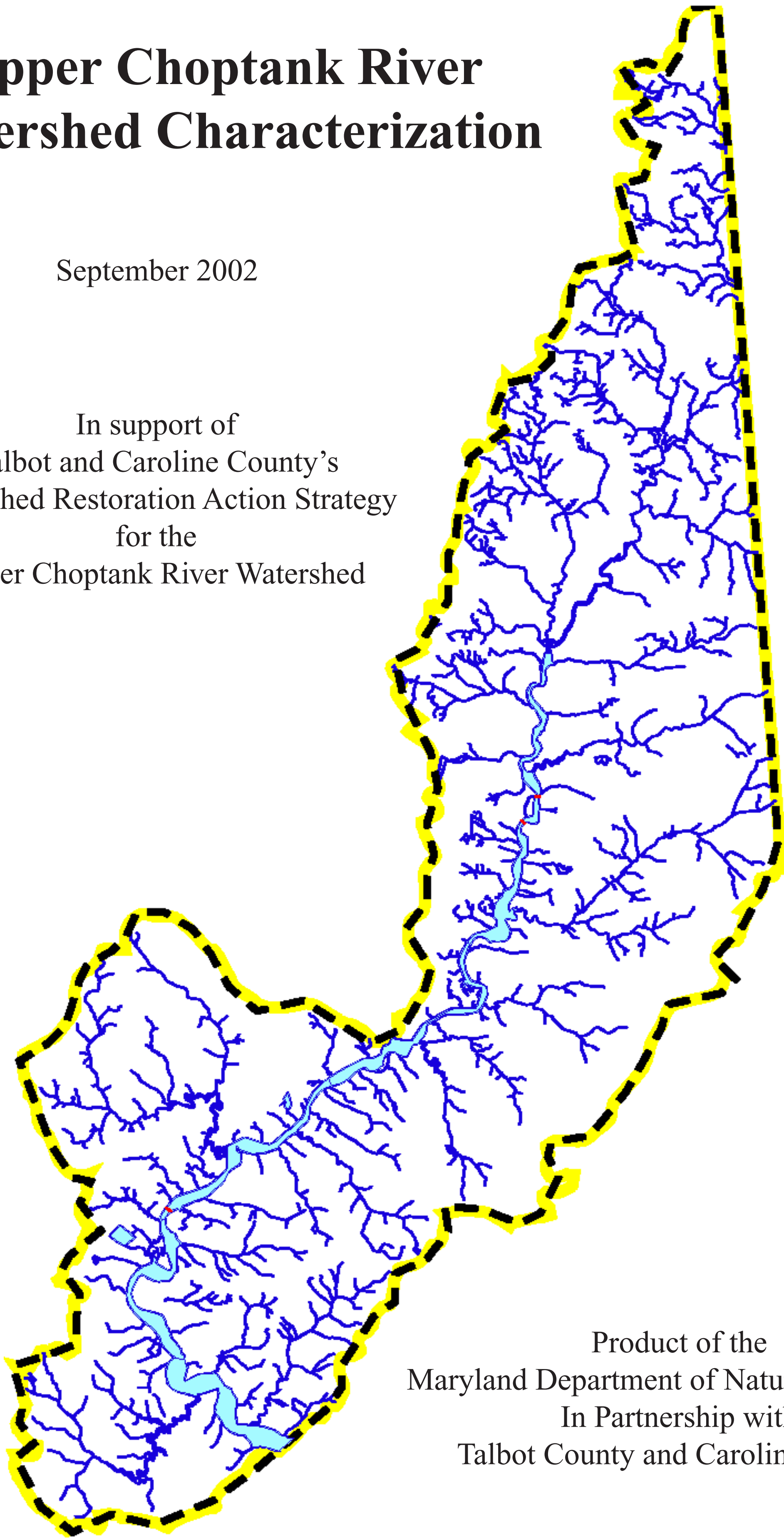
Upper Choptank River Watershed Characterization

September 2002

In support of
Talbot and Caroline County's
Watershed Restoration Action Strategy
for the
Upper Choptank River Watershed



Product of the
Maryland Department of Natural Resources
In Partnership with
Talbot County and Caroline County

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A message to Maryland's citizens

The Maryland Department of Natural Resources (DNR) seeks to preserve, protect and enhance the living resources of the state. Working in partnership with the citizens of Maryland, this worthwhile goal will become a reality. This publication provides information that will increase your understanding of how DNR strives to reach that goal through its many diverse programs.

J. Charles Fox
Secretary

Karen M. White
Deputy Secretary

Maryland Department of Natural Resources
Tawes State Office Building
580 Taylor Avenue
Annapolis, Maryland 21401-2397

Toll free in Maryland: 1-877-620-8DNR x8611
Out of state call: 410-260-8611
www.dnr.state.md.us

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For the Upper Choptank Characterization

Talbot and Caroline Counties in Maryland are receiving Federal grant funding and State technical assistance to prepare a Watershed Restoration Action Strategy (WRAS) for their portions of the Upper Choptank River watershed. The WRAS project area encompasses about 162,000 acres which is 72% of the entire Upper Choptank River watershed. Portions of the watershed in Delaware and Queen Annes County, Maryland, are being considered in the WRAS project but these jurisdictions are not active partners in developing the WRAS.

As part of WRAS project, the Maryland Dept. of Natural Resources (DNR) is providing technical assistance. For example, DNR is working with the Counties to prepare a Watershed Characterization which is a collection of available water quality related information and identification of issues that may be used as the County generates its Watershed Restoration Action Strategy.

Water Quality

Overall, water quality as measured by some parameters like dissolved oxygen is frequently satisfactory. However, water quality impairments associated with nutrients and sediment have existed for many years. They appear to be causing high algae populations (chlorophyll *a*) and poor water clarity (shallow secchi depth). The nutrient impairment is linked to significant loads from both point and nonpoint sources. A fecal coliform impairment in limited areas do not have a currently identified source. These impairments will be the subject of Total Maximum Daily Load (TMDL) programs within the next few years. Biological impairments in some water bodies as measured by benthic macroinvertebrate community assessment appear to be local in nature.

Land Use / Land Cover

The Upper Choptank River watershed in Maryland is nearly 60% agricultural and nearly 30% forest or brush. Only about 8% of the watershed is developed. Land use / land cover upstream of the WRAS project area in Delaware are less intensively used: 50% agriculture, 45% forest, 3% developed. Large areas of agricultural and developed lands are on hydric soil and/or poorly drained soil which is drained by Public Drainage Association ditches. Maintenance of these ditches is central to continuation of much of the current economic activity in the watershed.

Living Resources and Habitat

The Upper Choptank River contains a valuable fisheries resource. It ranks as the third most important striped bass spawning and nursery area in the Chesapeake Bay watershed in terms of size and productivity. In the Upper Choptank, most fish species appear to be stable or doing well. For example, a survey of tidal large mouth bass found the population to be stable or slowly increasing over the three-year study period 1999 through 2001. However, a fish consumption advisory recommends limiting consumption of channel catfish and white perch caught in the mainstem of the Choptank River due to PCB and/or pesticide contamination.

Assessment nontidal streams based on benthic macroinvertebrate communities found that more than 60% of the sites assessed rated as poor or very poor. Assessment of the same stream segments based on fish communities rated more than 60% of the sites as good or fair. These differences indicate that fish, in general, can inhabit maintained ditches more readily than benthic organisms.

Beds of submerged aquatic vegetation (SAV) in the Upper Choptank River are small and limited to narrow areas along the river's shoreline. SAV is limited by poor water clarity in much of it potential habitat.

Restoration Targeting Tools

A synopic survey and benthic community assessment of nontidal streams is collecting data was conducted in 2002. It will assist is identifying areas with issues regarding water quality and benthic macroinvertebrates. A stream corridor assessment is being considered that would identify conditions that potentially impact waters quality and habitat using teams walking along waterways.

Four blockages to fish movement have been eliminated in recent years but at least 21 blockages are identified as opportunities for restoration.

GIS scenarios were generated to assist in targeting opportunities for restoring stream buffers and wetlands. Hydric soils were used as a key targeting element as well as land use. Based on this analysis of the Upper Choptank River watershed in Maryland, there are over 26,500 acres of wetlands and nearly 43,000 acres of hydric soils. Nearly 24,000 acres of hydric soils were being used as cropland in 2000. This suggests that many opportunities for restoration may be available depending upon land owner interests. A subset of these potential opportunities, about 7,300 acres of hydric soils are within 300 feet of existing wetlands.

CONTRIBUTORS TO THE WATERSHED CHARACTERIZATION

Local Representatives	Raymond Clarke — Talbot County Dept. of Public Works Betsey Krempasky — Caroline County Planning and Code Administration Shane Johnston — Caroline County Planning and Code Administration Matt Kropp — Talbot County Dept. of Planning and Zoning
Maryland Department of Natural Resources (DNR)	Chesapeake and Coastal Watershed Service Katharine Dowell, Kathleen Freeman, Greta Guzman, Susan Phelps-Larcher, Catherine Rappe, Ted Weber, John Wolf Fisheries Service Harley Speir, Rick Schaefer, Brett Coakley, Chris Judy, Jim Thompson Public Lands John Dulaney Resource Assessment Service (RAS) Ron Klauda, Sherm Garrison, Martin Hurd, Thomas Parham, Renee Karrh
Other Representatives	Maryland Dept. of Agriculture (MDA) - John Roderick, Bonita Sims Maryland Department of the Environment (MDE) - Robert Daniel, Patrick Dinicola Maryland Department of Planning (MDP) - Deborah Weller U.S. Fish & Wildlife Service (USFWS)

Editor and Primary Author

Ken Shanks, Watershed Management and Analysis Division
Chesapeake and Coastal Watershed Service
Maryland Department of the Natural Resources

INTRODUCTION

Watershed Selection

Maryland's Clean Water Action Plan, completed in 1998, identified water bodies that failed to meet water quality requirements. As part of the State's response, the Maryland Department of Natural Resources (DNR) established a program to offer funding and technical assistance to Counties willing to work cooperatively to devise and implement a Watershed Restoration Action Strategy (WRAS) for the impaired water bodies.[1,2]

Talbot and Caroline Counties are participating in the second round of the WRAS program. The portions of the Upper Choptank Watershed in these Counties are the area selected for restoration. This watershed has several key physical characteristics:

- The Upper Choptank is entirely in the Mid Atlantic coastal of Maryland's Eastern Shore;
- The watershed is predominantly rural and agricultural with significant forest, small towns and pockets of suburban development;
- Open waters of the Upper Choptank mainstem exhibit limited tidal influence. They receive fresh water input from numerous sluggish tributaries including many that are ditched.

Location

The Upper Choptank watershed is part of the Choptank River basin as shown in Map 1 Regional Context. It extends through three Maryland Counties and into Delaware as shown in Map 2 County Context For WRAS. As the adjacent table indicates, the majority of the watershed is in Talbot and Caroline Counties, Md. These two counties are the focus of the Watershed Restoration Action Strategy which is shown in Map 3 WRAS Project Area. For analytical purposes, DNR has divided the Upper Choptank into 44 subwatersheds as shown in Map 4A, Map 4B, and Map 4C.

Upper Choptank Watershed Acreage Summary

Area	Land	Water	Total
Talbot County	36,397	1,607	38,004
Caroline County	120,655	3,133	123,788
Queen Annes Co	1,932	0	1,932
Delaware	61,000	0	61,000
Watershed Total	219,984	4,740	224,724

Purpose of the Characterization

One of the earliest steps toward devising a Watershed Restoration Action Strategy is to characterize the watershed using immediately available information. This Watershed Characterization is intended to meet several objectives:

– briefly summarize the most important or relevant information and issues
– provide preliminary findings based on this information
– identify sources for more information or analysis
– suggest opportunities for additional characterization and restoration work.

Additional Characterization Recommended

The Watershed Characterization provides a foundation for developing strategies that can be implemented over time to improve water quality. It is part of a framework for a more thorough assessment involving an array of additional inputs:

– self-investigation by the local entity of existing programs and policies
– targeted technical assistance by partner agencies or contractors
– input from local stakeholders
– Stream Corridor Assessment, i.e. physically walking the streams and cataloguing important issues, is part of the technical assistance offered by DNR
– Synoptic water quality survey, i.e. a program of water sample analysis, can be used to focus on local issues like nutrient hot spots, point source discharges or other selected issues. This is also part of the technical assistance offered by DNR.

Identifying Gaps in Information

It is important to identify gaps in available watershed knowledge and gauge the importance of these gaps. One method is to review available information in the context of four physical / biological assessment categories that have been successfully applied in other watershed restoration efforts. These are the main categories that impact aquatic biota:

– Habitat: physical structure, stream stability and biotic community (including the riparian zone)
– Water Quantity: high water - storm flow & flooding; low water - baseflow problems from dams, water withdrawals, reduced infiltration
– Water Quality: water chemistry; toxics, nutrients, sediment, nuisance odors/scums, etc.
– Cumulative effects associated with habitat, water quantity and water quality.

Adaptive Management

In addition, the Watershed Characterization and the Watershed Restoration Action Strategy should be maintained as living documents within an active evolving restoration process. These documents will have to be updated periodically as new, more relevant information becomes available and as the watershed response is monitored and reassessed. This type of approach to watershed restoration and protection is often referred to as “adaptive management.”

WATER QUALITY

Priority for Restoration and Protection

The 1998 *Maryland Clean Water Action Plan* established priorities for watersheds in the State water quality restoration and protection. In the Plan, the Upper Choptank River watershed was included in two categories for priority action:

- Category 1 Priority watershed (highest State priority for restoration)
- Category 3 watershed (indicates that protection us needed for identified resources)

As the basis for the prioritization, indicators of water quality, landscape and living resources were developed for all watersheds in Maryland. These indicators are described in greater detail in separate sections in this watershed characterization.

Designated Uses

All waters of the State are assigned a "Designated Use" in regulation, COMAR 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. These designated uses may or may not be served now but they should be attainable. All surface waters in the Upper Choptank River watershed are designated Use I for Water Contact Recreation, and Protection of Aquatic Life. Waters designated as Use II for Shellfish Harvesting in the Choptank River are located in estuarine waters downstream of the Upper Choptank River watershed. Map 5 Designated Uses shows that Use I water encompass the entire Upper Choptank watershed. For official regulatory information, please see either COMAR or contact MDE. [3,4]

Not Supporting Designated Use – 303(d) Listings

Some Upper Choptank River watershed water bodies are identified as "impaired waters" by listings in the *Draft Maryland's 2002 303(d) List* summarized below. Satisfactory completion of a public comment period and approval by US EPA is required before the list can be finalized later in 2002. Each water body listed in the table may require preparation of a Total Maximum Daily Load (TMDL) to address the water quality and/or habitat impairment.[4]

Draft 2002 303(d) List of Impaired Waters Upper Choptank River Watershed Summary[4]			
Name Stream or Watershed	Impairment	Sources	Priority
Choptank Marine Beach	Fecal coliform bacteria	Nonpoint sources	high
Upper Choptank Watershed	Nutrients	Point, Nonpoint, Natural	low
Upper Choptank Watershed	Sediments	Point, Nonpoint, Natural	low
Stream segments in Talbot County: Beaverdam Branch and unnamed tributaries to Miles Creek Stream segments in Caroline County: Burrsville Br., Coolspring Br., Gravelly Br., Oldtown Br., Tidy Island Ck & an unnamed tributary to it, and unnamed tributaries to each of Andover Branch, Choptank River, Forge Branch and Herring Run	Biological	Unknown	low

These listings mean that pollution associated with the impairment listed are preventing full use of these water bodies based on State criteria.

A statewide assessment of water quality is required under Section 303(d) of the Federal Clean Water Act. As part of the assessment, Maryland tracks waterways that do not support their designated use in a list of "impaired waters" and in a prioritized list of "Water Quality Limited Basin Segments" also known as the 303(d) priority list. Information considered in setting the 303(d) list priorities include, but is not limited to, severity of the problem, threat to human health and high value resources, extent of understanding of problem causes and remedies.[5]

Total Maximum Daily Loads

The Maryland Department of the Environment (MDE) uses the 303(d) priority list to help set State work schedules for various programs including establishment of Total Maximum Daily Loads (TMDLs). The intent of establishing one or more TMDLs for a water body is to estimate a pollutant load that the water body can assimilate and still meet water quality standards. Then a waste load allocation is generated to identify appropriate pollution reduction needs among current pollutant sources.

Based on January 2002 modeling load projections, 2006 is MDE's target year for establishing a fecal coliform TMDL to protect the Choptank Marine Beach. The January 2002 modeling load projection did not include a schedule for nutrient or sediment TMDLs for the Upper Choptank River.

In general, TMDLs include several key parts:

1- Existing conditions for pollutant loads (pounds per day) and pollutant sources.

2- Maximum pollutant load that the water can accept and while still allowing the water body to meet its intended use.

3- Allocation of the maximum pollutant load (#2 above) to specific pollutant sources.

To ensure that TMDLs are not exceeded, programs developed by the State and local governments need to be implemented to address pollutant reduction.

Why Are Local Waters Impaired?

Nutrients. In Maryland, most water bodies naturally have low levels of the nutrients nitrogen or phosphorus. These nutrients enter waterways from all types of land uses and from the atmosphere. Nutrient pollution or over-enrichment problems may arise from numerous sources. For example, residential land can be an important contributor of nutrients depending on fertilizer use, extent of lawn and the working condition and location of septic systems. Many farmers carefully manage nutrients using different approaches, so nutrients entering waterways from crop land varies greatly depending on management techniques. Typically, smaller amounts of nutrients reach surface waters from an acre of forest land than from an acre of other types of land. The atmosphere can contribute various forms of nitrogen arising from manmade sources such as the burning of fossil fuels in power plants and from automobile exhaust.

Suspended Sediment. Most unpolluted streams and tidal waters naturally have limited amounts of sediment moving "suspended" in the water. Excessive amounts of suspended sediment in waterways are considered pollution because they can inhibit light penetration, prevent plant growth, smother fish eggs, clog fish gills, etc. Sediment in streams tends to arise from stream bed and bank erosion and from land that is poorly vegetated or disturbed. Suspended sediment pollution may arise from construction sites, crop land, bare ground and exposed soil generally. The amount of sediment conveyed to a stream varies greatly site to site depending upon stream stability, hydrology, management controls and other factors.

Fecal Coliforms. One class of bacteria typically found in the digestive tract of warm-blooded animals, including humans, is known as fecal coliforms. Fecal coliform bacteria are always found in animal waste and human sewage (unless it is treated to kill them). In unpolluted streams and tidal waters, water samples commonly contain very few of these bacteria. Water samples exhibiting significantly larger fecal coliform bacteria populations are "indicators" of contamination by fecal material. Depending on local conditions, sources of fecal contamination may include any combination of the following: inadequately treated sewage, failing septic systems, wild or domestic animals, urban stormwater carrying pet waste and similar sources.

National Academy Press, Clean Coastal Waters (2000)
What Are the Effects of Nutrient Over-Enrichment? [6]

The productivity of many [lake, estuary and] coastal marine systems is limited by nutrient availability, and the input of additional nutrients to these systems increases primary productivity [microscopic organisms including algae]. In moderation in some systems, nutrient enrichment can have beneficial impacts such as increasing fish production; however, more generally the consequences of nutrient enrichment for coastal marine ecosystems are detrimental. Many of these detrimental consequences are associated with eutrophication.

The increased productivity from eutrophication increases oxygen consumption in the system and can lead to low-oxygen (hypoxia) or oxygen-free (anoxic) water bodies. This can lead to fish kills as well as more subtle changes in ecological structure and functioning, such as lowered biotic diversity and lowered recruitment of fish populations.

Eutrophication can also have deleterious consequences on estuaries even when low-oxygen events do not occur. These changes include loss of biotic diversity, and changes in the ecological structure of both planktonic and benthic communities, some of which may be deleterious to fisheries. Seagrass beds and coral reefs are particularly vulnerable to damage from eutrophication and nutrient over-enrichment.

Harmful algal blooms (HABs) harm fish, shellfish, and marine mammals and pose a direct public health threat to humans. The factors that cause HABs remain poorly known, and some events are entirely natural. However, nutrient over-enrichment of coastal waters leads to blooms of some organisms that are both longer in duration and of more frequent occurrence.

Although difficult to quantify, the social and economic consequences of nutrient over-enrichment include aesthetic, health, and livelihood impacts

Water Quality Indicators

The 1998 *Clean Water Action Plan* Unified Watershed Assessment established priorities for watersheds in the State for restoration and protection. In the Plan, the Upper Choptank River watershed was included in one category for priority action: highest priority for restoration.[2]

As the basis for the prioritization, indicators of water quality, landscape and living resources were developed for all watersheds in Maryland. Other approaches to assessing water quality have been in use for several years and are further described below. In general they do not look comparatively at watersheds as the Unified Assessment did in an effort to set priorities. The Unified Assessment also considered a range of living resource and landscape indicators described a little later. The findings for the water quality indicators are explained in the following text.

1. State 303(d) Impairment Number

The Upper Choptank River watershed appeared in the 303(d) list for three impairments, which means that the impairments need to be corrected. For this indicator, presence on the 303(d) list means that the watershed needs restoration.

2. Nontidal Total Phosphorus Index

In comparison to the other watersheds that drain to the Chesapeake Bay in Maryland, the Upper Choptank River watershed was among those with a lower total phosphorus (TP) concentration based on data from "core" nontidal stream monitoring stations in the watershed. Watersheds in Maryland that had this data available were ranked on a 1(worst) to 10(best) scale to allow comparison of total phosphorus among them using the Tributary Team reporting methods for status/trends. The Upper Choptank River watershed was ranked "9" for TP.

To create a benchmark for this indicator, the TP scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

3. Nontidal Total Nitrogen Index

In comparison to the other watersheds that drain to the Chesapeake Bay in Maryland, the Upper Choptank River watershed was among those with a lower total nitrogen (TN) concentration based on data from "core" nontidal stream monitoring stations in the watershed. Watersheds in Maryland that had this data available were ranked on a 1(worst) to 10(best) scale to allow comparison of total phosphorus among them using the Tributary Team reporting methods for status/trends. The Upper Choptank River watershed was ranked "8" for TN.

To create a benchmark for this indicator, the TN scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

4. Tidal Habitat Index

Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those having better tidal habitat based on an index combining three measurements of water quality: surface chlorophyll *a*, secchi depth and summer bottom dissolved oxygen (July-Sept.). Using data collected 1994-1996, the Upper Choptank River watershed ranked “6.3" on a scale of 1(worst) to 10(best).

To create a benchmark for this indicator, the index scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) “exceeded” the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

5. Tidal Eutrophication Index

Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those having less eutrophication problems based on an index combining of three measurements of water quality (in surface mixed-layer water): total nitrogen, total phosphorus and total suspended solids. Using data collected 1994-1996, the Upper Choptank River watershed ranked “5.9" on a scale of 1(worst) to 10(best).

To create a benchmark for this indicator, the index scores for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the lowest quartile (25% of the watersheds) “exceeded” the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

6. Modeled Total Nitrogen Load

Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those transporting less total nitrogen (TN) to the Chesapeake Bay. The modeled TN load reaching the Chesapeake Bay from the Upper Choptank River was 9.21 lbs/acre. Nitrogen Load is a measure of how much of this important nutrient is reaching streams and other surface waters. For each type of land use in the watershed, on average, stormwater tends to carry or transport a characteristic amount of nitrogen from the land to nearby streams. Based on these averages, computers can be used to estimate (model) how much nitrogen is likely to be reaching Chesapeake Bay..

To create a benchmark for this indicator, the modeled TN loads for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) “exceeded” the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

7. Modeled Total Phosphorus Load

Compared to other Chesapeake Bay watersheds in Maryland, the Upper Choptank River watershed ranked among those transporting excessive loading of total phosphorus (TP) to the Chesapeake Bay. The modeled TP load reaching the Chesapeake Bay from the Upper Choptank

River was 0.75 lbs/acre. Total Phosphorus is a measure of how much of this important nutrient is reaching streams and other surface waters. The ranking for modeled TP Load was performed in parallel to the ranking for modeled TN Load above.

To create a benchmark for this indicator, the modeled TP loads for the 8-digit watersheds draining to the Chesapeake Bay were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark which included theUpper Choptank River watershed.

Tributary Team Characterization

As part of the work of the Upper Eastern Shore Tributary Team, Upper Choptank water quality was characterized several parameters at two monitoring sites that are listed below. [1, 9] The status for each parameter in the table is a relative ranking at three levels: good, fair and poor. For example, poor means that the Upper Choptank River ranking is poor compared to similar Chesapeake Bay tributaries with similar salinity. This information is taken from DNR's Internet site www.dnr.state.md.us/bay/tribstrat/index.html which shows the status and trends for various Chesapeake Bay areas. These maps allow qualitative comparison of regional conditions. Summary assessments are shown in tables for Ganey Wharf and Red Bridges.

Choptank River at Ganey Wharf		
Parameter	**Status 1997 -99 data**	**Trend 1985 through 1999**
Nitrogen: total	Poor	Degrading
Phosphorus: total	Fair	Improving (29%)
Algae: Abundance	Fair	No Trend
Dissolved Oxygen (summer, bottom waters)	Good	No Trend
Water Clarity: secchi depth	Poor	No Trend
Suspended Solids: total	Poor	No Trend

Choptank River at Red Bridges (Greensboro)		
Parameter	**Status 1997 -99 data**	**Trend 1985 through 1999**
Nitrogen: total	Fair	No Trend
Phosphorus: total	Fair	No Trend
Algae: Abundance	n/a	n/a
Dissolved Oxygen (summer, bottom waters)	n/a	n/a
Water Clarity: secchi depth	n/a	n/a
Suspended Solids: total	Good	No Trend

Water Quality Assessment

In 2001, Talbot County contracted with the University of Maryland Horn Point Laboratory to collect available water quality data for the waters in and around Talbot County and for water bodies in the Choptank River Basin generally. In late 2001, Horn Point Laboratory provided a draft GIS-based product designed to allow visualization of water quality conditions for numerous parameters. The following water quality assessment is drawn from Horn Point Laboratory's work.

Map 6 Monitoring Water Quality shows the location of monitoring stations that were used in the Horn Point Laboratory project. As the map indicates, several different programs have recently collected data that contribute to understanding local water quality conditions. Immediately downstream of Tuckahoe Creek in the Choptank River is the most heavily sampled spot in the Upper Choptank River watershed. The Chesapeake Bay Program and most other programs operating in the watershed have sampled in this approximate location. The most wide spread sampling sites for the TMDL program were established relatively recently and will operate for only a few years to meet the needs of that program.

In the following discussion, the description of the Creek Watchers program also includes an explanation of the potential benefits for monitoring selected water quality parameters. Additional sections follow that offer a brief interpretation of local water quality conditions based on particular water quality parameters.

Additional water quality-related data is available via the Internet. Two recommended Web sites are www.dnr.state.md.us/irc/datasets.html and www.chesapeakebay.net/wquality.htm . To view data for station ET5.2, which is in the Choptank River downstream of the Upper Choptank River watershed, see http://www.dnr.state.md.us/bay/conditions/index.html.

1. Creekwatchers Water Quality Sampling

Beginning in 2001, volunteers with the Creekwatcher Program began sampling the Upper Choptank River.

The Creekwatcher Program was created as a community partnership between the Chesapeake Bay Foundation (CBF) and the Chesapeake Bay Maritime Museum (CBMM). The goal of the Creekwatcher Program is to recruit and mobilize a grassroots volunteer force to monitor the waters of the bay tributaries in Talbot County. The data collected by the volunteers can be used to identify water quality conditions in different locations. Creekwatcher volunteers have monitored six river systems in Talbot County since July 1999 seven water bodies in addition to the Upper Choptank River: Miles River, Wye River, Harris Creek, Broad Creek, Tred Avon River, Island Creek and La Trappe Creek.

The following water-quality measures were collected:

Acidity (pH)-The pH level is directly related to the health of the fish and plants and in a healthy system, should be between 6.5 and 8.5. The most common causes of variations include stormwater runoff and air deposition of nitric and sulfuric acids discharged by industries, power plants, and automobiles.

Dissolved oxygen-Dissolved oxygen is essential to all marine life. Readings lower than 5 mg/l indicate insufficient oxygen to support aquatic life. Common causes of low readings include an increase in algae which consumes oxygen as it decomposes and seasonal changes in water salinity levels which can impact dissolved oxygen levels.

Temperature-Temperature is important to maintaining healthy marine life. Industrial and municipal discharges and stormwater runoff can impact temperature levels. Temperature levels are dependent upon the season however; healthy levels should be < 30 degrees Celsius.

Salinity-Salinity levels are an important water quality parameter and help to define which aquatic resources will live in the area. The salinity ranges change with the season and rainfall however, typical levels for Talbot County waters is around 15 ppt (or 1.5%) which is about half the salinity of the ocean.

Turbidity-Turbidity measures the ability of light to pass through the water. Poor water clarity indicated by a low visual turbidity reading indicates that the water is not clear enough for light to penetrate to a depth to support the growth of underwater grasses. Healthy ranges are a visual turbidity reading greater than 3 feet.

Conductivity-Conductivity measures the ability of water to conduct electricity. The more saline the water the higher the conductivity. Additionally, metals from discharges and stormwater runoff can impact conductivity readings. Healthy ranges are less than 25 MS/cm.

Total Nitrogen (TN)& Total Phosphorus (TP)-Though essential to all bay life, nitrogen and phosphorus, in excessive levels, are the most significant pollutants baywide. Nitrogen and phosphorus are natural fertilizers that stimulate algae blooms. These blooms block sunlight from underwater grasses and, when the algae die, lead to low dissolved oxygen. Moreover, some naturally occurring algae may be toxic or have toxic stages in their life cycles. TN levels should be less than 1 mg/liter and TP levels should be less than 0.1 mg/liter

Submerged Aquatic Vegetation (SAV)- Several creeks have been monitored beginning in 2000. These grasses are essential habitat for young crabs and fish. They also help to stabilize shorelines, reduce erosion and reduce wave action that can also damage shorelines.

2. Salinity

Salinity in the Upper Choptank River	
Choptank River Location	**Salinity in parts per thousand (ppt)**
Bow Knee Point to the Choptank Wetlands Preserve	Highly variable ranging from 0.1 to over 8.0 ppt, i.e. From nearly fresh to slightly brackish (low mesohaline)
Choptank Wetlands Preserve to Tuckahoe Creek	tends to be in the 0.1 to 3.0 ppt range but periods of salinity slightly higher than 7.0 ppt have been measured.
Upstream of Tuckahoe Creek	generally less than 1.0 ppt

3. Dissolved Oxygen

The most complete recent dissolved oxygen (DO) data is the Chesapeake Bay monitoring station ET5.2 which is in tidal waters downstream of the Upper Choptank watershed. This downstream station shows that tidal Choptank River waters in warm months generally exhibit low DO below the standard 5.0mg/l.

Significantly less complete data for tidal stations on the Choptank River mainstem in the Upper Choptank River suggest that a similar, but less pronounced, pattern may be occurring. While most DO samples are above 5.0 mg/l, several samples collected between May and September fail to meet the standard.

Nearly all nontidal monitoring stations report DO concentrations above the 5.0 mg/l standard. However, in Talbot County one station reported one very low DO concentration below 2.0 mg/l in the unnamed tributary at North Dover Road. In Caroline County, the station at Old Town Branch reported on concentration approaching 3 mg/l.

4. Secchi Depth

On Map 7 Secchi Depth, average secchi depth measurements along the tidal Choptank River in the Upper Choptank River watershed show that monitoring sites with average secchi depths of at least one meter are interspersed with sites averaging less than one meter secchi depth. These differences may relate primarily to differing local hydrologic conditions. Where ever secchi depths of less than one meter are typical, the poor light penetration would tend to inhibit growth of submerged aquatic vegetation (SAV).

5. Total Suspended Solids (TSS)

Map 8 Total Suspended Solids shows that TSS concentrations tend to higher downstream of Tuckahoe Creek and tend to have the lowest concentrations upstream of Denton. Concentrations of 15 mg/l or greater for total suspended solids (TSS) is believed to generally inhibit growth of SAV because light can not penetrate to the plants' leaves.

6. Chlorophyll *A*

As shown in Map 9 Chlorophyll *A*, the areas with the higher average chlorophyll *a* concentrations are generally between Denton and Tuckahoe Creek in the Choptank River. This finding indicates that higher average algae populations tend to be found in these upper reaches of tidal influence.

Additional information and maps can be found at the Chesapeake Bay Remote Sensing Program Internet site www.cbrsp.org . This information shows the variability of algae populations in the entire Choptank River.

Point Sources

Discharges from discrete conveyances like pipes are called “point sources.” Point sources may contribute pollution to surface water or to groundwater. For example, waste water treatment discharges may contribute nutrients or microbes that consume oxygen (measured as Biochemical Oxygen Demand (BOD) that reduce oxygen available for aquatic life. Stormwater discharges may contribute excessive flow of water and/or seasonally high temperatures. Industrial point sources may contribute various forms of pollution. Some understanding of point source discharges in a watershed targeted for restoration is useful in helping to prioritize potential restoration projects.

According to the Maryland Department of the Environment (MDE) permit data base as summarized in the summary table below, there are 26 permitted surface water discharges and three permitted groundwater discharges in the Upper Choptank River watershed.

MDE Permit Summary Upper Choptank River Basin In Maryland		
County	Surface Discharge	Groundwater Discharge
Talbot	5	0
Caroline	21	3
Queen Annes	0	0

Summary information for each permit is grouped geographically due to the size of the Upper Choptank watershed as listed below:

- Map 10A MDE Permits - South — MDE Permits Listing for Map 10A
- Map 10B MDE Permits - Central — MDE Permits Listing for Map 10B
- Map 10C MDE Permits - North — MDE Permits Listing for Map 10C

Characteristics of the these permitted discharges (volume, temperature, pollutants, etc.) are tracked by MDE through the permit system. Most of this information is accessible to the public and can be obtained from MDE.

MDE Permits Listing for Map 10A Upper Choptank River South (9/2001 data)			
Type / MDE Category	**Facility Name**	**MD Permit / NPDES**	**Receiving Stream / Location**
Surface Water Waste Water Treatment Plants (WWTP)	Easton	96DP0579 MD0020273	Unnamed tributary east of Easton North Dover Road, Easton
	Prettyman Manor	98DP3271 MD0068063	Mitchell Run Dover Bridge Road
Gen. Industrial Stormwater Permit	Easton WWTP (sewage treatment)	97SW0556	Unnamed tributary east of Easton North Dover Road, Easton
	Midshore Regional Solid Waste Facility	97SW0765	Barker Creek Barkers Landing Road, Easton
General Permits	Barker's Landing Pit (sand and gravel)	00MM9812 MDG499812	Barker Creek Barkers Landing Road, Easton
	Ewing, Inc., Saathoff Pit (sand, gravel borrow pit)	00MM9805 MDG499805	Kings Creek Matthewstown Road, Easton

MDE Permits Listing for Map 10B Upper Choptank River Central (9/2001 data)			
Type / MDE Category	**Facility Name**	**MD Permit / NPDES**	**Receiving Stream / Location**
Surface Water / Municipal	Denton	00DP0537 MD0020494	Upper Choptank below Denton, American Legion Road, Denton
Waste Water Treatment Plants (WWTP)	N. Caroline High School	00DP0657 MD0023621	Upper Choptank north of Denton River Road, Ridgely
	Ridgely	97DP0530 MD0020427	Unnamed stream, Belle Rd, Ridgely (to be replaced by spray irrigation[7])
Surface Water / Industrial	Choptank Electric Coop (electric services)	98DP3046 MD0066761	Unnamed tributary to Choptank R. Meeting House Road
	Fil (US) Inc. (plastic products)	00DP0290 MD0001007	Unnamed tributary to Choptank R. Meeting House Road
Groundwater / Industrial	Ches. Farm Credit	97DP2216	Deep Shore Road, Denton
	Mulholland-Harper Co.	00DP0047	Meeting House Road, Denton
Gen. Industrial Stormwater Permit	Fil (US) Inc. (plastic products)	97SW0627	Choptank River Meeting House Road, Denton
	Royster-Clark, Inc. (fertilizer blending)	97SW0320	Choptank River River Landing Road, Denton
	Schultz & Sons Salvage (scrap/waste metals)	97SW1140	Choptank River Meeting House Road, Denton
	SHA Denton Shop	97SW1317	Choptank R. Caroline St., Denton
General Permits	Breeding (Borrow) Pit (sand and gravel)	TBA	Watts Creek Harmony Road, Denton
	Breeding (Brubaker) Pit (sand and gravel)	00MM9884 MDG499884	Chapel Branch Burrisville Road, Denton
	Denton Water Supply	00HT9417 MDG679417	Choptank River Legion Road, Denton
	Crouse Oil Company (bulk petroleum)	98OGT4063 MDG344063	Choptank River River Landing Road, Denton

MDE Permits Listing for Map 10C **Upper Choptank River North** **(9/2001 data)**			
Type / MDE Category	**Facility Name**	**MD Permit / NPDES**	**Receiving Stream / Location**
Surface Water / Waste Water Treatment Plants	Cedar Mobile Home Park	00DP1669A MD0057487	Tidy Island Creek ?? Lepore Road, Marydel
	Greensboro	99DP0597 MD0020290	Upper Choptank near Greensboro Greensboro Rd., Greensboro
Groundwater / Municipal	Caroline Acres Mobile Home Community	97DP1264	Henderson Rd. and Maple Drive, Henderson
Gen. Industrial Stormwater Permits	Eagle Auto Salvage (used auto parts)	97SW1141	Choptank River S. Main Street, Greensboro
	Foy's Salvage (used auto parts)	97SW1367	Forge Branch Harrington Road, Greensboro
	W. Mitchell Car Parts (used auto parts)	97SW0901	Gravelly Branch Drapers Mill Road, Greensboro
General Permits	Schiff Farms, Inc. (beef cattle feedlot)	96AF9903 MDG019903	Spring Branch Kibler Road, Greenboro
	Greensboro Water Supply	00HT9516 MDG679516	Choptank River Greensboro

NonPoint Sources

A quantitative estimate of nonpoint source loads (surface water or groundwater) is not available for the Upper Choptank River watershed. However, nutrients and sediment are a significant issue in the watershed based on two sources:

– The 303(d) listing of the watershed for nutrients, sediments, and fecal coliform bacteria is believed to be associated with nonpoint sources.
– Long term water quality monitoring data from Ganey Wharf indicates that nitrogen and suspended sediment concentrations are poor and phosphorus concentrations are fair. Upstream of this point in the river, point source loads are probably small compared to nonpoint source loads. Therefore, it is likely that nonpoint sources are the primary cause of degraded water quality at this location.
– Long term water quality monitoring data from Red Bridges indicates that nitrogen and phosphorus concentrations are fair. Upstream of this point in the river, point sources are not significant. Consequently, nonpoint sources are the likely reason that water quality is not good at this location.
– Modeled phosphorus load in the *Water Quality Indicators* section in this Watershed Characterization indicates that a combination of factors in the watershed, including land use, would generally lead to excessive phosphors transport.

To create an inventory of nonpoint sources for the Upper Choptank River WRAS, Talbot and Caroline Counties are considering urban stormwater and agricultural runoff separately. As part of urban nonpoint sources, rural residential communities are grouped with other types of urban land. In this exercise, the Counties are considering urban nonpoint sources in association with atmospheric deposition, stormwater runoff (managed and unmanaged), on-site disposal systems and illicit discharges.[18] For example, it is believed that septic tanks, both failing and properly operating, are contributing nitrogen to the Choptank River. However, an inventory of septic tank locations and condition would need to be generated to planning and project targeting.

Also for this exercise, agriculture nonpoint sources are being considered in association with atmospheric deposition, stormwater runoff (managed and unmanaged) and illicit discharges.[18]

Shoreline Erosion

Wherever land and open water meet, change in the form of erosion or accretion of land is typically the inevitable result of natural processes. Human activity in these areas either tends to inadvertently accentuate these natural processes or purposefully attempts to control movement of water and/or loss of land. Erosion of shorelines can contribute significant amounts of nutrients (mostly phosphorus) and sediment (water column turbidity, habitat loss.)

Countywide shoreline erosion is summarized in the following table. [8]

Shore Erosion Rate By County (Miles of Shoreline)

County	Total Shoreline	Total Eroding Shoreline	Erosion Rate		
			0 - 2 feet / year	2 - 4 feet / year	4 and greater feet / year
Caroline	66	10 (15%)	9	1	0
Talbot	442	139 (31%)	91	25	23

The relatively limited shoreline erosion rates listed in the table for Caroline County account for most of the Choptank River shoreline in the Upper Choptank River watershed. These erosion rates are probably also indicative of Talbot County's shoreline in the watershed. The majority of the Talbot County's shoreline, as listed in the table above, is outside of the Upper Choptank River watershed along the Lower Choptank River and the Chesapeake Bay where erosion rates are generally higher.

Maps of historic shoreline change were produced in 1999 by the Maryland Geological Survey (MGS) in a cooperative effort between DNR and the National Oceanic and Atmospheric Administration (NOAA). These maps included digitized shorelines for several years in Talbot and Caroline Counties. The maps also show relatively little change adjacent to smaller water bodies that are typical along the Choptank River in the Upper Choptank River watershed. Copies of these 1:24000 scale maps are available from the MGS.

Water Supply

The Upper Choptank River watershed has only one type of public water supply system. There are at least 24 public community groundwater systems in the watershed that use wells as their water source. These community water supply wells tend to draw from deep aquifers as summarized below. These deep aquifers are relatively distinct from surface water and shallow ground water. They are relatively unaffected by the water quality issues discussed elsewhere in this watershed characterization.

Categories of Water Supply Systems	Upper Choptank Watershed Status December 2001
Surface Intakes (source water from rivers or streams)	none
Community Surface Water Systems (source from impoundments)	none
Community Groundwater Systems (source water from wells)	yes
Well Head Protection (active protection efforts)	none

Aquifers Used by Community Groundwater Systems in Maryland's portion of the Upper Choptank River watershed are listed below:
- Aquia Formation
- Cheswold Aquifer
- Federalsburg Aquifer
- Frederica Aquifer
- Piney Point Formation

LAND USE / LAND COVER
Upper Choptank River Watershed

Landscape Indicators

Water quality, particularly in streams and rivers, is affected by the land in the riparian zone and the land use throughout the watershed. In an effort to gauge the affects of land use on water quality, and to allow comparison between watersheds, DNR has developed a series of Landscape Indicators. These indicators can be used to portray landscape conditions on a watershed scale that tend to support good water quality or that tend to degrade water quality.

The *Maryland Clean Water Action Plan* published in 1998 listed landscape indicators for the Upper Choptank River watershed as summarized in sections that follow.[2]

1. Impervious Surface

On average across the entire Upper Choptank River watershed, 2.1% of surface cover is impervious. This average imperviousness compares well with similar watersheds in Maryland.[2]

Roads, parking areas, roofs and other human constructions are collectively called impervious surface. Impervious surface blocks the natural seepage of rain into the ground. Unlike many natural surfaces, impervious surface typically concentrates stormwater runoff, accelerates flow rates and directs stormwater to the nearest stream. Watersheds with small amounts of impervious surface tend to have better water quality in local streams than watersheds with greater amounts of impervious surface. Side-effects of impervious surfaces become increasingly significant and negative as the percentage of impervious area increases. Examples of related problems include reduction of groundwater infiltration, increased soil and stream bank erosion, sedimentation, destabilization or loss of aquatic habitat, and "flashy" stream flows (reduced flow between storms and excessive flows associated with storms.) The Maryland Biological Stream Survey has related the percent of impervious surface in a watershed to the health of aquatic resources. For areas with less than 4% impervious cover, streams generally rate "Fair" to "Good" for both fish and in-stream invertebrates. Beyond about 12% impervious surface, streams generally rate "Poor" to "Fair" for both. Reduction of impervious area can be a valuable component of a successful Watershed Restoration Action Strategy (WRAS).

The impervious surface estimate used for this indicator was generated for the 1998 Maryland Clean Water Action report. Each land use type in the 1994 Maryland State Planning land use data was assigned an estimated imperviousness taken from the TR-55 manual used by the former Soil Conservation Service.

To create a benchmark for comparing impervious area among Maryland watersheds, the percent of impervious area for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

2. Population Density

The population density in the Upper Choptank River watershed was 0.16 people per acre using pre-2000 Census data. This density compares well with similar Maryland watersheds.[2]

To create a benchmark for comparing population density among Maryland watersheds, the people per acre for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed this benchmark.

While population density may be beyond the scope of a WRAS, directing growth is a potential WRAS component. As human population increases, effects of human activity that tend to degrade, displace or eliminate natural habitat also tends to increase. Watersheds with higher populations, assuming other factors are equal, tend to exhibit greater impacts on waterways and habitat. However, growth can be directed in ways to reduce negative impacts.

3. Historical Wetland Loss

The historical loss of wetlands in the Upper Choptank River watershed is estimated to be 48,169 acres which is a relatively large loss of wetlands compared with other similar Maryland watersheds.[2]

This interpretation is based on the assumption that the hydric soils in the watershed were all, at one time, wetlands. Thoughtful selective restoration of historic wetland areas can be an effective WRAS component. In most of Maryland's watersheds, extensive wetland areas have been converted to other uses by draining and filling. This conversion unavoidably reduces or eliminates the natural functions that wetlands provide.

To create a benchmark for comparing impervious area among Maryland watersheds, the historic wetland loss acreage for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed exceeded the benchmark because it is in the highest quartile.

4. Unbuffered Streams

Approximately 49% of streams in the Upper Choptank River watershed were not buffered with trees based on 1998 information. This finding compares well with other similar Maryland watersheds.[2]

DNR recommends that forested buffer 100 feet wide , i.e. natural vegetation 50 feet wide on either side of the stream, is typically necessary to promote high quality aquatic habitat and diverse aquatic populations. Replacement of natural vegetation adjacent to streams can be a valuable and relatively inexpensive WRAS element. In most of Maryland, trees are key to healthy natural streams. They provide numerous essential habitat functions: shade to keep water temperatures down in warm months, leaf litter "food" for aquatic organisms, roots to stabilize stream banks, vegetative cover for wildlife, etc. In general, reduction or loss of riparian trees / stream buffers degrades stream habitat while replacement of trees / natural buffers enhances stream habitat. (For this indicator only "blue line streams" were included. Intermittent streams were not considered.)

This estimate of streams lacking forested buffer was generated for the 1998 Maryland Clean Water Action Plan by using Maryland Department of State Planning GIS data for streams and for 1994 land use.

To create a benchmark for comparing impervious area among Maryland watersheds, the percent of unbuffered streams for 8-digit watersheds were ranked highest to lowest and then divided into four groups each containing 25% of the watersheds (quartiles). The watersheds in the highest quartile (25% of the watersheds) "exceeded" the benchmark. The Upper Choptank River watershed did not exceed the benchmark.

5. Soil Erodibility

The average soil erodibilty of lands within 1000 feet of streams in the Upper Choptank River watershed is 0.28 value/acre which suggests that control of soil erosion is particularly important here.[2]

Watersheds with more highly erodible soils are naturally more susceptible to surface erosion, sedimentation, streambank erosion and other problems related to soil movement. These negative effects of soil erodibility on water quality can be minimized through careful management. The soil erodibility indicator accounts for natural soil conditions but not for management of the land. (Existing crop land management was not considered.) The naturally erodible soils in the watershed are addressed by techniques called Best Management Practices (BMPs) to prevent soil loss that are typically in use on local farms. BMPs like no-till, reduced till, cover crops, field strips, and others significantly reduce erosion and sediment movement. These BMPs can be seen in use in many places in the watershed. A WRAS can reasonably promote a reduction in disturbance of erodible soils and/or effective soil conservation practices like planting stream buffers.

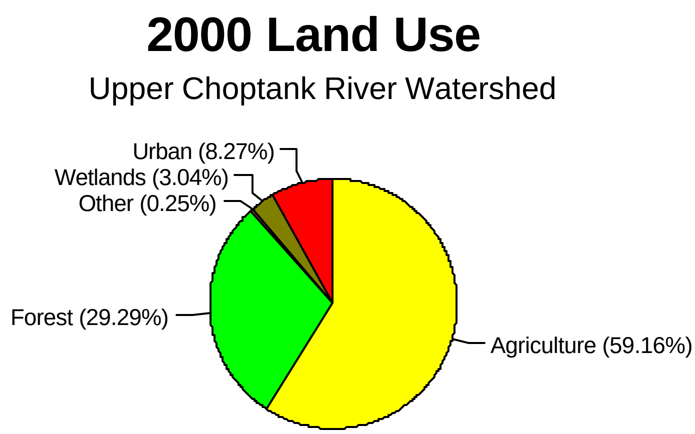
This estimate of soil erodibility was generated through an analysis of GIS data that incorporated the soil erodibility factor (K), slope steepness, land area within 1000 feet of streams and cropland within that 1000 feet buffer based on 1994 Maryland Department of State Planning land use data.

To compare Maryland watersheds for this index, the benchmark of 0.275 value/acre was used, i.e. less than 0.275 was considered relatively beneficial for water quality and 0.275 or greater was considered to be a likely factor for water quality problems.

2000 Land Use / Land Cover

The following table and pie chart summarize 2000 land use for the Upper Choptank Watershed in Maryland. Based on this information, the watershed was dominated by agriculture (59%) and forest (29%). The remaining approximately 12% of the land in the watershed was mostly developed lands with small amounts of tidal and emergent wetlands and other land uses.

Viewing these land uses as potential nonpoint sources of nutrients, agricultural lands are likely to dominate loads to local waterways.



Map 11 Generalized Land Use 2000 shows the distribution of these land categories in the watershed.

2000 Land Use Upper Choptank Watershed		
Category	**Description**	**Acres**
Agriculture	Field, Pasture, Ag buildings	93,886
Forest	All woodlands and brush	46,485
Developed Lands	Residential, commercial, etc.	13,124
Wetlands	Tidal marsh, Emergent wetlands	4,818
Other	Extractive and bare ground (not graphed)	395
Watershed Total for Land Use (excl. open water)		**158,708**
Watershed Total including open water		**163,449**

Green Infrastructure

An additional way to interpret land use / land cover information is to identify "Green Infrastructure." In the GIS application developed by Maryland DNR and its partners, Green Infrastructure refers to areas of natural vegetation and habitat that have statewide or regional importance as defined by criteria developed by DNR. The criteria for identifying of lands as Green Infrastructure is limited to considering natural resource attributes currently found on those lands. One example of the criteria is that interior forest and wetlands complexes at least 250 acres in size are considered as part of Green Infrastructure. As a second example, sensitive species habitat that is located within areas of natural vegetation at least 100 acres in size is also counted as Green Infrastructure. Other potential attributes of Green Infrastructure lands, such as ownership or if the current natural conditions are protected in some way, are not criteria for Green Infrastructure but they may be considered independently.

Within the Green Infrastructure network, large blocks of natural areas are called hubs, and the existing or potential connections between them, called links or corridors. Together the hubs and corridors form the Green Infrastructure network which can be considered the backbone of the region's natural environment.

Protection of Green Infrastructure lands may be addressed through various existing programs including Rural Legacy, Program Open Space, conservation easements and others. The 2001 Maryland General Assembly approved $35 million for the Green Print program which is targeted primarily to protecting Green Infrastructure areas. This funding category is administered by Program Open Space.

Map 12 Green Infrastructure shows several significant local characteristics of Green Infrastructure:

– A significant number of Green Infrastructure hubs are found in the Upper Choptank River watershed. Many, but not all of these hubs are along the Choptank River and its tributaries. Also, many of these areas of natural vegetation have some association with wetlands and/or wet soils.
– Many corridors selected by the computer analysis have significant amounts of agricultural land shown within the potential corridor. In general, viability of these corridors for protection or restoration requires local on-the-ground assessment to provide additional information regarding site conditions, land owner preferences and potential viability of projects.

Protected Lands

As used in the context of watershed restoration, "protected land" includes any land with some form of long term limitation on conversion to urban / developed land use. This protection may be in various forms: public ownership for natural resource or recreational intent, private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through the purchase of an easement, etc. The extent of "protection" varies greatly from one circumstance to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel by parcel through the local land records office to determine the true extent of protection.

For purposes of watershed restoration, a knowledge of existing protected lands can provide a starting point in prioritizing potential restoration activities. In some cases, protected lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals.

Map 13 Protected Land and Smart Growth shows the locations of protected lands in the Upper Choptank River watershed. Based on the information summarized in the table, Protected Land Summary By County, several overall findings can be made:

– Protection of agricultural land is the most active form of land conservation in the watershed. In total, agricultural easements encompass about 9,600 acres covering 6% of the watershed. Agricultural Districts encompass an additional 10,400 acres beyond the acreage under easements. This is an additional 6.5% of the watershed.
– Conservation easements cover about 4,200 acres (2.6% of the watershed) including about 2,400 in Talbot County and over 1,800 acres in Caroline County. These figures include easements held by private organizations and by the Maryland Environmental Trust.
– Government owned land in the Upper Choptank watershed amounts to less than half of one percent of the watershed. No federal land is identified there. Caroline County has about 178 acres of park land in the watershed. DNR land in the watershed encompasses 460 acres including about 300 acres recently acquired from Chesapeake Forest, Inc. Other DNR land in the watershed includes a small portion of Seth Forest in Talbot County and Marinak State Park in Caroline County.

In drafting the WRAS for the Upper Choptank Watershed in Talbot and Caroline Counties, existing protected lands could be assessed for their potential role in watershed management:
– Public land could be assessed for potential implementation and/or demonstration project sites.
– Land owner interests could be surveyed regarding opportunities for management enhancement like agricultural best management practices.
– Opportunities for expanding protection from currently protected land to adjacent parcels

Protected Land Summary By County Upper Choptank River Watershed In Maryland*						
Area Category	Talbot		Caroline		Queen Annes	
	Acres	%	Acres	%	Acres	%
Agricultural Easement	1,038	3	8,526	7	84	4
Agricultural District**	2,807	8	7,636	6	0	--
Conservation Easement: MET ***	2,162	6	1,186	1	0	--
Conservation Easement: Private	235	0.6	641	0.5	0	--
County Parks	0	--	178	0.1	0	--
DNR Land	12	--	448	0.4	0	--
Total Protected Land In County/Watershed	6,254	17	18,615	15	84	4
Total County Land In Watershed	36,575	100	120,982	100	1,937	100

* Data in the table is from late 2000 or earlier depending on the category.

** Agricultural Districts provide various advantages to farmers but do not inhibit land owner decisions to change farm land to nonagricultural land uses in the long term.

*** MET - Maryland Environmental Trust

Smart Growth

Within Maryland's Smart Growth program, there are two targeting programs that should be considered as potential watershed restoration projects are considered. In Rural Legacy Areas, protection of land from future development through purchase of easements (or in fee simple) is promoted. In Priority Funding Areas, State funding for infrastructure may be available to support development and redevelopment. Both are shown in Map 13 Protected Land and Smart Growth:

- Rural Legacy Area in the Upper Choptank watershed is concentrated near Tuckahoe Creek. A little over 5400 acres of the Tuckahoe Rural Legacy area are in the WRAS watershed. State funding for the Tuckahoe Rural Legacy area was appropriated in State fiscal years 1999 and 2000.

- Priority Funding Areas in Caroline County, they are associated with several small communities. Collectively, these areas include nearly 4,100 acres covering a little over 11% of the Upper Choptank watershed in Talbot County.

- Priority Funding Areas in Talbot County are concentrated around Easton and the Route 50 corridor. All together these areas total nearly 3,900 acres covering slightly more than 3% of the Upper Choptank watershed in Caroline County.

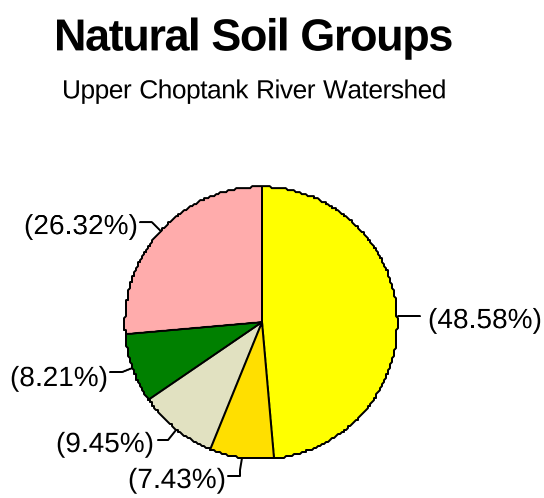
Soils

1. Interpreting Local Conditions with Natural Soil Groups

Soil conditions, like soil type and moisture conditions, greatly affect how land may be used and the potential for vegetation and habitat on the land. Soil conditions are one determining factor for water quality in streams and rivers. Local soil conditions vary greatly from site to site as published information in the Soil Surveys for Talbot and Caroline Counties show. This complicated information can be effectively summarized using Natural Soil Groups to help identify useful generalizations about groups of soils.

In Map 14 Soils and the pie chart, prime farmland is depicted in yellow or yellow with crosshatching. About 56% of the Upper Choptank Watershed in Maryland is prime farmland based on the list below:

48.6% - Best prime agriculture soil (B1)
7.4% - Other prime agriculture soil
9.5% - Excessively well drained soil
8.2% - Wet soils in flood zones
26.3% - Wet soils in uplands



2. Soils and Watershed Planning

Local soil conditions can be a useful element in watershed planning and for targeting restoration projects.

Soils with limitations related to wetness or slope naturally inhibit active use for farming or development. Land owners in the watershed have tended to leave many of these areas in natural vegetation or other low intensity use. By comparing Map 14 Soils with Map 11 1997 General Land Use and Map 12 Green Infrastructure several tendencies can be seen. Green Infrastructure and forest in general tends to coincide with soils that are either hydric & poorly drained or with soils that are excessively well drained. Additionally, development, which often relies on septic systems, tends to be concentrated on excessively well drained soils and to avoid hydric soils.

Considering the existing tendencies among landowners suggested above, Natural Soils Groups or similar soils assessment techniques can be used to help identify potential areas for restoration projects or habitat protection. Once areas of interest are targeted and land owner interest is verified, additional detailed soil assessment is an essential step in identifying viable restoration project sites.

Wetlands

1. Introduction to Wetland Categories

The Eastern Coastal Plain Province likely has the highest diversity of emergent estuarine and palustrine wetland communities relative to other Maryland physiographic regions because both tidal and nontidal freshwater marshes occur here. Wetlands are most abundant in the Coastal Plain due to the low topographic relief and high groundwater table characteristic of the region.

Estuarine Wetlands. Estuarine wetlands are abundant throughout the Coastal Plain. These systems consist of salt and brackish tidal waters and contiguous wetlands where ocean water is at least occasionally diluted by freshwater runoff from the land. These wetlands may extend far upstream in tidal rivers to freshwater areas. Differences in salinity and tidal flooding within estuaries have a significant effect on the distribution of these wetland systems. Salt marshes occur on the intertidal shores of tidal waters in areas of high salinity. Brackish marshes are the predominant estuarine wetland type in Maryland. They are found along the shores of Chesapeake Bay, mostly on the Eastern Shore, and for considerable distance upstream in coastal rivers. Estuarine shrub swamps are common along the Maryland coastal zone. Aquatic beds, comprised mostly of submerged aquatic vegetation, are abundant in shallow water zones of Maryland's estuaries, especially Chesapeake Bay and its tributaries.

Palustrine wetlands. Forested wetlands are the most abundant and widely distributed palustrine wetland type on the Coastal Plain. These wetlands are found on floodplains along the freshwater tidal and nontidal portions of rivers and streams, in upland depressions, and in broad flat areas between otherwise distinct watersheds. Tidal freshwater swamps occur along coastal rivers in areas subject to tidal influence. Scrub-shrub swamps are not abundant on the Eastern Shore but are represented in the Upper Choptank River watershed. Emergent wetlands on the Coastal Plain are characterized by a wide range of vegetation, depending on water regime. (Adapted from *Wetlands of Maryland*, Tiner and Burke, 1995.)

2. Tracking Wetlands

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Dept. of the Environment (MDE) is the lead agency for the State and cooperates with DNR, the Army Corps of Engineers and other Federal and local agencies. As part of its responsibility, MDE tracks State permitting and the net gain or loss of wetlands over time.

As the Wetlands Regulatory Status table shows, changes tracked in the State regulatory program show that a net increase of wetland acreage of nearly 11 acres has occurred in the Upper Choptank River watershed over the past 10 years.

Tracking Nontidal Wetland Change By Watershed For The Talbot and Caroline County Area In Acres 1/1/1991 through 12/31/2001 [14]

Watershed	Basin Code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net
Upper Choptank	02130404	-1.84	0	0	12.62	10.79
Lower Choptank	02130403	-7.28	1.58	14.00	11.46	19.76
Tuckahoe Creek	02130405	-1.10	1.12	2.30	0	2.32
Marshyhope Creek	02130306	-2.38	4.4	12.0	0	14.02
Eastern Bay	02130501	-5.53	4.03	1.18	0	-0.32
Miles River	02130502	-2.86	0.54	0	0.33	-1.99
Wye River	02130503	-1.50	0	6.00	0	4.50

Notes: Only nontidal wetland changes are shown, tidal wetland changes are excluded. Acreage presented for each watershed does not identify County and is not normalized. Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998.

3. Interpreting Wetland Distribution

Wetlands in most of the Upper Choptank River watershed tend to occur along waterways as shown in the maps listed below. However, the map also shows that wetland in the northern end of the watershed tend to be more defuse and they are less likely to associated with waterways.

- Map 15A Wetlands - South
- Map 15B Wetlands - Central
- Map 15C Wetlands - North

In comparing the wetlands map to Map 11 1997 Generalized Land Use, it can be seen that much of the forested land in the watershed is found in association with wetlands or adjacent to them. Additionally, comparing the maps shows that many of the nontidal wetland areas on the wetland maps are depicted as forest on the land use map. This difference is simply the result of two differing views of the landscape. For example, wooded nontidal wetlands can be viewed as "wetlands" from a habitat / regulatory perspective and they can be viewed as "forest" from a land use perspective.

In the context of the Watershed Restoration Action Strategy (WRAS), wetlands serve valuable water quality and habitat functions that may not be provided by other land uses. Therefore, protection and enhancement of existing wetlands, and restoration of past wetland areas, can be a valuable element in the WRAS. (Also see the Wetland Restoration section.)

National Wetlands Inventory Acreage Summary
Upper Choptank River Watershed

Wetland Class		Acres
Estuarine, Subtidal (E1)	unconsolidated bottom	3
Estuarine, Intertidal (E2)	emergent	3,896
Lacustrine (L)	open water lake	122
Palustrine (P)	emergent	628
	forested	16,628
	scrub shrub	611
Riverine (R)	tidal	516
Total Wetlands National Wetlands Inventory		22,404

Wetlands of Special State Concern (WSSC) 845 acres
NOTE: WSSC regulations apply to selected wetlands listed in table above. See the Sensitive Species Section for discussion.

Floodplains

Map 16 Floodplain and Sea Level Rise shows that the 100-year floodplain extends far up tributaries to the Choptank River. The extent of potential flood areas in the Upper Choptank River watershed has significant implications for land use decisions and watershed management including potential restoration projects.

In recent years, stormwater management requirements have provided a means to limit impacts of new development and impervious area that would otherwise contribute to stream degradation and flooding. However, these new projects may not significantly improve water quality or quantity that are driven by systemic watershed factors.

For existing development and impervious area, retrofitting controls to enhance water quality and limit peaks in stormwater runoff may offer an additional way to protect waterways. However, consideration of retrofits must take into account at least two local issues:

- Land owner interests and preferences.
- Management directions already established by Public Drainage Associations (PDAs)

Low Elevation Areas Subject to Sea Level Rise

Most areas of the Upper Choptank River watershed have sufficient elevation to be unaffected by any potential for sea level rise in the next 50 to 100 years. However, marshes and other low-lying wetlands are at risk for inundation. The potential for sea level rise impacts need to be considered as part of any comprehensive watershed management effort. For example, the identification and prioritization of potential WRAS projects will take into account the risk of inundation during the life of the project.

As a gauge of potential sea level rise risk, a Maryland-wide assessment of land with an elevation of 1.5 meters or less was first published in 1998 and then repackaged in a 2000 State report.[9] At this statewide scale, the general area at risk to inundation from sea level rise is limited to marsh/wetland areas along the Choptank River. As shown in Map 16 Floodplain and Sea Level Rise, the area of concern in the Upper Chotank River watershed extends from Bow Knee Point to Barker Creek just upstream of the Choptank Wetlands Preserve. A significant portion of the Choptank Wetlands Preserve is at risk for inundation.

LIVING RESOURCES AND HABITAT

Overview

Living resources, including all the animals, plants and other organisms that call the land and waters of the Upper Choptank River watershed home, are being affected by human activity. The information summarized here suggests that some of the significant stresses on living resources in the watershed are manipulation of habitat, excessive movement of sediment and excessive availability of nutrients.

The Living Resource information summarized here should be considered a partial representation because numerous areas of potential interest or concern could not be included due to lack of information, time, etc. For example, information on many forms of aquatic life, woodland communities, terrestrial habitats, etc. should be considered as watershed restoration decisions are being made. Therefore, it is recommended that stakeholders in the watershed identify important living resource issues or priorities so that additional effort can be focused where it is most needed. New information should be added or referenced as it becomes available.

Living Resource Indicators

Aquatic organisms are sensitive, in varying degrees, to changes in water quality and aquatic habitat. This association offers two perspectives that are important for watershed restoration. First, improvements for living resources offer potential goals, objectives and opportunities to gauge progress in watershed restoration. Second, the status of selected species can be used as to gauge local conditions for water quality, habitat, etc. This second perspective is the basis for using living resources as an "indicator."

The *Maryland Clean Water Action Plan* published in 1998 listed the following living resource indicators for the Upper Choptank River Watershed.[2] Several of these indices rely on index rankings generated from a limited number of sampling sites which were then generalized to represent entire watersheds. Considering this limitation on field data, it may be beneficial to conduct additional assessments to provide a more complete understanding of local conditions as part of the WRAS:

1. SAV Abundance Index

For tidal areas of the Upper Choptank River watershed, the abundance of submerged aquatic vegetation (SAV) scored "1.5" for the Abundance Index which means that SAV covered about15% of the potential SAV habitat. This index is designed to allow comparison of watersheds based on actual SAV acreage versus potential SAV acreage. To generate the score for this index, two measurements of SAV area were estimated: 1) area covered by SAV in the year 1996 was measured using aerial survey data, and 2) the potential SAV area was measured based on water depth (up to two meters deep), physical characteristics and historic occurrence of SAV.

The benchmark used for the SAV Abundance Index was 10%. If less than 10% of the potential SAV area in a watershed was covered by SAV in 1996, then the watershed was listed in the category “needs improvement”. If more than 10% of the potential SAV area in a watershed was covered by SAV in 1996, then the watershed was listed in the category “needs preventative action” to protect or enhance SAV abundance. No watershed in the State scored higher than 2, reflecting a maximum observed coverage of 20%.

2. SAV Habitat Requirements Index

For tidal areas of the Upper Choptank River watershed, the abundance of submerged aquatic vegetation (SAV) scored "5.0" for the Habitat Requirement Index which means that SAV habitat requirements were not met based on 1994-1996 data. This index is designed to allow comparison of watersheds based on several measurements of habitat conditions: secchi depth, dissolved inorganic nitrogen where applicable, dissolved inorganic phosphorus, Chlorophyll *a* and total suspended solids.

The benchmark used for the SAV Habitat Requirements Index was 7. A score of 7 or higher means that 1994 through 1996 data showed that habitat conditions for SAV in a watershed were sufficient and the watershed was listed in the category for “restoration needed”. A score less than 7 means that the watershed’s habitat conditions were not favorable for SAV and the watershed was listed in the category for “needs preventative action”.

3. Nontidal Benthic Index of Biotic Integrity

Streams in the Upper Choptank River watershed are generally in poor condition on average based on assessment of benthic macroinvertebrate communities (stream bugs). For this index, Liberty Reservoir streams scored an average of 4.9 on a scale of 1 (worst) to 10 (best). For this index, an average score for an 8-digit watershed less than 6.0 means that restoration is needed and a score of 8.0 or greater means that protection is recommended. To generate this index, each stream site that is assessed is compared to reference conditions that were established for comparable streams that are minimally impacted. Nontidal rivers (streams seventh order and larger) are not incorporated into this index. Also see Why Look at Benthos in Streams?

4. Nontidal Fish Index of Biotic Integrity

Based on assessment of fish communities, streams in the Upper Choptank River watershed scored 6.5 on a scale of 1 (worst) to 10 (best) indicating a generally fair/good condition on average. For this index, an average score for an 8-digit watershed less than 6.0 means that restoration is needed and a score of 8.0 or greater means that protection is recommended. In each stream site where fish are surveyed, the makeup of the overall fish population is measured in nine distinct ways such as the number of native species, number of benthic fish species, percent of individuals that are "tolerant" species, etc. These nine scores are then integrated to generate an index ranking for the survey site. To generate the index for the watershed, the scores for all the stream sites assessed within the 8-digit watershed are averaged together.

5. Nontidal In-Stream Habitat Index

Based on habitat conditions in nontidal streams in the Upper Choptank River watershed, conditions are generally fair on average. In this index, Upper Choptank River streams scored an average of 4.9 on a scale of 1 (worst) to 10 (best). This index allows comparison of streams based on habitat for fish and benthic organisms as measured by in-stream and riparian conditions. For each stream site that was assessed, visual field observations are used to score the site for substrate type, habitat features, bank conditions, riparian vegetation width, remoteness, aesthetic value, etc. For each site, the individual scores are integrated to generate a single score for each stream site. The index score reported for each stream site is a relative score to the maximum attainable score for comparable streams. The watershed index is created by averaging the scores for all the sites that were assessed in the watershed.

Fish

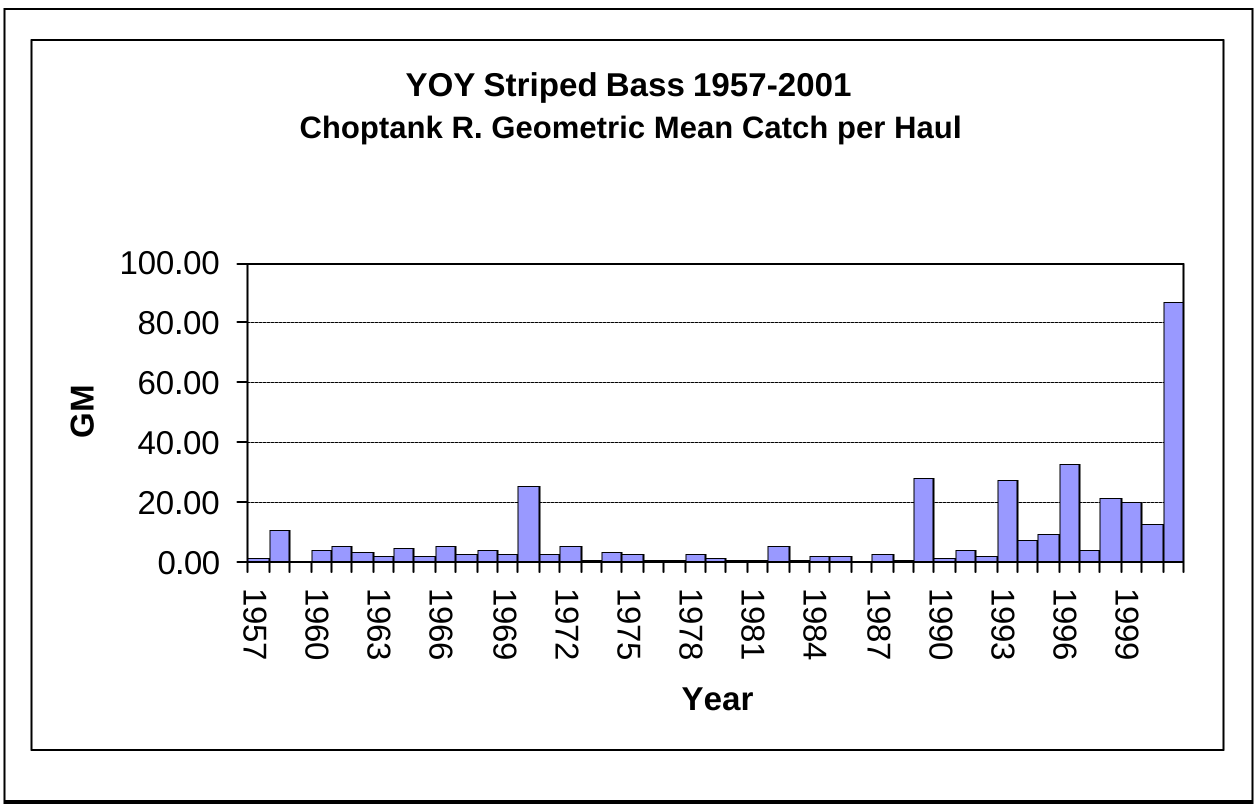
1. Striped Bass Spawning and Nursery

The Upper Choptank River is one of the most important spawning and nursery areas for striped bass (rock fish) in the Chesapeake Bay watershed. In terms of size and productivity, the Upper Choptank ranks third (behind 1. Upper Chesapeake Bay and 2. Potomac River). Within the Upper Choptank River, the area most used by striped bass for spawning and nursery extends from near Denton to approximately Bow Knee Point.[17]

2. Juvenile Fish Survey

DNR Fisheries Service conducts numerous surveys to gauge the condition of fisheries and some of the sampling sites have been located in the Upper Choptank River. The Bay-wide Estuarine Juvenile Finfish Survey samples 22 sites each year including one in the Upper Choptank River near Denton and three other sites downstream in the Choptank River. Additionally the annual Blue Crab Survey includes five stations in the Choptank River.

As shown in the graph below taken from the DNR Fisheries Service Internet site, 2001 was an excellent recruitment year for young-of-year (YOY) striped bass in the Choptank River. Additionally, 2001 in the Choptank River was an excellent year for young-of-year atlantic menhaden, a good year for white perch and yellow perch and poor year for some species. For additional information see http://www.dnr.state.md.us/fisheries/juvindex/index.html .



3. Tidal Largemouth Bass Studies 1998-2001[10]

The Eastern Regional Staff of Freshwater Fisheries has sampled the Upper Choptank for largemouth bass abundance since the 1980's. In 1999, the survey techniques were changed to increase overall precision, and to better address the correlation between largemouth bass abundance and habitat quality. Roughly forty 250m stations representing prime, average and marginal habitats were sampled each year using an electofishing boat to collect data on largemouth bass and other recreationally important species. The results of these data were encouraging; the bass population in the Upper Choptank appears to be stable or slowly increasing over the three-year study period. Catch-per-unit effort (CPUE) for all bass collected per 100m increased over time from 1.52 in 1999, 1.69 in 2000 to 2.25 in 2001. Similarly, CPUE of young-of-year bass has increased as well from 1999-2001. Overall, when compared to other fisheries, the Upper Choptank River supports an excellent fishery for tidal largemouth bass. It is described by consistent reproduction and a balanced age and size structure of bass in optimal physical condition. Bass abundance was highest in areas of prime habitat characterized by areas with an abundance of structure, adjacent deep water and tidal current breaks. Continued growth of SAV beds in the river will undoubtedly enhance the fishery by creating additional prime habitat.

Year	CPUE (95% CI)	CV	POP Index (95%CI)
Largemouth Bass All Sizes			
1999	1.52 (1.42 - 1.62)	22%	946 (884 - 1008)
2000	1.69 (1.60 - 1.77)	17%	1047 (993 - 1101)
2001	2.25 (2.14 - 2.35)	15%	1174 (1120 - 1227)
Largemouth Bass > 305 mm (12 inches)			
1999	0.83 (0.79 - 0.87)	17%	516 (490 - 542)
2000	1.01 (0.94 - 1.07)	22%	625 (582 - 667)
2001	0.86 (0.81 - 0.92)	21%	537 (502 - 571)
Largemouth Bass Young of Year			
1999	0.14 (0.13 - 0.16)	32%	
2000	0.35 (0.32 - 0.38)	28%	
2001	0.38 (0.36 - 0.41)	21%	

4. Commercial Fisheries

Commercial fisheries harvest information for the Choptank River is tracked by DNR Fisheries Service. While this information aggregates Upper Choptank River information into the Choptank River-wide information, it provides some indication of local conditions. Also see http://mddnr.chesapeakebay.net/mdcomfish/mdcomfishery.html .

– Blue Crabs: For the entire Choptank River, the annual commercial harvest ranged from 6 million pounds in 1994 to 3,346,000 pounds in 1999. The harvest decline during this period appears to be consistent with a similar trend throughout the Chesapeake Bay.

– Oysters: There are no current or historic oyster bars in Upper Choptank River watershed. Additionally, there are no oyster lease areas in the vicinity. The closest oyster bars are about three miles downstream of Bow Knee Point near the mouth of the Warwick River, Dorchester County.[13]

– Striped Bass: The commercial harvest data for the entire Choptank River extends all the way back to 1929. Over the 70-year period from 1929 to 1999, the annual striped bass harvest in the Choptank River occasionally exceeded 200,000 pounds prior to 1976. Since that time, the annual harvest has been significantly smaller. 1998 was the highest harvest year during the 1990s yielding around 135,000 pounds.

5. Recreational Fish Stock Assessment[11]

During 2000, DNR Fisheries Service conducted an extensive effort across the Chesapeake Bay to assess the status of selected fish species that are important for recreational activities. Part of this effort involved sampling of Upper Choptank River fish in the vicinity of the Tuckahoe Creek confluence using experimental fyke nets at five locations. The report on this work, released in 2001, included several findings that may be relevant to the Upper Choptank River WRAS:[11]

– Channel Catfish recruitment in the Choptank River may have improved recently. A higher percentage of 2 to 5 year years amoung the population was found in 1999 and the absolute numbers of channel catfish between 200 mm and 310 mm length increased substantially in 1999 and 2000. From 1993 to 1998 the most frequently found length among channel catfish was consistently increasing. However, 1999 and 2000 surveys suggest that this trend may be reversing.

– White Catfish populations in the Choptank River may be expanding based on trends toward increasing length and increasing pre-recruit abundance. Their numbers counted during 2000 were greater than any year since 1993. The fyke net catches in the Choptank River were nine times the level in 1998.

– White Perch populations appear to be stable (based on relatively constant length frequencies).

– Yellow Perch netted in the 2000 survey indicated continuing strong recruitment in the Choptank River in recent years. The 1996 year-class accounted for 60% of the yellow perch population.

6. Fish Consumption Advisory

In late 2001, MDE issued revised fish consumption advisories. The advisory recommended limiting consumption of channel catfish and white perch caught in the mainstem of the Choptank River due to PCB and/or pesticide contamination. The complete advisory list is available at www.mde.state.md.us/fish_tissue/index.html .

MDE cited changes in the EPA's recommended daily consumption estimates, new sampling data and improved analytical techniques, which led to the revised advisory to limit consumption of 13 species of fish recreationally caught in 14 Maryland waterways. While contaminant levels have not changed, the consumption advisories are especially important for children and women of child-bearing age who are or may become pregnant or are nursing.

Two sampling stations for this effort were located in the Upper Choptank River watershed as shown in Map 6 Monitoring Water Quality: near the mouth of Hog Creek and at Red Bridges near the Sewell Mills USGS gauging station. Seven additional sampling stations were located elsewhere in the Choptank River Basin

Maryland Biological Stream Survey [15, 16]

Brief summaries of the findings by the Maryland Biological Stream Survey (MBSS) for sampling years from 1994 through 2000 are presented here. More complete information on MBSS findings for each sampling site is available at http://mddnr.chesapeakebay.net/mbss/search.cfm .

Findings in the benthic and fish indexes may be used in identifying potential areas for stream protection or restoration.

Sampling of streams in the Upper Choptank wateshed by MBSS will likely be scheduled again in 2005 at the earliest. However, sampling by citizen volunteers in the MBSS Stream Waders program could occur sooner if sufficient interest arises.

1. Benthos in Nontidal Streams

Assessment of benthos or benthic macroinvertebrates is an valuable way to interpret stream conditions based on organisms living in the stream. The text box Why Look At Benthos In Streams explains the importance of benthos in streams.

Assessment of benthic macroinvertebrates or benthos in the Upper Choptank River watershed for the period 1994 through 2000 is presented in Map 17 Benthic Index:

– Good: 14% All but one are downstream of Denton.
– Fair: 22% Scattered throughout the watershed but mostly downstream of Denton.
– Poor: 36% Scattered throughout the watershed.
– Very Poor: 28% These sites are scattered but most tend to be upstream of Denton.

The surveys reported in the map were conducted by the Maryland Biologcial Stream Survey (MBSS), a program in DNR. Each symbol on the map characterizes a stream segment (about 100 feet) based on the benthic population and habitat conditions. An index of "good" means that the stream segment that was sampled has a benthic population and habitat conditions that are close to those found in a comparable "reference" stream. Reference streams are found to have the most natural, least impacted stream conditions found in the area for a particular type of stream. Other index findings varying from fair to poor to very poorly deviate further and further from reference stream conditions.

2. Fish in Nontidal Streams

In Map 18 Fish Index, an assessment of fish populations and habitat conditions in the Upper Choptank River watershed for the period 1994 through 2000 are presented:

– Good: 26%
– Fair: 48%
– Poor: 26%
– Very Poor: one site

Why Look at Benthos in Streams?

Benthos are sometimes called "stream bugs" though that name overly simplifies the diverse membership of this group. Unimpaired natural streams may support a great diversity of species ranging from bacteria and algae to invertebrates like crayfish and insects to fish, reptiles and mammals. Benthic macro-invertebrates, collectively called benthos, are an important component of a stream's ecosystem. This group includes mayflies, caddisflies, crayfish, etc. that inhabit the stream bottom, its sediments, organic debris and live on plant life (macrophytes) within the stream.

The food web in streams relies significantly on benthos. Benthos are often the most abundant source of food for fish and other small animals. Many benthic macroinvertebrates live on decomposing leaves and other organic materials in the stream. By this activity, these organisms are significant processors of organic materials in the stream. Benthos often provide the primary means that nutrients from organic debris are transformed to other biologically usable forms. These nutrients become available again and are transported downstream where other organisms use them.

Benthos are a valuable tool for stream evaluation. This group of species has been extensively evaluated for use in water quality assessment, in evaluating biological conditions of streams and in gauging influences on streams by surrounding lands. Benthos serve as good indicators of water resource integrity because they are fairly sedentary in nature and their diversity offers numerous ways to interpret conditions. They have different sensitivities to changing conditions. They have a wide range of functions in the stream. They use different life cycle strategies for survival.

Sensitive Species

Sensitive species are most widely known in the form of Federally-listed Endangered or Threatened animals such as the bald eagle. In addition to these charismatic rare animals, both US EPA and Maryland DNR work through their respective Federal and State programs to protect numerous endangered, threatened, or rare species of plants and animals and the habitats that support those species.

For the purposes of watershed restoration, it is valuable to account for known locations of habitat for these species. These places are often indicators, and sometimes important constituents, of the network of natural areas or "green infrastructure" that are the foundation for many essential natural watershed processes. Protecting these species and/or promoting expansion of their habitats can be an effective foundation for a watershed restoration program.

DNR's Wildlife and Heritage Division uses three designations for areas providing habitat for sensitive species. These designations are described in the text box Maryland's Sensitive Species Protection Areas. As shown in Map 19 Sensitive Species, two of the three sensitive species designations are found in the Upper Choptank watershed. The purpose of these designations is to help protect sensitive species and their habitat through the review of applications for State permits or approvals, and review of projects that involve State funds. For the types of projects potentially described above, DNR makes recommendations and/or requirements to protect sensitive species and their habitat.

These categories do not place requirements on any activities that do not require a permit/approval or do not involve State funds. However, there are State and Federal restrictions that address "takings" of protected species that apply more broadly. In addition, many counties have incorporated safeguards for these areas into their project and permit review processes. In all instances, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership. More details and guidance can be requested from DNR Natural Heritage Division staff.

Sensitive Species Protection Areas in the Upper Choptank River Watershed

Sensitive Species Project Review Area (SSPRA)

At least 18 SSPRAs are identified in the Upper Choptank River watershed. Each SSPRA contains one or more sensitive species habitats. However, the entire SSPRA is not considered sensitive habitat. The SSPRA is an envelope identified for review purposes to help ensure that applications for permit or approval in or near sensitive areas receive adequate attention and safeguards for the sensitive species / habitat they contain. Also see Map 19 Sensitive Species.

Natural Heritage Area (NHA)

No NHAs are located in the Upper Choptank River watershed. NHAs are rare ecological communities that encompass sensitive species habitat. They are designated in State regulation COMAR 08.03.08.10. For any proposed project that requires a State permit or approval that may affect an NHA, recommendations and/or requirements are placed in the permit or approval that are specifically aimed at protecting the NHA. To help ensure that proposed projects that may affect an NHA are adequately reviewed, an SSPRA is always designated to encompass each NHA and the area surrounding it.

Wetlands of Special State Concern (WSSC)

Numerous small WSSCs are designated in the Upper Choptank River watershed. At least of these areas are visible on Map 19 Sensitive Species but most are not visible. These wetlands are associated with one or more sensitive species habitats that are in or near the wetland. For any proposed project that requires a wetland permit, these selected wetlands have additional regulatory requirements beyond the permitting requirements that apply to wetlands generally. To help ensure that proposed projects that may affect a WSSC are adequately reviewed, an SSPRA is always designated to encompass each WSSC and the area surrounding it. For a listing of designated sites see COMAR 26.23.06.01 at www.dsd.state.md.us

Submerged Aquatic Vegetation

SAV beds in the Upper Choptank River watershed are small and limited to narrow areas along the shoreline. This is, in part, due to the depth of the river channel which limits the area of potential physical habitat in the Upper Choptank River.[12] These areas are too small to be identified in the remote sensing data that is publicly available via DNR's MERLIN Internet mapping tool which shows data for each year from 1984 through 1999. (Also see www.vims.edu/bio/sav/ for extensive information or www.mdmerlin.net for annual distribution maps 1984 through 1996).

Interest in restoring SAV in the Choptank River is currently on the rise. A "Grasses for the Masses" workshop for the Choptank River was held February 2002. The workshop by the Chesapeake Bay Foundation (CBF) and Horn Point Laboratory encouraged local people to grow SAV at home for transplantation to the Choptank River in spring 2002. In general, transplantation sites were in the Lower Choptank River.

RESTORATION TARGETING TOOLS

2002 Stream Corridor Assessment

Using the Stream Corridor Assessment Methodology (SCAM) developed and applied by the DNR Watershed Restoration Division, valuable information can be compiled to assist in targeting restoration activities. DNR has proposed a partnership with Talbot and Caroline Counties to conduct a Stream Corridor Assessment in the Upper Choptank River watershed. Using this approach, trained teams from the Maryland Conservation Corps would walk along streams and other significant waterways to identify and document potential problems and restoration opportunities such as the items listed below: DNR will provide a report of findings for County use.

Stream Corridor Assessment Data Collection Categories	
Pipe Outfalls	Fish Blockages
Pond Sites	Exposed Pipe
Tree Blockages	Unusual Conditions
Inadequate Buffers	Trash Dumping
Erosion	In or Near Stream Construction

2002 Synopic Survey and Benthic Community Assessment

Working from 2002 sampling in the Upper Choptank River watershed, DNR staff will report on water quality in nontidal streams to supplement knowledge of local conditions. Based on parameters listed below, the survey findings will help identify problem areas and relative conditions among local streams. It will also help rank subwatersheds by their nutrient load contributions to tidal areas of the Upper Choptank River.

For the same 2002 sampling sites, DNR staff will also report on benthic organism populations in nontidal streams as a gauge of water quality and habitat conditions. DNR's report of 2002 findings will include assessment of water quality, benthic organism populations and the potential relationships that may be drawn from the 2002 data.

Synopic Survey Data Collection Parameters	
Dissolved Oxygen	Nutrients (nitrogen and phosphorus)
pH	Conductivity

Agricultural Conservation Programs

Both Caroline and Talbot Counties have significant levels of participation conservation programs. Farmers in these counties willingly implement management systems that address nutrient runoff and infiltration, erosion and sediment control, and animal waste utilization. The Soil and Water Conservation Districts in these counties work with farmers and landowners in the development of Soil Conservation and Water Quality plans that recommend best management practices that will prevent nutrient and sediment impact on surface and ground water. Some of the conservation practices installed were grassed waterways, riparian herbaceous and riparian forested buffers, conservation cover, cover crops, shallow water wildlife areas and grade stabilization structures. The Maryland Agricultural Cost-Share program (MACS), the Conservation Reserve Program (CRP and CREP) and the Environmental Quality Incentive Program (EQIP) are some of the state and federal programs promoted and administered by the Soil and Water Conservation Districts and the National Resource Conservation Service (NRCS).

Farmers in the watershed who are already using good management practices that benefit water quality could provide examples to promote adoption of similar practices by other farmers.

Marina Programs

Discharges of sewage from boats are a concern for water quality because they contribute nutrients, biochemical oxygen demand, pathogens, etc. These discharges are preventable if a sufficient number of pumpout facilities are locally available and boat operators take advantage of these services.

In the Upper Choptank River watershed, three marinas are located in the Caroline County and none in Talbot County as shown in Map 20 Marinas. Of these marinas, only one offers pumpout facilities. None of these marinas is currently participating in Maryland's Clean Marina Program.

The Clean Marinas Program is a way for marina owners to gain certification and public recognition for voluntarily undertaking a number of actions related to marina design, operation, and maintenance intended to properly manage all kinds of marine products and activities, and to reduce and properly manage waste. Information is available at DNR's website, www.dnr.state.md.us/boating.

DNR also funds installation and maintenance of marine pumpout facilities, including those at certified Clean Marinas. Information may be obtained from the Waterway and Greenways Division at DNR.

One potential element of a Watershed Restoration Action Strategy (WRAS) is to encourage and/or support adding marina pumpout facilities serving the local area and increasing participation in the Clean Marina Program.

Fish Blockage Removal

Many fish species need to move from one stream segment to the next in order to maintain healthy resilient populations. This is particularly true for anadromous fish species because they spawn and hatch from eggs in free flowing streams but live most of their lives in estuarine or ocean waters. However, blockages in streams can inhibit or prevent many fish species from moving up stream to otherwise viable habitat.

The distribution of fish blockages known to exist in the Upper Choptank River watershed in 2001 and earlier are shown in Map 21 Fish Blockages. The map shows that all currently known blockages in the Upper Choptank River watershed are in Caroline County.

Four previously existing blockages that have been corrected are also show on the map and are listed in the table Corrected Fish Blockages. One corrected blockage is in Talobt County and the other three corrected blockages are on Herring Run and Broadway Branch in Caroline County.

All immediately available information on fish blockages is from the DNR's Fish Blockage Database. DNR's Fisheries Service uses this information to help prioritize stream blockages for mitigation or removal. A summary of the 21 currently identified blockages listed in the Upper Choptank River watershed appears in the table Fish Blockage Removal Opportunities.

In general, removal of a fish blockage is recommended if its correction would open a large stream segment containing high quality habitat with existing or potential return of significant fish populations. Some of these blockages to fish movement may be structural components of farm ponds, drainage ditches, etc. If a blockage is found to be in this category, circumstances like requirements for drainage control function and public or land owner needs are considered in determining the potential for a restoration project.

The list of fish blockage removal opportunities should be considered as supporting information to help guide additional site assessments and planning for blockage removal. Based on experience in other watersheds, it is likely that a Stream Corridor Assessment would identify additional potential fish blockage problems.

As part of the WRAS project, local government and other constituencies may elect to either provide input into DNR's fish blockage removal priorities or to generate a list of local priorities.

Corrected Fish Blockages Upper Choptank River Watershed				
Site ID	Blockage Corrected	County	Stream	Name / Location
CP004	1996	CO	Herring Run	Dam #1 on Herring Run
CP005	1996	CO	Herring Run	Dam #2 on Herring Run
CPU01	1989	TA	Beaverdam Branch	Beaverdam Creek Weir, near Rt 328
CPU02	1997	CO	Broadway Branch	Lake Bonnie Dam, south of Greenboro

Fish Blockage Removal Opportunities in the Upper Choptank River Watershed			
Site ID	**County**	**Stream**	**Name / Location**
CP001	Caroline	Chapel Branch	Road east of Rt 317 and Rt313 intersection
CP002	Caroline	Choptank River	Road off Rt 313 north of Greensboro
CP006	Caroline	trib to Skeleton Creek	End of Poplar Neck Road
CPU03	Caroline	Burrsville Branch	Above Dead End Road
CPU05	Caroline	Choptank River	Red Bridges Road
CPU06	Caroline	Choptank River	Mud Mill Pond
CPU07	Caroline	Engle Ditch/ Chapel Br.	0.75 miles above Rt 13
CPU08	Caroline	Engle Ditch/ Chapel Br.	1.05 miles above Rt 313 at powerline
CPU09	Caroline	Forge Branch	0.25 miles above Rt 480
CPU10	Caroline	Fowling Creek	0.2 miles above Rt 16
CPU11	Caroline	Fowling Creek	Statum Road
CPU13	Caroline	Little Creek	Frazier Neck Road (Marsh Road)
CPU14	Caroline	Mill Creek	Williston Mill Dam
CPU16	Caroline	Spring Branch	100 yards from Rt 313
CPU18	Caroline	trib to Skeleton Creek	Poplar Neck Road
CPU20	Caroline	trib to Choptank River	Rt 328 (low flow consideration)
CPU21	Caroline	trib to Choptank River	0.4 miles below Rt 328
CPU22	Caroline	trib to Choptank River	0.4 miles above River Rd, (low flow consideration)
CPU23	Caroline	trib to Choptank River	Holsinger Rd
CPU24	Caroline	trib to Forge Branch	2 miles south of Greensboro on Rt 480
CPU25	Caroline	trib to Forge Branch	Holly Road

Stream Buffer Restoration

1. Benefits and General Recommendations

Natural vegetation in stream riparian zones act as stream buffers that can provide numerous valuable environmental benefits:

- – Reducing surface runoff
- – Preventing erosion and sediment movement
- – Using nutrients for vegetative growth and moderating nutrient entry into the stream
- – Moderating temperature, particularly reducing warm season water temperature
- – Providing organic material (decomposing leaves) that are the foundation of natural food webs in stream systems
- – Providing overhead and in-stream cover and habitat
- – Promoting high quality aquatic habitat and diverse populations of aquatic species.

To realize these environmental benefits, DNR generally recommends that forested stream buffers be at least 100 feet wide , i.e. natural vegetation 50 feet wide on either side of the stream. Therefore, DNR is promoting this type of stream buffer for local jurisdictions and land owners who are willing to go beyond the minimum buffer standards. The DNR Watershed Restoration Division and other programs like CREP are available to assist land owners who volunteer to explore these opportunities.

2. Using GIS

Identifying the areas that need buffer restoration and prioritizing them for action can be a time-consuming expensive project. Fortunately, use of a computerized Geographic Information System (GIS) to manipulate remote sensing data can help save limited time and funds. To assist in this technical endeavor, DNR Watershed Management and Analysis Division is offering assistance, including GIS work, to help target restoration of naturally vegetated stream buffers, wetlands and other watershed management projects that may be identified locally. With these tools, information generated by a Stream Corridor Assessment and additional on-the-ground verification or "ground truthing," local government may more efficiently and confidently consider stream buffer restoration as part of a local Watershed Restoration Action Strategy.

Several scenarios are presented here to help consider potential areas for stream buffer and wetland restoration. These scenarios can be used alone or in combination as models for targeting potential restoration sites for field verification. These maps are intended to demonstrate a methodology that can be used to locate sites having a high probability of optimizing certain ecological benefits of stream buffers. The resolution of the data used to generate these maps is not sufficient for an accurate site assessment, but can be used to identify potential candidate sites for more detailed investigation. The streams presented in the maps are perennial (blue line) streams as generally shown on US Geological Survey Quadrangle Maps. Intermittent streams were not considered in the stream buffer scenario maps.

3. Headwater Stream Buffers

Headwater streams are also called first order streams. These streams, unlike other streams (Second Order, etc.), intercept all of the surface runoff within the watersheds that they drain. In addition, for many watersheds, first order streams drain the majority of the land within the entire watershed. Therefore, stream buffers restored along headwater (First Order) streams tend to have greater potential to intercept nutrients and sediments than stream buffers placed elsewhere. In targeting stream buffer restoration projects, giving higher priority to headwater streams is one approach to optimizing nutrient and sediment retention.

Restoring headwater stream buffers can also provide habitat benefits that can extend downstream of the project area. Forested headwater streams provide important organic material, like decomposing leaves, that "feed" the stream's food web. They also introduce woody debris which enhances in-stream physical habitat. The potential for riparian forest buffers to significantly influence stream temperature is greatest in headwater regions. These factors, in addition to positive water quality effects, are key to improving aquatic habitat.

4. Land Use and Stream Buffers

One factor that affects the ability of stream buffers to intercept nonpoint source pollutants is adjacent land use. Nutrient and sediment loads from different land uses can vary significantly. The loading rates shown in the table here were calculated for the Lower Potomac River Tributary Basin from the model of the Chesapeake Bay Watershed Model.

In general, restoration of stream buffers has been an agricultural Best Management Practice (BMP), with less applicability in urban areas. By identifying land uses in riparian areas with inadequate stream buffers, like crop land adjacent to streams, the potential to reduce nutrient and sediment loads can be improved. To assist in finding areas with crop land adjacent to streams, the same land use data shown in Map 11 Generalized Land Use 2000 can be filtered using GIS.

Annual Nonpoint Source Pollution Load Rates
By Land Use
Chesapeake Bay Watershed Model (2000)

Land Use	Nitrogen (lbs/ac)	Phosphorus (lbs/ac)	Sediment (tons/ac)
Crop land	17.11	1.21	0.74
Urban	7.5	0.7	0.09
Pasture	8.40	1.15	0.30
Forest	1.42	0.00	0.03

The land use / land cover information selectively shown in Map 22 Stream Buffer Land Use Scenario focuses on the land use within 50 feet of a stream. This view, supplemented with the land use pollution loading rates, suggests potential buffer restoration opportunities that could minimize nutrient and sediment loads. (Note: DNR is encouraging naturally vegetated stream buffers 50 feet wide on each side of the stream, which is significantly greater than minimum buffer requirement, to enhance nutrient and habitat benefits beyond minimum buffer requirements.)

5. Nutrient Uptake from Hydric Soils in Stream Buffers

In general, the nutrient nitrogen moves from the land into streams in surface water runoff and in groundwater. In watersheds like the Upper Choptank, a significant percentage of nitrogen enters streams in groundwater. Stream buffers can be used to capture nitrogen moving in groundwater if buffer restoration projects have several key attributes:

– Plant with roots deep enough to intercept groundwater as it moves toward the stream
– Plants with high nitrogen uptake capability, and
– Targeting buffer restoration projects to maximize groundwater interception by buffer plants.

Hydric soils in stream riparian areas can be used as one factor to help select stream buffer restoration sites. Siting buffer restoration on hydric soils would offer several benefits:

– Plant roots are more likely to be in contact with groundwater for longer periods of time
– Hydric soils tend to be marginal for many agricultural and urban land uses
– Natural vegetation in wet areas often offers greater potential for habitat.

Map 23 Stream Buffer Hydric Soils Scenario identifies lands adjacent to streams that are composed of hydric soil and also lack stream buffers in the Upper Choptank River watershed. To generate the map, hydric soils (Natural Soils Group of Maryland, MDP) were grouped into two classes and rated in terms of their potential to maximize groundwater/root zone interaction: poorly drained hydric soils (high nutrient retention efficiency), and moderately well drained hydric soils (moderately high nutrient retention efficiency). An important next step in using this information is verification of field conditions. Care must be taken during field validation to evaluate any hydrologic modification of these soils, such as ditching or draining activities, which would serve to decrease potential benefits.

A revision of the above scenario is shown in Map 24 Stream Buffer Scenario: Hydric Soils On Cropland. The presentation in this map is based on the same hydric soil data as the previous map but refines the area highlighted by showing only hydric soils that were used for cropland in 2000. This scenario suggests areas where current agricultural stream buffer restoration programs may be focused.

6. Wetland Associations

Wetlands and adjacent natural uplands form complex habitats that offer a range of habitat opportunities for many species. These “habitat complexes” tend to offer greater species diversity and other ecological values that are greater than the values that the wetland or uplands could offer independently. Therefore, restoring stream buffers adjacent to or near existing wetlands tends to offer greater habitat benefits than the restoration project could otherwise produce. Map 25 Stream Buffer Wetland Proximity Scenario identifies unforested buffer zones that are in close proximity (within 300 feet) to wetlands (National Wetlands Inventory). Restoration projects in these areas may offer opportunities to enhance and expand wetland habitat in addition to providing other desirable buffer functions.

7. Optimizing Water Quality Benefits by Combining Priorities

Strategic targeting of stream buffer restoration projects may promote many different potential benefits. To maximize multiple benefits, site selection and project design need to incorporate numerous factors. For example, finding a site with a mix of attributes like those in the following list could result in the greatest control of nonpoint source pollution and enhancement to living resources:

– land owner willingness / incentives
– marginal land use in the riparian zone
– headwater stream
– hydric soils
– selecting appropriate woody/grass species
– adjacent to existing wetlands / habitat

Additionally, selecting restoration projects that are likely to produce measurable success is an important consideration in prioritizing projects for implementation. In the early stages of a watershed restoration program, measurable water quality improvement can be one of the strongest ways to demonstrate project success.

In general, targeting restoration projects to one or a few selected tributaries or small watersheds will tend to offer the greatest probability of producing measurable water quality improvement. By selecting small areas like a small first order stream for restoration, there is greater likelihood that water quality problems arise locally and that they can be corrected by limited investment in carefully selected local restoration projects.

In the Upper Choptank River watershed, available water quality data reinforces the premise that targeting restoration projects to locally generated problems is an important consideration. Because significant inputs to water quality in the Choptank River arise from multiple states and counties, it be will difficult for local projects to demonstrate water quality improvements in the river mainstem.

However, if watershed restoration projects are targeted to selected tributary streams, improvement in in-stream water quality are more likely to be measurable in terms of water quality parameters, benthos populations or other parameters. Water quality improvements achieved in the tributary will also inevitably contribute to improving the river mainstem. However, improvement in the mainstem of the river may not be measurable if the magnitude of the problem is as great as the data suggest.

Wetland Restoration

Wetlands serve important environmental functions such as providing habitat and nursery areas for many organisms, facilitating nutrient uptake and recycling, providing erosion control. However, most watersheds in Maryland have significantly fewer wetland acres today than in the past. This loss due to draining, filling, etc. has led to habitat loss and negative water quality impacts in streams and in the Chesapeake Bay. Limiting or reversing this historic trend is an important goal of wetland restoration. One approach to finding candidate wetland restoration sites involves identifying "historic" wetland areas based on the presence of hydric soils using GIS. The GIS maps can help initiate a candidate site search process, assist in discussions with willing land owners and targeting site investigations.

For the Upper Choptank River watershed, a GIS scenarios were developed as described below:

– Data used: Hydric soils (Natural Soil Groups), existing wetlands (National Wetlands Inventory), land use (MDP 1997).
– Identify candidate hydric soil areas based on land use. Hydric soils on open land (agricultural fields, bare ground, etc.) are retained while those underlying natural vegetation and developed lands are excluded.
– Identify hydric soils on open land that are close to existing wetlands or streams.

Two of many possible scenarios for finding potential wetland restoration sites are presented on the accompanying maps:

– Map 26 Wetland Restoration Opportunities shows that wetland restoration opportunities are numerous throughout the watershed.

– Map 24 Stream Buffer Hydric Soils On Cropland Scenario shows stream buffer restoration opportunities are reasonably common across the watershed.

The potential wetland restoration sites suggested in these scenarios can be filtered further by using more accurate wetlands and soil information, considering landownership, etc. Next steps that could also be beneficial are considering additional criteria like habitat enhancement opportunities, sensitive species protection, targeting specific streams or subwatersheds for intensive restoration, and using Conservation Reserve Enhancement Program (CREP) information.

Additional wetland restoration opportunities may be identified on non-agricultural lands. For example, residential properties, particularly low density areas, may also provide viable project sites that do not appear on the scenarios presented above.

PROJECTS RELATED TO THE WRAS PROCESS

Overview

There are numerous projects and programs that have the potential to contribute to successful development and implementation of a Watershed Restoration Action Strategy (WRAS). The listing included here suggests opportunities for cooperation and coordination that can improve the likelihood of success for the WRAS. This listing is not all-inclusive. It is recommended that this list be augmented as new information becomes available and that follow-up should continue to promote the WRAS process with these and other projects and programs.

319(h)-Funded Projects

The Federal funding source generally known as "319" is funding a project that includes the Upper Choptank River watershed. This Maryland Dept. of Agriculture project is known as the *Progressive Management Practices for Lower Eastern Shore Public Drainage Associations (PDAs)*. To date, the project has been funded in Federal fiscal year 1999 and 2000. Additional funding is proposed for Federal fiscal 2002. The project is intended to improve water quality in the Lower Eastern Shore by installing best management practices on PDAs to reduce the amount of sediment flow and nutrients into rivers that receive agricultural drainage by:

– Installing weirs or other water control structures on 50 miles of public drainage systems for water quality improvement.

– Demonstrating the viability of pocket wetland systems on public drainage systems on the Lower Eastern Shore.

– Providing cost-share funds for repair and stabilization of emergency blowouts, channel obstructions and weir maintenance on existing PDAs for water quality protection.

– Providing cost-share funds to increase PDA buffer protection and maintenance areas up to 35 feet from the drainage system center line.

Other Projects

This section summarizes projects that have the potential to contribute to development and implementation of the Watershed Restoration Action Strategy that have not been addressed elsewhere in the watershed characterization.

1. Agricultural / PDA BMP Monitoring

The Maryland Department of Agriculture (MDA) and DNR will begin monitoring several agricultural areas served by Public Drainage Associations (PDAs) on Maryland's Eastern Shore in summer 2002. The intent of the project is gather information on the water quality affects of selected

Best Management Practices (BMPs). Some of this information will be collected in the Upper Choptank River watershed. This locally collected information can also be used to better quantify water quality conditions in the drainage ditches where the monitoring is stationed.

2. Conservation Reserve Program (CRP)

The CRP program pays farmers on a per acre basis to remove fields from production. One of numerous benefits from the program is reduction of sediment and nutrient movement into streams.

3. Conservation and Restoration Enhancement Program (CREP)

The CREP program reimburses farmers who restore stream riparian areas to natural vegetation. Under the program, this land creates new or enhanced stream buffer which is placed under a conservation easement.

4. Greenways

The Year 2000 edition of the Maryland Greenways Atlas identifies Greenway and Green Infrastructure projects and issues that include the Upper Choptank River watershed area:

- Easton-Clayton Rail Trail (recreational greenway) is proposed to extend through the Upper Choptank River watershed from the existing section completed in 1998 in Talbot County. As proposed, the completed project would extend outside of the watershed and then eventually re-enter the watershed in Caroline County to extend through Hillsboro, Ridgely and Goldsboro.
- Choptank and Tuckahoe River Water Trail has been proposed as a partnership between Talbot County, Caroline County and private citizens that would establish an official water trail. This portion of the Choptank River within the Upper Choptank River watershed would build on the existing popularity among canoe and kayak enthusiasts.
- Denton Municipal Greenway proposal would connect Denton to Martinak State Park on the Choptank River within the WRAS watershed.
- Hillsboro Rail Trail is a proposal for a recreational greenway on an inactive railroad spur between Hillsboro and Denton.
- Upper Choptank River Greenway is proposed to be an ecological and recreational greenway. It would follow the Choptank River (in the Upper Choptank River watershed) connecting the County Christian Park to the boat ramp in Greensboro.

POTENTIAL BENCHMARKS FOR WRAS GOAL SETTING

Several programs designed to manage water quality and/or living resources have existing or proposed goals that are relevant to setting goals for the Breton Bay Watershed Restoration Action Strategy (WRAS). The goals from these other programs tend to overlap and run parallel to potential interests for developing WRAS goals. Therefore, to assist in WRAS development, selected goals from other programs are included here as points of reference.

Coastal Zone Management

– The Watershed Restoration Action Strategy (WRAS) Initiative is a component of the Cumulative and Secondary Impacts section of the *Maryland Coastal Zone Management Program Section 309 Strategy (2000-2005)*. Watershed strategies are defined as comprehensive plans that will identify areas of concern, monitoring strategies, gaps in information, mitigation options, and restoration and protection opportunities.

– WRAS projects funded under Coastal Zone Management must be in Maryland's Coastal Zone and must include a local program change as part of the effort. This could include incorporation into the County Comprehensive Plan, adoption of local implementing tools like zoning ordinances and environmental codes, modification of sensitive areas elements or alterations to Smart Growth Priority Funding Areas.

Chesapeake 2000 Agreement

The Chesapeake 2000 Agreement (C2K) includes several significant commitments pertaining to local watershed management planning and implementation. The goal in the C2K Agreement that is directly related to the development of watershed management plans and action strategies is "By 2010, work with local governments, community watershed groups and watershed organizations to develop and implement locally supported watershed management plans in two-thirds of the Bay watershed covered by this Agreement. These plans would address the protection, conservation and restoration of stream corridors, riparian buffers and wetlands for the purposes of improving habitat and water quality, with the collateral benefits for optimizing flow and water supply."

Four common elements of watershed management planning were adopted by the Chesapeake Bay Program member jurisdictions to be applied Bay-wide. Those elements support the WRAS components which were also identified as common Bay-wide criteria for watershed management planning. The four approved C2K Agreement watershed planning elements are as follows:

1. Does the plan "address the protection, conservation and restoration of stream corridors, riparian forest buffers and wetlands?" Each watershed management plan needs to be based on an assessment of natural resources within the watershed. At a minimum, the assessment will evaluate the condition of stream corridors, riparian buffers and wetlands within the watershed.

2. Does the plan reflect the goals and objectives of "improving habitat and water quality?" The plan should reflect the issues that the stakeholders feel are important, and, at a minimum, exhibit a

benefit to habitat and water quality within the watershed.
The goals should be based on priority issues identified by the watershed assessment.

3. CWiC Criteria #3-- Does the plan identify implementation mechanisms?
Capacity to implement the plan will be demonstrated by identifying:
- What are the specific management actions?
- What are the resources necessary for implementation?
- Who will implement the plan?
- And when will the actions will be implemented?

The implementation mechanisms should also incorporate a periodic re-evaluation to ensure the plan is "living" and flexible to the changes in the watershed.

4. Does the plan have demonstrated local support? Every effort should be made to demonstrate a diversity of local support. At a minimum, local governments, community groups and watershed organizations should be encouraged to participate in developing and implementing the watershed management plan.

Goals from the *Clean Water Action Plan* [2]

– Clean Water Goals - Maryland watersheds should meet water quality standards, including numerical criteria as well as narrative standards and designated uses.
– Watersheds should achieve healthy conditions as indicated by natural resource indicators related to the condition of the water itself (e.g. water chemistry), aquatic living resources and physical habitat, as well as landscape factors (e.g. buffered streams and wetland restoration).

Water Quality Improvement Act of 1998

- The most significant feature is requiring nutrient management plans for virtually all Maryland farms. The requirement is being phased in over a several year period.
- Nitrogen-based plan implementation will be required on all farms beginning December 31, 2001.
- Phosphorus-based plan implementation will be required on farms using chemical fertilizer beginning December 31,2002 and on farms using manure or biosolids by July 1, 2005.
- Up to 87.5% cost share is available for development of nutrient management plans and up to $20 per ton cost share assistance with costs of manure transportation are available. Implementation of projects assisted by this funding has the potential to move nutrients to sites where they are needed.

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GLOSSARY

303(d)	A section of the federal Clean Water Act requiring the states to report which waters of the state are considered impaired for the uses for which they have been designated, and the reasons for the impairment. Waters included in the "303(d) list" are candidates for having TMDLs developed for them.
319	A section of the federal Clean Water Act dealing with non-point sources of pollution. The number is often used alone as either a noun or an adjective to refer to some aspect of that section of the law, such as grants.
8-digit watershed	Maryland has divided the state into 138 watersheds, each comprising an average of about 75 square miles, that are known as 8-digit watersheds because there are 8 numbers in the identification number each has been given. These nest into the 21 larger 6-digit watersheds in Maryland which are also called Tributary Basins or River Basins. Within the Chesapeake Bay drainage, 8-digit watersheds also nest into 10 Tributary Team Basins.
Anadromous fish	Fish that live most of their lives in salt water but migrate upstream into fresh water to spawn.
Benthic	Living on the bottom of a body of water.
CBIG	Chesapeake Bay Implementation Grant Program, a DNR-administered program that awards grants from the Chesapeake Bay Program to reduce and prevent pollution and to improve the living resources in the Chesapeake Bay.
CBNERR	The Chesapeake Bay National Estuarine Research Reserve in a federal, state and local partnership to protect valuable estuarine habitats for research, monitoring and education. The Maryland Reserve has three components: Jug Bay on the Patuxent River in Anne Arundel and Prince Georges' Counties, Otter Point Creek in Harford County and Monie Bay in Somerset County.
CCWS	Chesapeake and Coastal Watershed Service, the unit in DNR that works with local governments and other interested parties to develop restoration strategies and projects.

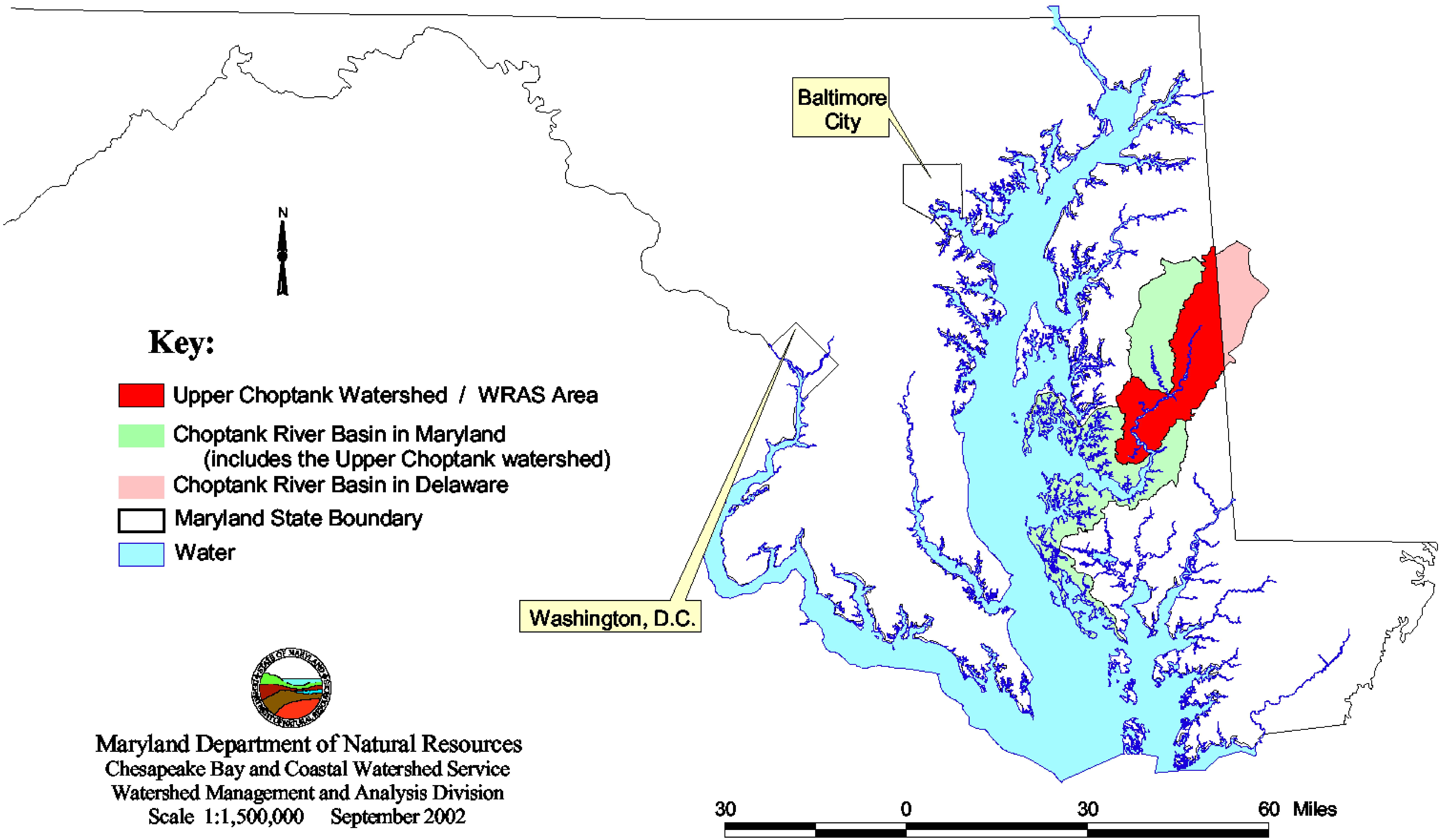
COMAR	Code Of Maryland Regulations (Maryland State regulations)
CREP	Conservation Reserve Enhancement Program, a program of MDA. CREP is a federal/state and private partnership which reimburses farmers at above normal rental rates for establishing riparian forest or grass buffers, planting permanent cover on sensitive agricultural lands and restoring wetlands for the health of the Chesapeake Bay.
CRP	Conservation Reserve Program, a program of Farm Service Agency in cooperation with local Soil Conservation Districts. CRP encourages farmers to take highly erodible and other environmentally-sensitive farm land out of production for ten to fifteen years.
CWAP	Clean Water Action Plan, promulgated by EPA in 1998. It mandates a statewide assessment of watershed conditions and provides for development of Watershed Restoration Action Strategies (WRASs) for priority watersheds deemed in need of restoration
CWiC	Chesapeake 2000 Agreement watershed commitments. CWiC is a shorthand phrase used in the Chesapeake Bay Program.
CZARA	The Coastal Zone Reauthorization Amendments of 1990, intended to address coastal non-point source pollution. Section 6217 of CZARA established that each state with an approved Coastal Zone Management program must develop and submit a Coastal Non-Point Source program for joint EPA/NOAA approval in order to "develop and implement management measures for NPS pollution to restore and protect coastal waters".
CZMA	Coastal Zone Management Act of 1972, establishing a program for states and territories to voluntarily develop comprehensive programs to protect and manage coastal resources (including the Great Lakes). Federal funding is available to states with approved programs.
Conservation Easement	A legal document recorded in the local land records office that specifies conditions and/or restrictions on the use of and title to a parcel of land. Conservation easements run with the title of the land and typically restrict development and protect natural attributes of the parcel. Easements may stay in effect for a specified period of time, or they may run into perpetuity.

DNR	Department of Natural Resources (Maryland State)
EPA	Environmental Protection Agency (United States)
Fish blockage	An impediment, usually man-made, to the migration of fish in a stream, such as a dam or weir, or a culvert or other structure in the stream
GIS	Geographic Information System, a computerized method of capturing, storing, analyzing, manipulating and presenting geographical data.
MBSS	Maryland Biological Stream Survey, a program in DNR that samples small streams throughout the state to assess the condition of their living resources.
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
MET	Maryland Environmental Trust, an organization that holds conservation easements on private lands and assists local land trusts to do similar land protection work.
MGS	Maryland Geological Survey, a division in DNR.
NHA	Natural Heritage Area, a particular type of DNR land holding, designated in COMAR.
NOAA	National Oceanic and Atmospheric Administration, an agency of the US Department of Commerce that, among other things, supports the Coastal Zone Management program, a source of funding for some local environmental activities, including restoration work.
NPS	Non-Point Source, pollution that originates in the landscape that is not collected and discharged through an identifiable outlet.
NRCS	Natural Resources Conservation Service, formerly the Soil Conservation Service, an agency of the US Department of Agriculture that, through local Soil Conservation Districts, provides technical assistance to help farmers develop conservation systems suited to their

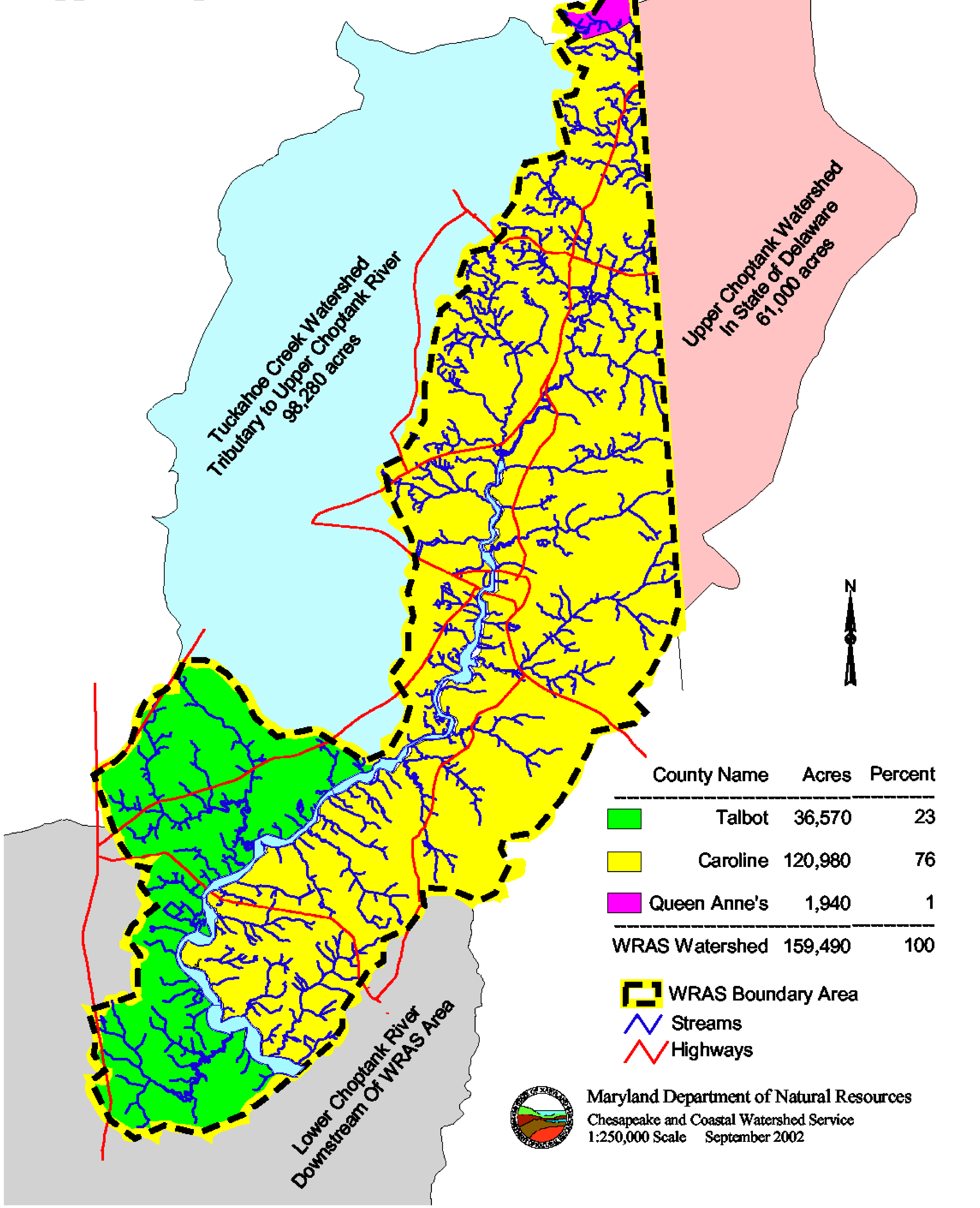
	land. NRCS participates as a partner in other community-based resource protection and restoration efforts.
PDA	Public Drainage Association
Palustrine Wetlands	Fresh water wetlands, including bogs, marshes and shallow ponds.
RAS	Resource Assessment Service, a unit of DNR that carries out a range of monitoring and assessment activities affecting the aquatic environment.
Riparian Area	1. Land adjacent to a stream. 2. Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e. a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines. (National Research Council, *Riparian Areas: Functions and Strategies for Management*. Executive Summary page 3. 2002)
SAV	Submerged Aquatic Vegetation, important shallow-water sea grasses that serve as a source of food and shelter for many species of fin- and shell-fish.
SCA[M]	Stream Corridor Assessment is an activity carried out by CCWS in support of WRAS development and other management needs, in which trained personnel walk up stream channels noting important physical features and possible sources of problems.
SCD	Soil Conservation District is a county-based, self-governing body whose purpose is to provide technical assistance and advice to farmers and landowners on the installation of soil conservation practices and the management of farmland to prevent erosion.
SSPRA	Sensitive Species Protection Review Area, an imprecisely defined area in which DNR has identified the occurrence of rare, threatened and/or endangered species of plants or animals, or of other important natural resources such as rookeries and waterfowl staging areas.

Synoptic survey	A short term sampling of water quality and analysis of those samples to measure selected water quality parameters. A synoptic survey as performed by DNR in support of watershed planning may be expanded to include additional types of assessment like benthic macroinvertibrate sampling or physical habitat assessment.
TMDL	Total Maximum Daily Load, a determination by MDE of the upper limit of one or more pollutants that can be added to a particular body of water beyond which water quality would be deemed impaired.
Tributary Teams	Geographically-focused groups, appointed by the Governor, oriented to each of the 10 major Chesapeake Bay tributary basins found in Maryland. The teams focus on policy, legislation, hands-on implementation of projects, and public education. Each basin has a plan, or Tributary Strategy.
USFWS	United States Fish and Wildlife Service, an agency of the Department of Interior.
USGS	United States Geological Survey
Water Quality Standard	Surface water quality standards consist of two parts: (a) designated uses of each water body; and (b) water quality criteria necessary to support the designated uses. Designated uses of for all surface waters in Maryland (like shell fish harvesting or public water supply) are defined in regulation. Water quality criteria may be qualitative (like "no objectionable odors") or quantitative (toxic limitations or dissolved oxygen requirements).
Watershed	All the land that drains to an identified body of water or point on a stream.
WRAS	Watershed Restoration Action Strategy, a document outlining the condition of a designated watershed, identifying problems and commiting to solutions of prioritized problems.
WSSC	Wetland of Special State Concern, a designation by MDE in COMAR.

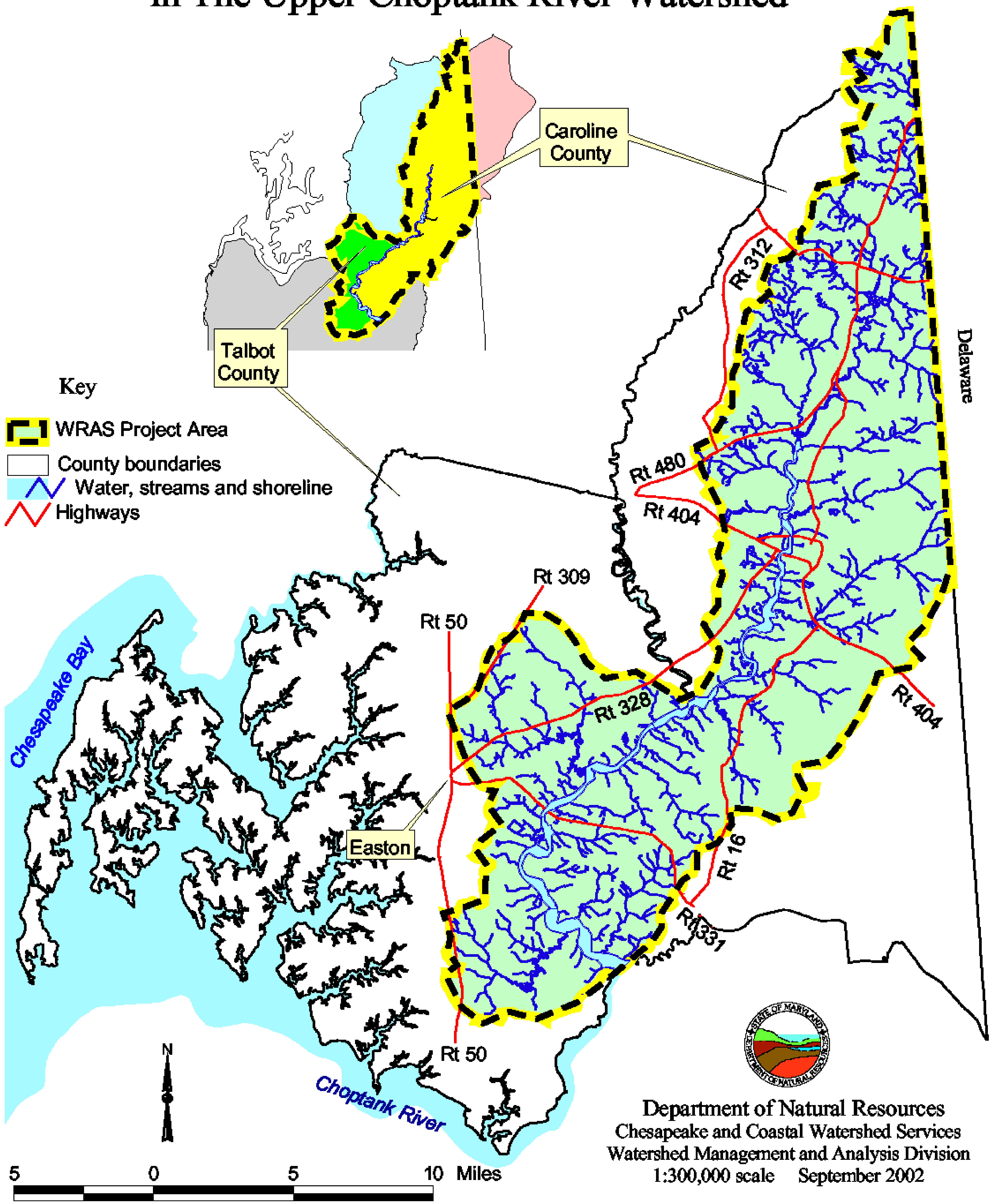
Map 1 Regional Context
Upper Choptank River Watershed In Talbot and Caroline Counties
Watershed Restoration Action Strategy (WRAS) Area



Map 2 County Context For WRAS
Upper Choptank River Watershed

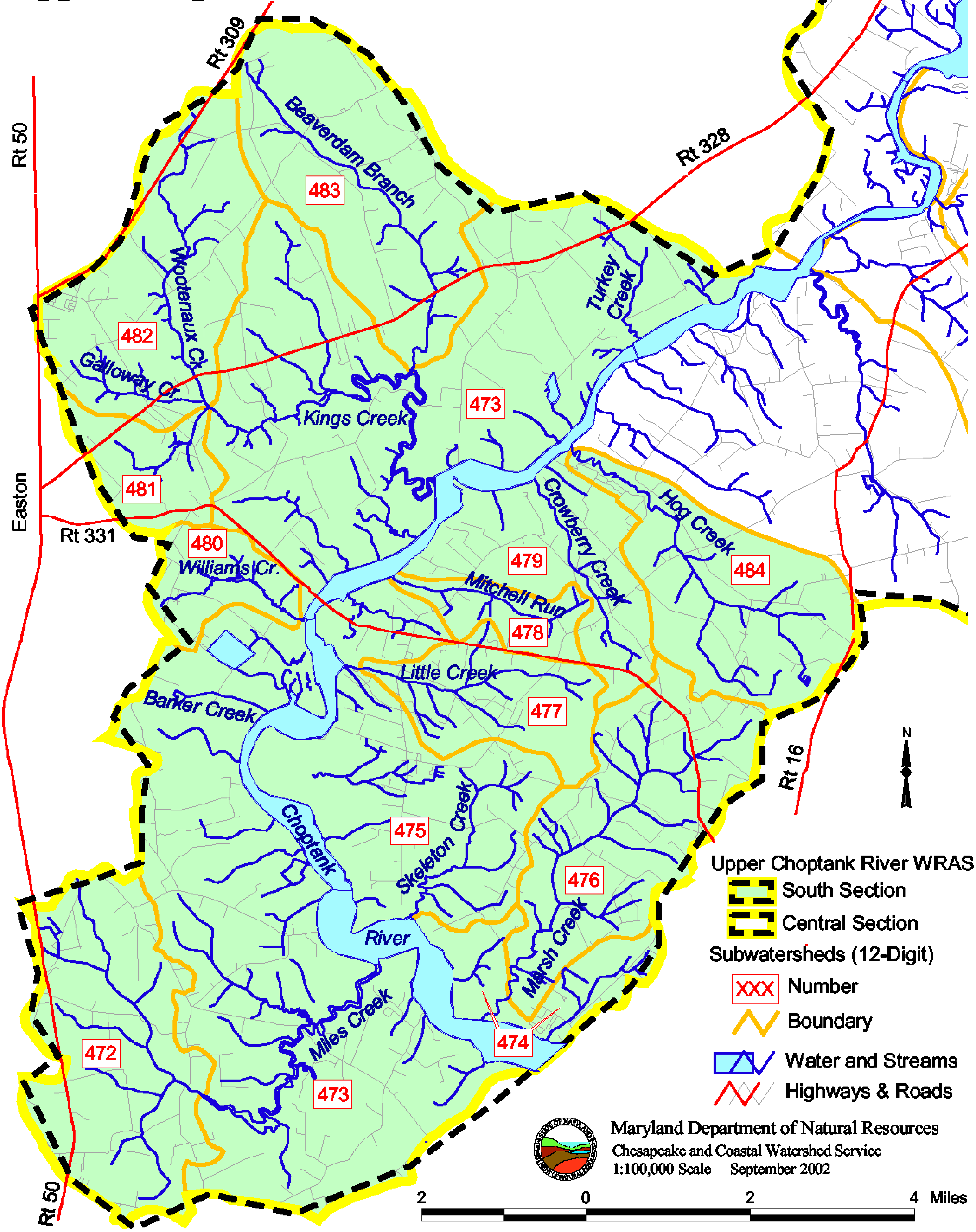


Map 3 WRAS Project Area
Talbot and Caroline Counties, Maryland
In The Upper Choptank River Watershed

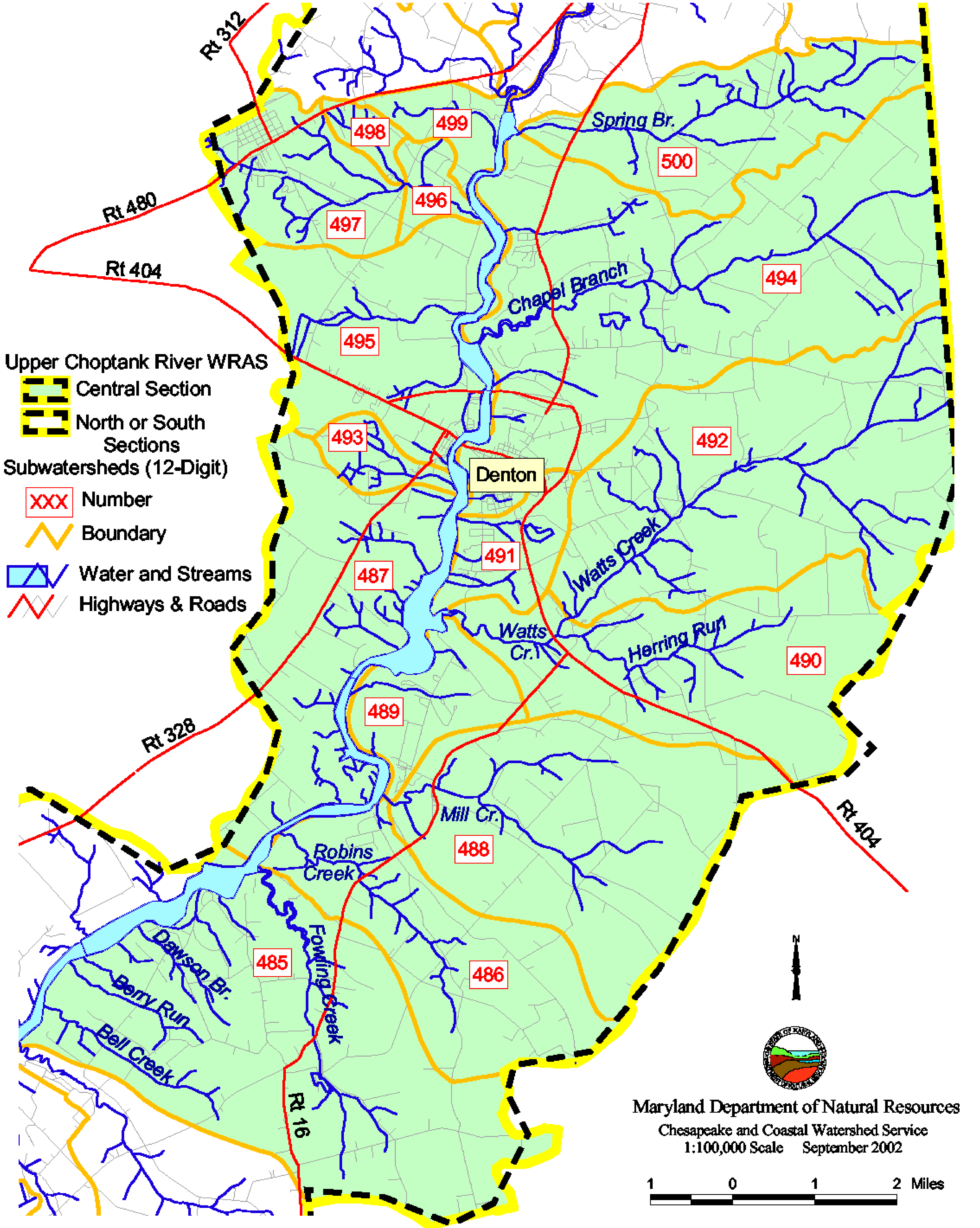


Department of Natural Resources
Chesapeake and Coastal Watershed Services
Watershed Management and Analysis Division
1:300,000 scale September 2002

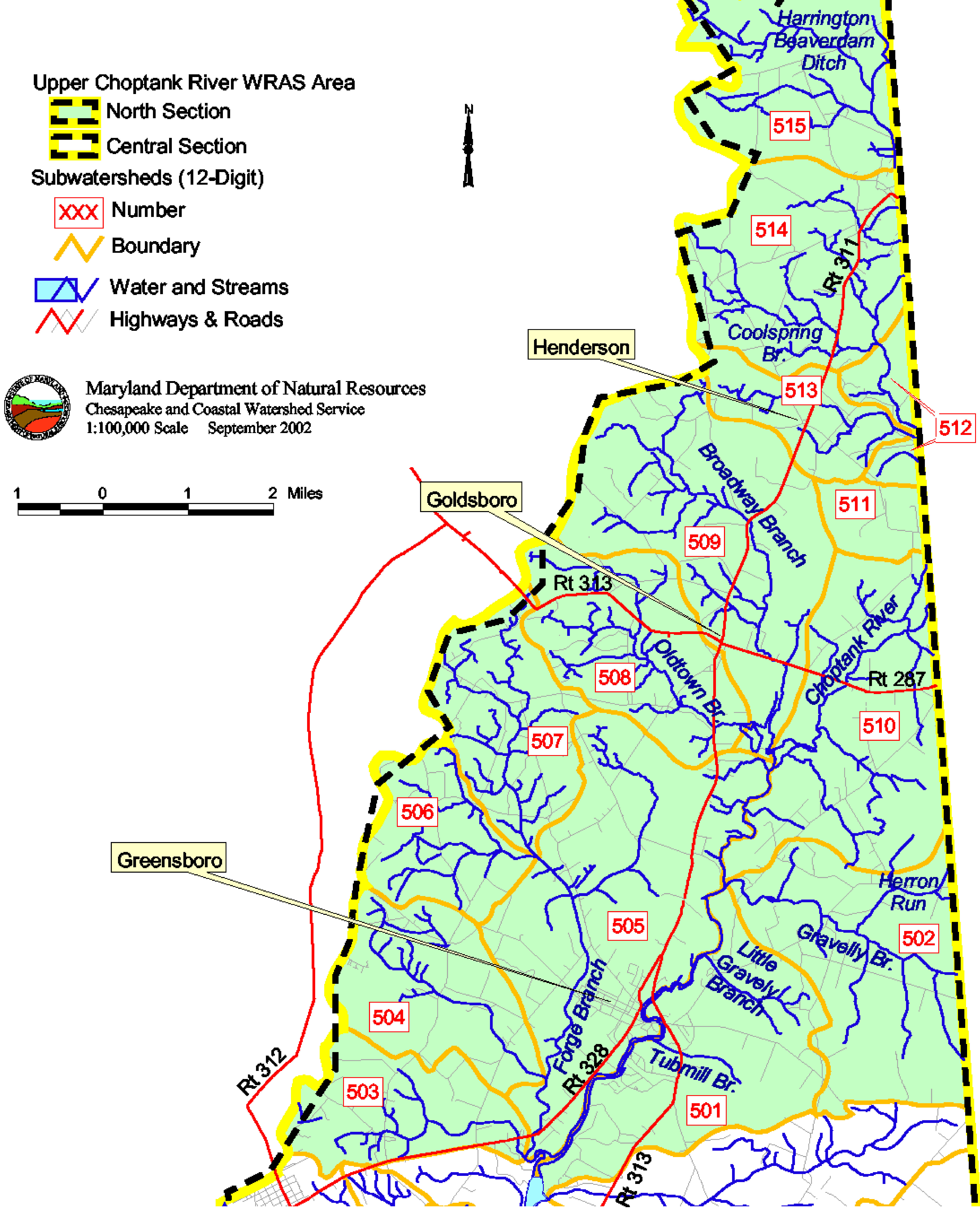
Map 4A Streams and Subwatersheds - South
Upper Choptank River Watershed 02130404



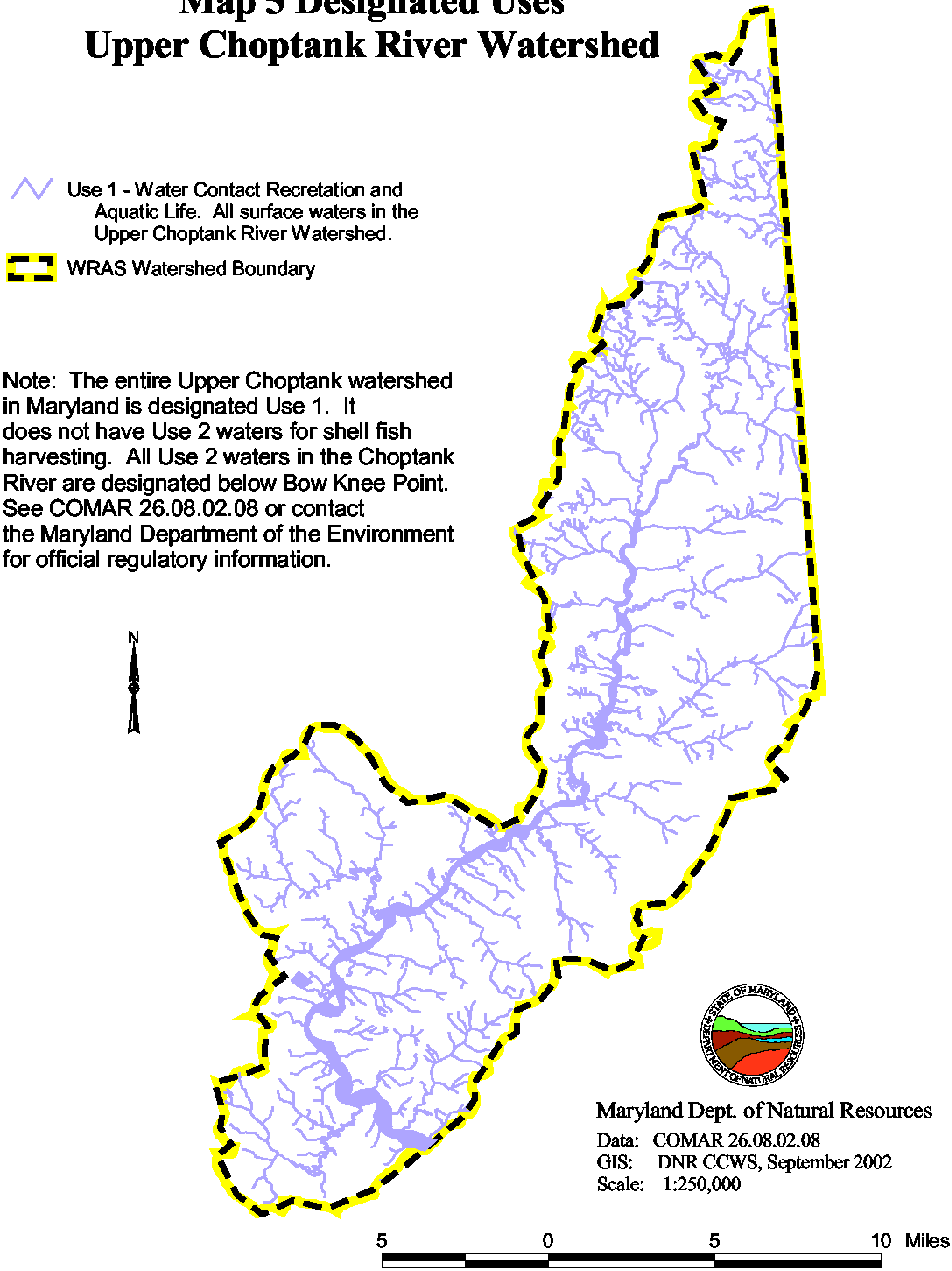
Map 4B Streams and Subwatersheds - Central Upper Choptank River Watershed 02130404



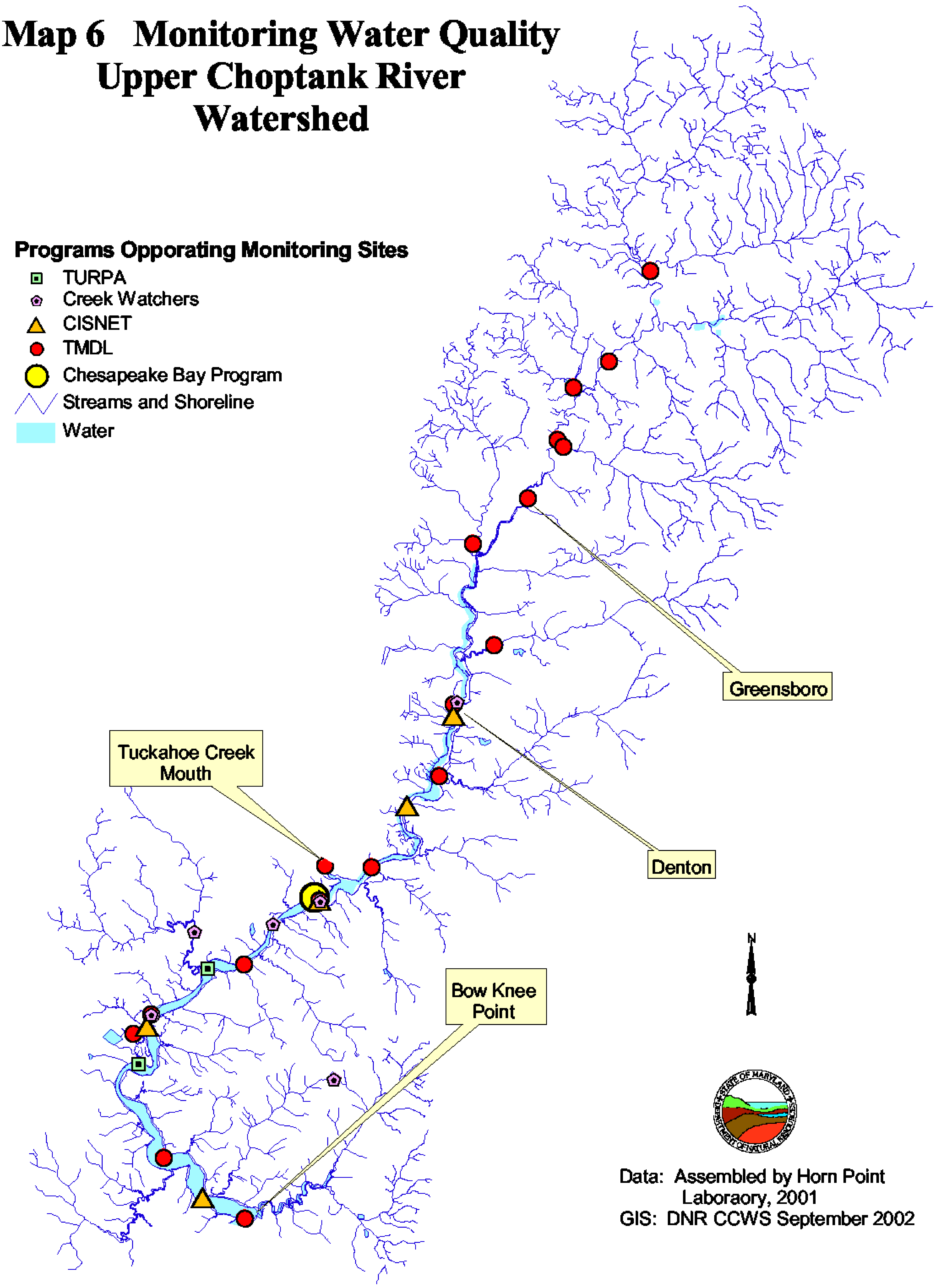
Map 4C Streams and Subwatersheds - North
Upper Choptank River Watershed
02130404



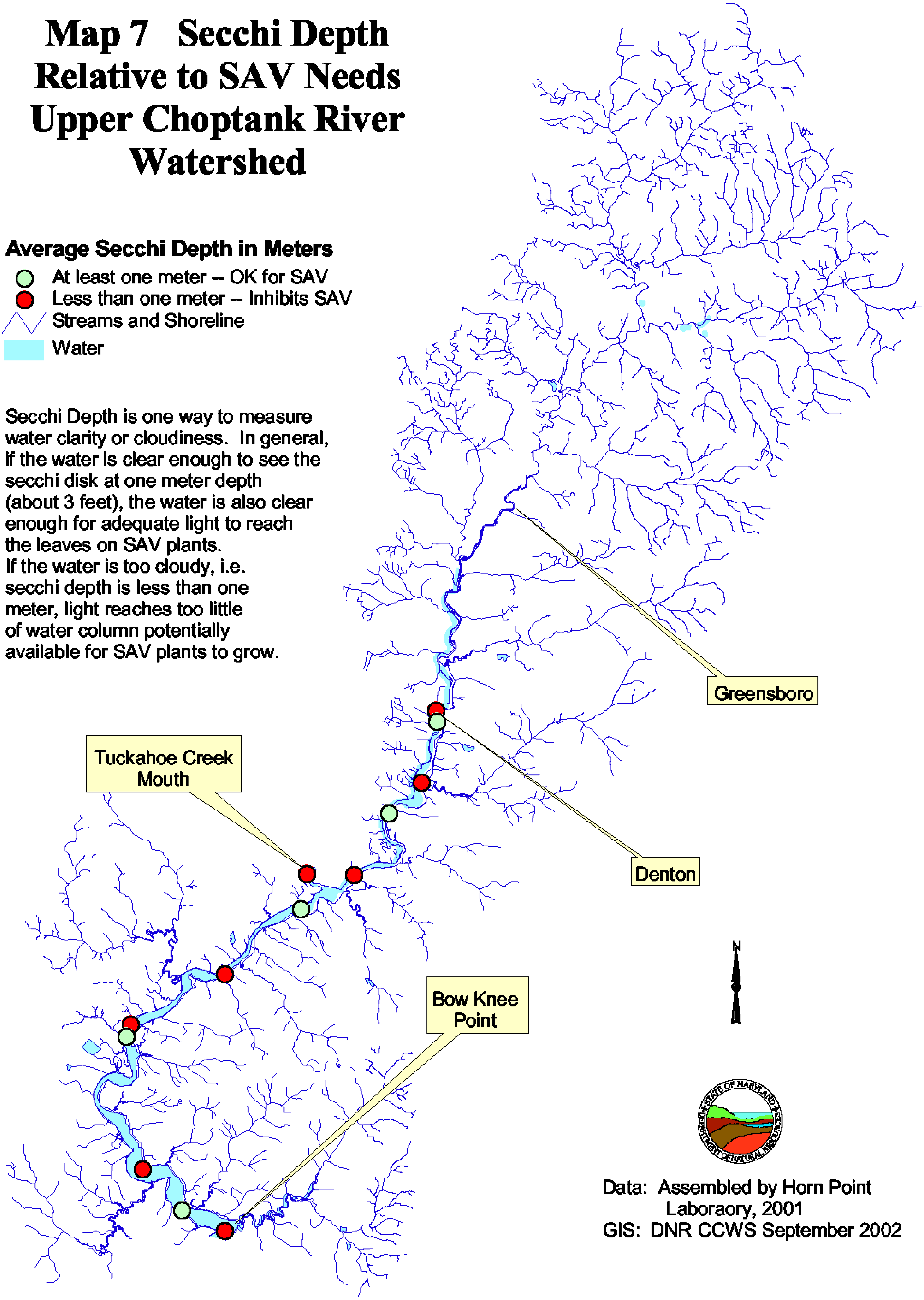
Map 5 Designated Uses
Upper Choptank River Watershed



Map 6 Monitoring Water Quality Upper Choptank River Watershed



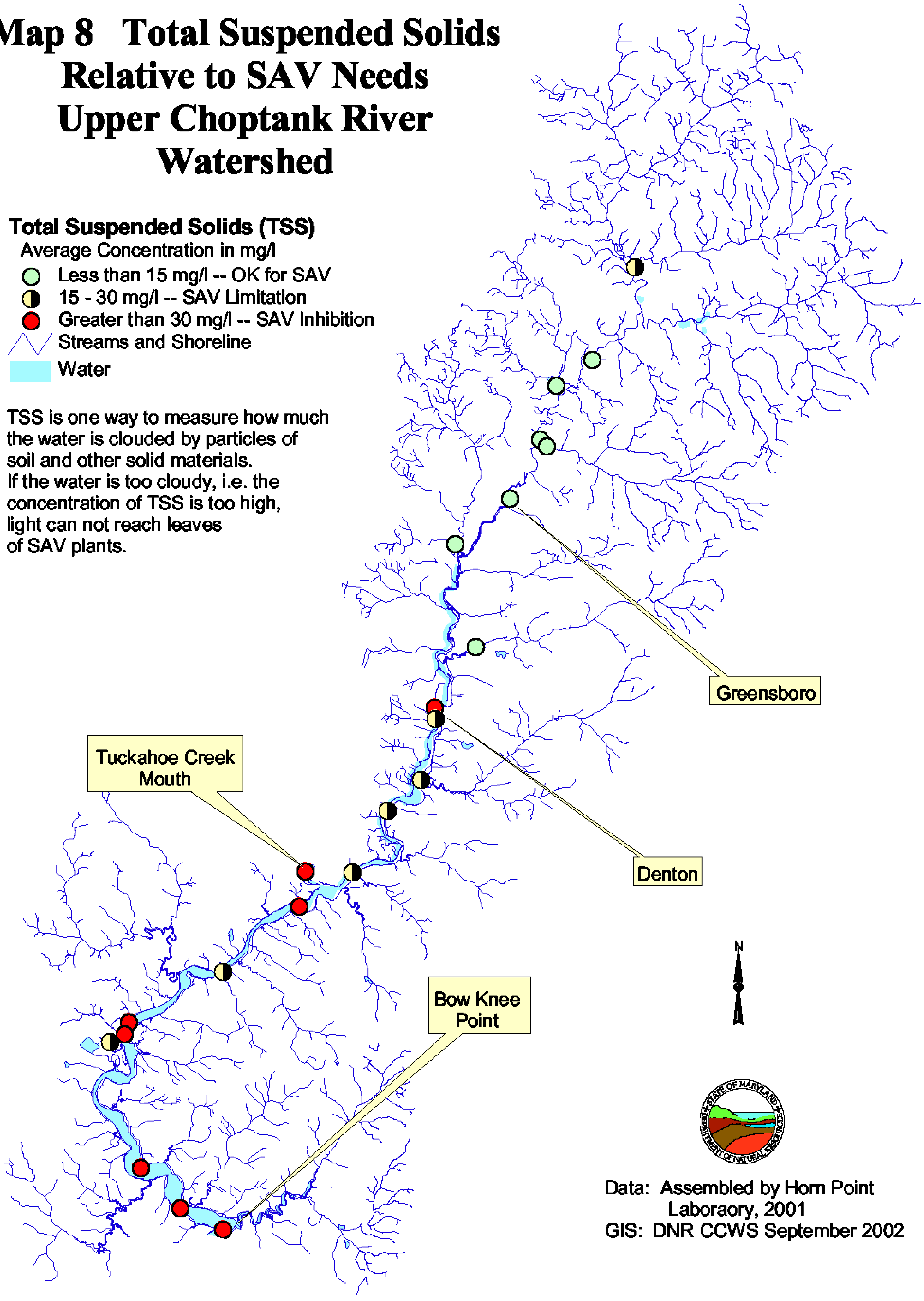
Map 7 Secchi Depth Relative to SAV Needs Upper Choptank River Watershed



Secchi Depth is one way to measure water clarity or cloudiness. In general, if the water is clear enough to see the secchi disk at one meter depth (about 3 feet), the water is also clear enough for adequate light to reach the leaves on SAV plants. If the water is too cloudy, i.e. secchi depth is less than one meter, light reaches too little of water column potentially available for SAV plants to grow.

Data: Assembled by Horn Point Laboraory, 2001
GIS: DNR CCWS September 2002

Map 8 Total Suspended Solids Relative to SAV Needs Upper Choptank River Watershed



TSS is one way to measure how much the water is clouded by particles of soil and other solid materials. If the water is too cloudy, i.e. the concentration of TSS is too high, light can not reach leaves of SAV plants.

Data: Assembled by Horn Point Laboraory, 2001
GIS: DNR CCWS September 2002

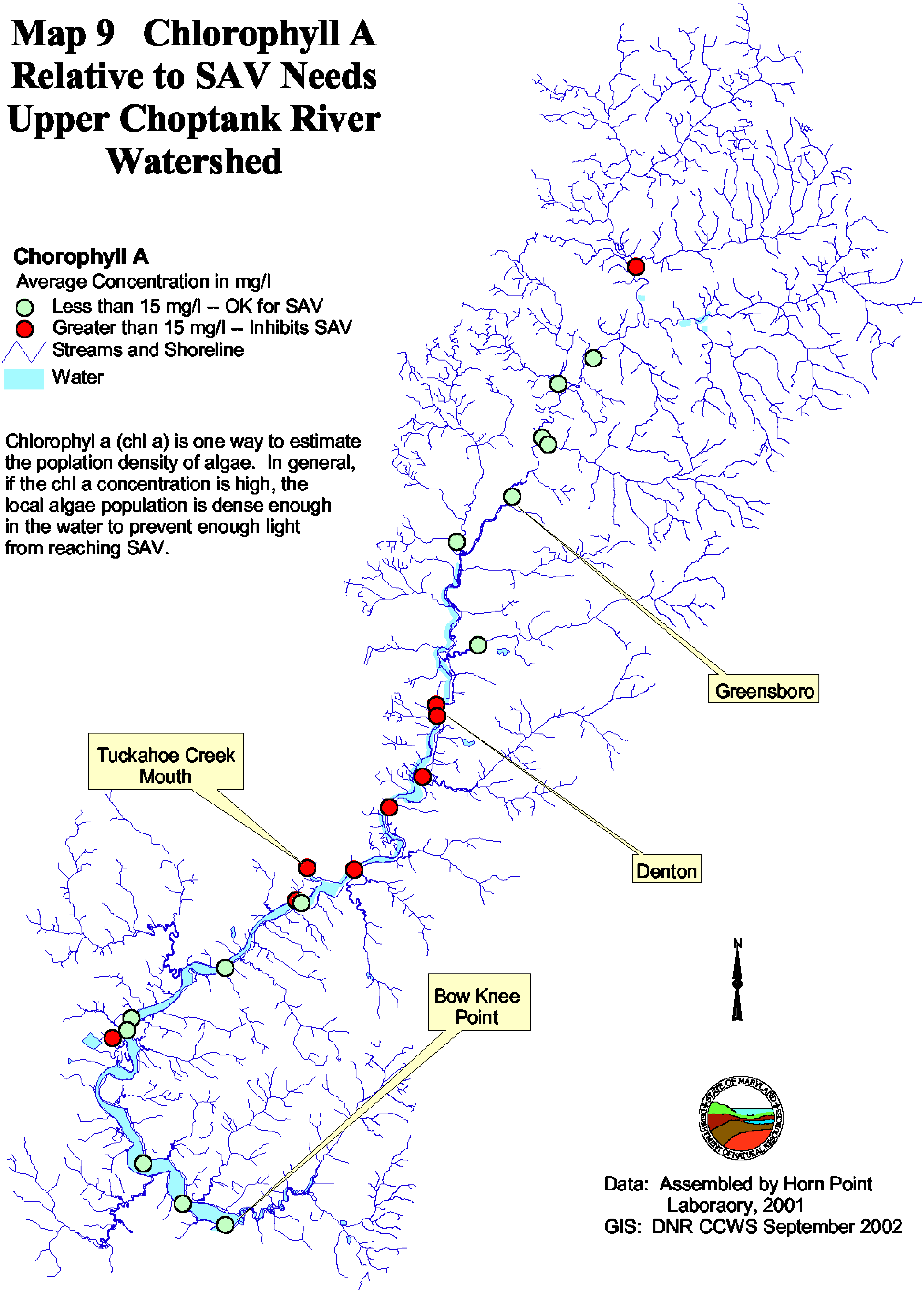
Map 9 Chlorophyll A Relative to SAV Needs Upper Choptank River Watershed

Chorophyll A

Average Concentration in mg/l

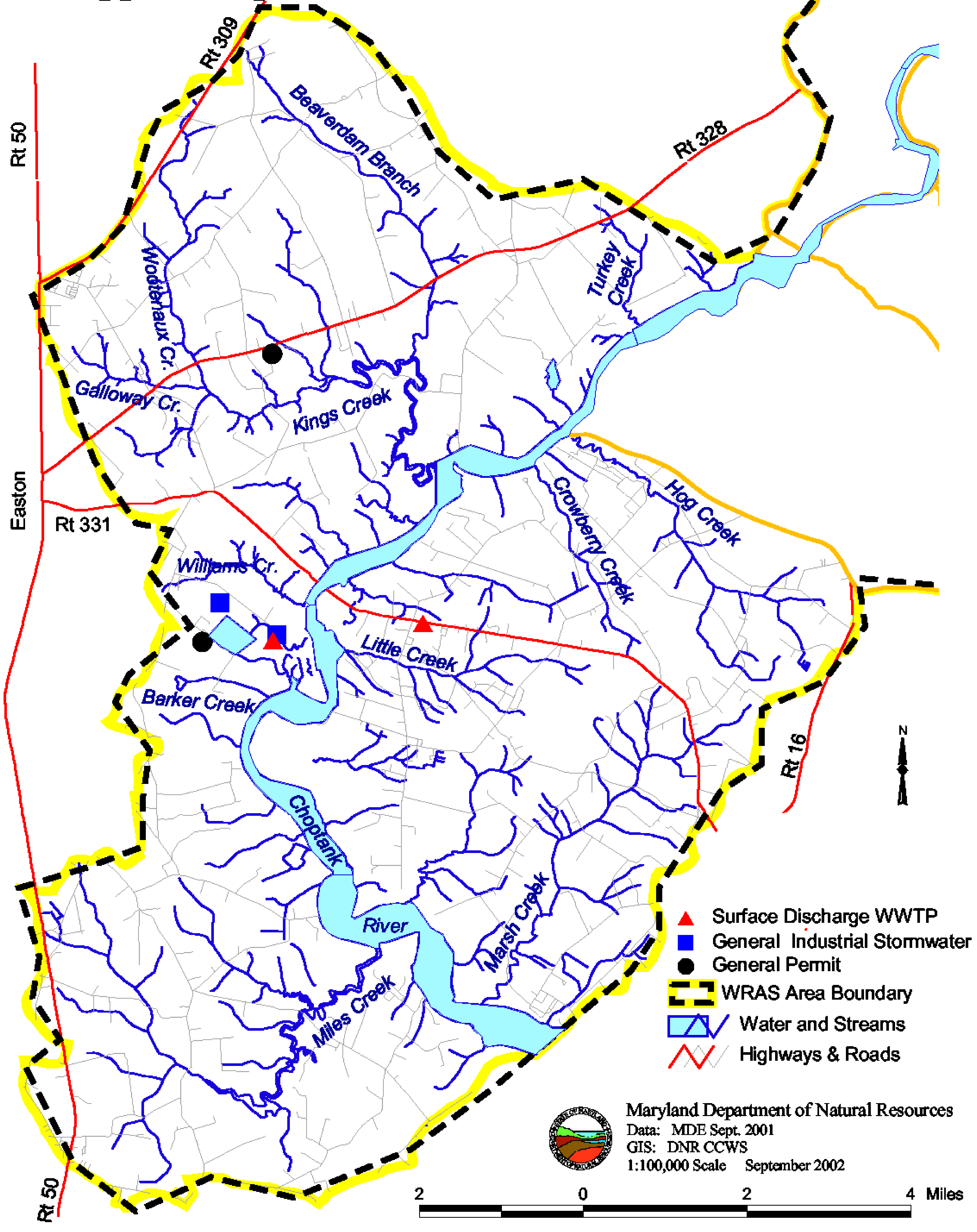
- Less than 15 mg/l -- OK for SAV
- Greater than 15 mg/l -- Inhibits SAV
- Streams and Shoreline
- Water

Chlorophyl a (chl a) is one way to estimate the poplation density of algae. In general, if the chl a concentration is high, the local algae population is dense enough in the water to prevent enough light from reaching SAV.

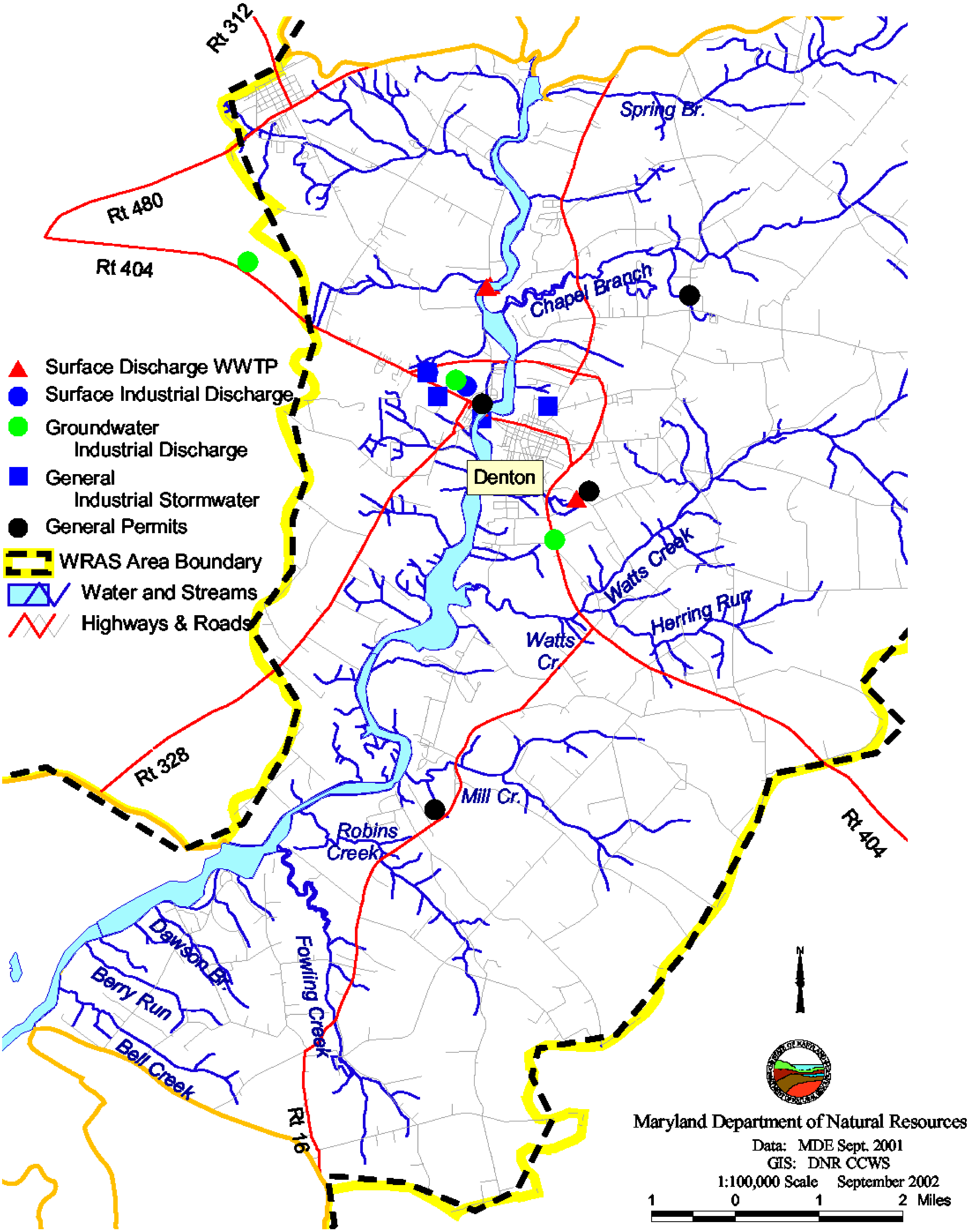


Data: Assembled by Horn Point Laboraory, 2001
GIS: DNR CCWS September 2002

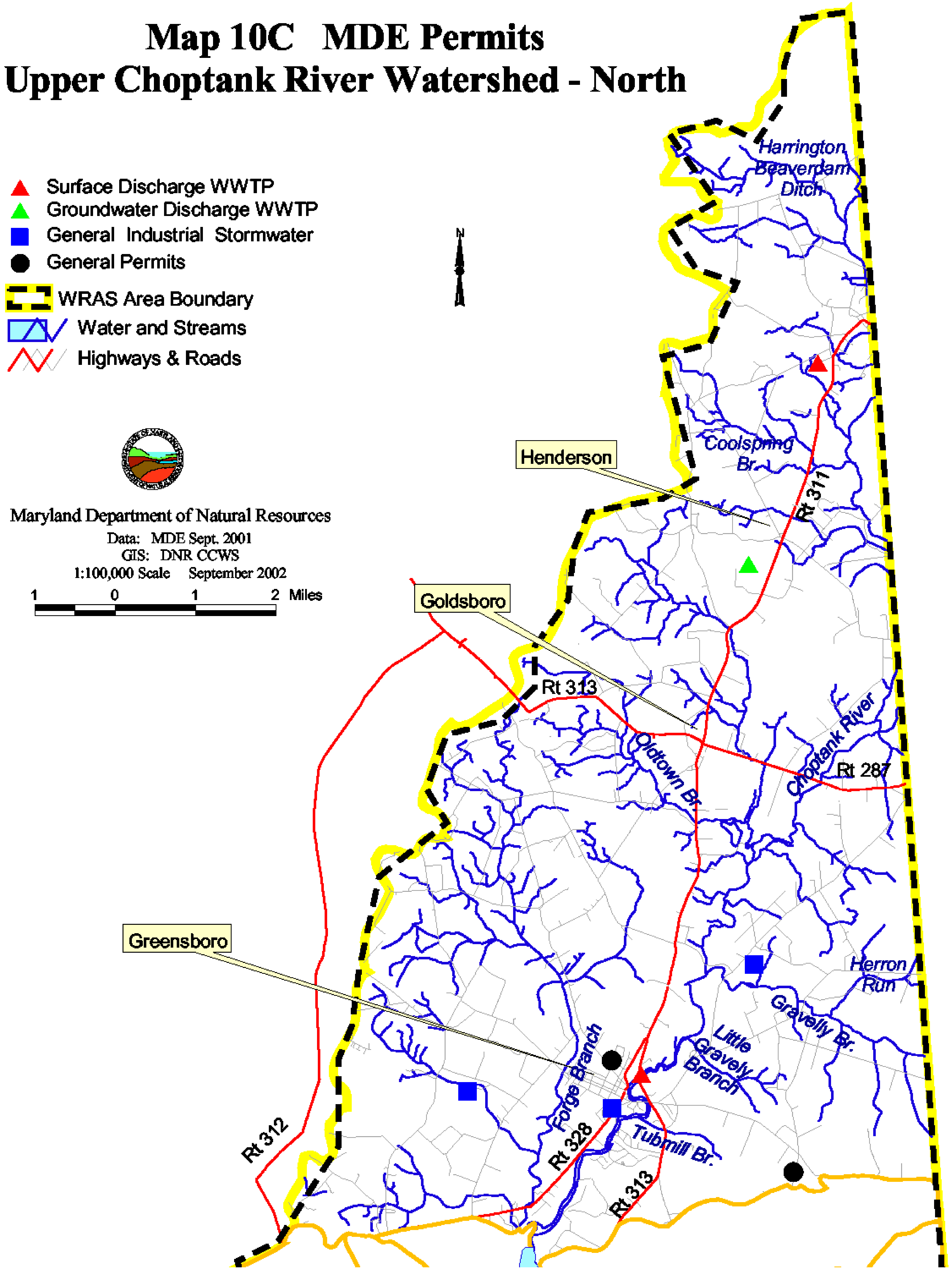
Map 10A MDE Permits
Upper Choptank River Watershed - South



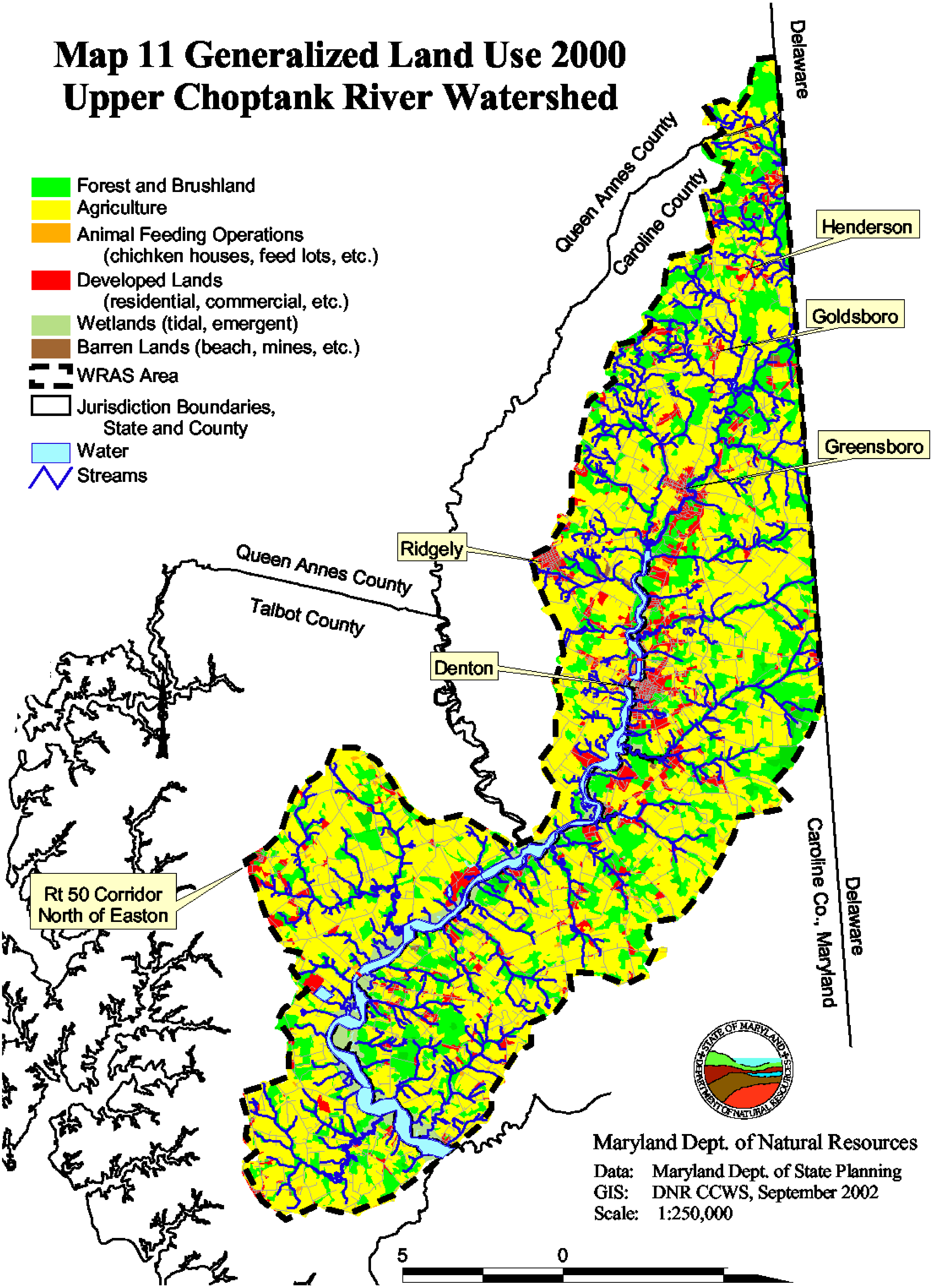
Map 10B MDE Permits
Upper Choptank River Watershed - Central



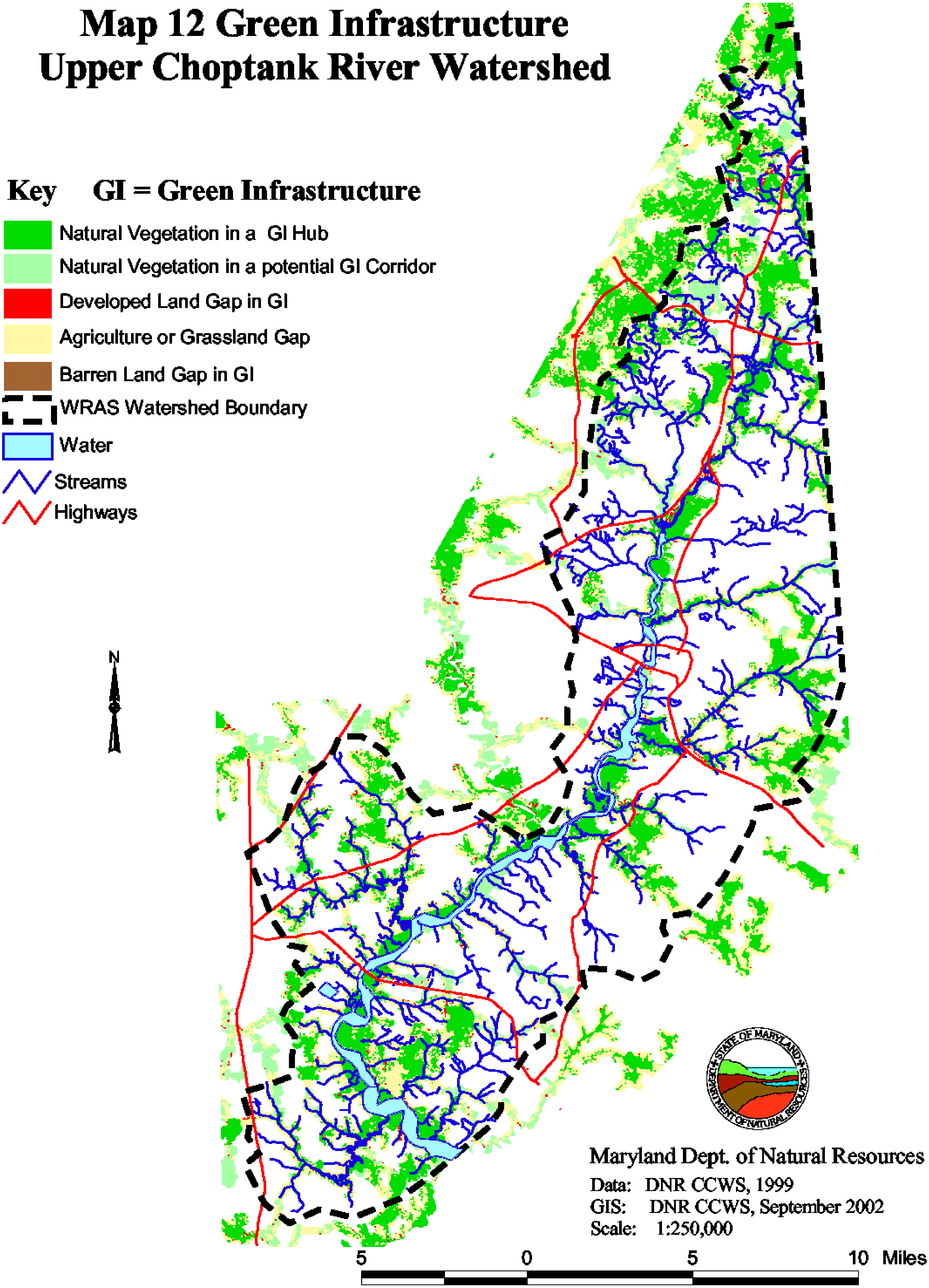
Map 10C MDE Permits
Upper Choptank River Watershed - North



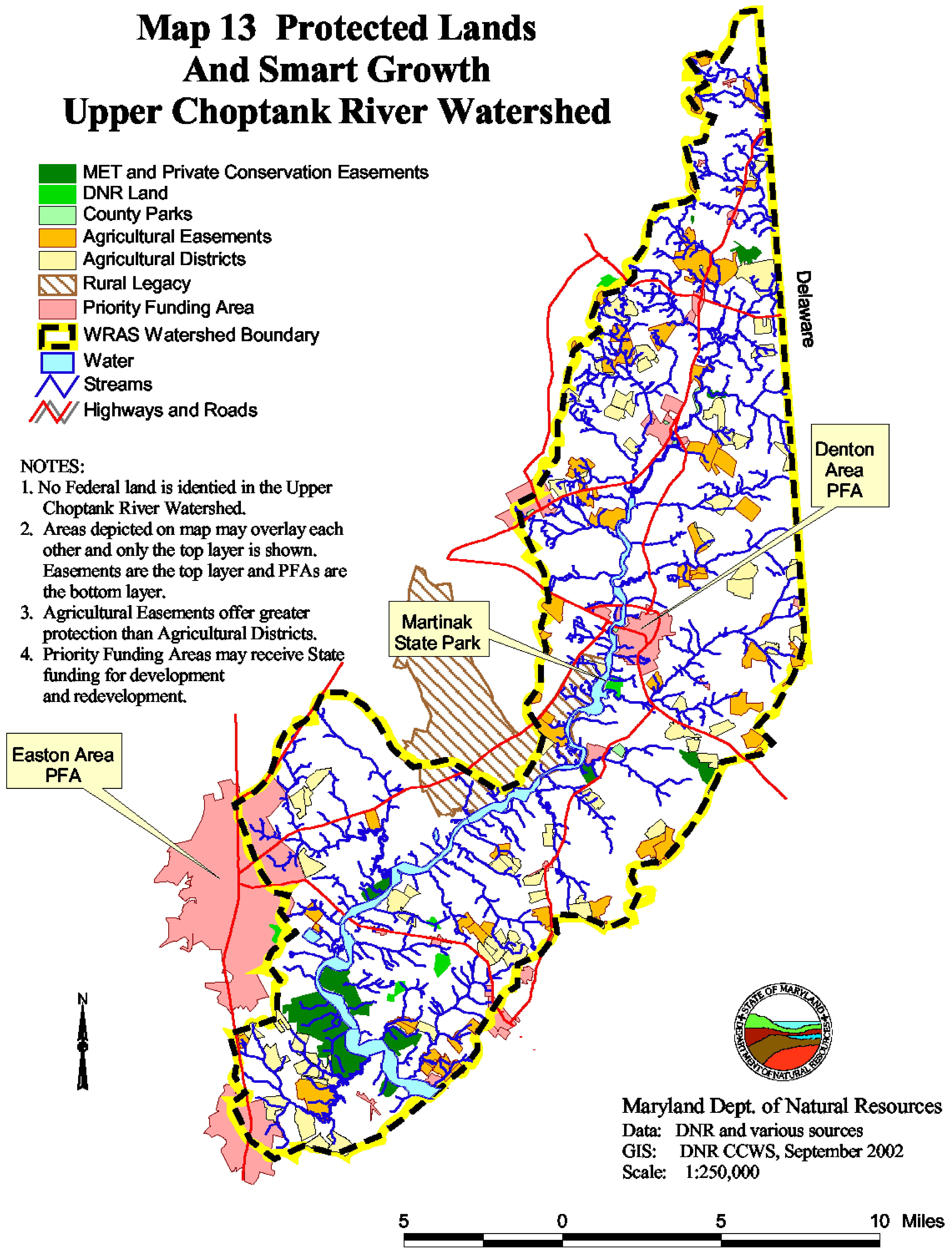
Map 11 Generalized Land Use 2000
Upper Choptank River Watershed



Map 12 Green Infrastructure
Upper Choptank River Watershed



Map 13 Protected Lands And Smart Growth Upper Choptank River Watershed



NOTES:

1. No Federal land is identied in the Upper Choptank River Watershed.
2. Areas depicted on map may overlay each other and only the top layer is shown. Easements are the top layer and PFAs are the bottom layer.
3. Agricultural Easements offer greater protection than Agricultural Districts.
4. Priority Funding Areas may receive State funding for development and redevelopment.

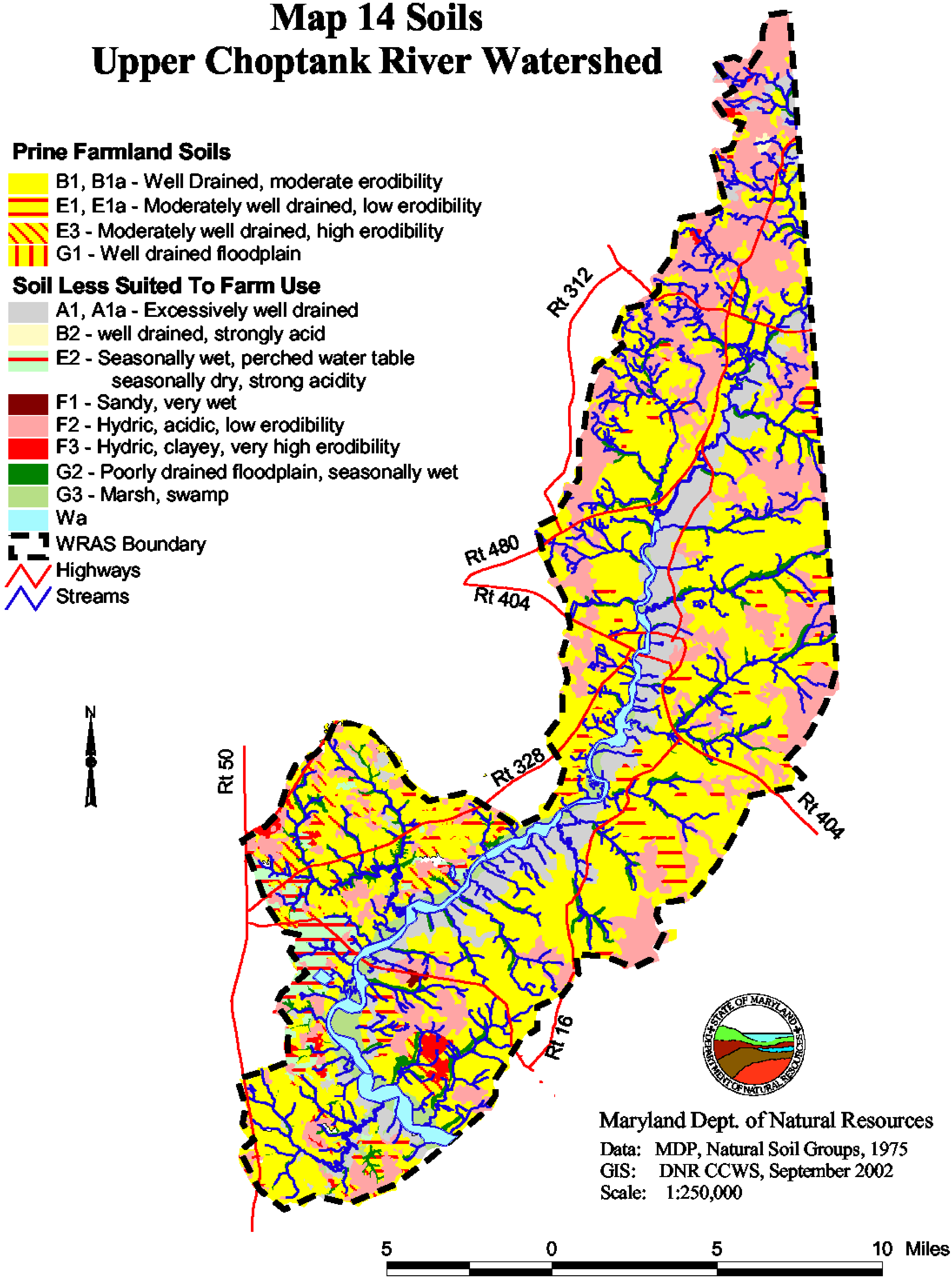
Maryland Dept. of Natural Resources

Data: DNR and various sources

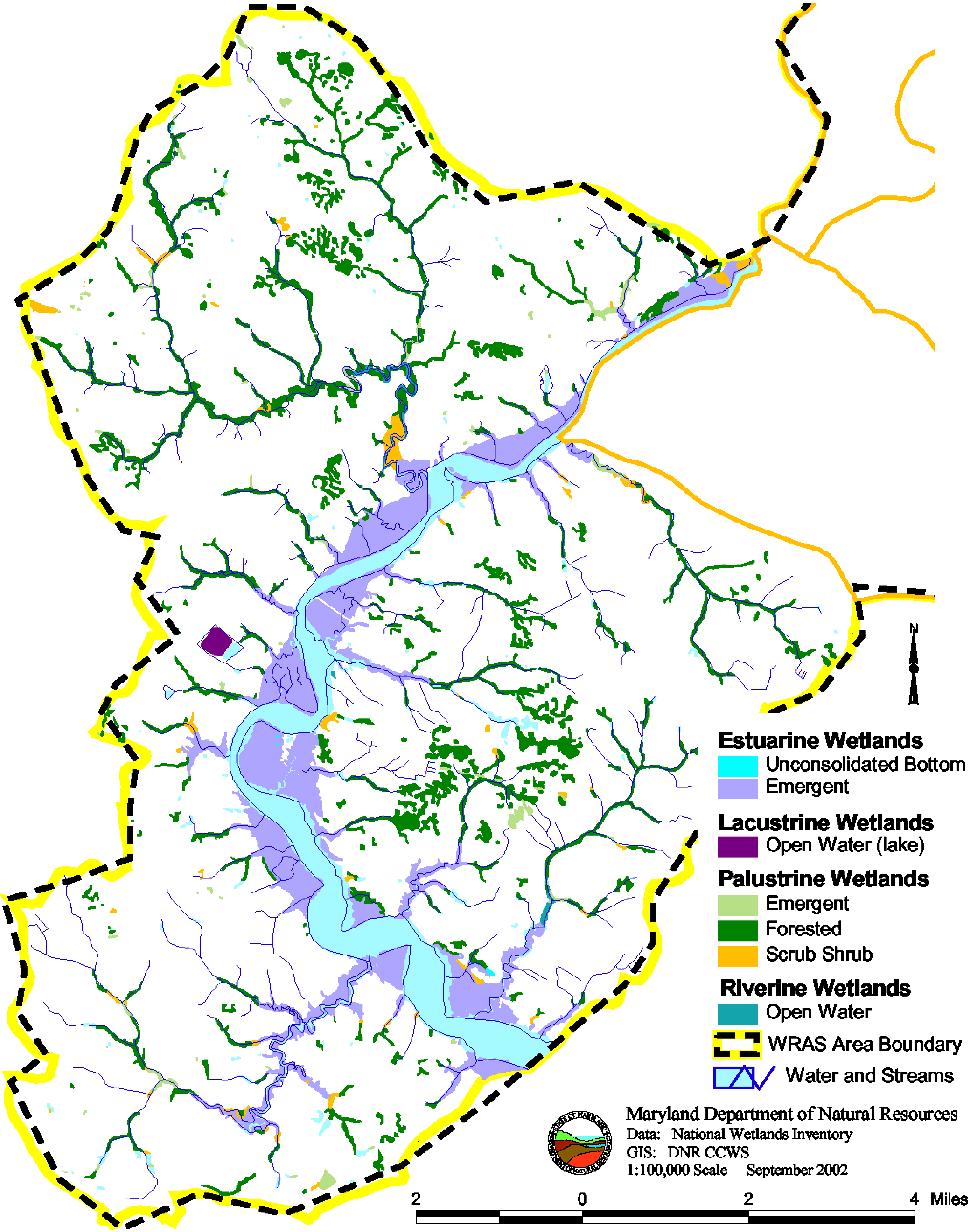
GIS: DNR CCWS, September 2002

Scale: 1:250,000

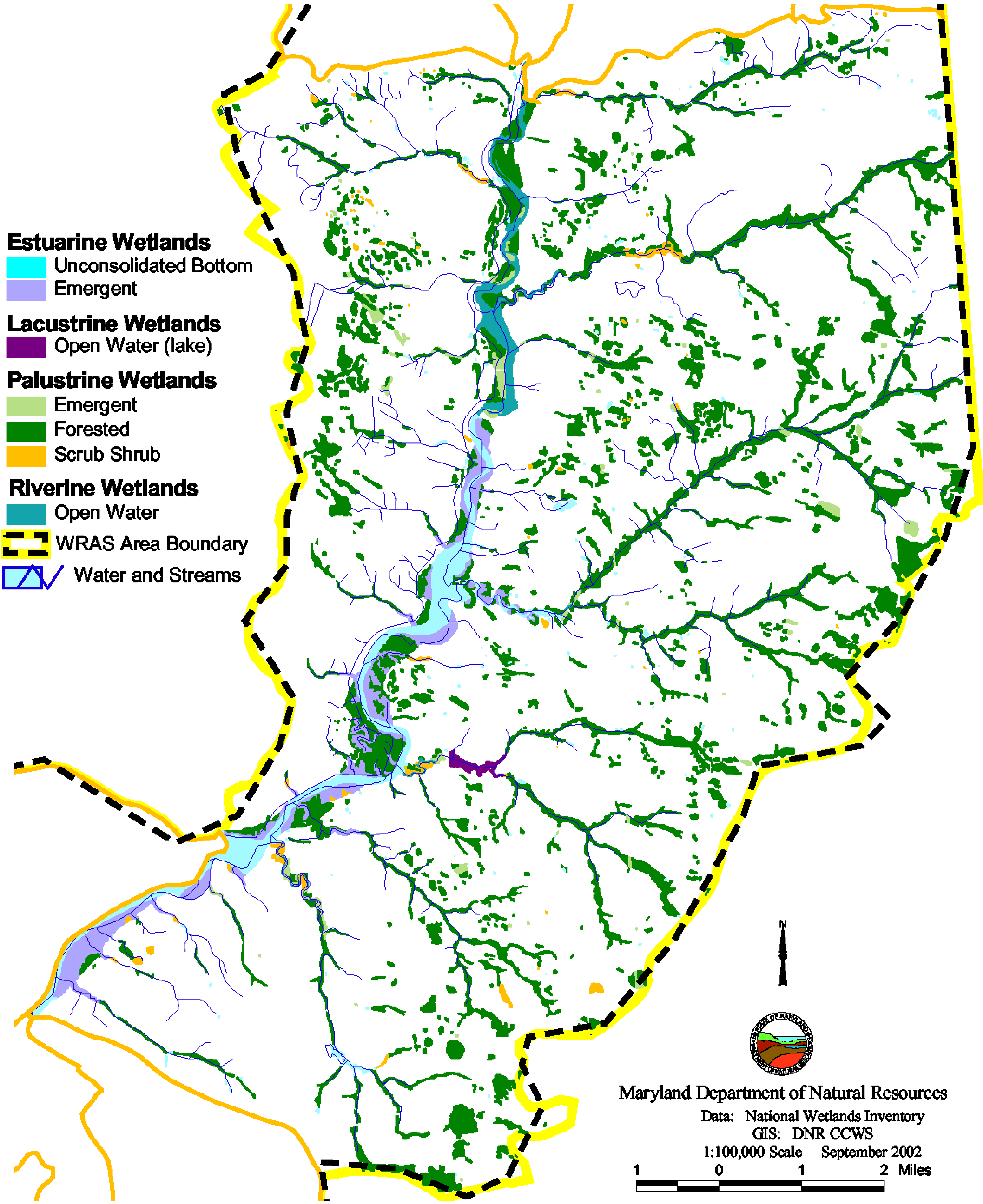
Map 14 Soils
Upper Choptank River Watershed



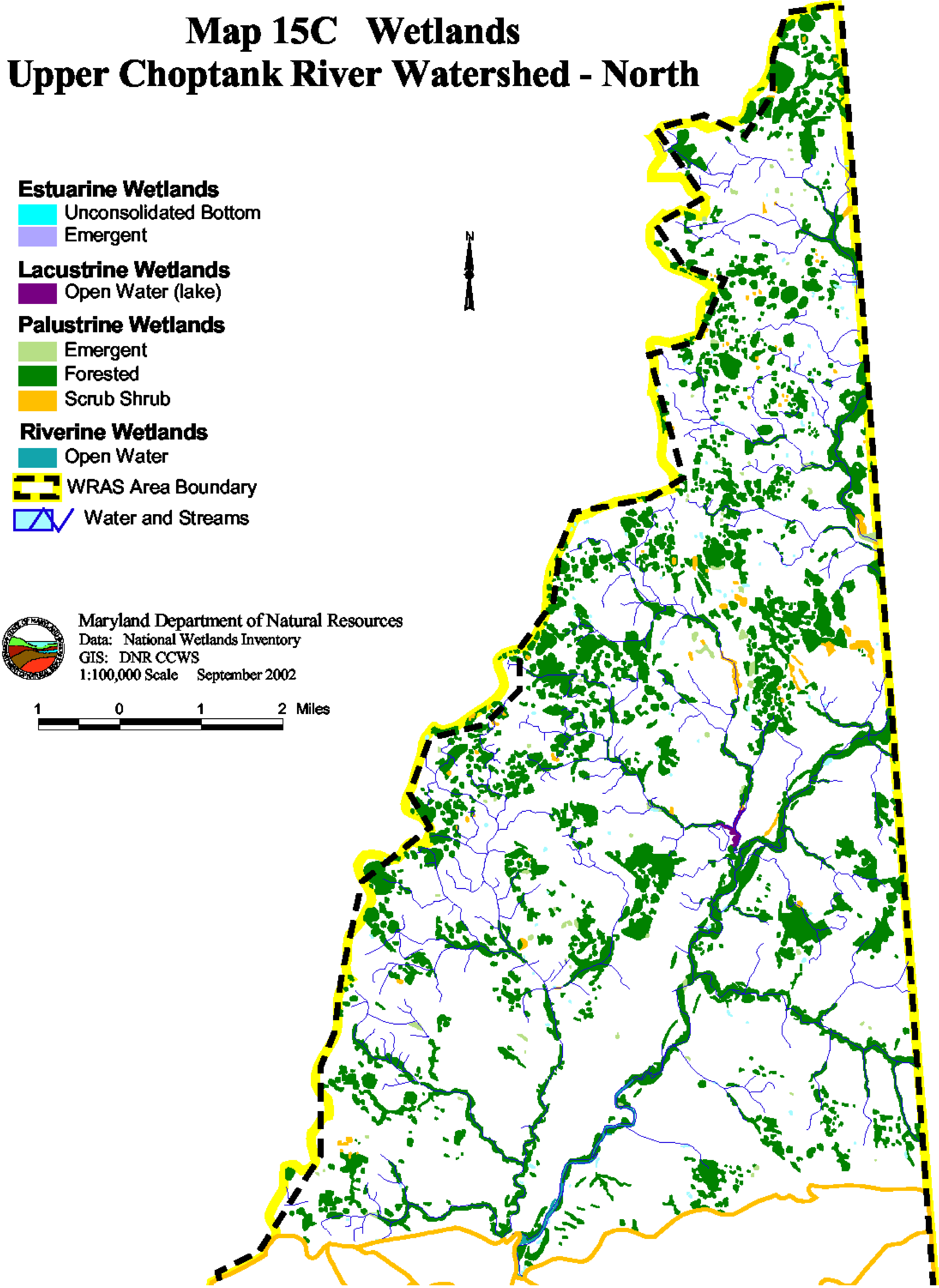
Map 15A Wetlands
Upper Choptank River Watershed - South



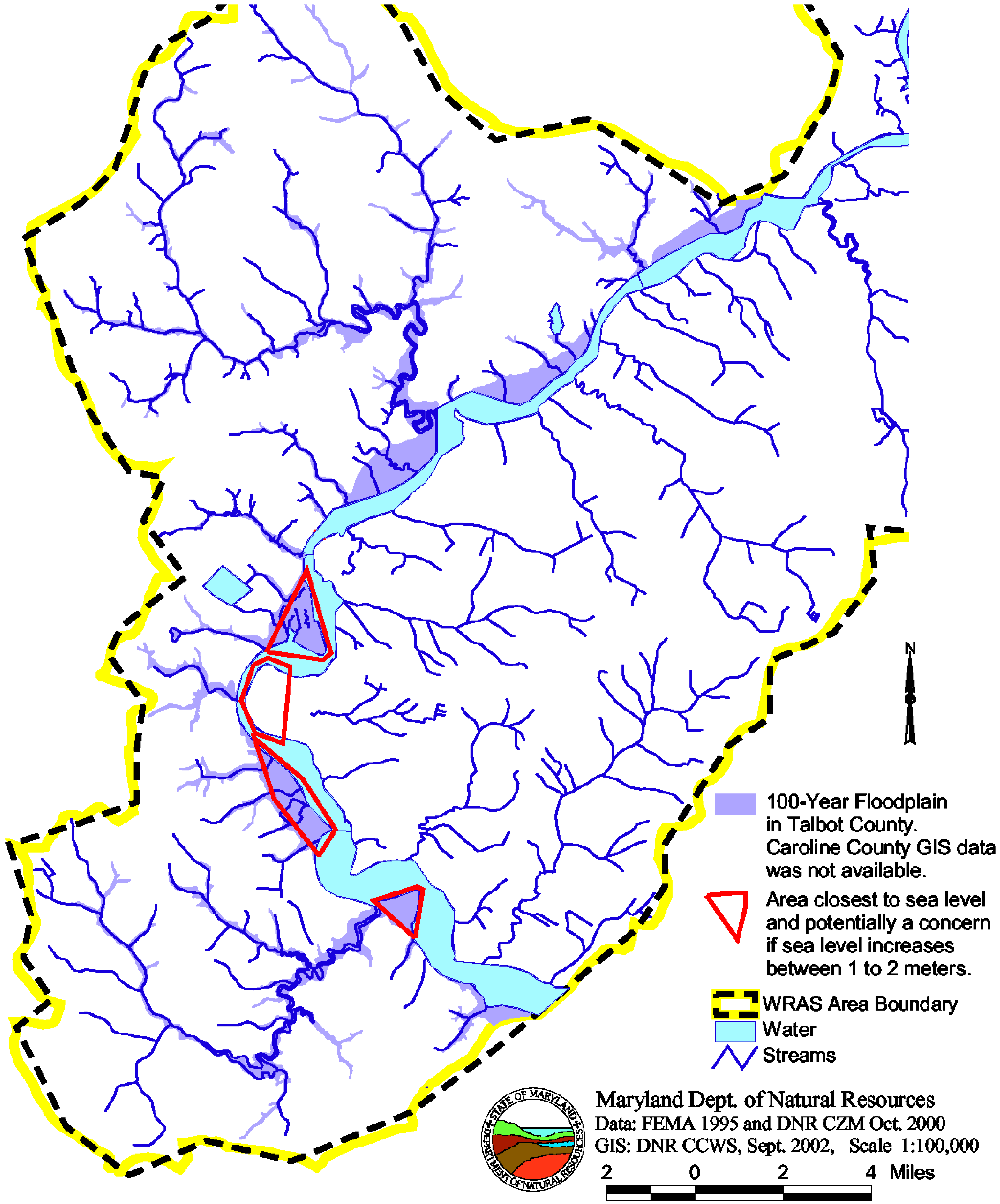
Map 15B Wetlands
Upper Choptank River Watershed - Central



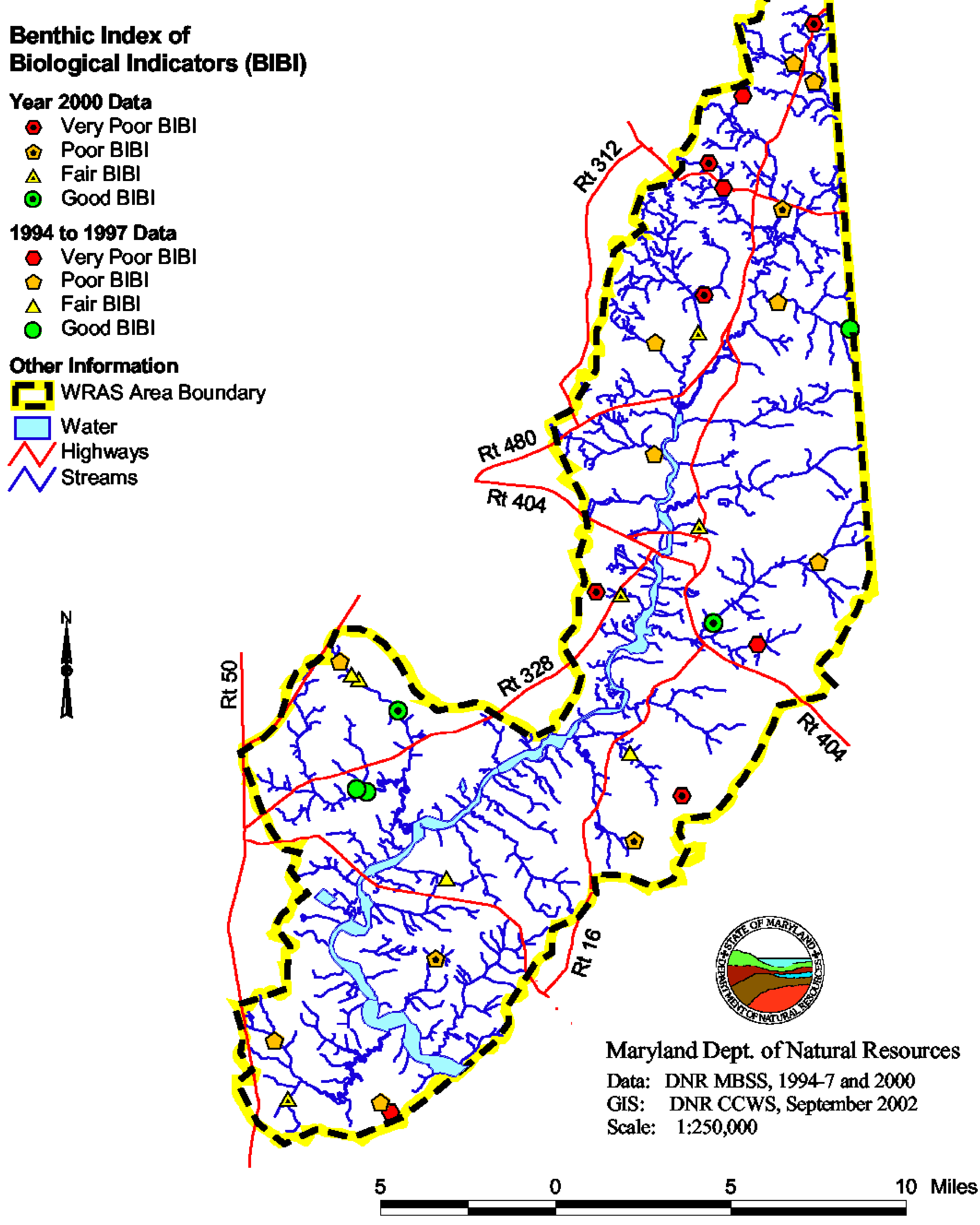
Map 15C Wetlands
Upper Choptank River Watershed - North



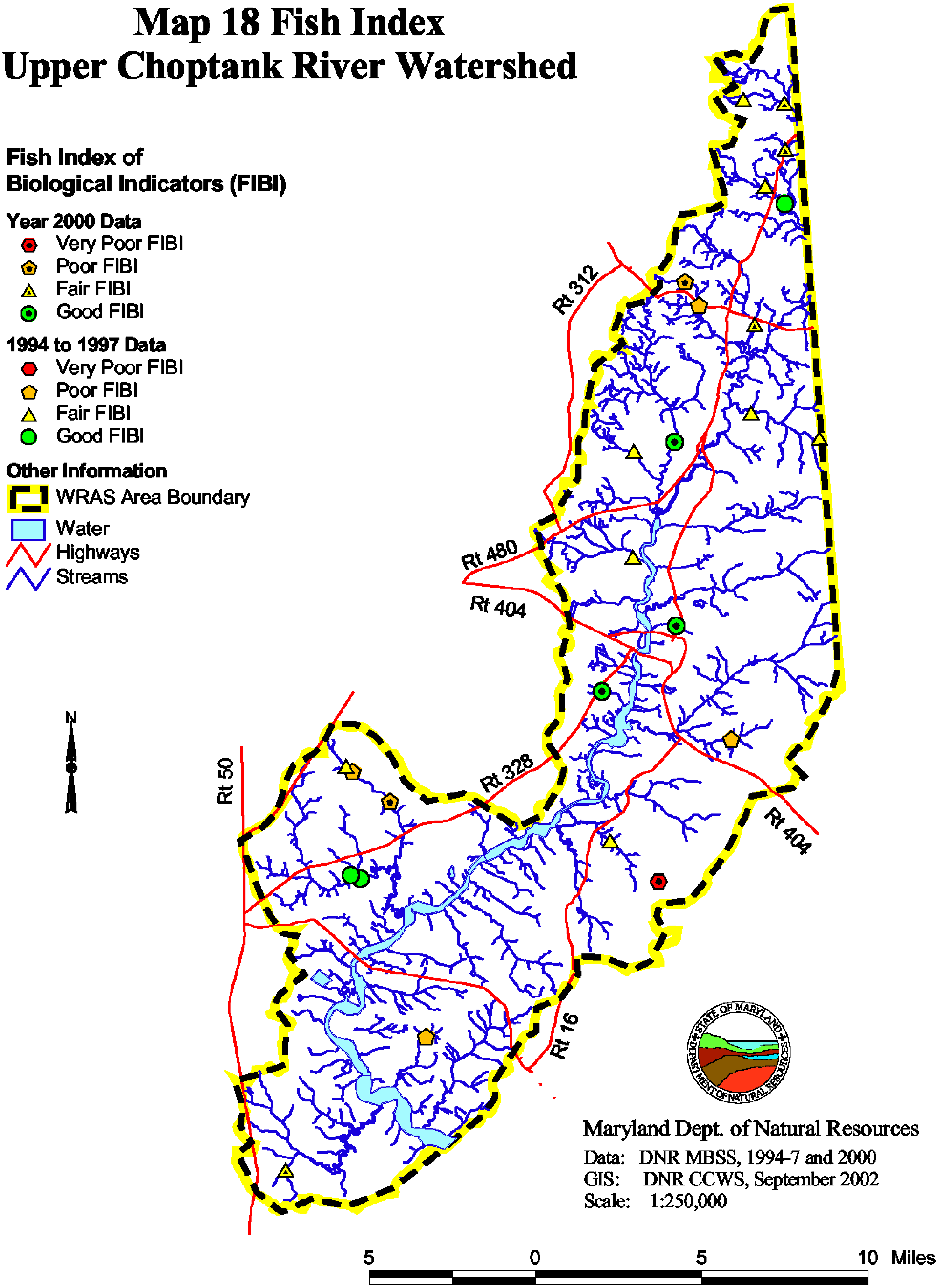
Map 16 Floodplain and Sea Level Rise
Upper Choptank River Watershed



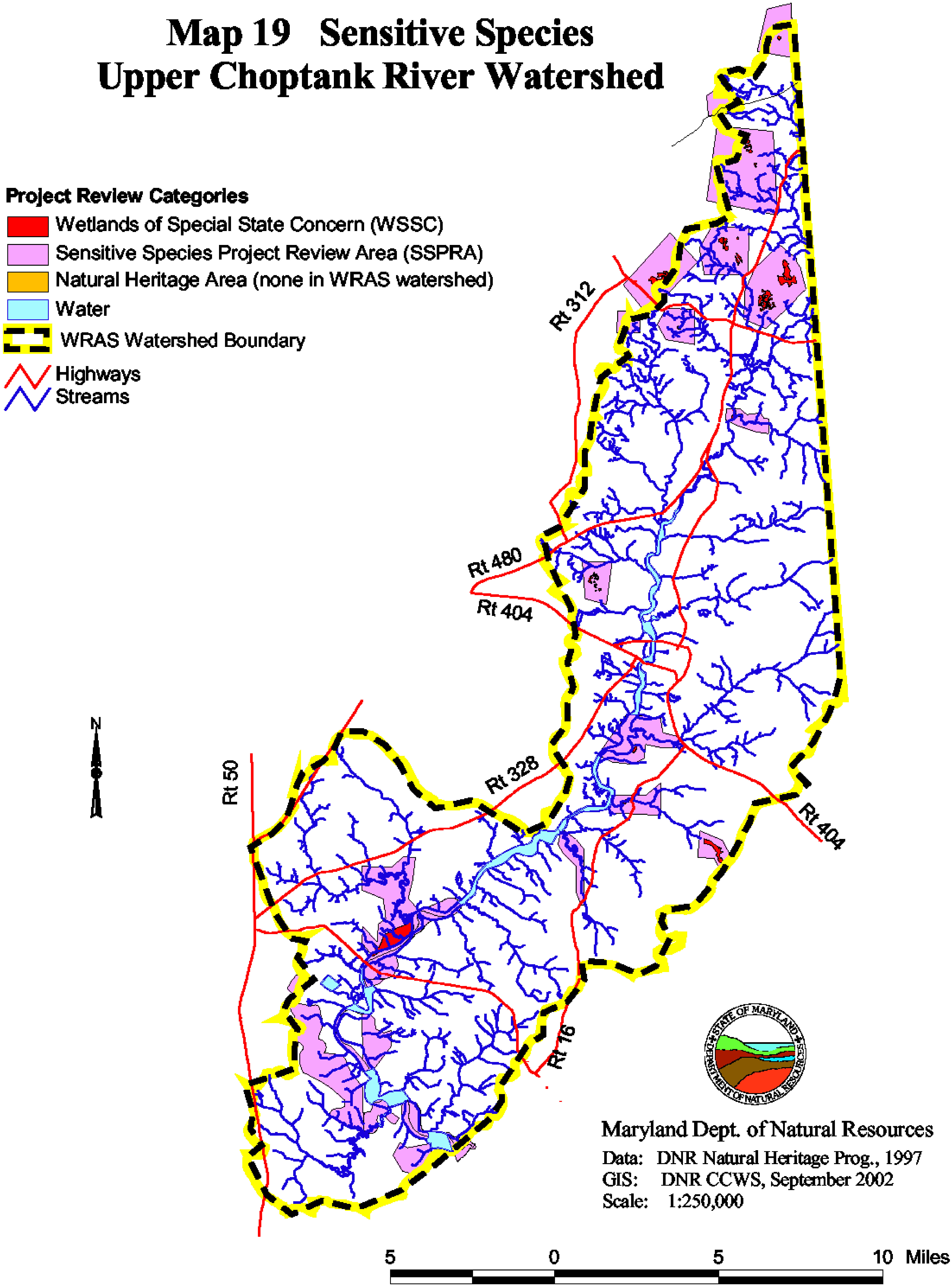
Map 17 Benthic Index
Upper Choptank River Watershed



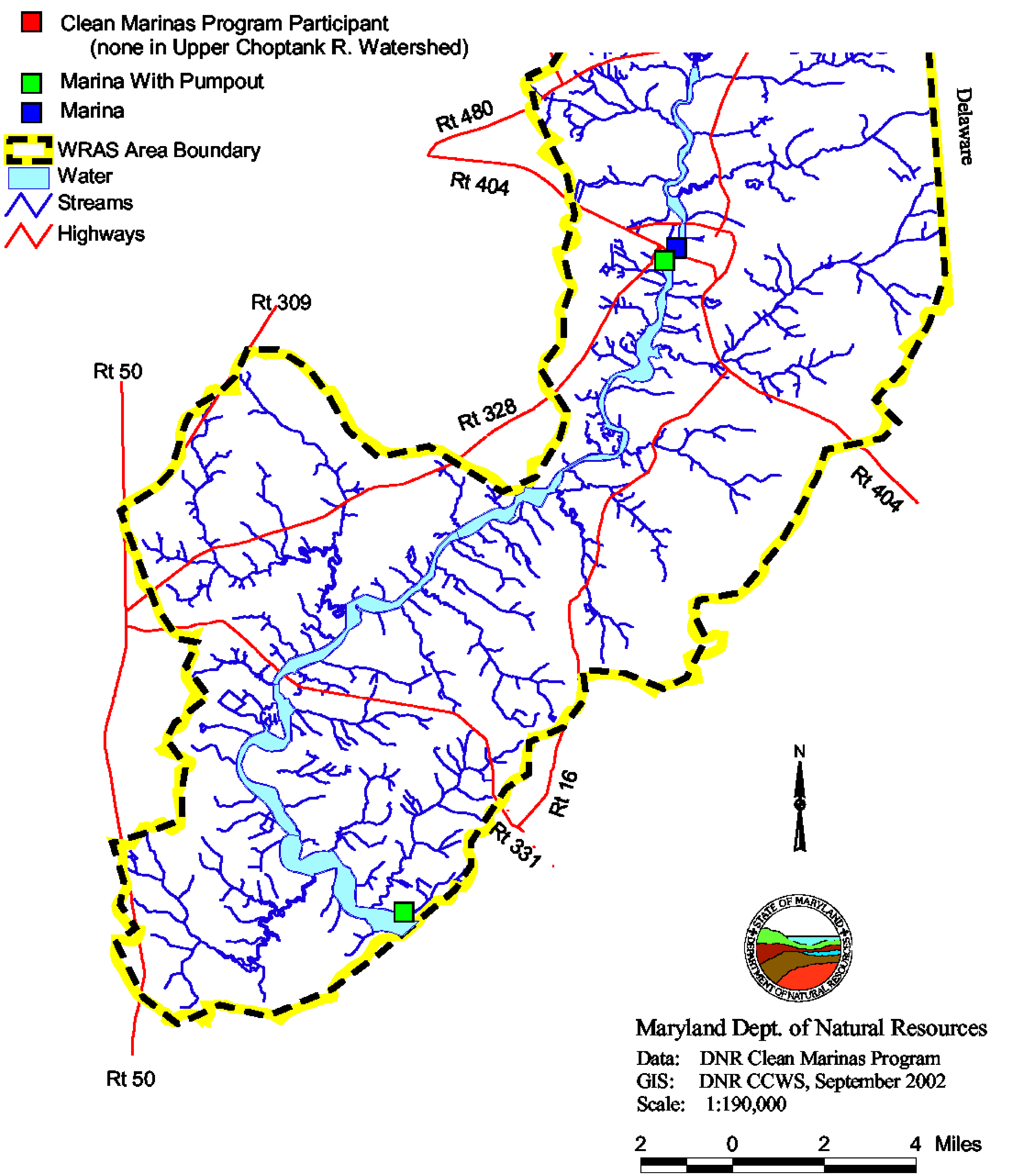
Map 18 Fish Index
Upper Choptank River Watershed



Map 19 Sensitive Species
Upper Choptank River Watershed



Map 20 Marinas
In the Upper Choptank River Watershed



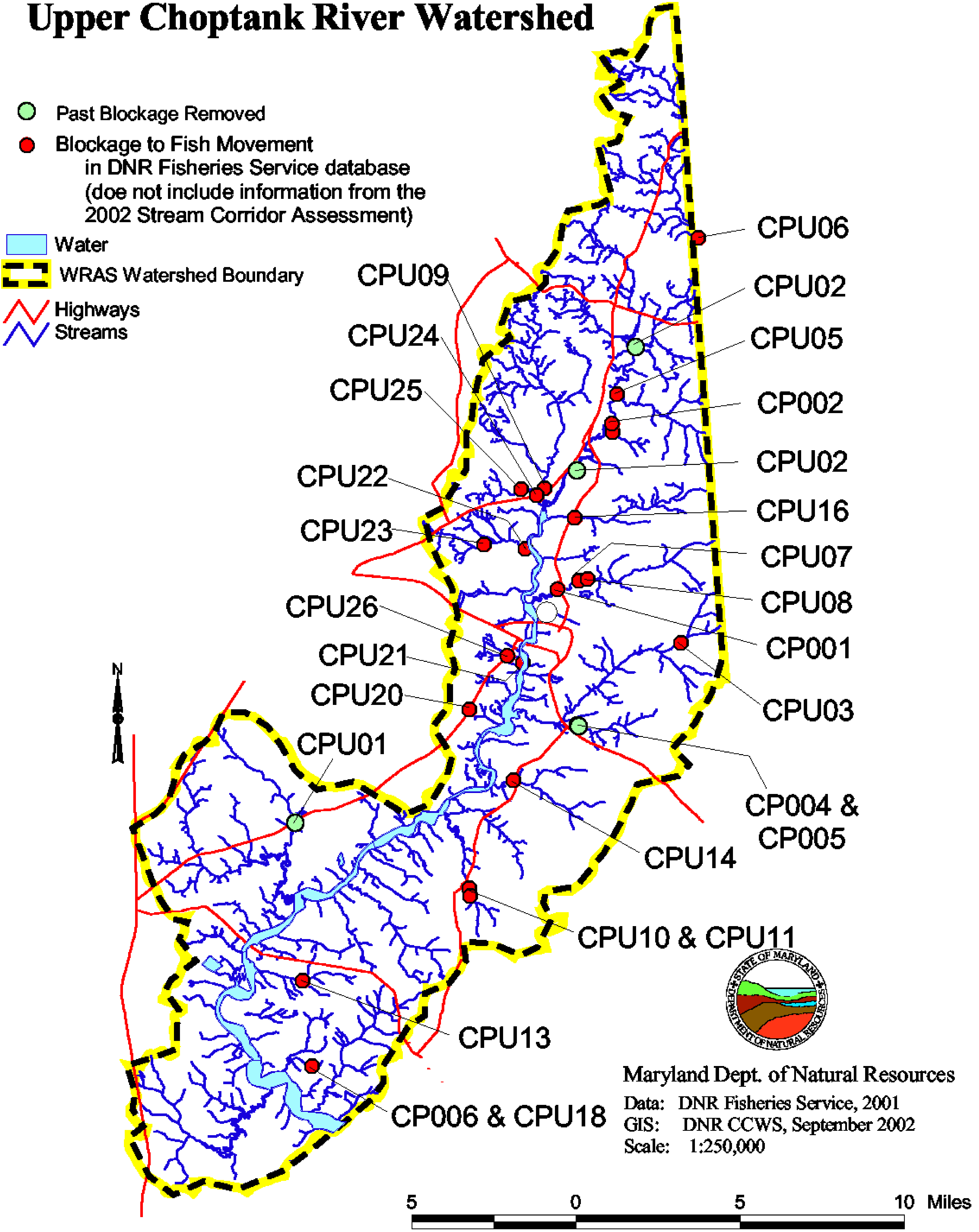
Maryland Dept. of Natural Resources

Data: DNR Clean Marinas Program

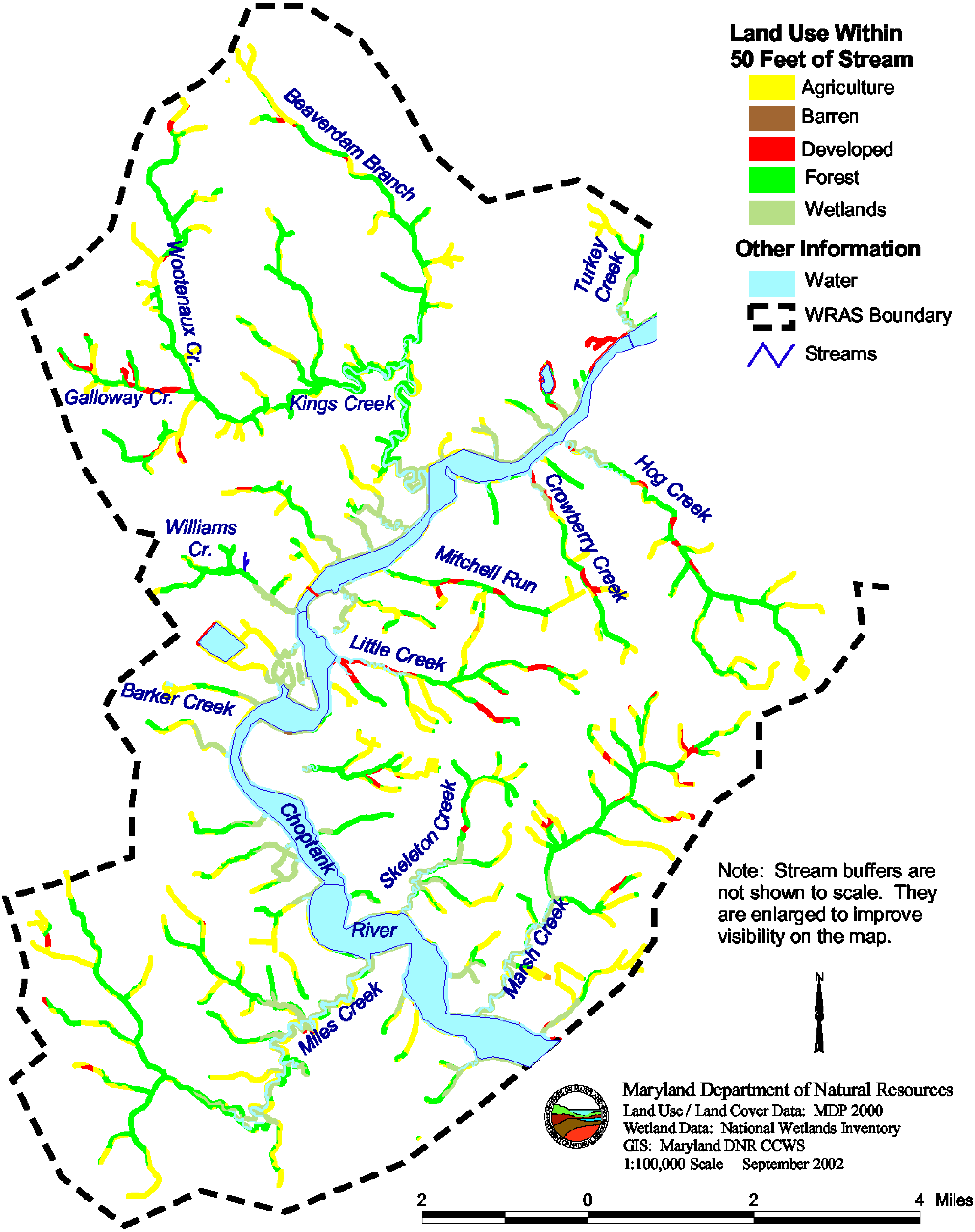
GIS: DNR CCWS, September 2002

Scale: 1:190,000

Map 21 Fish Blockages
Upper Choptank River Watershed



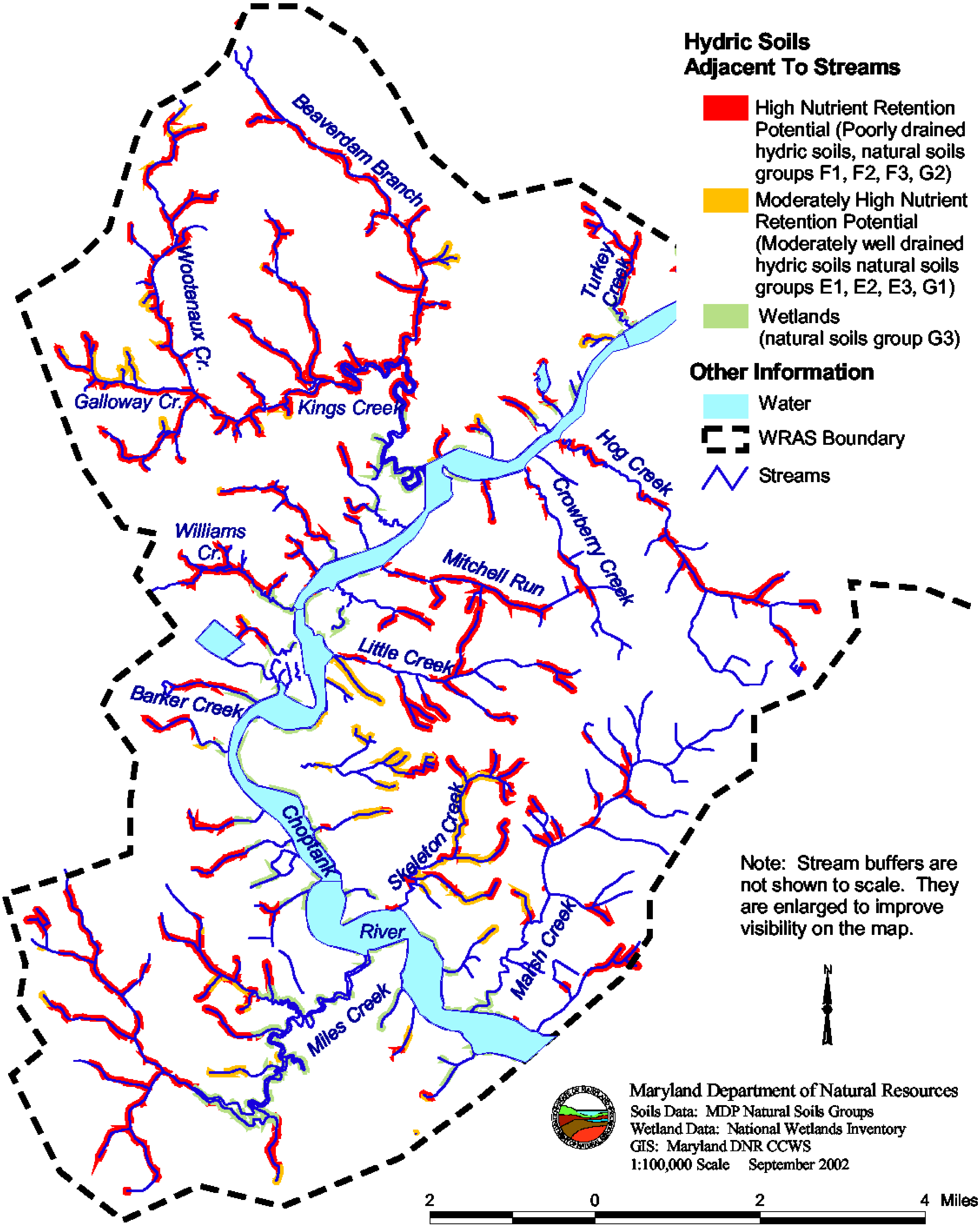
Map 22 Stream Buffer Land Use Scenario
Upper Choptank River Watershed



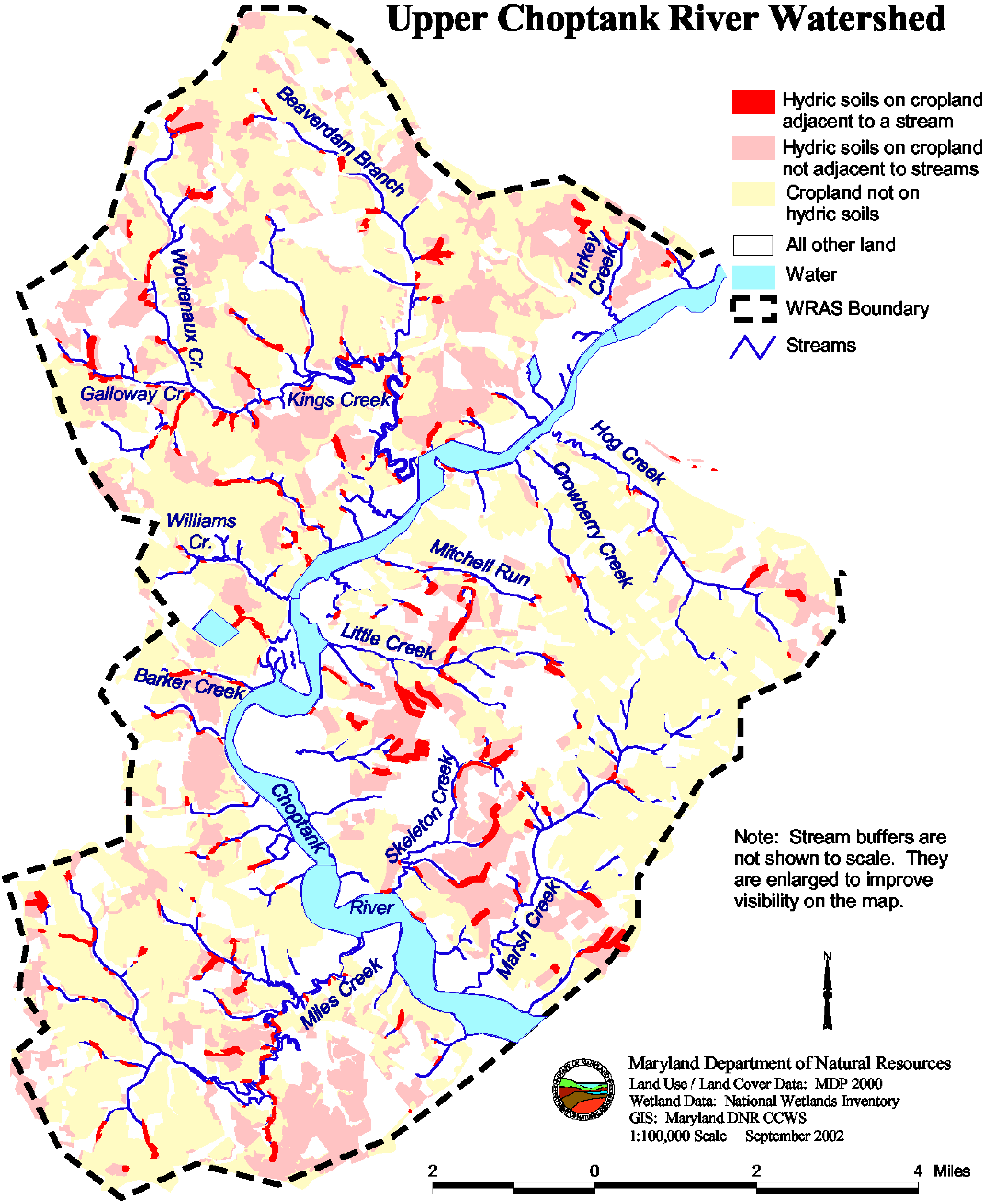
Note: Stream buffers are not shown to scale. They are enlarged to improve visibility on the map.

Maryland Department of Natural Resources
Land Use / Land Cover Data: MDP 2000
Wetland Data: National Wetlands Inventory
GIS: Maryland DNR CCWS
1:100,000 Scale September 2002

Map 23 Stream Buffer Hydric Soils Scenario
Upper Choptank River Watershed



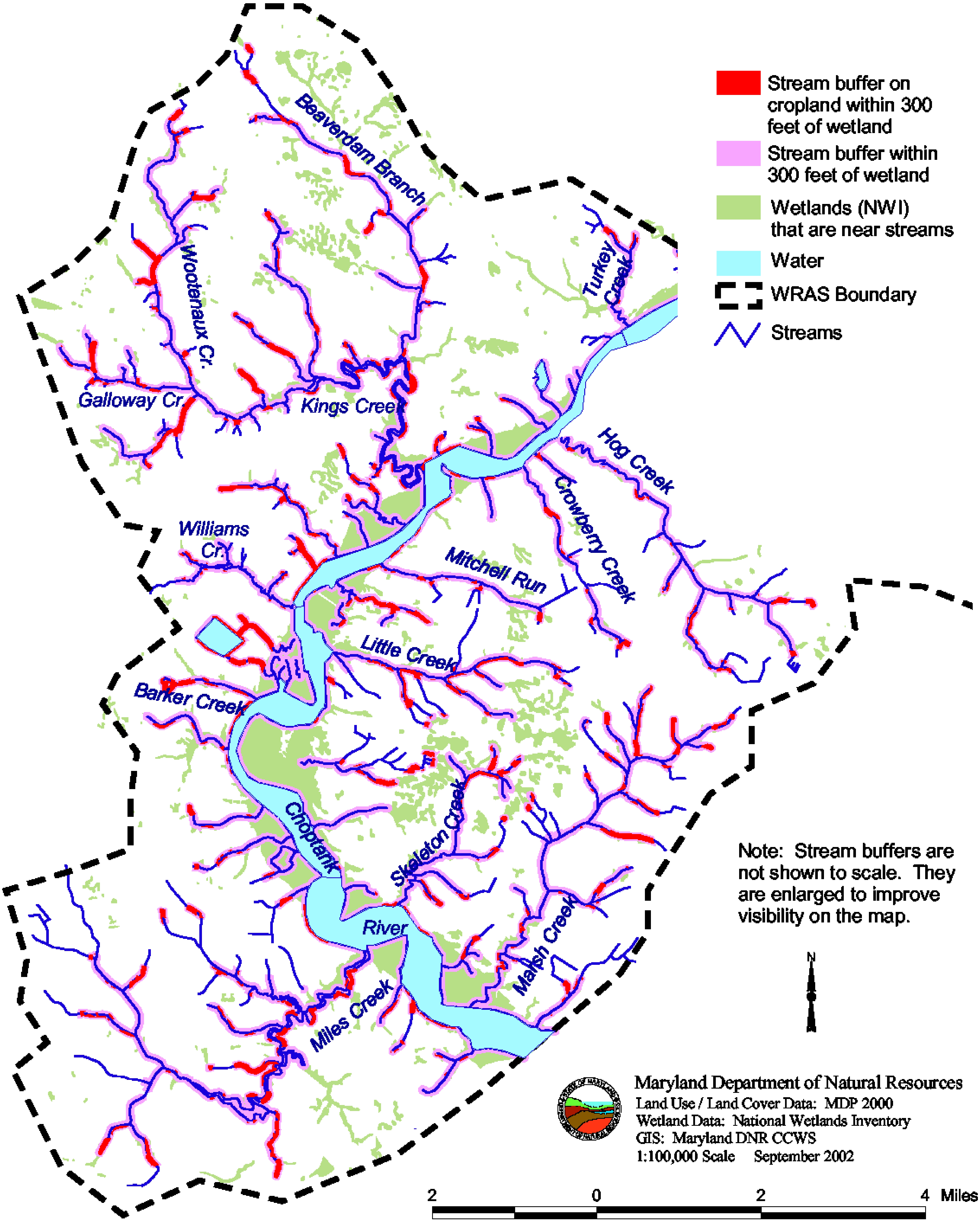
Map 24 Stream Buffer Scenario
Hydric Soils On Cropland
Upper Choptank River Watershed



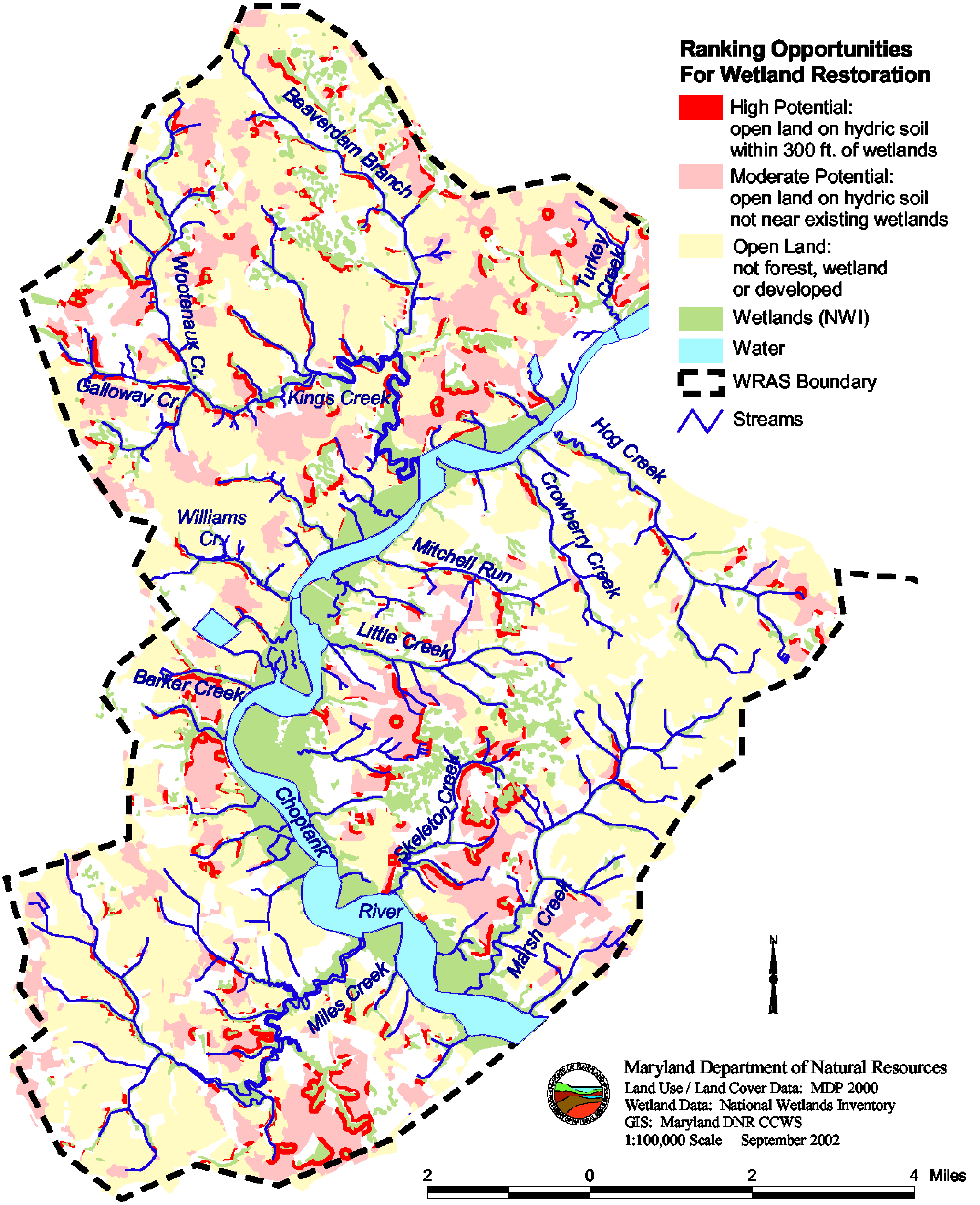
Note: Stream buffers are not shown to scale. They are enlarged to improve visibility on the map.

Maryland Department of Natural Resources
Land Use / Land Cover Data: MDP 2000
Wetland Data: National Wetlands Inventory
GIS: Maryland DNR CCWS
1:100,000 Scale September 2002

Map 25 Stream Buffer Wetland Proximity Scenario
Upper Choptank River Watershed



Map 26 Wetland Restoration Opportunities
Upper Choptank River Watershed



APPENDIX A – Stream Length Summary Table

The Stream Length Summary Table provides stream length and watershed area information summarized for the Upper Choptank River based on subwatersheds identified as the *Maryland 12-digit Watersheds*. These watersheds have been adopted by State agencies as one of several standardized approaches to analyzing and sharing information across the State of Maryland.

The table is broken into three segments consistent with the three maps that match three maps entitled *Stream and Subwatersheds* in the Upper Choptank River Watershed Characterization.

One key identifier for subwatersheds relates the tables and maps:

- in the table, the second column contains a three digit number
- on the maps, the same three digit number is a unique identifier shown for each subwatershed. (These are the same subwatersheds mapped by DNR/MDE for the entire state known as "12-digit watersheds.)

Example:

- on Map 3A, the stream Beaverdam Branch, which is east of Easton, is near the top of the map.

- the map labels the Beaverdam Branch subwatershed as "483".

- on table "Stream Summary for Map 3A", look either for "Beaverdam Branch" or "483"

- the table shows that DNR GIS system shows 17 linear miles of stream for Beaverdam Branch

Additional Notes:

12-Digit Name - A unique number assigned by DNR to each "12-Digit Watershed" in the State. The table truncates the leading zero (example 0472 in the table is 472).

Potential Watershed Name - Most of the "12-Digit Watersheds" designated by DNR do not have an official English name. The names listed here are offered only to raise the issue and to promote clear communication.

Stream Miles. This estimate is based on Statewide large-scale map digitization rounded to the nearest whole mile. Other sources, like the County's Planning and Zoning Maps, probably show additional stream reaches not included in the statewide data. Lakes and ponds that appear on USGS Quad Maps as open water were digitized with a left and a right shoreline. Therefore, the stream miles estimate reflects an estimate of the water body's perimeter.

Stream Summary for Map 3A		Upper Choptank River - South Section		October 2001
12-Digit Count & Number		Potential Watershed Name	Stream Miles Total	Watershed Area w/ Open Water (Total Acres)
1	472	Miles Creek Headwaters	11	4,448
2	473	Miles, Kings, Turkey Creeks	89	22,110
3	474		< 1	1,701
4	475	Skeleton Creek	25	5,591
5	476	Marsh Creek	19	4,232
6	477	Little Creek	8	1,979
7	478	Mitchell Run	5	880
8	479	Crowberry Creek	8	2,780
9	480	Williams Creek	4	1,138
10	481	Kings Creek Headwaters	3	1,288
11	482	Galloway and Wootenaux Creeks	11	4,165
12	483	Beaverdam Branch	17	4,766
13	484	Hog Creek	11	3,524

Stream Summary for Map 3B Upper Choptank River – Central Section October 2001				
12-Digit Count & Number		**Potential Watershed Name**	**Stream Miles Total**	**Watershed Area w/ Open Water (Total Acres)**
14	0485	Fowling Creek	29	9,334
15	0486	Robins Creek	17	4,050
16	0487		32	5,036
17	0488	Mill Creek	9	6,355
18	0489		6	1,519
19	0490	Herring Run	12	5,228
20	0491		7	1,116
21	0492	Watts Creek	25	7,977
22	0493		5	606
23	0494	Chapel Branch	31	10,284
24	0495		20	4,083
25	0496		2	488
26	0497		10	2,050
27	0498		3	347
28	0499		12	829
29	0500	Spring Branch	13	3,550

Stream Summary for Map 3C		Upper Choptank River – North Section		October 2001
12-Digit Count & Number		**Potential Watershed Name**	**Stream Miles Total**	**Watershed Area w/ Open Water (Total Acres)**
30	0501	Tubmill Branch	14	3,442
31	0502	Gravelly Branch	11	3,760
32	0503		6	1,947
33	0504		7	2,334
34	0505	Lower Forge Branch	29	5,611
35	0506	Forge Branch west headwaters	9	1,650
36	0507	Forge Branch north headwaters	13	2,250
37	0508	Oldtown Branch	13	2,732
38	0509	Broadway Branch	18	4,729
39	0510	Choptank River near Rt 287	19	4,067
40	0511		< 1	645
41	0512		3	635
42	0513		5	1,242
43	0514	Coolspring Branch	15	3,444
44	0515	Harrington Beaverdam Branch	13	3,754
TOTAL		**Upper Choptank River Watershed**	**564**	**163,699**

APPENDIX B – Delaware's Upper Choptank River Watershed

Delaware Department of Natural Resource and Environmental Control
(DNREC)
Watershed Assessment Section