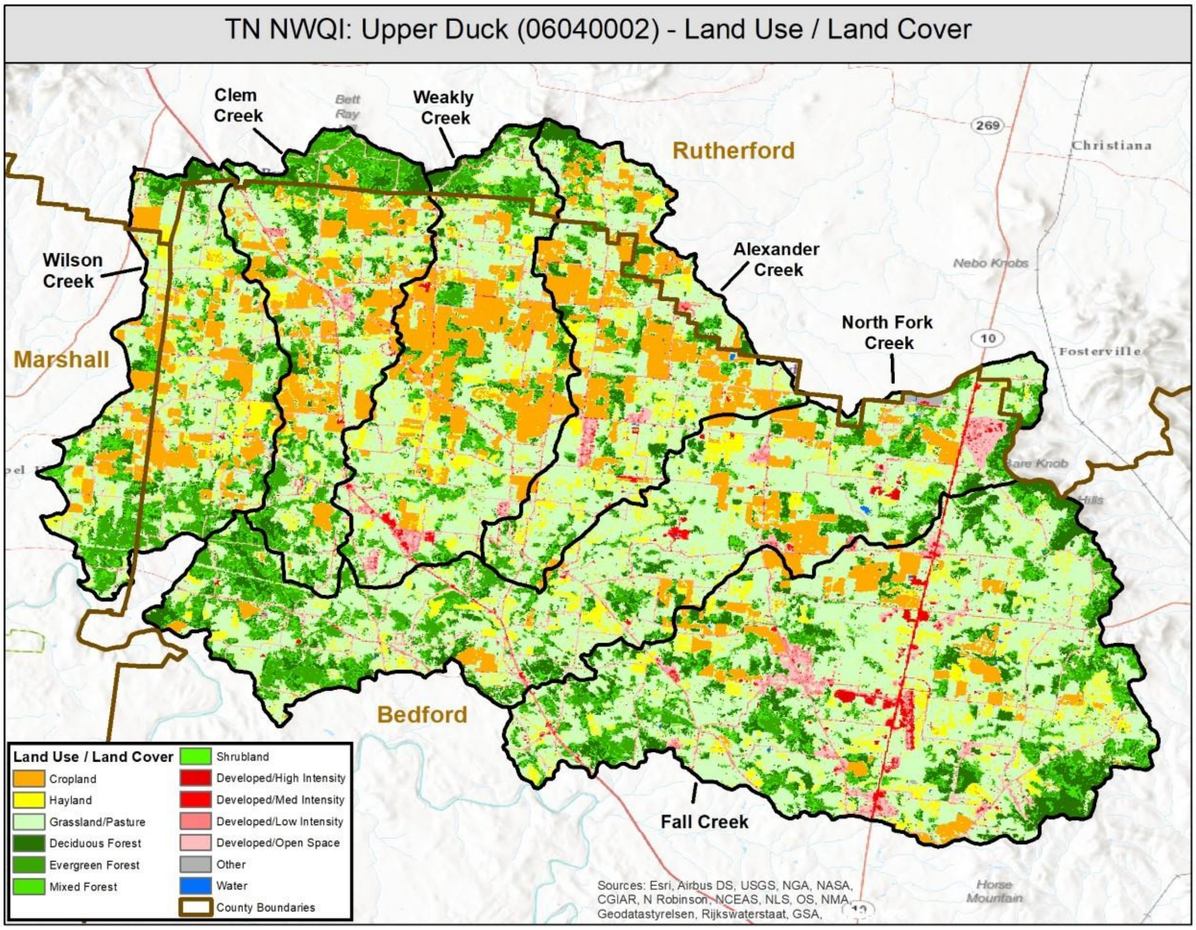

Figure 4: Land Use Map[1]

Land Use and Land Cover

Predominant land uses within the NWQI watersheds are grassland/pasture, hay land, crop, forest and developed land. Unionville, TN is the only developed community within the six priority watersheds and is located on Weakly Creek. Tennova Health Care Center and Boomer Shelbyville Airport is located in the headwaters of Fall Creek along Highway 231, which is located north of the Shelbyville city line.[1]

Upper Duck				
NAME	ACRES		NAME	ACRES
Cropland	11,634		Shrubland	143
Hayland	6,412		Developed/High Intensity	175
Grassland/Pasture	39,618		Developed/Med Intensity	846
Deciduous Forest	9,239		Developed/Low Intensity	2,266
Evergreen Forest	4,938		Developed/Open Space	4,021
Mixed Forest	7,243		Other	92
Shrubland	143		1Water	75

Climate

The climate in the watershed is mild, and generally warm and temperate. The average high temperature is 81 degrees. The hottest temperatures 89 degrees occur July-August and coldest temperatures 31 degrees in December-February. Precipitation averages approximately 57 inches per year and about 3 inches of snow per year. The US average is 28 inches of snow per year. On average, there are 208 sunny days in the watershed. Late summer through early fall are the driest parts of the year and late winter through early spring are the wettest parts of the year. The growing season in the watershed typically lasts for 6.8 months (209 days) ranging from approximately April 4th to October 29th.[10]

Geology

Ordovician and Mississippian carbonate rocks underlie most of the study area. Formations of Ordovician age include, in descending order, undifferentiated Ordovician units, the Bigby-Cannon, Carters, Lebanon, and Ridley Limestones. Compositional differences between the Ordovician and Mississippian carbonate units affect the terrain and hydrology in the study area. The Ordovician carbonates are predominantly limestone with some thin shaly beds, phosphate-rich zones, and bentonite layers. They are generally flat lying to gently dipping, but joints, which are parallel fractures oriented perpendicular to the bedding planes, are common throughout the Nashville Basin. Much of the Ordovician limestone is relatively pure calcite with a small amount of insoluble material, such that during the weathering process, little residual material remains. As a result, soils overlying bedrock in the Inner Nashville Basin are relatively thin, typically 20 ft thick or less, and bedrock outcrops are common. Soils are derived from the phosphatic, sandy, and clay-rich limestones and from shaly layers that are present in the limestone.[11]

Ground water flows in solution openings in bedrock that form as a result of physical and chemical weathering. Rainfall is mildly acidic, and the acidity of rainfall increases as it infiltrates and moves through the soil zone and interacts with carbon dioxide in the soil. As this acidic water moves through the subsurface, dissolution of carbonate bedrock occurs predominantly along bedding planes and vertical joints resulting in the development of karst features, such as sinkholes, caves, disappearing streams, and springs. Ground water primarily flows in solution openings that have formed along bedding planes and joints. The number and size of solution openings decrease with depth, and the zone of active ground-water flow generally is less than 300 ft below land surface.[12] Ground-water-flow paths are typically short, and much of the water moves rapidly through the aquifer and discharges to streams and springs. Recharge to the aquifer occurs from the infiltration of rainfall through the soil as well as focused recharge from runoff entering sinkholes and joints in bedrock. Locally, recharge may occur from streamflow loss where openings in bedrock in the stream channels are connected to the aquifer.

Geomorphology

Geomorphology of streams in the Inner Nashville Basin (71i)

The physiography of the Inner Nashville Basin is smooth to rolling plains with some small knobs and hills. The elevation is 500 to 900 feet with local relief from 60 to 400 feet. Very shallow clay soils cover limestone bedrock. The natural vegetation is cedar glades and thickets, cedar-hardwood forests and deciduous forests, however, much of the Inner Nashville Basin has been cleared for urban development and agriculture (primarily pasture and hay). Typical streams are low gradient and flow over limestone bedrock. Streams are often dry or subterranean during low flow periods.[13]

There are two reference streams that the Tennessee Department of Conservation and Environment surveyed while collecting geomorphological data for the Nashville Basin. They were on the West Fork Stones River in Ecoregion Inner Nashville Basin. The typical cross-section for streams in this ecoregion is the sloped C-type according to *Rosgens Stream Classification System.*[14] The dominant bed material for most of the streams was bedrock resulting in a C1 classification. The typical valley structure associated with C-type streams in the Inner Nashville Basin is type VIII, broad with alluvial terraces and gentle down-valley elevation relief.[13,14]

Soils

These watersheds are located in the Nashville Basin or Central Basin major land resource area (MLRA) or MLRA 123. Soils in this MLRA are dominated by clayey limestone residuum and clayey alluvium on the flood plains and stream terraces. Soils found on flood plains are Eagleville, Godwin, and Agee with slopes ranging from 0 to 2 percent. Eagleville soils formed in clayey limestone alluvium, are somewhat poorly drained with a water table at 12 to 24 inches, have limestone bedrock at 20 to 40 inches, and have very low to moderately low permeability. Godwin soils formed in clayey limestone alluvium, are somewhat poorly drained with a water table at 12 to 24 inches, and moderately high permeability. Agee soils formed in clayey alluvium over limestone residuum, are poorly drained with a water table at 0 to 12 inches, and very low to moderately low permeability. Tupelo soils are found on stream terraces formed in clayey limestone alluvium with a slope range of 0 to 2 percent. These soils are deep and somewhat poorly drained with a water table at 12 to 24 inches, and very low to moderately low permeability. Soils forming in depressions in clayey limestone alluvium with 0 to 2 percent slopes are the Roellen soils. Roellen soils are deep, poorly drained with a water table at 0 to 12 inches, and moderately low to moderately high permeability. Capshaw soils are also found on stream terraces and formed in clayey alluvium or loess over clayey limestone residuum. Slopes range from 0 to 5 percent. Capshaw soils are deep, moderately well drained with a water table at 24 to 40 inches, and moderately low to moderately high permeability. Nesbitt soils are found on the side slopes and crests with a slope range of 0 to 5 percent and formed in alluvium. These soils are deep, moderately well drained with a water table at 24 to 48 inches, and moderately high permeability. [15]

The dominant soils forming in clayey limestone residuum on side slopes and crests are Bradyville, Talbott, and Lomond soils. Bradyville soils are deep, well drained, and have very low to moderately low permeability with slopes ranging from 2 to 12 percent. Talbott soils have limestone bedrock at 20 to 40 inches, are well drained, and very low to moderately low permeability with slopes ranging from 2 to 20 percent. Lomond soils formed in loess or alluvium over limestone residuum, are well drained, and moderately high to high permeability with slopes ranging from 0 to 5 percent. Gladeville soils are found on flats and formed in clayey limestone residuum with slopes ranging from 0 to 2 percent. These soils have limestone bedrock at 8 to 20 inches, are well drained, and have very low to moderately low permeability.[15]

Hydric Soils

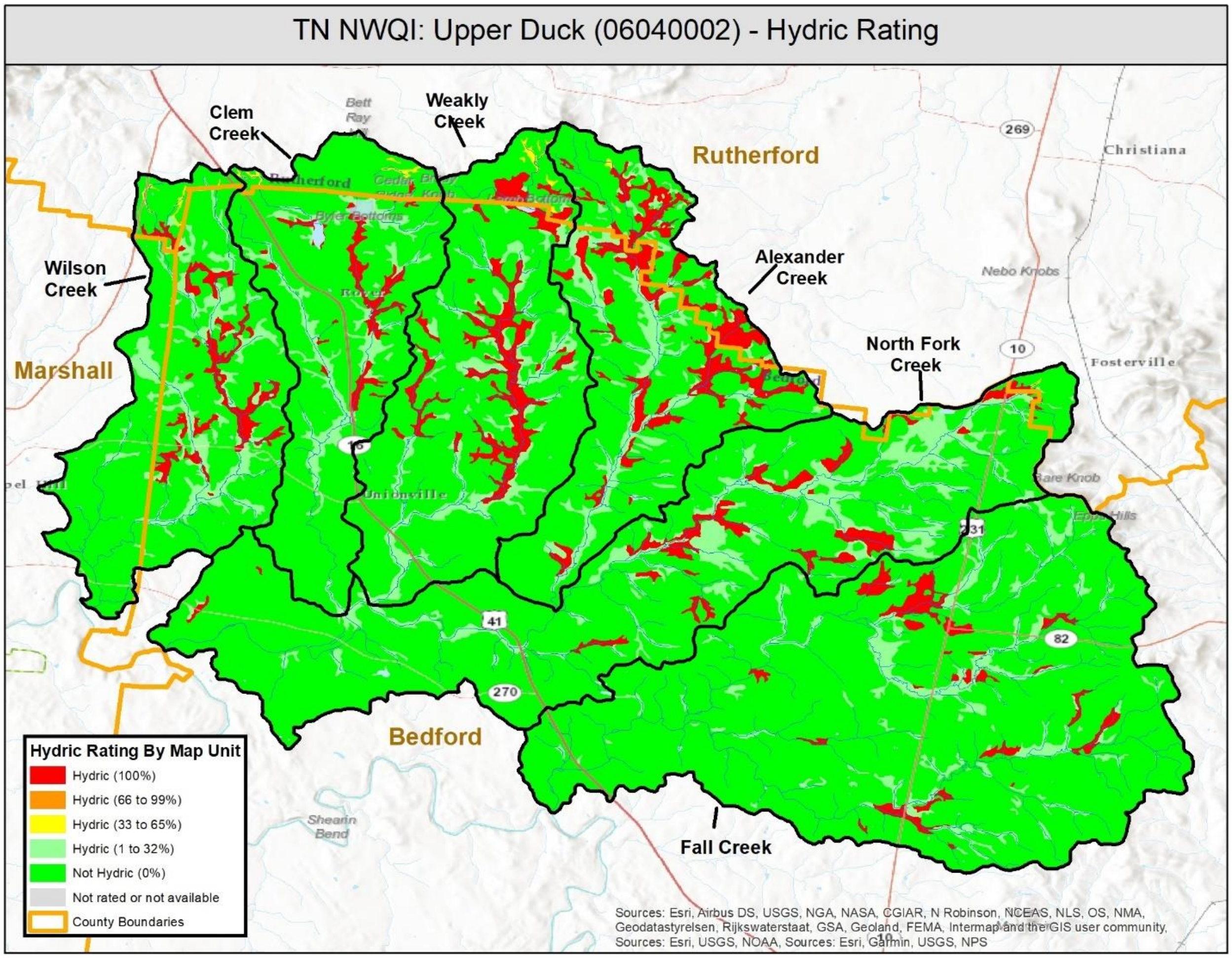

Figure 6: Hydric Soils[16]

The definition of a hydric soil is a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soils are important indicators of wetlands.

Land Capability Class

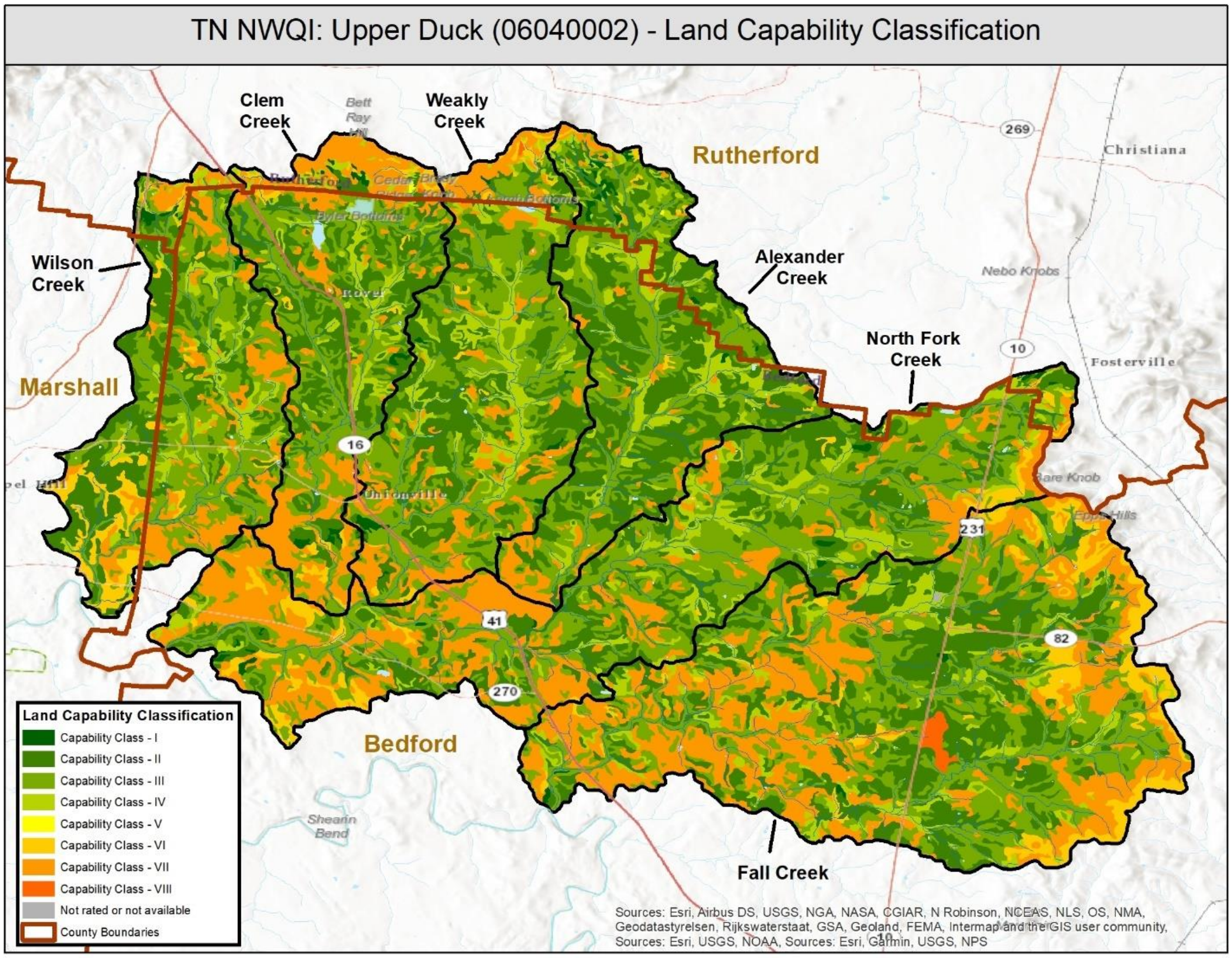

Figure 7: Map Land Capability Classification[16]

Land Capability Classification shows the suitability of soils for most kinds of field crops (United States Department of Agriculture, Soil Conservation Service, 1961). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive land forming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forestland, or for engineering purposes. In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Capability classes, the broadest groups, are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use. [16]

The Capability Classes are defined as follows:

- **Class 1** soils have slight limitations that restrict their use.
- **Class 2** soils have moderate limitations that restrict the choice of plants or that require moderate conservation practices.

- **Class 3** soils have severe limitations that restrict the choice of plants or that require special conservation practices, or both.
- **Class 4** soils have very severe limitations that restrict the choice of plants or that require very careful management, or both.
- **Class 5** soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
- **Class 6** soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
- **Class 7** soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.
- **Class 8** soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes.

Prime Farmland Distribution Maps

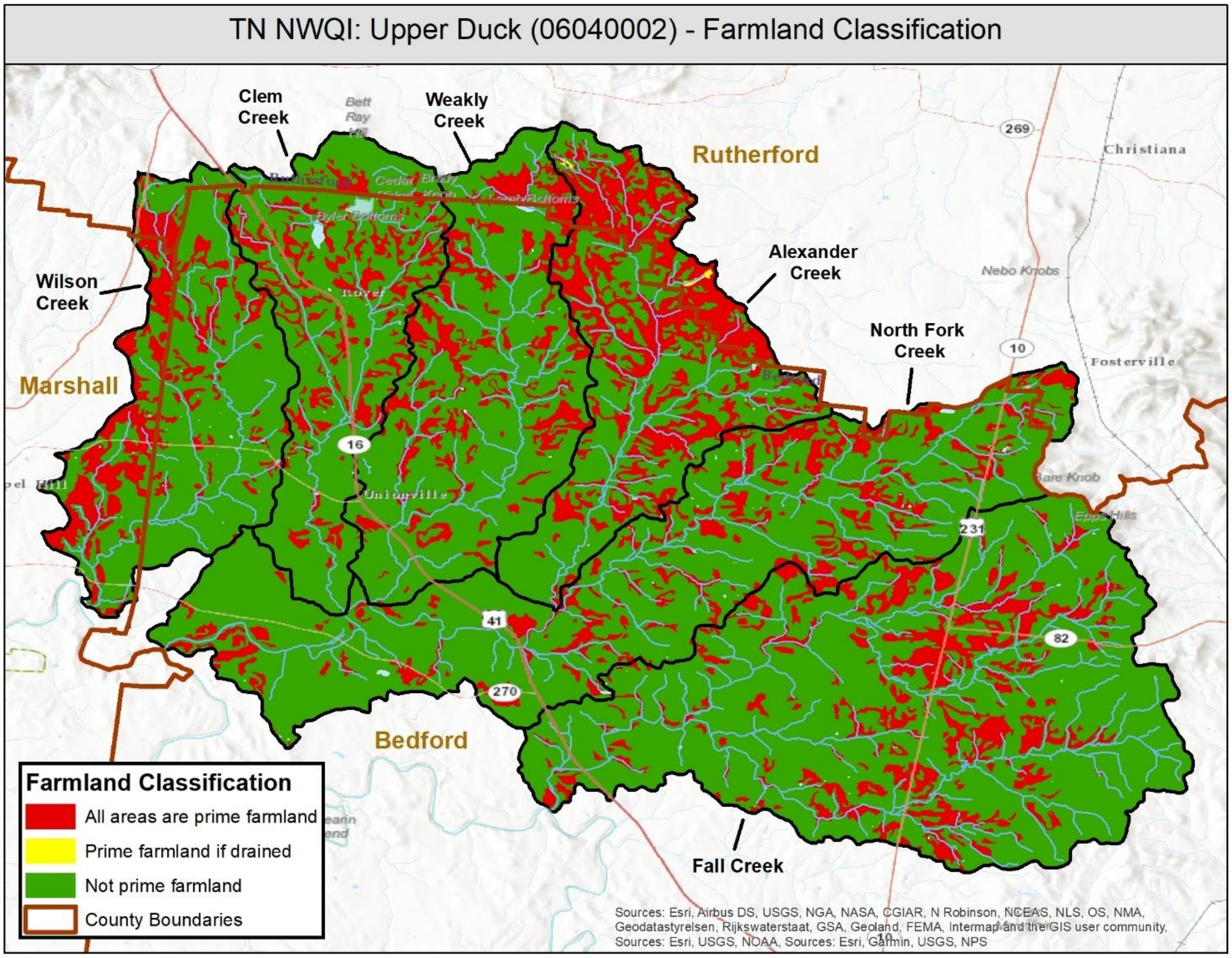

Figure 8: Prime Farmland[16]

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, and few or no rocks. Its soils are permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time, and it either protected from flooding or does not flood frequently during the growing season. Users of the lists of prime farmland map units should recognize that soil properties are only one of several criteria that are necessary. Other considerations include land use, frequency of flooding, irrigation, water table, and wind erodibility (USDA Soil Survey)[16]

Highly Erodible Land Distribution Map

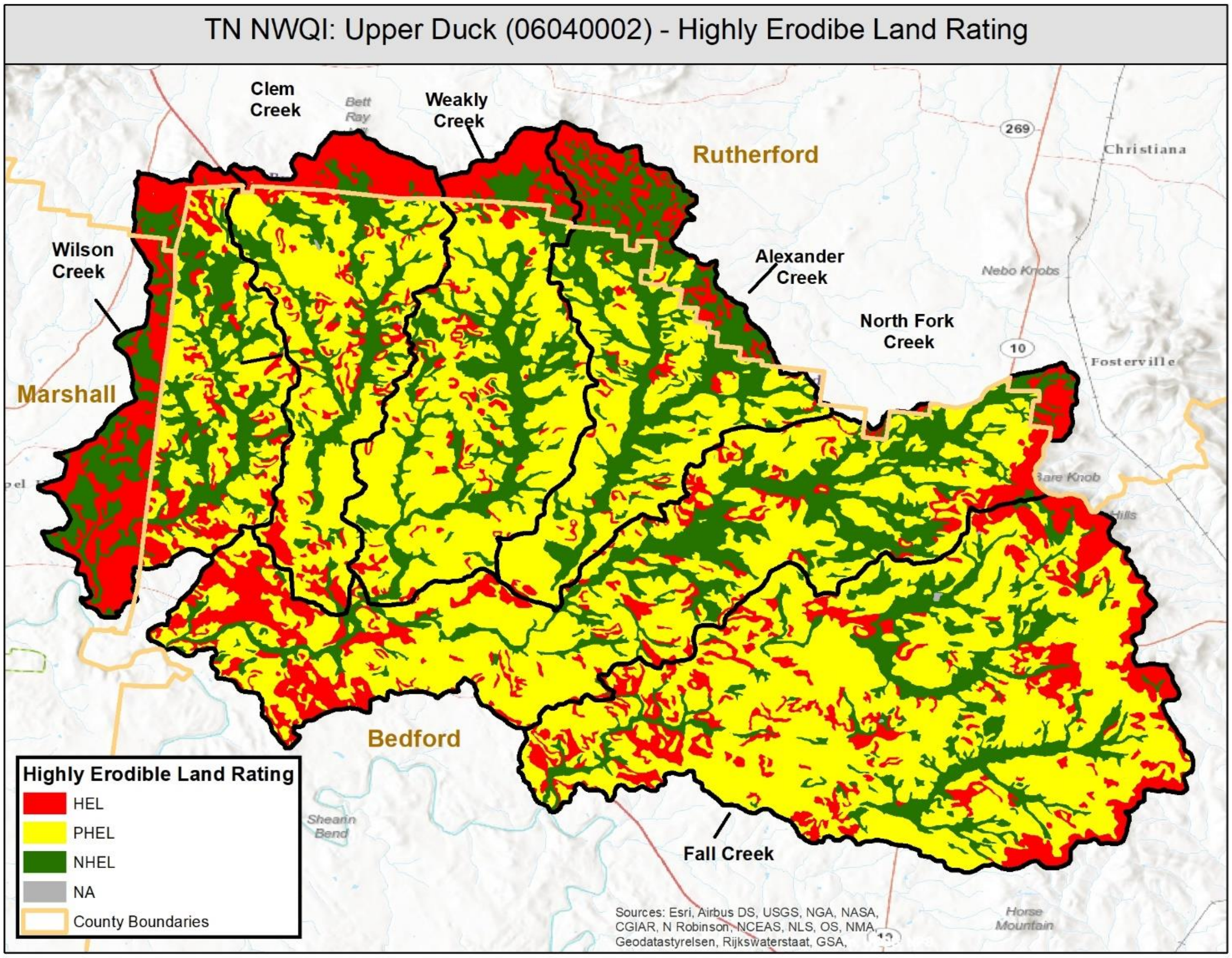

Figure 9: Highly Erodible Land

Highly erodible land is cropland, hay land or pasture that can erode at excessive rates and contains soils that have an erodibility index of eight or more. If a producer has a field identified as highly erodible land, the producer is required to maintain a conservation system of practices that keeps erosion rates at a substantial reduction of soil loss. Fields that are determined as not highly erodible land are not required to maintain a conservation system to reduce erosion. (USDA Soil Survey)[16]

Vulnerable Areas

Watershed areas that are the most prone to impairing water quality and degrading soils are considered "vulnerable". A vulnerability index was formulated by Tennessee NRCS GIS specialists to identify areas that are most likely to contribute to water pollution. The indices are used to determine areas with the highest need for conservation treatment. Indices are calculated from three factors: land capability class, land use, and distance to a stream. Since cropland is the dominant agricultural use, the index was weighted towards resource concerns associated with cropland.

Land Capability Class	Land Use	Distance from Stream
Class 1 – Value 1	Cropland – Value 5	<= 220 Ft. - Value 3
Class 2 – Value 2	Hayland – Value 4	> 220 Ft. - Value 1
Class 3 – Value 3	Pasureland – Value 3	
Class 4 – Value 4	Forest - Value 1	
Class 5 – Value 5	Other - Value 0	
Class 6 – Value 6		
Class 7 – Value 7		
Class 8 – Value 8		

Watershed VI = LCC Value x Landuse Value x Distance from Stream Value

VI Rating	Acres
High	5,000
Medium	23,883
Low	50,172
Not Rated	7,586

Table 5. Acres VI Rating

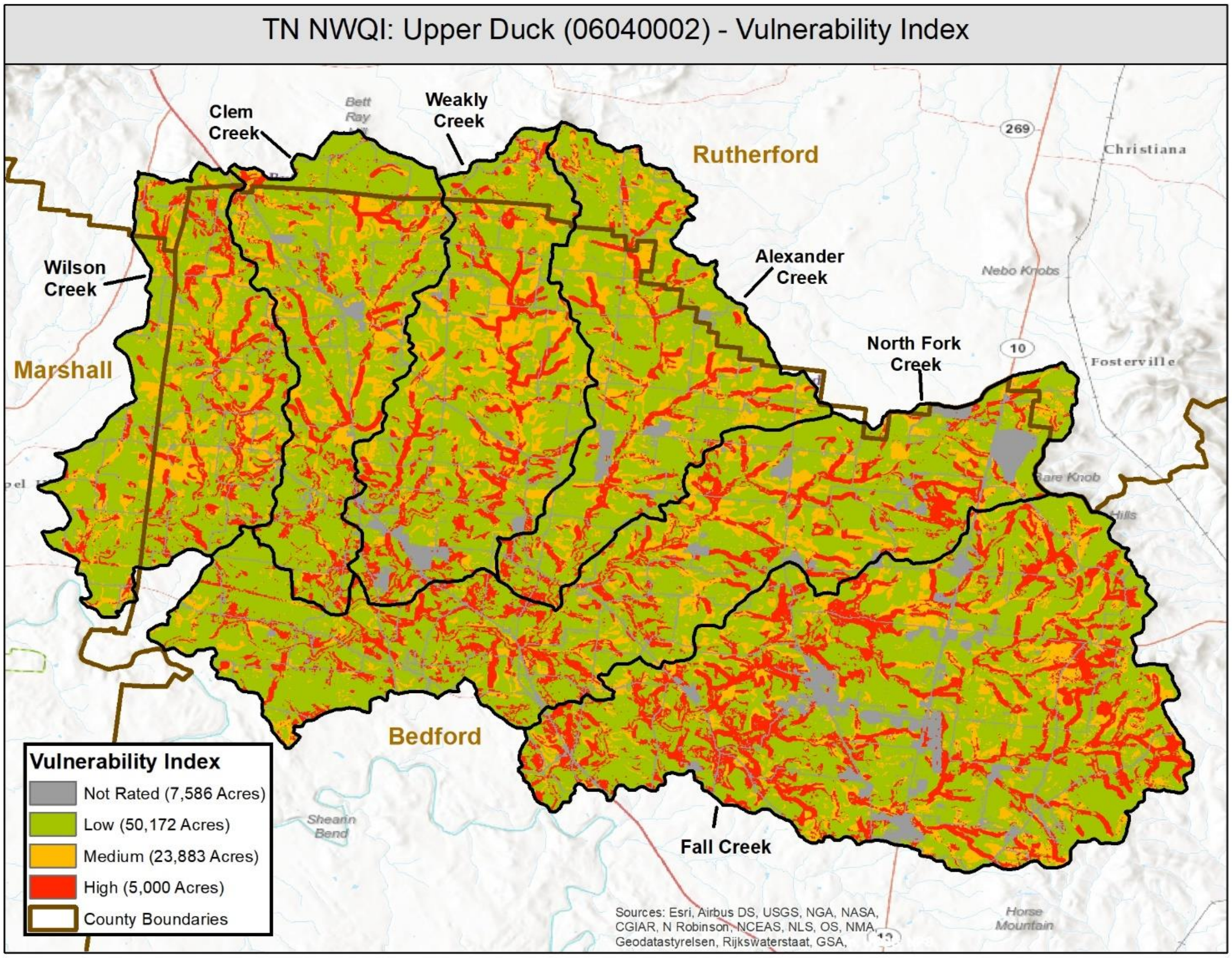

Figure 10: **Vulnerability Index** Red = High; Yellow = Medium; and, Low = Green

Socioeconomic Conditions

The USDA National Agricultural Statistics Service 2017 Census of Agriculture-County Data Summary Highlights, shown below, provides an overview of the number, acres, and types of farms that are in Bedford and Rutherford Counties. Major crops consist of soybean and corn for both counties. Major livestock production in Bedford is poultry.[17]

Bedford County Agriculture Summary
1,430 Farms with 237,842 acres in Farms

Top Crops	Acres
Forage (hay/haylage)	49,204
Soybeans for beans	19,889
Corn for grain	8,677
Wheat for grain	5,578
Corn silage or greenchop	1,613

Major Livestock Production	
Broilers and other	5,494,471
Cattle and Calves	56,120
Goats	2,207
Hogs and pigs	69
Horses and ponies	3,832
Layers	52,317
Pullets	94,669
Sheep and lambs	1,362
Turkeys	94

Rutherford County Agriculture Summary
1,414 Farms with 152,946 acres in Farms

Top Crops	Acres
Forage (hay/haylage)	34,732
Soybeans for beans	10,959
Corn for grain	6,115
Wheat for grain	1,569

Major Livestock Production	
Broilers	1.636
Cattles and calves	27,540
Goats	3,405
Hogs and pigs	792
Horses and ponies	2,438
Layers	7,857
Pullets	989
Sheep and lambs	1,197
Turkeys	86

Table 5. Agriculture Census

Total Producers	Bedford	Rutherford
SEX and AGE		
Total Population	2,346	2,343
Male	1,442	1,412
Female	904	931
<35	135	155
35-64	1,328	1,397
65 and older	883	791
RACE		
White	2,291	2,251
Black or African American	10	65
American Indian	10	12
Asian	18	13
Pacifica Islander	3	-
Hispanic Population Total	34	17
More than one race	14	2

Table 6.[17]

III. Water Quality and Hydrologic Characterization

Water Quality

According to TDEC, the six priority watersheds were monitored through the TDEC Watershed 5 year monitoring process and were found to be impaired. They do not meet the criteria for their designated use, particularly recreational use and fisheries/aquatic life. These pollutants have been identified as pathogens, nutrients sedimentation/siltation and alteration of habitat associated with agricultural activities[5]. Water quality concerns in the priority area are listed in Table 7.

The table below represents the stream status according to TDEC 2020 and stream status at the time of the development of 2004-2006 Total Maximum Daily Loads (TMDLs). Only one stream's impairment, Hurricane Creek, showed improvement from TMDL assessment in 2004 -2006 to the 2020 TDEC stream assessment. Seven miles were taken off of the list of impaired streams. Clem Creek was assessed and noted as impaired during the TMDL process but was not assessed in the TDEC 2020 list.

Water Quality Impairments

The table below provides the pollutant sources and the specific impairment causes listed by the *TN Department of Environment and Conservation's 2020 List of Impaired Streams*. It lists both agricultural and non-agricultural pollutant sources.[6,7.18,19]

TDEC Water Quality ID	Water Body	Miles	Water Quality Parameters	Source	TMDL Developed 2004-06
TN06040002039_0200	Weakly Creek	6.2	ESCHERICHIA COLI (E. COLI)	GRAZING In RIPARIAN	No Change
TN06040002039_0250	Weakly Creek	13.1	SEDIMENTATION/SILTATION	GRAZING In RIPARIAN	No Change
TN06040002039_0250	Weakly Creek	13.1	NITRATE/NITRITE (NITRITE + NITRATE AS N)	GRAZING In RIPARIAN	No Change
TN06040002039_0250	Weakly Creek	13.1	ALTERATION IN STREAM-SIDE	GRAZING In RIPARIAN	
TN06040002039_0250	Weakly Creek	13.1	ESCHERICHIA COLI (E. COLI)	GRAZING In RIPARIAN	No Change
TN06040002039_0300	Alexander Creek	21.1	ESCHERICHIA COLI (E. COLI)	GRAZING IN RIPARIAN	No Change
TN06040002039_0300	Alexander Creek	21.1	SEDIMENTATION/SILTATION	GRAZING IN RIPARIAN	No Change
N06040002039_2000	North Fork Creek	4	ESCHERICHIA COLI (E. COLI)	GRAZING IN RIPARIAN	No Change
TN06040002039_2000	North Fork Creek	4	NUTRIENTS	GRAZING IN RIPARIAN	No Change
TN06040002039_1000	North Fork Creek	3.7	ESCHERICHIA COLI (E. COLI)	GRAZING IN RIPARIAN	No Change
TN06040002039_3000	North Fork Creek	9.2	ESCHERICHIA COLI (E. COLI)	GRAZING IN RIPARIAN	No Change
TN06040002039_3000	North Fork Creek	9.2	SEDIMENTATION/SILTATION	GRAZING IN RIPARIAN	No Change
TN06040002039_3000	North Fork Creek	9.2	NUTRIENTS	GRAZING IN RIPARIAN	No Change
TN06040002039 – 0100	Clem Creek	14.2	ESCHERICHIA COLI (E. COLI)	GRAZING IN RIPARIAN	Not assessed 2020
TN06040002038_1000	Fall Creek	11.4	ESCHERICHIA COLI (E. COLI)	GRAZING IN RIPARIAN	No Change
TN06040002038_0300	Hurricane Creek	22.03	SEDIMENTATION/SILTATION	GRAZING IN RIPARIAN	Change 29.4 miles
TN06040002038_0300	Hurricane Creek	22.03	ALTERATION OF HABITAT	GRAZING IN RIPARIAN	Change 29.4 miles
TN06040002046_1000	Wilson Creek	19.5	ALTERATION OF HABITAT	GRAZING IN RIPARIAN	No Change
TN06040002046_1000	Wilson Creek	19.5	NITRATE/NITRITE (NITRITE + NITRATE AS N)	GRAZING IN RIPARIAN	

Table 7. TDEC List of Impaired Streams

Pathogens

Pathogens are disease-causing organisms such as bacteria or viruses that can pose serious health threats. Many pathogens that are transferred through water are capable of causing serious diseases. The main source is untreated human or animal fecal matters.[20]

Concentrations of *E. Coli*, an indicator species, are measured to determine if criteria of the stream's designated use is being met. High levels during heavy rainfall can be associated with wastewater collection system problems or with large concentrations of livestock and inadequate buffer zones adjacent to streams or rivers. Concentrations of *E. coli* can be elevated under low flow conditions also, especially in areas with failing or inadequate septic systems or places where livestock have direct access to streams or rivers.

Nutrients

Nutrient pollution is one of the most common problem and is costly, particularly related to treating drinking water. Nutrient impacts are related to nitrogen and phosphorus concentrations. Nutrient loading is difficult to reduce, due to source identification, transportation and interaction with soils and geology.

Nutrients promotes algal growth which produces oxygen during daylight hours, but as it algae and organisms decay it uses oxygen at night. This leads to significant diurnal fluctuations in oxygen levels. You might notice floating algal mats or filamentous algae in waters with high nutrient concentrations.

Streams with high nutrients cause aquatic fauna to shift towards species that eat algae and can tolerate dramatic dissolved oxygen fluctuations. This often reduces or eliminate more intolerant (sensitive) or specialized organisms.[20]

Siltation

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.[20]

Soil loss due to land disturbance and stream instability results in tons of fertile soil lost every year. Siltation impacts stream processes, increases flooding, raises the cost of drinking water treatment, and adversely impacts aquatic habitat.[20]

Habitat alteration

Disturbance and changes along stream corridors have a significant impact on both aquatic and terrestrial habitat. Removal of vegetation, whether it is removed mechanically or by livestock, has significant impact on stream corridors and stream stability affecting aquatic and terrestrial species. Riparian vegetation plays an important role in connectivity of habitats and traveling corridors for wildlife species.[20] Riparian vegetation provides:

- A buffer zone that filters sediment and other pollutants from entering the water.

- Roots that stabilize stream banks.
- Habitat for fish and other aquatic life.
- Canopy that shades the stream or river. (This shading keeps water temperatures down and prevents excessive algal growth, which in turn prevents large fluctuations in dissolved oxygen levels.)
- A food source for aquatic invertebrates that eat fallen leaves and for fish that eat insects that fall from trees.

Total Maximum Daily Load (TMDL) Analysis Methodology

States are required to develop TMDLs for water bodies that are not meeting water quality standards. The TMDL process determines the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant. The process determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant. The TMDL may then be used to develop a plan with conservation practices along with other measures to reduce pollution from both point and nonpoint sources in order to restore and maintain the quality of water resources.[21]

TMDL = Sum of Point Sources + Sum of Nonpoint Sources + Margin of Safety

A TMDL is developed for each waterbody/pollutant combination. For example, if one waterbody is impaired or threatened by three pollutants, three TMDLs might be developed for the waterbody. Three TMDLS were developed for the Upper Duck that addressed the priority watersheds.

Three TMDL's have been developed for the Upper Duck. The six priority watersheds are addressed in these documents and will be covered in the next section.

- Total Maximum Daily Load For Fecal Coliform In The Upper Duck River Watershed (HUC 06040002), 2004
- Total Maximum Daily Load For Siltation and Habitat Alteration In The Upper Duck River Watershed (HUC 06040002), 2006
- Total Maximum Daily Load For Low Dissolved Oxygen and Nutrients In The Upper Duck River Watershed (HUC 06040002), 2005

TMDL Analysis Methodology for Pathogens

The TMDL analysis process varies according to pollutant. Pathogen TMDL's are developed using an approach related to flow regime and is referred to as load duration curve. The duration curve analysis allows for characterizing water quality concentrations (or water quality data) at different flow regimes. This method provides a visual display of the relationship between stream flow and loading capacity. Using the duration curve analysis, the frequency and magnitude of water quality standard exceedances, allowable loadings, and size of load reductions are easily presented and can be better understood.

Load duration curve analysis characterizes the hydrologic condition, i.e. wet versus dry and to what degree. Flow duration curves are grouped into several broad categories or zones. These zones provide additional insight about conditions and patterns associated with the impairment. A common way to look at the duration curve is by dividing it into five zones: one representing high flows (0-10%), another for moist conditions (10- 40%), one covering mid-range flows (40-60%), another for dry conditions (60-90%), and one representing low flows (90-100%). One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of *E. coli* by differentiating between point and nonpoint source problems. The load duration curve analysis can be utilized for implementation planning. [21]

Table 8 below represents the load reduction needed to meet the target level for designated use of the priority watershed. All were found to be load precipitation induced nonpoint sources.[7]

Impaired Stream	HUC-12	TMDL Reduction Load to Meet Target
		%
Fall Creek and Hurricane	60400020306	86.2
North Fork	60400020404	87.9
Alexander Creek	60400020401	87.3
Weakley Creek	60400020402	87.1
Clem Creek	60400020403	89.9
Wilson Creek	60400020701	89.3

Table 8. Reduction of Load to Meet Target.[7]

TMDL Analysis Methodology for Nutrients and Sediments

Using numeric criteria is another type of TMDL analysis and is used to determine loading levels for the sediment and nutrient TMDL for the Upper Duck River. TDEC has established in the water quality criteria a numeric value for these pollutants. The reference stream reach approach is used with the numeric criteria. Reference reaches are relatively undisturbed stream segments that can serve as examples of the natural biological integrity of a region.

Detailed information regarding Tennessee ecoregion reference sites can be found in *Tennessee Ecoregion Project, 1994-1999*).[13]

Reference reaches are relatively undisturbed stream segments that can serve as examples of the natural biological integrity of a region. One of the ways to establish criteria (or goal) is the selection of a percentile from the distribution of primary variables of known reference systems. Primary variables include the causal variables of total nitrogen (TN) and total phosphorus (TP), and the response variables, algal biomass as chlorophyll and turbidity or transparency. EPA recommends the use of the 75th percentile value as the reference condition. [21]

The data in the Table 9 represents nutrient concentration goals, corresponding to the 75th percentile data for Level IV ecoregions 71i reference site: [19]

Level IV Ecoregion	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)
71i	0.755	0.160

Table 9. Ecoregion Reference site for Nitrogen and Phosphorous Levels

All of the streams, except for Alexander Creek, were estimated to need reduction in Nutrients.

Estimates of Percent Reduction for Nitrogen and Phosphorus			
Impaired Stream	HUC-12	Nitrogen	Phosphorus
		%	%
Fall Creek and Hurricane	60400020306	44	
North Fork	60400020404	57.9	45.2
Alexander Creek	60400020401	None	
Weakley Creek	60400020402	24.5	
Clem Creek	60400020403	43.3	
Wilson Creek	60400020701	61.9	

Table 10. Estimates of Percent Reduction of Nutrients

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 and aquatic life. [19]

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.

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.

TMDL Analysis Methodology for Siltation/Habitat Alteration

The Watershed Characterization System (WCS) Sediment Tool, an ArcView geographic information system (GIS) based mode,l 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 ecoregion 71i are summarized in Table 11.[18]

Level 4 Ecoregion	Reference Site	Stream	Drainage Area	Average Annual Sediment Load
			(acres)	[lbs/acre/year]
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**

Table 11. Average Annual Sediment Loads of Level IV Ecoregion Reference Sites[18]

Reference streams used by TDEC/WPC indicate that natural stream systems lose an average of nearly 500 pounds of soil per acre per year. However, impaired streams on the 303(d) list are losing 5 to 55 percent more soil per year than the natural streams. Due to the Total Maximum Daily Load (TMDL) studies conducted by TDEC/WPC, streams with severe sediment loading have been identified and can be targeted so that sediment reduction activities can be concentrated to produce the greatest benefit per cost. [22]

Three of the priority watersheds were assessed to need reduction in comparison to the reference site.

Percent Reduction of Nonpoint Source-Average Annual Sediment Load		
Impaired Stream	**HUC-12**	**TMDL Reduction Load to Meet Target**
		%
Fall Creek and Hurricane	60400020306	None
North Fork	60400020404	42.8

Alexander Creek	60400020401	42.8
Weakley Creek	60400020402	42.8
Clem Creek	60400020403	None
Wilson Creek	60400020701	None

Table 12. Percent Reduction of Nonpoint Source-Average Annual Sediment Load

Agricultural Source Areas

An important part of the TMDL process is identifying the sources of the pollutants, both nonpoint and point source. The priority watersheds were addressed in the TMDL process and were found to be impaired by predominantly agriculture. The load allocation was determined for pathogens to be induced by precipitation. There are no municipal and industrial wastewater treatment facilities within the priority watersheds. All of the priority watersheds were analyzed in great detail through the TMDL process between 2004-2006. Water quality monitoring in 2020 found all streams, except for Hurricane Creek were still impaired to the same extent.[7,18,19]

As identified in the previous table, sources of pollutants were associated with agriculture particularly grazing in the riparian area of the streams. According to USCOE Engineers, riparian corridors have been denuded to great extent in the priority watersheds, this directly correlates with habitat alteration and siltation.[22]

Nonpoint sources of coliform bacteria are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of coliform bacteria on land surfaces and wash off as a result of storm events. Nonpoint sources of E. coli loading are primarily associated with agricultural and urban land uses. The majority of waterbodies identified on the 2020 List of Impaired and Threatened Waters as impaired due to E. coli are attributed to nonpoint agricultural.[7]

Agricultural activities are considered to be a significant source of pathogen loading to surface waters. See 2017 Census of Agriculture on page 23 for livestock data for counties within the priority watersheds.

The activities of greatest concern are typically those associated with livestock operations[7]:

- Livestock waste deposited onto land surfaces contains pathogens. This material accumulates during periods of dry weather and during storm events is and transported to surface waters during storm events. The number of animals in pasture and the time spent grazing are important factors in determining the loading contribution. [5]

- Animal waste from confined feeding operations is often applied to land surfaces and can provide a significant source of pathogen loading. Guidance for issues relating to manure application is available through the University of Tennessee Agricultural Extension Service and the Natural Resources Conservation Service (NRCS). [7]

- Livestock and other unconfined animals that have direct access to waterbodies and provide a concentrated source of pathogen loading directly to a stream. Other impacts from livestock in a stream are streambank instability, siltation and nutrient loading.

Concentrated Animal Feeding Operations

Animal Feeding operations (AFO) are agricultural enterprises where animals are kept and raised in confined situations. AFO's typically congregate animals in a small area, where feed, manure and urine collect in a small area. Oppose to the animals grazing, feed is brought to them. CAFO's are AFO's that meet certain criteria with respect to animal type, number of animals and type of manure management system. The operation may meet criteria for CAFO I (large) or CAFO II (medium). CAFO's are considered to be potential point sources of pathogen loading and are required to obtain and NPDES permit. [7]

According 2022 TDEC Data-viewer, there is only one livestock operation located in Clem Creek watershed, that has obtained an individual CAFO permit within the priority watersheds. [23]

Wildlife

Wildlife deposited pathogens can be transported during storm events to nearby streams. The overall deer density for Tennessee was estimated by the Tennessee Wildlife Resources Agency (TWRA) to be 23 animals per square mile. The impaired priority watersheds are not predominantly forested supporting wildlife to exceed the numbers to impact streams. Thus, wildlife has not been identified to have a direct impact in these watersheds.[7]

Failing Septic Systems

Some of the pathogen loading in the priority watersheds can be attributed to failure of septic systems and discharges of raw sewage. Failing septic systems impacts to water quality, ground and surface, are recognized and funding has been provided to support communities with alternative systems in TN. Tracking the source of the pathogen requires more in-depth monitoring and is not available at all monitoring sites. TDA through the 319 Program have successful implemented new systems in watersheds in TN with great success. In middle and eastern Tennessee, it is estimated that there are approximately 2.37 people per household on septic systems, some of which can be reasonably assumed to be failing. As with livestock in streams, discharges of raw sewage provide a concentrated source of coliform bacteria directly to waterbodies. [7]

State of Tennessee Monitoring Sites

Impaired waters are monitored, at a minimum, every five years coinciding with the watershed cycle established by TDEC. Waters that do not support fish and aquatic life are sampled once for macroinvertebrates (semi-quantitative sample preferred) and monthly for many of the listed pollutant(s). Streams with impacted recreational uses, such as those impaired due to pathogens are sampled monthly for *E coli*. Another acceptable sampling strategy for *E. coli* is an approach in which an initial geometric mean is collected (5 samples within a 30-day period) in the first quarter. If the geomean is well over the existing water quality criterion of 126 colony forming units, the waterbody remains impaired with no additional *E. coli* sampling needed. If the geomean results meet the water quality criterion, staff will continue with monthly samples during the remainder of the monitoring cycle. If the geomean is not substantially over the criterion, field staff may at their discretion continue monthly monitoring in the hope that additional samples will indicate that the criterion is met.[7]

The maps below show the location of the TDEC monitoring sites.[23] The priority watersheds have 26 monitoring sites. TDEC's last monitoring date for Upper Duck on the five-year cycle was in 2019-2020 and will be monitored again in 2024 and 2025. Water quality monitoring is also conducted on a need to basis. Chemical, biological, physical and bacterial data from other government entities, such as TVA, TWRA, Corps of Engineers, and US Geological Survey, is also provided to support the watershed assessment process.

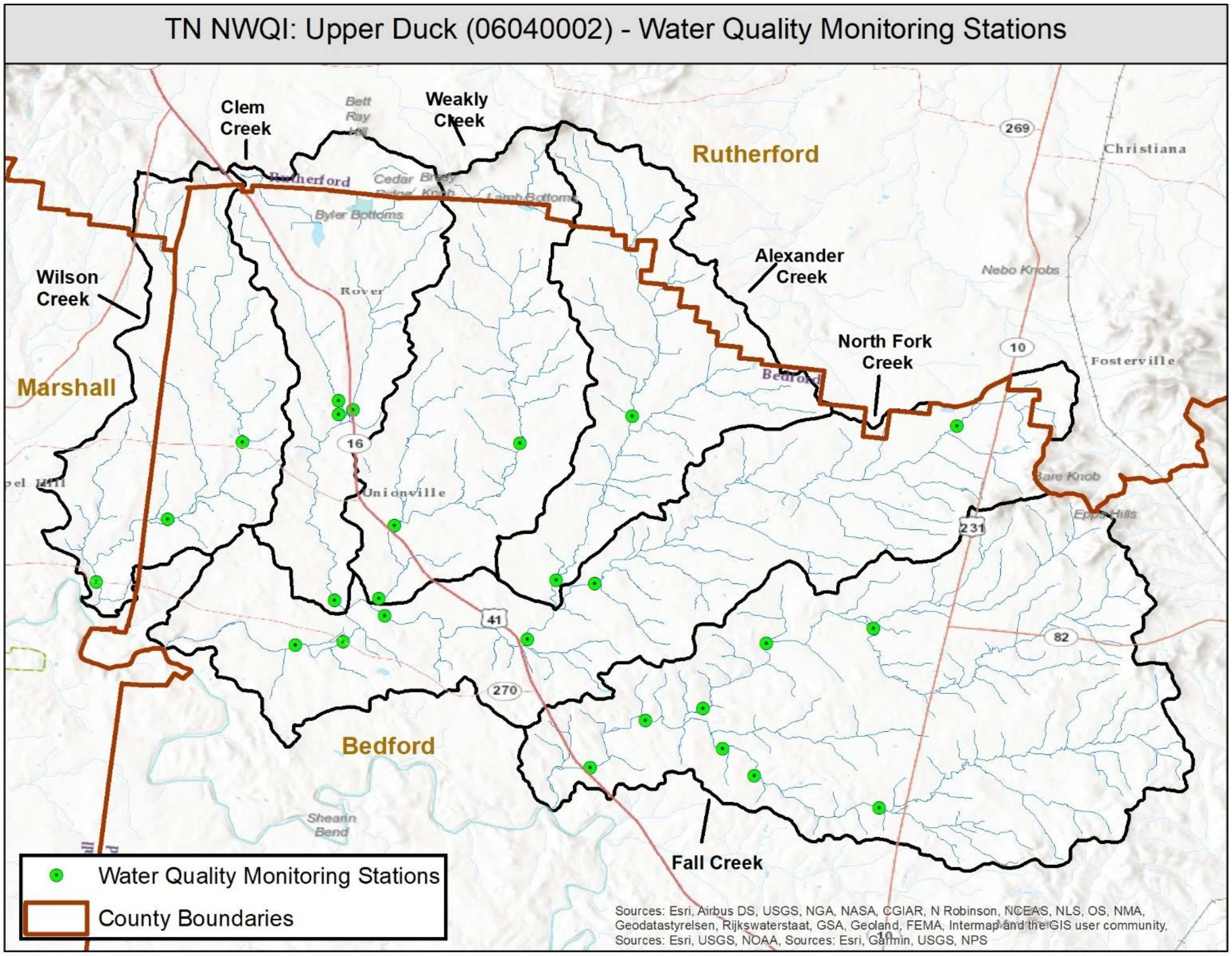

Figure 11: Map Monitoring Sites[23]

IV. Resource Analysis/Source Assessment

Analysis and Monitoring Tools

Prior to and during the installation of conservation practices, the following tools may be used to determine relevant agriculture related resource conditions and to measure improvement of soil and water resources: SVAP2, RUSLE 2, GIS analysis, Vulnerability Index and treatment of acres identified as high and medium.

Determining source through TMDL Strategies

Implementation strategies for developing TMDL's are organized according to the dominant land use type and the sources associated with each (see table below). The 12 digit sub-watershed is grouped and targeted for implementation based on this source area organization. Since the focus of NRCS is related to Agriculture, only the agricultural TMDL analysis is represented in Table 13. Agricultural is defined as cropland and pasture, with predominant source categories associated with livestock and manure management activities.

Conservation Practice Needs

The table below represents implementation strategies for *E. coli* and Nutrient load reduction in impaired waterbodies impacted by agriculture. The list of agriculture practices corresponds with the potential effectiveness under each hydrologic flow zones.[7]

Practice names do not reflect **NRCS terminology of practices,** table developed according to **TDEC TMDL analysis.**[7]

Flow Condition	High	Moist	Mid-range	Dry	Low
Percent Time Flow Exceeded	0-10	10-40	40-60	60-90	90-100
Grazing Management					
Prescribed Grazing	**H**	**H**	**M**	**L**	
Pasture & Hayland Mgmt	**H**	**H**	**M**	**L**	
Deferred Grazing	**H**	**H**	**M**	**L**	
Planned Grazing System	**H**	**H**	**M**	**L**	
Proper Grazing Use	**H**	**H**	**M**	**L**	
Proper Woodland Grazing	**H**	**H**	**M**	**L**	
Livestock Access Limitation					
Livestock Exclusion			**M**	**H**	**H**
Fencing			**M**	**H**	**H**
Stream Crossing			**M**	**H**	**H**
Alternate Water Supply					
Pipeline			**M**	**H**	**H**
Pond			**M**	**H**	**H**
Trough or Tank			**M**	**H**	**H**

Well			**M**	**H**	**H**
Spring Development			**M**	**H**	**H**
Manure Management					
Managing Barnyards	**H**	**H**	**M**	**L**	
Manure Transfer	**H**	**H**	**M**	**L**	
Land Application of Manure	**H**	**H**	**M**	**L**	
Composting Facility	**H**	**H**	**M**	**L**	
Vegetative Stabilization					
Pasture & Hayland Planting	**H**	**H**	**M**	**L**	
Range Seeding	**H**	**H**	**M**	**L**	
Channel Vegetation	**H**	**H**	**M**	**L**	
Brush (& Weed) Mgmt	**H**	**H**	**M**	**L**	
Conservation Cover		**H**	**H**	**H**	
Riparian Buffers		**H**	**H**	**H**	
Critical Area Planting		**H**	**H**	**H**	
Wetland restoration		**H**	**H**	**H**	
CAFO Management					
Waste Management System	**H**	**H**	**M**		
Waste Storage Structure	**H**	**H**	**M**		
Waste Storage Pond	**H**	**H**	**M**		
Waste Treatment Lagoon	**H**	**H**	**M**		
Mulching	**H**	**H**	**M**		
Waste Utilization	**H**	**H**	**M**		
Water & Sediment Control Basin	**H**	**H**	**M**		
Filter Strip	**H**	**H**	**M**		
Sediment Basin	**H**	**H**	**M**		
Grassed Waterway	**H**	**H**	**M**		
Diversion	**H**	**H**	**M**		
Heavy Use Area Protection					
Constructed Wetland					
Dikes	**H**	**H**	**M**		
Lined Waterway or Outlet	**H**	**H**	**M**		
Roof Runoff Mgmt	**H**	**H**	**M**		
Floodwater Diversion	**H**	**H**	**M**		
Terrace	**H**	**H**	**M**		

Potential for source area contribution under given hydrologic condition (H: High; M:Medium; L: Low)

Table: 13: Effectiveness of Conservation Practices according to TDEC TMDL for Pathogens

Previous Participation and Practice Implementation 2011-2021 with EQIP funding

The table below represents practices that have been implemented between 2011-2021 through USDA NRCS Environmental Quality Incentives Program (EQIP) in the priority sub-watersheds. These numbers indicate landowners' interest in conservation efforts in the priority area due to past participation. The fact that some of these practices have not been implemented at higher numbers suggest a large percentage of acres within the watershed are in need of conservation practices, particularly those impacting water quality. Many of the practices to be implemented through NWQI such as riparian buffers, cover crops, watering facilities and prescribed grazing will be implemented in the critical source areas.[24]

Practice	Amount	Unit
Access Control	126	ac
Composting Facility	5	no
Comprehensive Nutrient Management Plan	79	no
Conservation Crop Rotation	288	ac
Cover Crop	3,442	ac
Fence	891	ft
Forage and Harvest Management	95	ac
Grassland Conservation Initiative	186	ac
Heavy Use Area Protection	231	Sq ft
Livestock Pipeline	763	ft
Nutrient Management	107	ac
Pasture and Hay Planting	108	ac
Pest Management Conservation	91	ac
Prescribed Grazing	770	ac
Pumping Plant	51	no
Residue and Tillage Management	297	ac
Stream Crossing	47	no
Upland Wildlife Habitat Management	73	ac
Waste Storage Facility	5	no
Water Well	2	no
Watering Facility	586	no

Table 14. Practices implemented 2011-2021[23]

Types of Conservation Practices, Costs, and Extent Needed

The table below lists the conservation practice standards needed to treat identified pollutant sources, according to the TMDL analysis of practice and pathogen occurrence related to precipitation.[25]
Estimated number of conservation practices to be implemented within the next four years as recommended

by NRCS field staff.[25]

Practice Number	Practice Name	Impairment Source Treated	Number of Practices Needed
313	Waste Storage Facility	Pathogens/Sedimentation	28,000
367	Roofs and Covers	Sedimentation/Nutrients	28,000
558	Roof Runoff Structure	Sedimentation/Nutrients	20,000
340	Cover Crop	Sedimentation/Nutrients	3,200
638	Water and Sediment Control Basin	Sedimentation/Nutrients	10,000
410	Grade Stabilization Structure	Sedimentation/Nutrients	4,000
528	Prescribed Grazing	Pathogens/Sedimentation	1,200
620	Underground Outlet		4,000
580	Streambank Stabilization	Sedimentation	400
342	Critical Area Planting	Sedimentation	40
484	Mulching	Sedimentation	40
382	Fence	Pathogens/Sedimentation	16,000
561	Heavy Use Area	Sedimentation	26,928
614	Watering Facility	Pathogens/Sedimentation	48
512	Forage and Biomass Planting	Sedimentation	160
516	Livestock Pipeline	Pathogens/Sedimentation	10,000
666	Forest Stand Improvement	Sedimentation	400
314	Brush Management	Habitat	400

Table 15. Practices Needed[25]

NEPA Analysis

Prior to practice implementation with USDA NRCS assistance, an NRCS-CPA-52 Environmental Evaluation form will be completed for each practice. If resource concerns are found, NRCS will contact the responsible agency for the resource. Agencies will include, but are not limited to, US Fish and Wildlife Service, Tennessee Wildlife Resource Agency, TN Department of Environment and Conservation, and State Historic Preservation Office.

V. Summary and Recommendations

The Upper Duck priority watersheds plan focuses on treatment of agricultural pollutant sources with an emphasis on pastureland and cropland. Selection of agricultural practices previously noted will help reduce pathogens, nutrients, siltation and improve habitat. NRCS personnel will be available to assist landowners within these watersheds providing a suite of conservation practices in a plan.

NRCS conservation practices are available to treat the agricultural-related sources of the water quality impairments. NRCS personnel are available to assist landowners within these watersheds.

Although USDA NRCS cannot provide financial assistance to treat *non-agricultural* water quality sources, it can promote agricultural practices and systems that may be adopted for non-agricultural use and have positive effects on local streams and watersheds and provide educational events and field days that are tailored to include non-ag persons, civic organizations, and students.

VI. Outreach Plan

Activities Impacting all Producers

Task	Responsible Person	Audience	Quarter
Outreach Kick Off Meeting	ECS Staff	Partners	Q4 2022
Outreach Local Meeting	ECS Staff / SCD/ Local NRCS State Outreach Coordinator	Landowners	Q4 2022
Consolidated Mail List	ECS Staff	Landowners	Q4 2022
Media Releases	PAS	Landowners	Q1 2023
Talking Points	ECS / PAS Staff	Landowners	Q1 2023
Benefit / Conservation Plans	ECS Staff	Landowners	Q2-3 2023

Table 16. Outreach Table

Partnerships

TN-NRCS has successful partnerships. Soil and Water Conservation Districts in these watersheds are active and strongly support conservation. Along with many other partners, they have created pathways of communication that improve conservation and help deliver conservation work that improves stream and floodplain habitats and improves water quality. Below are a few of the partnerships within the priority watersheds.

Tennessee Department of Agriculture (TDA)

Tennessee Wildlife Resources Agency (TWRA)

The Nature Conservancy (TNC)

Tennessee Dept. of Conservation and Environment (TDEC), Water Resources

Tennessee Dept. of Conservation and Environment (TDEC), Water Supply Program

Tennessee Dept. of Conservation and Environment (TDEC), Natural Heritage

U.S. Fish and Wildlife Service

U.S. Corps of Engineers (USCOE)

Tennessee Duck River Development Agency.

The Duck River Watershed Association works to preserve, protect, enhance, and restore the ecological health and biodiversity of the Duck River and the natural resources within its watershed for the people, aquatic life and wildlife who depend on it. Their goal is to accomplish this through advocacy, education, community activities and involvement, and identifying and studying potential threats to the watershed system.

The Nature Conservancy has worked on the Duck River since 1999 with local communities, businesses, and government agencies to ensure the long-term protection of the river's water quality and ecological integrity. Strategies pursued over the years include:

- Working with farmers to implement conservation practices on agricultural land.
- Protecting riparian areas with conservation easements.
- Spearheading restoration efforts that reduce sedimentation in the watershed.
- Promoting development of greenways and increased access to the river.

Local citizen-led and implemented conservation practices have the potential to provide the most efficient and comprehensive approach for reduction of loading rates from nonpoint sources.

VII. Footnotes/Bibliography

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