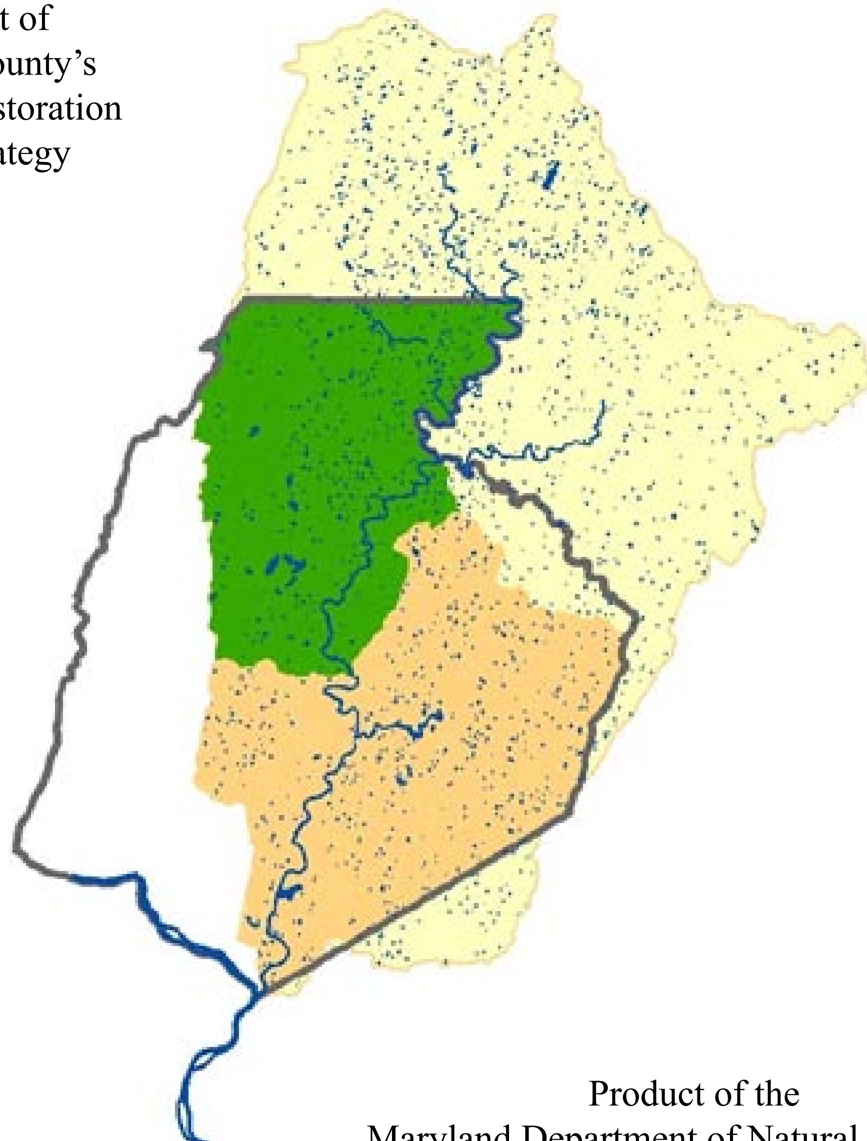
Characterization
Of The
Upper Monocacy River Watershed In Frederick County, Maryland

January 2005

In support of
Frederick County's
Watershed Restoration
Action Strategy



Product of the
Maryland Department of Natural Resources
Watershed Services
In partnership with Frederick County

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Executive Summary

The Monocacy River is tributary of the Potomac River that drains to the Chesapeake Bay and then to the Atlantic Ocean. The Monocacy River watershed covers 966 square miles in Maryland and Pennsylvania. Maryland divides its portion of the Monocacy River watershed into three "8-digit" watersheds, the Upper Monocacy, the Lower Monocacy and Double Pipe Creek. About 204 square miles of the Upper Monocacy River watershed is in Frederick County, Maryland. Frederick County is receiving Federal grant funding to prepare a Watershed Restoration Action Strategy (WRAS) for their portion of the Upper Monocacy River Watershed. The WRAS project area covers over 30% of Frederick County's total jurisdiction.

As part of WRAS project, the Maryland Department of Natural Resources (DNR) is providing technical assistance, including preparation of a watershed characterization (compilation of available water quality and natural resources information and identification of issues), a stream corridor assessment (uses field data to catalog issues and rate severity) and a synoptic survey (analyzes benthic macroinvertebrates, fish and water samples with focus on nutrients). The County will consider the information generated in these efforts as it drafts the County Watershed Restoration Action Strategy.

Water Quality

There are two designated uses for waterbodies in the Upper Monocacy River watershed: natural trout streams that are mostly in upland areas, and recreational trout streams that include all remaining streams in the watershed. Water quality impairments that affect these designated uses include nutrients, sediment, fecal coliform bacteria and biological impairment (poor or very poor ranking for fish or benthic macroinvertebrates based on in-stream assessments). A fish consumption advisory is in effect for three fish species due to methylmercury concentration measured in locally caught fish.

Several long term water quality monitoring stations are maintained in the Monocacy River mainstem. Based on comparing local measurements with comparable streams in Maryland, several overall findings are reported. Nitrogen concentrations are decreasing over time and are at moderate levels in recent years. Phosphorus concentrations are high and no trend toward a change is identified. Sediment concentrations are moderate and no trend toward change is identified.

Point source contributions of nutrients associated with sewage effluent in Frederick County include the Town of Thurmont Wastewater Treatment Plant that discharges more the one millions per day (MGD) and eight other smaller plants that each discharge less than 1 MGD. Additionally, one sewage effluent discharge of less than 1 MGD is located upstream in Carroll County.

Natural Resources

Geology and soils help define two major areas of the watershed that have great influence on water quality and habitat. The Catoctin Mountain area on the west side of the watershed is characterized by steep slopes and extensive areas of highly erodible soil. The Frederick Valley area that characterizes the remainder of the watershed is more gently rolling with some prime agricultural soils. High quality coldwater streams that begin on the mountain warm significantly in the valley where riparian areas frequently exhibit reduced vegetative cover and disturbed soils.

Green Infrastructure is a network of natural areas identified by DNR that are ecologically important on a statewide or regional scale. The Green Infrastructure includes areas like large blocks of forest or wetlands, habitat for sensitive species and protected conservation areas. These areas are grouped into hubs that contain the bulk of these resources and corridors than link the hubs together.

In the Upper Monocacy River watershed, Green Infrastructure hubs encompass about 39,500 acres of natural vegetation. All of the large hubs are in the western part of the watershed, which is characterized by extensive forest that is frequently on steep terrain and on soils with high erosion potential. Only two small Green Infrastructure hubs are identified in the lowland part of the watershed. Approximately half of these hubs are in public ownership, which affords some protection from conversion to developed land uses. The corridors that connect these Green Infrastructure hubs, including the corridor along the Monocacy River, contain limited fragmented areas of natural vegetation totaling about 2,900 acres. In these corridors, about one percent of natural vegetation is in public ownership.

About 2,700 acres of nontidal wetlands are mostly dispersed in the watershed but a few local areas exhibit greater concentration of wetlands. Sixteen sites grouped into ten wetland areas are designated as Wetlands of Special State Concern, which affords them additional regulatory protection through the wetland permit process. Compared to wetlands, 100-year floodplains are more extensive and cover nearly 9,300 acres. These floodplains tend to be concentrated along major rivers and large streams.

Computer GIS assessment of the WRAS project area identified 424 miles of stream including banks of the Monocacy River. Within this total are about 380 miles of tributary streams that flow to the Monocacy River mainstem. Of these tributary streams, about 44% do not have natural vegetated buffers. The assessment also identified several miles of tributary streams that lack naturally vegetated buffers and also flow through areas of highly erodible soils.

Living Resources and Habitat

Self-sustaining trout populations are active in at least seven streams in the Upper Monocacy River watershed. Viable trout habitat is generally in the streams draining the steep forested uplands on the west side of the watershed. Efforts to stock fish in recreational cold water streams continue to be successful.

A fish consumption advisory is in affect for three fish species taken from any impoundment in the watershed. Eating limitations are recommended for large and small mouth bass and bluegill to limit the potential risks associated with methyl mercury contamination.

Maryland tracks 58 sensitive species of animals and plants in the watershed. These species are found in at least 26 ecologically significant areas (ESAs) mapped by the DNR Natural Heritage program.

Land Use

The pattern of land use / land cover, like natural resource lands, agriculture, development and developing areas affect nonpoint source impacts on waterways.

The generalized land use categories of agriculture and forest each cover about 45% of the Upper Monocacy River watershed according to Maryland Department of Planning 2002 data. Forest tends to be concentrated in mountainous uplands and areas of steep slopes while agriculture tends to be in more gently sloping lowlands.

Low density developed lands tend to be scattered across the lowlands. Higher density developed lands tend to be concentrated in four areas of the watershed. These four areas are designated as Priority Funding Areas (PFAs) that are eligible to receive State funding for growth-related infrastructure improvements: Emmitsburg, Frederick, Thurmont, and Walkersville.

Residential development covers about 6% of the watershed of which 85% is low density (less than 2 residential units per acre). About 36% of this residential land use is within PFAs. Average lot size is about 1/3 acre in the PFAs and about 3 acres outside the PFAs.

About 38% of all improved residential parcels are served by individual septic systems. Of these residential parcels, most are located outside of the PFAs (nearly 3500 out of 4100 parcels).

Between 1973 and 2002, the area of developed land with the watershed has increased at the expense of agricultural and forest lands. The acreage of low density residential development increased from 3,110 acres in 1973 to 7,265 acres in 2002. The Maryland Department of Planning projects that an additional 7,100 residential parcels will be improved between 2002 and 2025. About 60% of these projected parcels are anticipated to be on existing sewer or planned sewer service.

Average impervious cover was estimated using land cover data collected in 1999-2001 for subwatersheds in the Upper Monocacy River watershed. Generally, impervious cover includes rooftops and roads that prevent stormwater from infiltrating in the ground. Significant water quality and habitat impacts are observed in streams in watersheds with average impervious cover of about 10% or greater. In Maryland, naturally reproducing trout populations are not found in streams that are feed by watersheds with greater than 2% average imperviousness.

In the Upper Monocacy River watershed, average imperviousness the subwatersheds assessed is low but it is in the range that impacts trout. Streams that support naturally reproducing trout are found only in the small forested watershed areas on Catoctin Mountain where average imperviousness is less than one percent.

Average imperviousness for most of the subwatersheds assessed in the WRAS area is between one and two percent with two exceptions. The subwatershed encompassing Glade Creek and the west side of Walkersville has an average imperviousness of nearly 2.4%. The Tuscarora Creek subwatershed, which includes the northern side of the City of Frederick, has an average imperviousness if nearly 3.3%.

Introduction

Watershed Planning Background

As a foundation for watershed monitoring, analysis and planning, the State of Maryland defined over 130 watersheds that cover the entire State in the 1970s. In 1998, the Maryland Clean Water Action Plan presented an assessment of water quality conditions in each of these watersheds. Based on these assessments, it also established State priorities for watershed restoration and protection.

In 2000, the Maryland Department of Natural Resources (DNR) initiated the Watershed Restoration Action Strategy (WRAS) Program as one of several new approaches to implementing water quality and habitat restoration and protection. The WRAS Program solicits local governments to focus on priority watersheds for restoration and protection. Since inception of the program, local governments have received grants and technical assistance from DNR for 20 WRAS projects in which local people identify local watershed priorities for restoration, protection and implementation.

Upper Monocacy WRAS Project

The Upper Monocacy River Watershed is in the Potomac River basin and part of it is in Frederick County, Maryland as shown in Map1 Location. This watershed is a high priority for both restoration and protection in the Maryland Clean Water Action Plan. For Frederick County's portion of the watershed, the County is working on a WRAS project to be completed in 2005. In the WRAS, Frederick County will identify and prioritize local restoration and protection needs associated with water quality and habitat. To support the County's effort, the Maryland Department of Natural Resources (DNR) is supplying grant funding and technical assistance, which includes production of this Watershed Characterization.

Map 2 WRAS Project Area shows Frederick County's portion of the watershed in greater detail. The map highlights subwatersheds defined by Frederick County that are used for analytical purposes throughout the Watershed Characterization. The Watershed Characterization focuses primarily on Frederick County's WRAS project area. Information on upstream areas of the Upper Monocacy River watershed in Carroll County, Maryland and Adams County, Pennsylvania is occasionally presented when it is immediately available.

Purpose of the Characterization

In support of the WRAS project, the Watershed Characterization helps to meet several objectives:

- Summarize immediately available 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.

Watershed Area By Jurisdiction In Square Miles For The Monocacy River				
Watershed Area	Maryland Counties			Total
	Frederick	Carroll	Montgomery	
Upper Monocacy River	204	41	0	245
Lower Monocacy River	264	9	31	304
Double Pipe Creek	28	165	0	193
Maryland Subtotal	496	215	31	742
Pennsylvania Subtotal For the Monocacy River Watershed				224
Monocacy River Watershed Total For Maryland and Pennsylvania				966

- Provide a common base of knowledge about the watershed for government, citizens, businesses and other interested groups.

The Watershed Characterization adds to other efforts that are important for the County's WRAS project:

- Local investigation by the County
- Stream Corridor Assessment, in which DNR personnel physically walk the streams and catalogue important issues
- Synoptic water quality survey, i.e. a program of water sample analysis, that 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
- Technical assistance and assessment by partner agencies or contractors

Moving Beyond The Characterization

In addition to the information presented in this document, it is important to identify gaps in available watershed knowledge and to gauge the importance of these gaps. As new information becomes available, the Watershed Characterization and other components of the WRAS should be updated and enhanced as needed. Here are some examples of issues for potential additional work:

- Habitat: physical structure, stream stability, biotic community (incl. the riparian zone)
- Water Quantity: high water–storm flow and 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.

Restoration and natural resource protection is an active evolving process. The information that supports the Watershed Restoration Action Strategy, including the Watershed Characterization, should be maintained as living documents within an active evolving restoration process. These documents will need to be updated periodically as new, more relevant information becomes available and as the watershed response is monitored and reassessed.

More Information Sources

The WRAS Program Internet home page has

additional information on the program and an index of available electronic copies of WRAS-related documents that can be downloaded free of charge. Available documents include detailed program information, completed WRAS strategies, stream corridor assessments, synoptic surveys and watershed characterizations. Please visit the WRAS Home Page at http://www.dnr.state.md.us/watersheds/wras/ Additional information on over 130 watersheds in Maryland is available on DNR's Internet page Surf Your Watershed at http://www.dnr.state.md.us/watersheds/surf/index.html

The Maryland Clean Water Action Plan is available at www.dnr.maryland.gov/cwap/

Water Quality

Water quality is in many respects the driving condition in the health of Maryland's streams. Historically, efforts to protect water quality have focused on chemical water quality. More recently, additional factors are being considered like measurements of selected biological conditions and physical conditions that affect habitat quality in streams and estuaries. This expanded view is reflected in current approaches to stream monitoring, data gathering, and regulation as reflected in this watershed characterization.

Designated Uses For Streams

All streams and other surface water bodies in Maryland are assigned a "designated use" in the Code of Maryland Regulation (COMAR) 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. In the Upper Monocacy River watershed, Natural Trout Waters and Public Water Supply (Use 3-P) applies to specifically designated stream areas as listed below and shown on Map 3 Designated Uses. These streams should meet the needs of naturally reproducing native brook trout populations and for protection of public water supply:

- Tuscarora Creek and all tributaries
- Fishing Creek and all tributaries
- Hunting Creek and all tributaries
- Owens Creek and all tributaries
- Friends Creek and all tributaries

For all other streams in the Upper Monocacy River watershed, the designation Recreational Trout Waters and Public Water Supply (Use 4-P) applies. These streams should meet needs for short-term survival of trout and for protection of public water supply. Use 4-P allows for higher temperature than Use 3-P.

Use Impairments

Some streams or other water bodies in the WRAS project area cannot be used to the full extent envisioned by their designated use in Maryland regulation. In these water bodies, water quality or habitat impairments are generally the cause. These areas, known as "impaired waters", are tracked by the Maryland Department of the Environment under Section 303(d) requirements of the Federal Clean Water Act as summarized below. Each listing for water body impairment remains on the list until either correction of the impairment is demonstrated or the listing is proven to be in error.

Bacteria

The Upper Monocacy River mainstem was listed for impairment by fecal coliform bacteria from unspecified sources based on data collected at two long term monitoring stations (MON0269, MON0528) 1995 through 1999.

Biological Impairment

The 2002 303(d) list included the Upper Monocacy River watershed for biological impairment based on assessment of fish and benthos by the Maryland Biological Stream Survey (MBSS) using their indices of biological integrity. The assessment of this information in the draft 2004 303(d) list indicates that the findings are not conclusive and recommends dropping the listing of biological impairment for the watershed.

However, biological impairment was listed in 2002 or 2004 for specific sites on Buzzard Creek, Creagers Branch, Fishing Creek, Flat Run, Friends Creek, Glade Creek, High Run, Little Hunting Creek, Middle Creek, Motter's Run, Owens Creek, Piney Creek, Sandy Run, Steep Creek, Toms Creek, Turkey Creek, Tuscarora Creek and unnamed tributaries to the Monocacy River.

These biological impairments are listed based on ratings of poor or very poor for stream sites that were assessed using either the benthic index of biological integrity and/or the fish index of biological integrity. Findings from these indices are summarized on maps in the Living Resources Chapter, Biological Monitoring Section.

Nutrients

Hunting Creek Lake was listed in 2002 for nutrient impairment from unknown sources based on an assessment conducted in 1993-1995. Upper Monocacy River was listed in 1996 for nutrient impairment from nonpoint and natural sources.

Sediment

Upper Monocacy River was listed in 1996 for sediment impairment from nonpoint and natural sources.

Total Maximum Daily Loads

In Maryland, the Department of the Environment (MDE) uses the 303(d) list of impaired water bodies to determine the need for establishing Total Maximum Daily Loads (TMDLs). A TMDL is the amount of pollutant that a water body can assimilate and still meet its designated use. The purpose of issuing a TMDL is to establish a maximum pollutant load (a cap) for the water body and to require reduction of pollutants below that cap. A water body may have multiple impairments and multiple TMDLs designed to correct and prevent reoccurrence the impairments. MDE is responsible for establishing TMDLs. In general, TMDLs have two key parts:

- Maximum pollutant load that the water can accept while still allowing the water body to meet its intended use.
- Allocation of the maximum pollutant load to specific pollutant sources.

As of July 2004 in the MDE has not developed any TMDLs in the Upper Monocacy River. However, based on the current list of impairments, Upper Monocacy River watershed TMDLs are anticipated for bacteria, nutrients, sediments and impairments associated with low indices of biological integrity. In its work on the Upper Monocacy River nutrient TMDL, MDE will explore the establishment of a quantified maximum threshold of nutrients in nontidal waters. Results of this work may be available in 2005. (1)

Water Quality Monitoring And Analysis

The Upper Monocacy River watershed is a fresh water system. It is comprised of free flowing waterways with a few small impoundments on tributary streams. Several of these impoundments are locally important sources for public water supply.

Water quality sampling in the watershed has been conducted over many years in the Monocacy River itself and short term monitoring has been conducted in some of the tributary streams. Map 4 Water Quality Monitoring shows the locations of these sampling sites and a summary of findings gathered from these sites follows below.

Long Term Monitoring

There are two long term monitoring stations in the mainstem of the Monocacy River. One is just upstream of the City of Frederick (Bigg's Ford, mon0269) and one at the north end of the watershed (Bridgeport, mon028). The findings from these stations summarized below show similar status and trends for the segment of the Monocacy River within the Upper Monocacy River watershed. (2)

Long term monitoring of the benthic community has been conducted in the Monocacy River in the vicinity of the Bridgeport station (mon0528). For the period 1976 through 1992, several findings can be reported. The diversity index findings were generally in the good range and the biotic index was generally in the fair range. Together these findings suggest the fair to good water quality was typical during this period. (3)

Current Monitoring

The table 2002 Water Quality Monitoring Summary shows average concentrations for total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS) from monitoring conducted by the State in 2002. This monitoring is part of a sampling program for 2002 through 2004. The base flow data used to generate this table is insufficient to provide a complete picture of these streams and discharges. However, it can be used for limited comparative interpretation.

Bigg's Ford (MON0269) – Monocacy River Water Quality Monitoring		
Parameter	**Status 2000-2002**	**Trend 1986-2002**
Nitrogen	Moderate, between 1.7 and 2.3 mg/l	Decreasing
Phosphorus	High, between 0.036 and 0.073 mg/l	No Trend
Suspended Solids	Moderate, between 5.4 and 7.8 mg/l	No Trend

Bridgeport (MON0528) – Monocacy River Water Quality Monitoring		
Parameter	**Status 2000-2002**	**Trend 1986-2002**
Nitrogen	Moderate, between 1.7 and 2.3 mg/l	Decreasing
Phosphorus	High, between 0.036 and 0.073 mg/l	No Trend
Suspended Solids	Moderate, between 5.4 and 7.8 mg/l	No Trend

2002 Water Quality Monitoring Summary -- Upper Monocacy Tributaries				
Map Number - Station Number	Stream Or Discharge Name	Average Concentration (mg/l)		
		TN	TP	TSS
1- TUS0018	Tuscarora Creek	2.27	0.067	5.72
2- FIS0004	Fishing Creek	0.92	0.117	9.02
3- HUN0009	Hunting Creek	1.23	0.09	4.63
4- MD0021121	Thurmont WWTP (Hunting Creek)	5.97	0.80	3.85
5- OWN0007	Qwens Creek	1.52	0.063	4.80
6- TOM0011	Toms Creek	1.02	0.10	6.29
7- TOM0038	Toms Creek	0.72	0.10	5.85
8- MD0020257	Emmitsburg WWTP (Toms Creek)	16.6	2.49	26.
9- TOM0062	Toms Creek	0.71	0.062	4.78
9- SMU0001	Saint Mary Run	3.2	0.87	11.1
10- SMU0011	Saint Mary Run	9.8	2.47	7.23
10- MD0023230	Mt. St. Mary's College WWTP	8.06	3.88	5.27
10- SMU0012	Saint Mary Run	0.71	0.078	6.4
11- MD0062391	Emmitsburg Water Treatment Plant	1.7	0.6	6.2
12- MTM0011	Middle Creek	0.51	0.063	4.38

Overall, TN and TP concentrations found in these tributaries do not have significant affects on free flowing waterways. Nutrients tend to be transported downstream to impoundments and/or tidal waters where nutrient-related water quality affects generally occur. The table shows that discharges from sewage treatment plants tend to have greater concentrations than the ambient waters. This condition is most clearly demonstrated in Saint Mary Run by comparing findings from sampling upstream (smu0012) of the Mount St. Mary's College and downstream (smu0011 and smu0001).

Regarding TSS, the data available for the table shows that most areas exhibit similar concentrations with two exceptions. The high concentration for TSS from the Emmitsburg WWTP is based on insufficient data to indicate if this finding is typical or not. However, findings for TSS concentrations appear to show a clear trend in Saint Mary Run. The TSS concentration increases from upstream to downstream. This data suggests that local erosion and sediment movement may be an issue for this stream and its watershed. (4)

Concentration data like that in the table will be used by MDE to draft one or more TMDLs for the Monocacy River. Until that is accomplished, the concentration data by itself is insufficient to determine good or bad conditions locally. However, by using average concentration and average flow data, pollutant load can be estimated for the TMDL to determine the relative contribution of various streams or watersheds to water quality problems in downstream impoundments and tidal waters. Addtional details are in Appendix B - Water Quality Monitoring 2002 Summary.

Water Supply

In May 2004, Maryland's Water Resources Advisory Committee reported on the status of water supply, demand and related issues for Maryland. Overall, the report noted that improved assessment tools are needed to better assess water supply.

The Monocacy River watershed was one of two pilot studies conducted to demonstrate approaches that could be used for similar assessments across the entire State. The Committee considered the entire watershed including areas in Maryland (Frederick and Carroll Counties) and in Pennsylvania (Adams County). Based on demand estimates for 15 subwatesheds spanning both Maryland and Pennsylvania, the Committee projects that demand for water in the watershed will increase from 48 million gallons per day (MGD) in the 2000 to 61 MGD in the year 2030.

In the Monocacy River watershed, the Committee reports that streams are an important source of water. It also notes that water appropriation permits limit withdrawals from streams and rivers so that enough water (flowby) remains to support minimum biological needs in the stream. For example, Consent Order CO-02-01-WS (State of Maryland Department of Environment v. City of Frederick) stipulates that the City's withdrawal from the Monocacy River cannot cause the rate of flow at the Jug Bridge stream gauge to drop below 50 cubic feet per second.

The Committee did not present specific details on the limitations affecting Monocacy-area streams to meet both water supply and biological needs like fish and other aquatic life. However, Committee's Executive Summary reports that "if minimum stream flows are to be protected, then users of streams without reservoirs or other storage will not be able to meet their needs at all times" in the Monocacy River watershed. (5)

Also in 2004, the Interstate Commission on the Potomac River Basin initiated a voluntary multi-State program to promote protection of drinking water sources including safeguarding public health and protection of the environment. Frederick County is one of numerous participants in the newly formed organization called the Potomac River Basin Drinking Water Source Protection Partnership (DWSP Partnership). The DWSP Partnership is intended to bring together water suppliers and appropriate agencies with a drinking water perspective to coordinate watershed protection efforts, to develop regional priorities and to work toward a watershed strategy. (6)

Point Sources

Discharges from pipes or other "discrete conveyances" are called "point sources." Point sources may contribute pollution to surface water or to groundwater. For example, wastewater treatment discharges may contribute nutrients or microbes that consume oxygen (measured as Biochemical Oxygen Demand (BOD)) reducing oxygen available for other aquatic life. Industrial point sources may contribute various forms of pollution. Some understanding of point source discharges in a watershed can be useful in helping to identify and prioritize potential restoration measures.

Findings from the Maryland Department of the Environment (MDE) permit database are summarized below. The Appendix C - MDE Permits lists additional details and Map 5 MDE Permits shows the distribution of permits across the watershed. Characteristics of these permitted discharges (volume, temperature, pollutants, etc.) are tracked by MDE and most is accessible to the public.

- There are 38 permits in Frederick County's portion of the Upper Monocacy River Watershed. Eight of these are small sewage effluent discharge to surface waters. Thurmont, the ninth sewage effluent discharge, is the only one identified as a major permit with over one million gallons per day discharge capacity.
- The Thurmont Wastewater Treatment Plant uses Biological Nutrient Removal technology (an oxidation ditch with oxygenated areas and anoxic areas) to promote removal of nitrogen by microbes. The collection system feeding the Plant has inflow and infiltration issues (water other than sewage entering the sewer pipes) that the Town hopes to correct. (7)
- The Emmitsburg Wastewater Treatment Plant has a design capacity of 800,000 gallons per day. It has a significant inflow and infiltration problem associated with five miles of sewer mains build prior to 1960 that include porous terra cotta tile. In recent years, the town has earmarked water and sewer revenue to address infrastructure needs. (8)
- Seven permits are active in Carroll County's portion of the watershed. The Taneytown wastewater treatment plant is the only sewage effluent discharge in this part of the watershed. Other permits do not appear to contribute nutrients.

Natural Resources

Water quality and quantity in surface waters and groundwater are greatly influenced by natural resources. Physical factors like geology and soils largely determine local topography, hydrology and potential for erosion. Variation of vegetation types in riparian areas and throughout the watershed produces additional influences that determine potential for stormwater infiltration or runoff and habitat quality. This chapter presents immediately available natural resource information for the Upper Monocacy River watershed.

Geology

Map 6 Geology shows that the Upper Monocacy River watershed is complicated geologically. The Catoctin Mountain area is primarily three formations: Wissahickon Formation, Weverton Formation and the Metarhyolite and associated pyroclastic sediments. The valley area is mostly the New Oxford Formation, Gettysburg Shale, Frederick and Grove Limestones. The valley area also includes smaller areas of the Antietam Formation, Diabase Sills and Dikes, Harpers Formation, and the Ijamsville Formation. The varying resistance that these underlying geologies to erosion and water infiltration greatly influence local topography and hydrology.

The Maryland Geological Survey report of investigations number 75, Stratigraphy of the Frederick Valley and its Relationship to Karst Development, was a multi-year study funded in part by a Maryland State Highway Administration research grant. The study addresses the distribution of sinkholes, the impact of cultural development on increased sinkhole activity causing infrastructure damage, and the environment impacts on groundwater resources. The major conclusions of the study are: certain carbonate units are more susceptible to sinkhole development; and redirection of existing drainage during construction upsets the natural equilibrium in a sinkhole terrain and is a major cause of increased sinkhole development and infrastructure damage. This study is used by SHA to not only plan highway construction, but also develop engineering solutions to avoid infrastructure damage and loss of life.

Soils

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 SSURGO data for Frederick County shows. Map 7 Soils shows the distribution of soils important to watershed planning in the Upper Monocacy River watershed:

- Prime agricultural soils account for about 14% of the watershed. The largest concentration of this soil is located in the Walkersville and City of Frederick area where much of it has been converted to development or is in danger of conversion in the foreseeable future.
- Highly erodible soil is concentrated on steep and/or mountainous areas of the watershed.
- Hydric soils are a small percentage of the watershed and tend to be scattered in small areas. The largest concentration is east of Emmitsburg.

Green Infrastructure

Forest and wetlands lands in the Upper Monocacy River watershed, particularly extensive areas of contiguous natural lands, provide valuable water quality and habitat benefits. In general, actions taken to assure that forest cover will be maintained, to avoid fragmentation of forest, and to restore forest in areas that have been cleared will contribute significantly to improving the water quality in this watershed and to conserving the biodiversity of the State.

DNR has mapped a network of ecologically important lands, comprised of hubs and linking corridors, using several of the GIS data layers used to develop other indicators. Hubs contain one or more of the following:

- Areas containing sensitive plant or animal species;
- Large blocks of contiguous interior forest (at least 250 contiguous acres, plus the 300 foot transition zone);
- Wetland complexes with at least 250 acres of unmodified wetlands;
- Streams or rivers with aquatic species of concern, rare coldwater or blackwater ecosystems, or important to anadromous fish, and their associated riparian forest and wetlands; and
- Conservation areas already protected by public (primarily DNR or the federal government) and private organizations like The Nature Conservancy or Maryland Ornithological Society.

This "Green Infrastructure" provides the bulk of the state's natural support system. Ecosystem services, such as cleaning the air, filtering and cooling water, storing and cycling nutrients, conserving and generating soils, pollinating crops and other plants, regulating climate, protecting areas against storm and flood damage, and maintaining hydrologic function. For more information on the Green Infrastructure identification project, see www.dnr.maryland.gov/greenways/

Protection of Green Infrastructure lands may be addressed through various existing programs including Rural Legacy, Program Open Space, conservation easements and others. Within Program Open Space, the Green Print program helps to target funds to protect Green Infrastructure areas.

Map 8 Green Infrastructure shows that, from the statewide perspective that guided the analysis, several Green Infrastructure are found in the Upper Monocacy River Watershed:

- Natural vegetation area in Green Infrastructure hubs totals about 39,500 acres. Most of this natural area is forest in large hubs on mountainous terrain. About half of this acreage is in local, DNR or Federal ownership. Two small hubs are identified along the Monocacy River: one northeast of Emmitsburg at the Pennsylvaina border (about 350 acres of natural vegetation) and one near Legore Bridge Road bridge across the Monocacy River (about 170 acres of natural vegetation).
- The large Green Infrastructure hubs on Catoctin Mountain that range from Pennsylvania to Frederick as shown on the map all rank in the top one third relative to other hubs in this physiographic region of Maryland based on a comparison of ecological values. The highest ranked hub runs roughly from Thurmont to Frederick. Based on this ranking, protection of land in this hub generally may present the greatest potential ecological benefit.
- The corridors connecting the Green Infrastructure hubs are characterized by discontinuous areas of natural vegetation that total about 2,900 acres. These natural areas are fragmented by land uses like agriculture and development. About one percent of this acreage is in local, DNR or Federal ownership. A similar percentage is protected by agricultural easement.

Large Forest Blocks

Large blocks of forest provide habitat for species that are specialized for conditions with relatively little influence by species from open areas or humans. For example, forest interior dwelling birds require forest interior habitat for their survival and they cannot tolerate much human presence. Map 9 Forest Interior shows blocks of contiguous forest that are at least 50 acres in size with at least 10 acres of forest interior (forest edge is at least 300 feet away) that may be important locally within the watershed. This size threshold was chosen to help ensure that the forest interior is large enough to likely provide locally significant habitat for sensitive forest interior dwelling species. The forest interior assessment map differs from the Green Infrastructure assessment in that forest interior areas are more numerous and more widely distributed because the forest interior size threshold is lower. Several findings on Upper Monocacy River watershed forest interior can be seen on the map by comparing it with the Green Infrastructure and protected lands maps:

- Several thousand acres of high quality forest habitat extends beyond Green Infrastructure hubs. These areas are mostly in the western part of the watershed.
- About 70% of the forest in the watershed (40,300 acres) is potential high quality forest interior habitat due historic land use patterns in response to steep terrain and prime agricultural land.
- About 47% of the high quality forest interior (19,000 acres) is in local, DNR or Federal ownership.

Wetlands

Map 10 Wetlands and Floodplains shows that there are about 2,707 acres of wetlands in Frederick County's portion of the Upper Monocacy River watershed according to DNR's Wetlands Inventory. The Maryland Department of the Environment, which regulates wetlands in Maryland, contributed the detailed assessment of wetlands in the watershed that follows. (9)

The Upper Monocacy River watershed is located partially in the Piedmont Province and partially in the Blue Ridge Province, with the geologic province affecting the types of wetlands found there. Wetlands in the Piedmont Province are generally less abundant compared to Maryland's Western and Eastern Shore areas (on the Coastal Plain Province), due to greater topographic relief, regional geology, lower groundwater table and lack of tidal influence. Wetlands in the Blue Ridge Province are even less common. Although less common, the wetlands of western Maryland are rather diverse. For example, this watershed has several circumneutral seepage wetlands (wetlands with near-neutral pH systems restricted to areas with specific geology, which provide unique habitat). The majority of Upper Monocacy River wetlands are associated with low-lying areas around streams, with a few isolated wetlands in surface depressions.

Wetland Categories

The following wetland descriptions for the Piedmont Province and Blue Ridge Province are summarized from *Wetlands of Maryland*.(10) Palustrine wetlands are located on floodplains associated with streams and rivers, upland depressions, and in flats between drainage systems. They are freshwater systems with high water tables and/or intermittent ponding on land. Palustrine forested wetlands are the most abundant type of wetland in this watershed. Forested wetlands within the Piedmont are typically found on floodplains in stream valleys and are characterized by the relatively short frequency and duration of flooding (seasonally flooded and temporarily flooded forested wetlands). Scrub shrub wetlands are found in wide river floodplains, valleys and meadows. Emergent wetlands can occur in areas of former forested wetlands that were cleared for agricultural, meadows and valleys, and are characterized by the greater frequency and duration of flooding (seasonally flooded marshes and meadows, and temporarily flooded wet meadows). The greater duration and frequency of flooding typically favors emergent plant species over scrub shrub and forested plant communities. There are also a few acres of riverine wetlands (located between deep water and the riverbank). In the Blue Ridge Province, wetlands are often found in topographic depressions and associated with riverine and palustrine environments.

Nontidal Wetlands of Special State Concern

Nontidal wetlands containing rare, threatened, endangered species or unique habitat are identified as nontidal wetlands of special state concern in MDE regulations. Nontidal Wetlands of Special State Concern in the Upper Monocacy River watershed, as summarized by DNR in 2004, include 16 sites grouped into 10 wetland areas.(11) The section on sensitive species addresses the distribution of these wetlands as designated in regulation. The Natural Heritage Program in DNR has also identified three additional wetland areas associated with Hunting Creek headwaters and Steep Creek for potential future designation.

- Buzzard Branch. The four Buzzard Branch sites (Buzzard Branch Site, Buzzard Branch Bog, Buzzard Branch Bottom, and East Buzzard Branch) are along Buzzard Branch and are connected through hydrology and forest. They are part of a fairly large healthy circumneutral seepage wetland habitat and contain several state rare threatened or endangered species, and otherwise uncommon species.

- Cunningham Falls Hollow. The three sites comprising Cunningham Falls Hollow wetland complex (Foxville Swamp, Upper Hunting Creek Swamp, and Hunting Creek Hollow) are part of a large circumneutral seepage wetland connected through a wetland/stream system. They contain several three state rare threatened or endangered plant species and additional uncommon or locally important plant species.
- Eylers Valley. This site is along the Little Owens Creek. It contains a state-threatened species. A utility line bisects the wetland and is providing the open canopy necessary for the sensitive species.
- Fishing Creek. The two sites in Fishing Creek wetland complex (Fishing Creek and Steep Creek Swamp) form a circumneutral seepage wetland complex draining into Fishing Creek Reservoir. Fishing Creek WSSC follows a portion of Fishing Creek and incorporates two man-made ponds while Steep Creek Swamp is located at the confluence of Steep and Fishing Creeks. These sites contain several state-threatened and endangered species, including one plant species with this being the only documented occurrence in the state, and other uncommon species.
- Legore Bridge. This site is located at the confluence of the Monocacy River and a tributary upstream of Le Gore Bridge. This wetland intersects two geologic formations with very different soil pH values, creating two distinct plant communities. This wetland contains three state rare or endangered plant species, three uncommon plant species, and two locally important species.
- Little Fishing Creek Pond. This circumneutral seepage wetland is located adjacent to a man-made pond. The wetland contains a state threatened species and the surrounding mesic shore contains two additional state endangered species. The pond has a variety of aquatic plant species that are locally rare.
- Owens Creek Swamp. This site is a large healthy circumneutral seepage wetland containing five state threatened or endangered species and an uncommon species. The maturing forest canopy provides gaps that are critical to the survival of the sensitive species.
- South Salamander Rock Fire Ponds. This circumneutral seepage wetland is located along a tributary to Steep Creek, near three man-made ponds. This site contains five state rare, threatened, or endangered species and other plant species of local importance.
- Turkey Creek. This site contains Rainbow Lake, a man-made reservoir, which receives water from Turkey Creek. Lake mesic shoreline habitat of the state threatened species is severely degraded from invasive weeds and shrubs.
- Wigville Swamp. This is a healthy circumneutral seepage wetland within a forest. This site contains two state rare threatened or endangered species and other uncommon or locally important species.

<u>Tracking Wetlands</u>

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Department 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 table shows, the

State regulatory program has measured a very small net increase of wetland acreage in the Upper Monocacy River Watershed over the past 12 years. In addition to the regulated wetland change in this watershed, at least 211 acres of wetland restoration/enhancement have been completed by Ducks Unlimited and other entities.

Tracking Nontidal Wetland Change Upper Monocacy River Watershed In Maryland 1/1/1991 through 12/31/2003 Tracking MDE In Acres				
Permanent Impacts	**Permittee Mitigation**	**Programmatic Gains**	**Other Gains**	**Net**
-1.60	1.67	0	0	0.07

Notes for the table: 1) Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998.
2) "Permanent Impacts" refers to acres altered (filled, drained) under permit from MDE.
3) "Permittee Mitigation" refers to acres restored by a permit holder as required by terms of the permit from MDE.
4) "Programmatic Gains" refers to acres restored by MDE using fees paid into a compensation fund by a permit holder in lieu of undertaking mitigation himself.
5) "Other Gains" refers to acres of wetlands restored when not required as mitigation for permitted losses.

Wetland Functions

Wetlands in Upper Monocacy River watershed have a high potential to provide functions for water quality improvement from nutrient retention/cycling and sediment removal. Since many wetlands in this watershed act as a riparian buffer adjacent to agriculture, they serve to filter out nutrients, sediments, and other pollutants that would otherwise enter the stream through runoff. These wetlands may also remove nutrients as they intercept groundwater entering the stream or as they receive floodwaters.

In addition to improving water quality during flooding events, they also have the potential to store floodwater, thereby reducing flooding. Some of the more isolated wetlands in surface depressions may also be important for reducing nutrients and sediment in runoff, especially when they are surrounding by agriculture or development. The wetlands in this area also provide wildlife habitat.

Wetland Losses

Over half of the wetlands originally in the county have been lost. Historic wetland loss in Upper Monocacy River watershed is estimated to be 15,277 acres.(12)

Wetland loss and wetland impacts result from disturbance to the wetland itself and to the surrounding areas. Examples of disturbances include: wetlands that are filled or drained for agriculture and development, vegetation removal (e.g. timber harvest), altering hydrology (e.g. changes in surface runoff or water table level), high pollutant load from surrounding areas, livestock grazing within wetlands, and fragmentation (e.g. roads or driveways being built through wetlands).

Due to the high growth in the watershed, there continues to be many wetland impacts associated with building new houses and other development. These impacts are generally small in acreage. However, this is misleading as to the overall impact to the watershed. The relatively small wetlands are currently connected by the larger stream corridor and floodplain system.

While current wetland regulations protect most of the wetland acreage, many of these critical stream corridor/floodplain systems are being fragmented and degraded. When the stream corridor and surrounding system is impacted, the remaining wetlands will no longer be part of a larger connected system, but instead isolated patches of degraded wetlands connected by narrow degraded stream corridors surrounded by development.

Since the current wetland regulations are not enough to protect these overall wetland systems, these systems must also be proactively protected by choice.

Restoration Opportunities

Hydric soils suggest where wetlands are located presently or were located historically. In this watershed, they tend to be associated with many streams but relatively few of these areas are still wetlands. Many of these hydric soils are currently in agricultural land use, many of them having been artificially drained or turned into muddy pasture. These areas are often ideal locations for wetland restoration. The Frederick Soil Conservation District, familiar with the local farms, may have knowledge of landowners interested in restoring wetlands on their property. Farmers may have an incentive to restore wetlands in areas with poor agricultural productivity. Hydric soils classified as being very poorly drained may be easier to restore to wetlands (e.g. Lantz). Additionally, soils flooded frequently make desirable wetlands since they may provide higher floodwater retention and nutrient cycling function (e.g. Melvin).

While it is important to protect all remaining wetlands, targeted wetland protection should include Wetlands of Special State Concern, extensive wetland complexes, wetlands surrounding sensitive areas (e.g. around Category III/IV streams), and wetlands providing high function. In addition to protecting the high value systems, we should also protect degraded systems that we will someday be able to restore. (13)

In mid-2005, MDE anticipates releasing a report assessing wetland restoration priorities in a report entitled *Priority Wetland Restoration and Preservation Sites*.(14) The document will present a comprehensive compilation of numerous resource inventories and management plans on wetlands, their surrounding environment and conditions, and management and restoration recommendations. It will also present priorities for restoration and identify sites and practices that will be most suitable for both voluntary restoration and mitigation projects throughout Maryland.

Floodplains

Map 10 Wetlands and Floodplains shows that in some areas like those highlighted, floodplains are more extensive than the wetlands in and around them. Overall in Frederick

County's portion of the Upper Monocacy there are about 9,300 acres of wetlands (7% of watershed). The natural threat of inundation in these areas tends to make them viable locations for undeveloped land uses like agriculture, parks and natural habitat. Where stream buffers are absent on floodplains, particularly on hydric soil and/or adjacent to existing wetlands, restoration of stream buffers or wetlands can provide multiple benefits.

Stream Buffers

The Upper Monocacy River watershed has about 424 miles of stream according to US Geological Survey data. About 380 miles are tributary streams and the remainder is the Monocacy River mainstem and land around impoundments.

Using this stream data with Maryland Dept of Planning 2002 land use / Land Cover data in computerized GIS, an interpretation of the land in local riparian stream buffers can be generated. Map 11 Stream Buffers shows the resulting GIS that can be used to help characterize areas where field data has not been collected by stream corridor assessment.

Of the 380 miles of tributary streams in the watershed, about 213 stream miles or 56% of local streams have natural vegetation in the riparian area. Areas that lack naturally vegetated buffers are divided into three categories. Developed land, open land (agricultural land or barren land) on highly erodible soil and open land on soils that are not highly erodible. Several miles of stream riparian area, that are characterized by open land on soil that has high potential for erosion, are not protected by naturally vegetated buffers.

This method of characterizing stream buffers has limitations that need to be considered but it provides a starting point for prioritizing field investigations:

- The resolution of this land use data does not allow independent characterization of each stream bank when land use differs on each side. Definitions of land use data are generalized to optimize for land use type rather than vegetative land cover.
- Field conditions and landowner interest are not part of the GIS data but these types of considerations need to be understood.

The map also shows stream buffer restoration projects reported to DNR Forest Service. The Forest Service database lists 45 projects stretching along nearly 28 miles of streambank and covering nearly 413 acres.

Benefits of Stream Buffers

Natural vegetation in stream riparian zones, particularly forest, provides 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.

Headwater Streams

Headwater streams are also called first order streams. For many watersheds, first order streams drain the majority of the land within the entire watershed. Therefore, stream buffers restored along headwater 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 that 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.

Since this watershed has a substantial percentage of its headwater streams in interior forests, protection of these forests against impacts from development may be an important part of WRAS strategies, along with reforestation where necessary.

Land Use Adjacent To Streams

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.

Stream buffers can effectively intercept nonpoint source sediment and phosphorus if these pollutants arising from land that is characterized by continuing soil disturbance/exposure and/or high erosion potential. Examples of these land uses are some types of agriculture, poorly vegetated lawns and athletic fields, unpaved roads and parking areas.

Based on monitoring conducted in Maryland, nonpoint source nitrogen entering streams appears to be greatest from development using septic systems and from certain types of agriculture depending on past and present application of fertilizer and manure. Targeting stream buffer restoration, using deep-rooted vegetation, to these areas may intercept nitrogen in groundwater before it emerges in streams. Naturally vegetated stream buffers on hydric soil have the potential to intercept nitrogen because plant roots are more likely to be in contact with groundwater for longer periods of time.

Optimizing Stream Buffer Restorations

Strategic targeting of stream buffer restoration projects may provide many different 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 currently in the riparian zone
- Headwater stream areas
- Soil type including hydric or highly erodible soils
- Selecting appropriate woody or grass species, natural vegetation for habitat
- Adjacent wetlands and habitat that may be enhanced.

Living Resources and Habitat

Living resources, including all the animals, plants and other organisms require water to survive. They and their habitats are intimately connected to water quality and availability. Living resources respond to changes in water and habitat conditions in ways that help us interpret the status of water bodies and the effects of watershed conditions. In some cases, water quality is measured in terms of its ability to support specific living resources like trout or shellfish. Information on living resources is presented here to provide a gauge of water quality and habitat conditions in the watershed. It is also a potential measure of efforts to manage water quality and watersheds for the living resources that depend on them.

Fish

Based experience working in Upper Monocacy River watershed streams, DNR Fisheries Service biologists are able to characterizes local conditions for selected fisheries resources.(15) In the watershed generally, the streams with headwaters in the Catoctin Mountains support high-quality cold-water fisheries that have the capacity to sustain naturally reproducing brook trout populations. Map 12 Fish –Trout Populations and MBSS Index shows that several of these streams have existing brook and brown trout populations.

As these streams flow into lowlands areas, they gradually warm up in stream segments with lower gradient, less shade, less naturally vegetated riparian buffer and more impacts of agriculture and development. It is a gradual transition with fish moving up and downstream in that vicinity. In the warm water stream areas, small mouth bass, channel catfish and red breasted sunfish are the predominant game fish species.

Tom's Creek has rainbow trout stocking that occurs in Pennsylvania. Some of these fish are caught in Maryland.

Owens Creek headwaters contain native brook trout and brown trout that were introduced (non natives) and now are naturalized with self-sustaining populations. Prior to the early 1990s, upper Owens Creek was stocked with adult rainbow trout to serve put and take fishing. Stocking was discontinued to avoid population impacts of stocked fish on wild fish populations. In most areas of upper Owens Creek, native brook trout have out-competed the naturalized brown trout. In lower Owens Creek from Raven Rock Road downstream to the covered bridge at Roddy Road, adult rainbow trout and brown trout are stocked to serve put and take fishing. From June 1 through the end of February this area is subject to catch-and-release restrictions. Little Owens Creek has wild or naturalized, reproducing brown trout in the upper reaches of the stream.

Hunting Creek has naturally reproducing brook trout and brown trout populations that are found upstream of Hunting Creek Lake. Down stream of the lake is a naturally reproducing brown trout population. Supplemental stocking of brook trout and rainbow trout is also done here to serve catch and return fishing in Catoctin Mountain Park and Cunningham Falls

Park. Brown trout have even been seen below Thurmont. Adults in the lower part of Hunting Creek get larger because of the larger size of the creek in that vicinity and greater diversity of forage. In heavy storm situations, sewage overflows have killed large brown trout.

Little Hunting Creek is the best wild fishery in the County. In the Manor area on the Cunningham State Park grounds, DNR stopped stocking fish in 1994. Since that time, the wild trout population increased significantly. Only catch and release fishing is allowed here. Native brook trout occur from the headwaters downstream to below Route 15. Brown trout can be found all the way to the confluence of Little Hunting Creek with Hunting Creek.

Fishing Creek is an excellent fishery for native brook trout that are found in both the right and left forks above the reservoir in the City of Frederick Municipal Forest. The right fork of Fishing Creek was stocked with adult rainbow trout in the past but stocking has been discontinued. Below Fishing Creek Reservoir, there are limited numbers of naturalized brown trout.

Tuscarora Creek has small populations of native brook trout. The Clifford Branch (Yellow Springs Road off Hamburg Road) has a native brook trout population. Trout populations are in headwater areas of the watershed, which is mostly forested. Rapid development in the lower Tuscarora watershed is likely to move upstream and may eliminate some areas of trout habitat because average impervious cover will exceed the 1 to 2 percent maximum that trout can tolerate. (See Impervious Area.)

Glade Creek lacks vegetated buffers, which makes it a warm water stream. At one time, the limestone spring at the Fountain Rock Nature Center in the Glade Creek watershed once supported a trout population but silt and drought probably contributed to loss of this population.

Fish Consumption Advisory

In June 2004, MDE issued revised fish consumption advisories for Maryland.(16) None of the advisory singled-out water bodies in the

Statewide - 2004 Advisory On Fish Consumption For Methyl-Mercury Recommended Maximum Allowable Meals Per Year				
Species	**Area**	**General Population 8oz meal**	**Women 6oz meal**	**Children 3oz. meal**
Smallmouth & Largemouth Bass	Lakes, Impoundments	48	48	24
	Rivers and Streams	no advisory	96	96
Bluegill	Lakes, Impoundments	96	96	96

Upper Monocacy River watershed but several statewide advisories affect portions of the watershed. The concern is accumulation of toxic mercury compounds in edible fish living in impoundments. The mercury compounds of concern accumulate in the bodily tissues of fish and people who eat them over time. Eventually mercury levels in a person could reach levels that would cause damage to nerves and cause other problems.

In the summary table, MDE's recommendations are listed in "meals per year". An easier way to consider the recommendation might be to think in terms of weekly menus. For example, it would be best to limit eating bluegill taken from ponds or lakes to less than two meals a week. For smallmouth and largemouth bass from ponds and lakes, the recommendation is to limit consumption to less than one meal per week for adults and less than one meal per month for children. (Children are more susceptible to effects of mercury toxicity than adults.)

Biological Monitoring In Streams

Unimpaired natural streams may support a great diversity of species like bacteria, algae, invertebrates like crayfish and insects to fish, birds, reptiles and mammals. All these groups of organisms have been extensively assessed relative to water quality and habitat quality. One group, benthic invertebrates, was found to serve as a good indicator of stream condition including water quality and habitat quality.

<u>Why Benthos Is Important</u>

Benthic invertebrates are sometimes called "stream bugs" though that name overly simplifies the diverse membership of this group. 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. Benthic macro-invertebrates are an important component of a stream's ecosystem.

The food web in streams relies significantly on benthic organisms. Benthos is 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 provides 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.

Assessment of benthic organisms is a valuable tool for stream evaluation. This group of species has been extensively used in water quality assessment, in evaluating biological conditions of streams and in gauging influences on streams by surrounding lands. These organisms 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.

<u>Assessment Of Local Streams</u>

During the 1990s, the Maryland Biological Stream Survey (MBSS) developed a standardized procedure for assessing benthic populations and communities. Their assessments are translated into an index that is intended to communicate overall in-stream conditions relative to comparable streams. Beginning in 1994, MBSS has been assessing stream conditions using this method. Conditions that underlie MBSS indices are complex and apply primarily to a local stream segment. Typically, a stream segment ranks as a mix of good, fair, poor and/or very poor for the three indices. There is a tendency for good/fair conditions to be associated with watersheds with the least disturbance (natural vegetation, forest) and for poor/very poor conditions to be associated with greater disturbance (impervious area, agriculture, construction sites).

The MBSS sampled stream conditions in the Upper Monocacy River watershed several times between 1996 and 2003. MBSS findings relating to fish are summarized on Map 12 Trout Populations and MBSS Fish Index. For additional details see the Appendix D – Maryland Biological Stream Survey.

MBSS findings based on assessment of benthic macroinvertebrates (benthos or stream bugs) are shown on Map 13 Benthos - MBSS Index. Though the map shows that good or poor ratings were reported throughout the watershed, some tendencies are visible. Ratings of good tend to be associated with the relatively undisturbed forests on the west side of the watershed. Poor and very poor ratings are most commonly found in streams that drain areas that are dominated by agriculture or development. Exceptions to these tendencies demonstrate that local streams conditions can be more important than general conditions in the surrounding area.

Sensitive Species

Sensitive species are generally recognized as being the plants or animals that are most at risk in regards to their ability to maintain healthy population levels. The most widely known are perhaps the State and Federally-listed Endangered or Threatened animals such as the bald eagle and Delmarva fox squirrel. In addition to charismatic animals such as these however, both the United States Fish and Wildlife Service and the Maryland DNR work through their respective Federal and State programs to protect a wide variety of declining non-game animals, rare plants, and the unique natural communities that support them.

For the purposes of watershed restoration, it is valuable to account for the known locations and areas of potential habitat for sensitive species in a given area. They are often indicators, and sometimes, important constituents, of the network of natural areas which form the foundation for many essential natural watershed processes. In fact, in addition to conserving biodiversity in general, protecting these species and/or promoting expansion of their habitats can be an effective component for a watershed restoration program.

DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation in different ways. Several sensitive species overlays are used by the State of Maryland to delineate habitat associated with these species. The purpose of utilizing these delineations is to help protect sensitive species by identifying the areas in which they are known to occur. Doing so allows DNR to work toward the conservation of these sensitive resources by evaluating potential impacts of proposed actions that may affect them. Specifically, working within an established procedural framework, the Wildlife and Heritage Service reviews projects and provides recommendations for activities falling within these overlays.

Map 14 Sensitive Species shows the general locations of sensitive species conservation areas in Frederick County's portion of the Upper Monocacy River watershed. A complete list of rare species tracked by Maryland in the Upper Monocacy River watershed is in the Appendix D - Sensitive Species. (17)

The geographic areas covered by these overlays are course filters. To allow for uncertainty pertaining to interpretation discrepancies, the polygons used on the map to depict these locations have been buffered. Accurate on the ground information regarding species locations and habitat delineations for a specific area can be obtained from DNR's Natural Heritage Program.

It is also important to note that outside of the Chesapeake Bay Critical Area, DNR generally only places requirements on projects requiring a permit/approval or those that are utilizing State funds. However, there are more broadly applied State and Federal laws and regulations that address "takings" of listed species.

In addition, many counties have incorporated safeguards for areas associated with sensitive species into their project and permit review processes as well as adopting specific ordinances in some cases to protect them. In all instances, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership.

Ecologically Sensitive Area (ESA)

At least 26 ESAs are identified in the Upper Monocacy River Watershed in Frederick County, as Map 14 Sensitive Species shows.

Each ESA contains one or more sensitive species habitats. However, the entire ESA is not considered sensitive habitat. The ESA 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.

Wetlands of Special State Concern (WSSC)

At least 20 WSSCs are designated in the Upper Monocacy River Watershed. These selected wetlands, which generally represent the best examples of Maryland's nontidal wetland habitats, are afforded additional protection in State law beyond the permitting requirements that apply to wetlands generally. The Maryland Department of the Environment may be contacted for more information regarding these regulations. To help ensure that proposed projects that may affect a WSSC are adequately reviewed, an ESA 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

Natural Heritage Area (NHA)

No NHAs are located in the Upper Monocacy River Watershed. In general, NHAs are designated because they represent rare ecological communities. They are areas that provide important sensitive species habitat. They are designated in State regulation (COMAR 08.03.08.10) and are afforded specific protections in the Critical Area Law criteria. For proposed projects that could potential affect a particular NHA, recommendations and/or requirements may be put in place during the permit or approval process. These would be specifically aimed at protecting the ecological integrity of the NHA itself. To help ensure that proposed projects that may affect a given NHA are adequately reviewed, an ESA is always designated to encompass each NHA and the area surrounding it.

Land Use And Land Cover

Water quality and habitat is greatly influenced by the way that land is used and managed. In a stream's watershed, changes in land use frequently increases or decreases water temperature, erosion and sediment movement, and the amount nutrients that enter the waterway. Land use change greatly affects the quality of in-stream habitat.

Maryland's Designated Growth Areas

In 1997, Maryland passed the Smart Growth Areas Act, targeting State infrastructure dollars to growth areas, referred to as Priority Funding Areas (PFAs). The Act is found in the Section 5-7B of the Finance and Procurement Article of the Annotated Code. These areas include existing municipalities, areas inside the Washington and Baltimore beltways, heritage areas, enterprise zones, and neighborhood revitalization areas. In addition, local jurisdictions were charged with certifying additional PFAs. Maryland Department of Planning (MDP) evaluates the county certified PFAs based on three criteria:

- A permitted density of 3.5 dwelling units per acre;
- Served by or planned for water and sewer service; and
- Geographical area that is no larger than needed to accommodate 20 year growth projections.

In cases where county certifies PFAs that do not meet criteria, MDP delineates these areas as "Comment Areas". Comment Areas are not eligible to receive state funds for development related projects, unless determined to be a public health and safety issue and/or as determined through a special exemption process. Development related projects include but are not limited to transportation infrastructure, water and sewer infrastructure, school construction, and economic development assistance.

The PFA Act allows for smaller communities, typically found at crossroads, to be designated as Rural Villages if they were designated in a county comprehensive plan as such by July of 1998. Boundaries of Rural Villages must be on the periphery of existing development, and growth in these villages must be infill development and/or that which does not change its community character or growth capacity. Rural Villages are eligible to receive state funds for development related projects only if they meet Rural Village criteria.

Designated growth areas, and particularly PFAs, function as one of Maryland's most significant growth management policy mechanisms. In conjunction with protective rural and resource zoning and rural preservation outside PFAs, if used as intended, PFAs can manage and reduce sporadic and dispersed development patterns throughout Maryland. Therefore, some effective indicators for assessing development patterns include:

- The number of developed residential parcels inside and outside PFAs;

- Average lot size inside and outside PFAs;
- Permitted zoning densities on the periphery of existing communities;
- Permitted zoning densities and the degree to which this zoning protects rural and resource lands from development pressures outside of PFAs;
- Areas planned for water and sewer service (referred to as sewer service areas), and;
- Areas not planned for water and sewer service.

Priority Funding Areas in the Upper Monocacy Watershed

The Upper Monocacy watershed contains four PFAs:

- Emmitsburg, which is located in the northeastern portion of the watershed where Route 140 and Route 15 intersect;
- Thurmont, which is located in the central portion of the watershed where Route 15 intersects with both Route 77 and Route 550;
- Walkersville, which is located in the southern portion of the watershed east of the Upper Monocacy River; and
- Frederick, which located in the southern portion of the watershed just west of the Upper Monocacy River.

All PFAs with the exception of the Walkersville PFA contain Comment Areas because they were designated by the county but determined by MDP not to meet PFA criteria for zoning density. Approximately 8% of the watershed's residential acres are located in the Comment Areas, all of which is zoned R-1, allowing for a maximum of one dwelling unit per acre. Most of this area is planned for water and sewer in a seven to twenty year timeframe, but there are small pockets of land area within the Comment Areas that are not planned for water and sewer service. The watershed also contains several Rural Villages. See Map 15 Priority Funding Areas and Protected Lands.

Growth Trends in the Upper Monocacy Watershed

Managing growth and its development patterns has implications for natural resource lands and water quality. Sporadic and dispersed development patterns result in consumption of natural resource land (forest and wetlands) and can minimize the ability of the natural resource lands to act as filters to nonpoint source pollutants. Increased impervious surface is created as a result of sporadic and dispersed development patterns, increasing stormwater run-off and increasing adverse effects on water quality.

As part of an effort to manage the impact of development on the environment, Maryland's PFAs are designed to minimize destruction and fragmentation of natural resource lands by concentrating growth to designated areas. This results in more compact development, typically producing less impervious surface. As discussed previously in the Land Use Assessment Section, the benefits of reducing existing or potential impervious surfaces can be seen in reduction of ground water infiltration, soil and stream bank erosion, sedimentation, destabilization or loss of aquatic habitat, and flashy stream flows. While it can be argued that concentrated growth produces concentrated nutrient loads, it can be easier to manage those nutrients when residential development is concentrated and site design is environmentally sensitive for two reasons: (1) less natural resource land is disturbed, which can act as a filter and (2) centralized nonpoint urban stormwater run-off can be managed by centralized best management practices.

Given the intent of the PFA to direct growth to designated areas so as to minimize consumption of natural resource lands - assessing development patterns is an important land use indicator in watershed planning efforts. In the following section, the following development indicators will be assessed:

- Residential development land use percent;
- The amount of acres consumed to accommodate residential parcels inside and outside PFAs;
- The number of residential parcels improved inside and outside PFAs;
- Density of residential development inside and outside PFAs;
- Residential development patterns throughout the watershed;
- Average lot size inside and outside PFAs;
- Land use changes from 1973 to 2002 to demonstrate changes in land use over a 30 year time period.

Residential Development Patterns

As of October of 2004, residential development within the Upper Monocacy watershed comprises 6 percent of its roughly 130,000 acres. Historical and current development patterns are somewhat sporadic and dispersed as shown in Map 16 Improved Residential Parcels. (18)

Of the watershed's residentially developed acres, 54 percent are located outside PFAs, 36 percent are located inside PFAs, and, 10 percent are located in the Comment Areas. The majority of the residential development is low-density residential development as the table below summaries. (19)

Residential Density Summary - Upper Monocacy Watershed		
Density	**Dwellings Units Per Acre**	**Percent**
Low	0.2 to 2	85
Medium	2 to 8	13
High	8 or more	2
All Densities		100

Average Residential Lot Size

The average lot size of improved residential parcels inside PFAs is .39 acres; in Comment Areas it is .82 acres; and outside PFAs it is 3.02 acres. The PFA Act density criterion requires 3.5 dwelling units per acre or approximately one lot per 1/3 an acre. The average lot size inside the watershed's PFAs, .39 acres, is slightly larger than what is required in the PFA Act. While this does not appear significant, cumulative impacts suggest wasteful consumption of natural resource lands inside PFAs. The same observation holds true for the average residential lot size in Comment Areas and outside PFAs. The average residential lot size outside PFAs is more than 10 times that of what exists inside PFAs.

Land Use Changes Between 1973 and 2002

Between 1973 and 2002, land use changes within the watershed demonstrate that growth (residential, industrial, and commercial) has occurred in existing communities and after 1997, PFAs and Rural Villages. However, during this time period, consumption of land outside growth areas and PFAs has also occurred in a sporadic fashion to some extent.

Approximately 9,300 acres of agricultural and resource lands were converted to developed lands (residential, commercial and industrial) from 1973 to 2002. The table below shows the categories of residential development that were created by this land use conversion. To see land use changes and the spatial distribution of development between 1997 and 2002, see Map 17 1973 Land Use, and Map 18 2002 Land Use. In the maps, the appearance of increased forest cover in 2002 compared to 1973 is associated with improvements in satellite imagery technology and not necessarily associated with changes on the ground. (20)

Residential Development Land Use Changes 1973 To 2002			
Category	**1973**	**2002**	**Acres % Increase**
Low Density	3,110	7,265	57
Medium Density	149	2,635	97
High Density	33	88	63

Residential Growth Projections

MDP's growth projections indicate that an additional 7,100 residential parcels will be improved in the Upper Monocacy River watershed between 2002 and 2025. Of these newly improved residential parcels, 62 percent will be developed inside PFAs, 2 percent will be developed in Comment Areas, and 36 percent will be developed outside PFAs.

New residential parcels will predominantly occur inside PFAs but land consumption will predominantly occur outside PFAs. The average residential lot size outside PFAs is 23 times greater than it is inside PFAs. Based on current zoning densities, the watershed's PFAs are able to accommodate more than twice the amount of improved residential parcels that is projected to occur between 2002 and 2025.

Average Residential Lot Size (Acres)		
Inside PFA	**Outside PFA**	**Comment Area**
0.4	3.02	0.82

Sewer Service

Availability of public sewer service affects both the way that land is used and the water quality in streams in the surrounding watershed. These affects are discussed independently below and projected expansion of these service areas follows at the end.

Development Patterns And Land Consumption Implications

Water and sewer service has implications for managing growth and minimizing development's impact on natural resource lands. Water and sewer infrastructure can act as a catalyst for growth, meaning that wherever additional water and sewer service capacity exists, growth will occur. Therefore, if water and sewer service is provided in a leapfrog fashion, development will occur in a leapfrog fashion. Leapfrog development patterns implies wasteful consumption and fragmentation of natural resource lands. This can minimize efforts to manage growth and increase development's impacts on natural resource lands and water quality.

If permitted zoning densities do not promote sprawl development patterns and the provisions of water and sewer service are expanded to accommodate growth as it occurs, the disturbance to natural resource lands and water quality can be minimized. Utilization of existing infrastructure can also be maximized.

To encourage orderly expansion of water and sewer service and minimize leapfrog development patterns, Maryland's PFA Act requires development inside PFAs to be served by or planned for adequate water and sewer service.

Development that is not served by water and sewer is served by individual septic systems. Individual septic systems generally require larger lot sizes compared to PFA Act criteria of approximately one lot per 1/3 an acre. Therefore, conceptually, development served by individual septic systems typically consumes more land than what is needed to accommodate development served by water and sewer service inside PFAs. This suggests wasteful consumption of land inside PFAs. Furthermore, many times Comment Areas are designated by the State because local jurisdictions designate growth areas that are not entirely planned for water and sewer service. This suggests wasteful consumption of land in Comment Areas.

Water Quality Implications

It is estimated that individual septic systems, on average, contribute nine pounds of nitrogen/person/household/year to the septic system drainage field. From the drainage field, it is estimated that 4.5 pounds of nitrogen/person/household/year enters the water system. Comparatively, wastewater treatment plants (WWTPs) upgraded with Biological Nutrient Removal (BNR) technologies are estimated to contribute two pounds of nitrogen/person/household/ year. Many of Maryland's major WWTPs are upgraded with BNR technologies. (21)

In 2003, the State of Maryland committed to implement the Enhanced Nutrient Removal Strategy (ENR), which will upgrade Maryland's major WWTPs to reduce nutrient loads to an estimated one-pound per person/household/year. The ENR Strategy also calls for an annual average of minor WWTPs to be based upon discharge flows at design capacity or projected 2020 flow (based on MDP growth projections). (22)

Current Sewer Service Areas

The Upper Monocacy watershed contains existing, planned, and no planned sewer service areas. The existing and planned sewer service areas are tightly drawn around existing municipalities and other areas inside PFAs of Emmitsburg, Thurmont, Walkersville, and Frederick. For a more detail on various sewer service area planning time lines and definitions, see Appendix F - Generalized Zoning Category Breakdown. (23)

There are several small sewer service areas outside of the watershed's PFAs. These sewer service areas generally correspond with the watershed's Rural Villages and are comprised of different land uses ranging from older subdivisions (prior to the 1997 PFA Act) to institutional uses and commercial uses. To see water and sewer service areas, existing and planned, see Map 19 Sewer Service Areas. In the map, the symbol west of the Route 15, indicates additional water and sewer service capacity. However, this package plant that serves the older subdivision of White Rock does not have additional capacity. (24)

There are currently 4,100 residential parcels served by individual septic systems, representing 38% of all improved residential parcels within the watershed. The majority, or nearly 3,500 of the residential parcels served by individual septic systems are located outside PFAs. This generally conforms to Maryland planning policies in that most of the improved parcels located inside PFAs are served by water and sewer service, while the majority of improved parcels located outside PFAs are served by individual septic systems.

Sewer Service Area Projections

Approximately 7,100 additional residential parcels will be improved between 2002 and 2025. Of those residential parcels, approximately 620 parcels will be served by water and sewer service inside PFAs. An additional 3,700 improved residential parcels inside PFAs will be planned for water and sewer service. This indicates that water and sewer service will not expand to accommodate growth as it occurs, and will have negative effects on water quality.

Protective Zoning Outside Priority Funding Areas

Mentioned throughout this land use assessment section of the Upper Monocacy watershed, wasteful consumption of resource lands and sporadic residential development patterns has negative implications on water quality. The weaker or less restrictive (a.k.a. less protective) the zoning requirements outside PFAs, the more intense is the destruction or "interruption" of the land's natural hydrology, habitat and natural resources. MDP assesses rural and resource zoning to measure its ability to protect lands from subdivision and fragmentation through its three "Generalized Zoning" categories. These categories are based on typical lot yields:

- Most Protective Zoning, yielding one residential lot or fewer per 20 acres of land;
- Moderately Protective Zoning, yielding one lot per 10-20 acres; and
- Least Protective Zoning, yielding one lot per 1-10 acres.

Of the nearly 120,000 acres outside PFAs and Comment Areas, restrictive zoning protects nearly 112,000 acres. Most Protective Zoning constitutes 60 percent of the watershed. Forty percent is Least Protective Zoning, but the majority of the Least Protective Zoning is actually Federal and State protected lands of the Catoctin Mountains and Catoctin Mountains Park. To see Generalized Zoning throughout the watershed, see Map 20 Generalized Zoning. For a detailed explanation of MDP's Generalized Zoning Categories, see Appendix F - Generalized Zoning Category Breakdown

Impervious Area

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.

Map 21 Impervious Surface reflects data developed by the University of Maryland's Regional Earth Sciences Application Center (RESAC) based on interpretation of 1999-2000 land cover. The map shows that the rural character in the northern area of the Upper Monocacy River watershed contributes to very low average imperviousness between 1 and 2 percent for those subwatersheds.

Two relatively suburbanized subwatersheds at the southern, downstream end of the WRAS area have a significantly higher average imperviousness. The Glade Creek subwatershed that encompasses portions of the Walkersville area has an average imperviousness of nearly 2.4 percent.

For the Tuscarora Creek subwatershed that includes some of the northern suburbs around the City of Frederick, the average imperviousness is nearly 3.3 percent. In this subwatershed, the impervious areas tend to be concentrated in downstream areas closest to the City of Frederick. However, upstream areas in the subwatershed are characterized by steep forestland that has little or no human-made impervious areas. This distribution of imperviousness in the Tuscarora Creek subwatershed, along with local stream buffer and water temperature conditions, helps to demonstrate the connection between the distribution of trout populations/habitat and land use management. Trout are almost always found in subwatersheds that have an average imperviousness less than one percent based on findings by the Maryland Biological Stream Survey in the year 2000.

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Appendix A - Glossary	
303(d)	A section of the federal Clean Water Act requiring the states to report waters 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.
305(b)	A section of the federal Clean Water Act that requires periodic assessment of the status of waters in a State or similar jurisdiction.
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.
Benthos	Organism that live on the bottom of a body of water.
BMP	Best Management Practice. As used here refers to on-the-ground approaches to control erosion, sedimentation, or stormwater movement.
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.
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.

Appendix A - Glossary	
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)
ESA	Ecologically Significant 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.
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 program 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.

Appendix A - Glossary	
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
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 DNR Watershed Services 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.
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 macroinvertebrate 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.

Appendix A - Glossary	
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, in 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.
WWTP	Wastewater Treatment Plant. Usually refers to sewage treatment facility.

Appendix B – Water Quality Monitoring 2002 Summary
Upper Monocacy River Watershed Characterization
MDE Data Summarized By DNR Watershed Services

Fishing Creek FIS0004									
SAMPLING DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/5/2002	12	261	0.1	7.7	1.3	1.4277	0.0681	2.5	4.76
4/2/2002	10.5	145	0	7.4	1.3	0.8808	0.0824	3.4	2.94
4/30/2002	9.8	114	0	7.3	1.1	0.7827	0.0739	7.6	4.2
7/9/2002	5.5	112	0	7.2	0.6	1.13	0.15	16.6	3.08
8/6/2002	6.1	130	0.1	7.3	0.7	0.905	0.1451	11.8	2.8
9/10/2002	6.6	180	0.1	7.4	1.2	0.8985	0.1327	5.7	0.98
AVERAGE	8.4	157	0.05	7.4	1	1.0	0.11	7.9	3.1

Tributary Station #2 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

Hunting Creek HUN0009									
SAMPLING DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/5/2002	12.9	367	0.2	7.8	1	1.9368	0.0367	2.4	2.52
4/2/2002	13.8	227	0	8.3	1.4	1.1745	0.0289	2.4	3.64
4/30/2002	10.7	197	0	7.7	0.6	0.9709	0.0427	4.6	3.78
7/9/2002	7.5	384	0.2	7.9	0.1	1.0762	0.1106	5.8	1.82
8/6/2002	6.9	417	0.2	7.6	1	1.1064	0.1852	8	3.64
9/10/2002	8.2	471	0.2	7.9	1.1	1.1094	0.1353	4.6	1.56
AVERAGE	10	344	0.13	7.9	0.9	1.2	0.09	4.6	2.8

Tributary Station #3 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

Middle Creek MTM0011									
SAMPLING DATE	DO MG /L	CONDUCTIVITY µOMHOS /CM	SALINITY PPT	pH	BOD MG /L	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
4/25/2002	9.2	255	0.1	8	1.4	0.4954	0.0395	2.4	5.88
5/2/2002	9.9	224	0.1	8.2	1.7	0.701	0.0569	6	6.44
5/9/2002	7.9	222	0.1	7.8	1.6	0.506	0.0533	6.4	
8/21/2002									
8/27/2002	7.1	327	0	7.9	1.3	0.755	0.1398	8	14.64
9/11/2002	7.1	350	0	7.8	1.3	0.6147	0.0913	3.5	2.8
AVERAGE	8.2	276	0.06	7.9	1.5	0.6	0.08	5.3	7

Tributary Station #12 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

Owens Creek OWN0007									
SAMPLING DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/4/2002	11.9	259	0.1	7.9		3.015	0.0502	2.7	3.5
4/1/2002	11.1	210	0.1	7.4		2.1305	0.0365	3.5	1.54
4/29/2002	10	199	0.1	7.6		2.104	0.0464	5.4	4.48
7/8/2002	8.2	270	0.1	7.8		0.5987	0.0745	3.4	1.4
8/5/2002	4.7	286	0.1	7.3		0.7437	0.1027	3.8	2.8
9/9/2002	6.1	312	0	7.8		0.5567	0.0656	10	2.8
AVERAGE	8.7	256	0.08	7.6		1.5	0.06	4.8	2.8

Tributary Station #5 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

St. Mary Run SMU0001									
SAMPLING DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
4/25/2002	9.4	594	0.3	7.7	1.3	3.78	1.2669	35.2	4.48
5/2/2002	9	483	0.2	7.7	1.2	2.696	0.915	21	7.56
5/9/2002	8.2	536	0.3	7.7	1.3	3.0826	1.0488	2.7	
8/21/2002									
8/27/2002	6.4	629	0	7.6	0.9	6.3922	0.9019	2.5	1.8
9/11/2002	7.7	750	0	7.8	0.9	3.2215	1.1164	5.2	2.1
AVERAGE	8.14	598.4	0.16	7.7	1.12	3.83446	1.0498	13.32	3.985

Tributary Station #9 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

St. Mary Run 0012									
SAMPLING DATE	DO MG /L	CONDUCTIVITY µOMHOS /CM	SALINITY PPT	pH	BOD MG /L	TN MG /L	TP MG /L	TSS MG /L	CHLOROPHYLL µG /L
4/25/2002	9.7	244	0.1	7.4	1.3	0.9105	0.0417	3.6	3.92
5/2/2002	9.5	166	0.1	7.3	1.9	1.274	0.0835	13.2	5.74
5/9/2002	8.4	177	0.1	7	2.4	1.0607	0.0532	4.8	
8/27/2002	4.9	383	0	7.2	0.8	0.4901	0.1537	5.6	2.04
9/11/2002	4.3	334	0.1	7	2.1	0.495	0.1368	11.2	19.6
AVERAGE	7.4	261	0.08	7.2	1.7	0.8	0.09	7.7	7.8

Tributary Station #10 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

Toms Creek TOM0062									
SAMPLING DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
4/25/2002	9.1	203	0.1	7.6	1.4	0.5384	0.0353	2.4	3.64
5/2/2002	9.1	191	0.1	7.6	0.8	0.6614	0.0362	5	5.04
5/9/2002	7.8	188	0.1	7.6	1.7	0.6687	0.0441	4.8	
8/21/2002	4.7	241	0	7.3	2.5	1.0203	0.1252	7.7	2.4
8/27/2002	6.5	208	0	7.4	1.5	0.7675	0.0771	4.8	5.88
9/11/2002	7	252	0	7.5	1.5	0.6264	0.0557	4	4.06
AVERAGE	7.4	214	0.05	7.5	1.6	0.7	0.06	4.8	4.2

Tributary Station #9 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

Tuscarora Creek TUS0018									
SAMPLING DATE	**DO MG /L**	**CONDUCTIVITY µOMHOS /CM**	**SALINITY PPT**	**pH**	**BOD MG /L**	**TN MG /L**	**TP MG /L**	**TSS MG /L**	**CHLOROPHYLL µG /L**
3/5/2002	13.4	335	0.2	8.1	0.9	2.578	0.0471	2.4	3.36
4/2/2002	11.4	283	0	7.6	1.4	1.8911	0.0598	3	2.52
4/30/2002	10.6	202	0	7.7	1.2	1.4357	0.0638	7.1	2.66
7/9/2002	9.1	452	0.2	8	0.4	2.7249	0.0456	3.1	2.52
8/6/2002	6.5	349	0.2	7.4	2.4	2.405	0.1209	13.6	11.9
9/10/2002	8.5	554	0.3	7.4	1.3	3.0388	0.0424	2.5	1.26
AVERAGE	9.9	363	0.15	7.7	1.3	2.3	0.06	5.3	4

Tributary Station #1 on Map 4 Water Quality Monitoring, Upper Monocacy River Watershed Characterization

Appendix C
MDE Permits, June 2004
3 Pages

MDE Permits - Upper Monocacy Watershed In Frederick County

FACILITY TYPE	NAME	MD PERMIT	NPDES	CITY
MAJOR SURFACE MUNICIPAL DISCHARGE (over 1 MGD capacity)	THURMONT WWTP	99DP0639	MD0021121	THURMONT
SURFACE MUNICIPAL DISCHARGE	EMMITSBURG WTP	99DP2364	MD0062391	EMMITSBURG
	EMMITSBURG WWTP	97DP0113	MD0020257	EMMITSBURG
	FOXVILLE GARDEN WWTP	99DP2535	MD0025119	SABILLASVILLE
	LEWISTOWN MILLS WWTP	02DP3108	MD0067237	LEWISTOWN
	LEWISTOWN MILLS WWTP NO.2	98DP3255	MD0067989	LEWISTOWN
	LEWISTOWN SCHOOL WWTP	03DP0730	MD0022900	LEWISTOWN
	MOUNT ST. MARY'S COLLEGE	99DP0690	MD0023230	EMMITSBURG
	SHAMROCK RESTAURANT	99DP1780	MD0058050	THURMONT
	VICTOR CULLEN CENTER WWTP	00DP0752	MD0023922	SABILLASVILLE
SURFACE INDUSTRIAL DISCHARGE	HUNTING CREEK FISHERIES	00DP2637		THURMONT
	REDLAND BRICK, INC. - ROCKY RIDGE	00DP1112	MD0052345	ROCKY RIDGE
	SHUFF'S MEAT MARKET	00DP0680	MD0050245	THURMONT
GW INDUSTRIAL DISCHARGE	P & M MEATS, INC.	04DP3478		KEYMAR
	ROCKO MEATS	01DP3126		FREDERICK
GW MUNICIPAL DISCHARGE	B. J. DUNN & CAROLYN ALEXANDER RESIDENCE	03DP3427		MYERSVILLE
	THORPEWOOD FOUNDATION	03DP3238		THURMONT
GENERAL OIL CONTAMINATION GROUNDWATER REMEDIATION	EXXON SERVICE STATION #2-5553	2003-OGR-4334	MDG914334	THURMONT

MDE Permits - Upper Monocacy Watershed In Frederick County				
FACILITY TYPE	**NAME**	**MD PERMIT**	**NPDES**	**CITY**
GENERAL TERMINAL DISCHARGE	MASON DIXON OIL COMPANY	2003-OGT-2403	MDG342403	EMMITSBURG
GENERAL PERMITS	CAMP AIRY	01SI6221	MDG766221	THURMONT
	CROW'S NEST CAMPGROUND	01SI6668	MDG766668	THURMONT
	LAUREL SAND & GRAVEL, INC.- LEGORE QUARRY	00MM0994	MDG490994	KEYMAR
	LEHIGH CEMENT COMPANY - WOODSBORO	00MM0457	MDG490457	WOODSBORO
	MASON DIXON FARMS, INC.	96AF9907		EMMITSBURG
	MOUNT ST. MARY'S COLLEGE	01SI6135	MDG766135	EMMITSBURG
	OAK BLUFF DAIRY FARM	96AF9904		WOODSBORO
	OLE MINK FARM RECREATION RESORT	01SI6215	MDG766215	THURMONT
	S.W. BARRICK & SONS, INC. - BARRICK QUARRY	00MM1429	MDG491429	WOODSBORO
	SUMMIT LAKE CAMP	01SI6314	MDG766314	EMMITSBURG
	TOWN OF EMMITSBURG POOL	01SI6465	MDG766465	EMMITSBURG
	TOWN OF EMMITSBURG WATER SUPPLY SYSTEM	00HT9466		EMMITSBURG
GENERAL INDUSTRIAL STORMWATER	FEDERAL STONE INDUSTRIES, INC.	02SW1188		THURMONT
	HOME RUN, INC.	02SW0991		THURMONT
	MOORE BUSINESS COMMUNICATION SERVICES	02SW0443		THURMONT
	ROCKVILLE FUEL & FEED CO. - MONTGOMERY VAULT	02SW1229		WOODSBORO
	SHA - THURMONT SHOP	02SW1344		THURMONT
MS4 GENERAL DISCHARGE	TOWN OF EMMITSBURG MS4	03-IM-5500-020		EMMITSBURG
	TOWN OF THURMONT MS4	03-IM-5500-003		THURMONT

MDE Permits - Upper Monocacy Watershed In Carroll County				
FACILITY TYPE	**NAME**	**MD PERMIT**	**NPDES**	**CITY**
MAJOR SURFACE MUNICIPAL DISCHARGE	TANEYTOWN WWTP	00DP0687	MD0020672	TANEYTOWN
GROUNDWATER INDUSTRIAL DISCHARGE	ESAB WELDING & CUTTING PRODUCTS	04DP3492		TANEYTOWN
GENERAL INDUSTRIAL STORMWATER	CHAZ'S USED AUTO PARTS & TOWING, INC.	02SW1812		TANEYTOWN
	EVAPCO, INC.	02SW0458		TANEYTOWN
	FLOWSERVE CORPORATION	02SW0062		TANEYTOWN
	TANEYTOWN WWTP	02SW1743		TANEYTOWN
	THE TANEY CORPORATION	02SW3012		TANEYTOWN

Appendix D - Maryland Biological Stream Survey

Data for the Upper Monocacy River Watershed

Excerpts from

Maryland Biological Stream Survey 2000-2004, Volume I: Ecological Assessment of Watersheds Sampled in 2000

7 Pages Total

MARYLAND BIOLOGICAL

STREAM SURVEY 2000-2004

Volume I: Ecological Assessment of Watersheds Sampled in 2000

Prepared for

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August 2001

Upper Monocacy River

Site Information

Site	Stream Name	12-digit Subwatershed Code	8-digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
UMON-101-R-2000	LITTLE HUNTING CR UT1 UT1	021403030244	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/20/00	07/06/00	1	420
UMON-103-R-2000	MONOCACY R UT1	021403030247	Upper Monocacy River	MIDDLE POTOMAC RIVER	Carroll	03/28/00	06/27/00	1	212
UMON-106-R-2000	GLADE CR	021403030242	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/20/00	07/06/00	1	1287
UMON-115-R-2000	SANDY RUN	021403030244	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/20/00	06/26/00	1	117
UMON-117-R-2000	GRACEHAM RUN	021403030251	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/27/00	06/28/00	1	425
UMON-119-R-2000	BUZZARD BR	021403030244	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/20/00	07/05/00	1	1078
UMON-128-R-2000	HIGH RUN	021403030251	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/27/00	06/28/00	1	107
UMON-131-R-2000	CREAGERS BR	021403030245	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/28/00	06/28/00	1	342
UMON-132-R-2000	STEEP CR UT1	021403030243	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/28/00	07/06/00	1	241
UMON-134-R-2000	TURKEY CR	021403030259	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/28/00	06/26/00	1	1069
UMON-207-R-2000	LITTLE HUNTING CR	021403030258	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/20/00	06/26/00	2	5510
UMON-221-R-2000	HUNTING CR	021403030244	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/27/00	07/05/00	2	7991
UMON-229-R-2000	MUDDY RUN	021403030251	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/27/00	07/05/00	2	1327
UMON-230-R-2000	HUNTING CR	021403030250	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/27/00	06/27/00	2	6536
UMON-304-R-2000	FRIENDS CR	021403030251	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/28/00	06/27/00	3	7185
UMON-310-R-2000	PINEY CR	021403030251	Upper Monocacy River	MIDDLE POTOMAC RIVER	Carroll	03/28/00	09/07/00	3	11531
UMON-322-R-2000	HUNTING CR	021403030258	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/28/00	09/07/00	3	10746
UMON-413-R-2000	TOMS CR	021403030257	Upper Monocacy River	MIDDLE POTOMAC RIVER	Frederick	03/28/00	09/19/00	4	27658

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Black Water Stream
UMON-101-R-2000	1.00	3.44	20.47	0	0
UMON-103-R-2000	NR	2.78	35.91	0	0
UMON-106-R-2000	1.00	2.11	10.01	0	0
UMON-115-R-2000	NR	3.44	19.17	0	0
UMON-117-R-2000	1.86	3.22	19.17	0	0
UMON-119-R-2000	NR	3.67	91.43	1	0
UMON-128-R-2000	NS	1.44	NS	NS	NS
UMON-131-R-2000	1.57	2.56	4.24	0	0
UMON-132-R-2000	NR	1.67	12.01	0	0
UMON-134-R-2000	1.57	2.78	40.74	0	0
UMON-207-R-2000	3.86	3.00	NS	0	0
UMON-221-R-2000	3.86	4.33	80.31	0	0
UMON-229-R-2000	3.86	3.00	68.38	0	0
UMON-230-R-2000	3.57	4.33	90.24	0	0
UMON-304-R-2000	4.43	4.11	89.50	0	0
UMON-310-R-2000	3.86	2.56	31.34	0	0
UMON-322-R-2000	4.14	4.11	97.77	0	0
UMON-413-R-2000	3.57	3.22	94.03	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other
UMON-101-R-2000	0.0	16.2	83.7	0.1
UMON-103-R-2000	0.0	86.7	13.3	0.3
UMON-106-R-2000	1.0	93.4	5.6	0.0
UMON-115-R-2000	0.0	0.0	100.0	0.0
UMON-117-R-2000	0.2	83.7	16.2	0.2
UMON-119-R-2000	0.0	0.5	99.3	0.2
UMON-128-R-2000	0.0	0.0	100.0	0.0
UMON-131-R-2000	2.7	90.4	6.6	0.8
UMON-132-R-2000	0.0	0.7	99.4	0.0
UMON-134-R-2000	0.0	0.3	99.6	1.6
UMON-207-R-2000	0.3	4.8	94.6	0.3
UMON-221-R-2000	5.8	13.5	80.5	0.9
UMON-229-R-2000	2.8	3.1	94.1	0.3
UMON-230-R-2000	0.3	9.9	89.7	1.0
UMON-304-R-2000	0.4	29.5	69.9	0.4

UMON-310-R-2000	2.0	81.3	15.8	1.3
UMON-322-R-2000	4.9	12.3	82.7	0.8
UMON-413-R-2000	1.6	20.8	77.2	0.9

Upper Monocacy River

Interpretation of Watershed Condition

- Watershed is very different in character on west side of Rt. 15 than on east side. Mountainous, mostly forested streams on west with higher gradient. Low gradient, farmland streams, more impacted on east side.
- Several sites in pastures where the cows have access - no riparian buffers (Sites 106, 310)
- Other problems included siltation, a few sites with high nitrate-nitrogen, historic channelization
- Several sites small, dry or with very little flow in summer (Sites 128, 131, 132)
- At site 134, all fish captured were small young-of-year; mostly shallow in pool/glide areas, nice riffles, crystal clear water
- Several sites in very good condition; Site 304 supports stocked trout

Upper Monocacy River

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (ueq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	P-P (mg/L)	TD-P (mg/L)	Ortho-P (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	TD-N (mg/L)	P-N (mg/L)	P-C (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs)
UMON-101-R-2000	7.18	143.0	676.9	21.506	0.486	5.949	0.011	0.079	0.064	0.003	0.283	0.907	0.118	1.245	1.701	6.8	0.5
UMON-103-R-2000	7.14	144.2	529.1	6.618	1.775	22.128	0.002	0.013	0.005	0.004	0.022	2.203	0.047	0.404	4.533	6.0	3.5
UMON-106-R-2000	8.16	537.0	4381.9	13.934	8.902	17.957	0.003	0.009	0.003	0.000	0.000	9.117	0.062	0.486	1.077	7.2	1
UMON-115-R-2000	5.60	31.9	9.1	1.231	0.283	7.240	0.000	0.005	0.000	0.000	0.000	0.365	0.036	0.267	1.772	9.6	1.6
UMON-117-R-2000	7.19	131.8	495.3	10.700	2.920	7.946	0.003	0.029	0.016	0.000	0.022	3.329	0.058	0.580	7.075	6.3	7.2
UMON-119-R-2000	7.05	55.3	256.3	3.555	0.139	5.757	0.000	0.006	0.000	0.000	0.000	0.214	0.026	0.180	1.841	7.3	3.1
UMON-128-R-2000	5.23	21.5	11.1	1.068	0.402	2.769	0.000	0.004	0.000	0.000	0.009	0.482	0.016	0.038	0.827	NS	NS
UMON-131-R-2000	7.45	299.4	1217.9	34.501	2.089	22.560	0.027	0.047	0.025	0.057	0.138	2.677	0.113	0.801	8.278	6.9	9.9
UMON-132-R-2000	4.92	49.5	-9.9	8.915	0.000	5.843	0.000	0.003	0.000	0.000	0.000	0.038	0.003	0.054	1.456	5.7	0.3
UMON-134-R-2000	7.30	83.0	319.5	5.790	0.369	10.540	0.001	0.006	0.003	0.000	0.014	0.440	0.027	0.238	2.369	9.2	1
UMON-207-R-2000	6.98	80.6	339.9	8.523	0.225	6.246	0.002	0.008	0.003	0.000	0.000	0.303	0.039	0.388	1.220	8.6	6.6
UMON-221-R-2000	7.42	117.6	395.3	16.555	0.462	7.761	0.001	0.005	0.001	0.001	0.018	0.693	0.044	0.469	5.658	8.0	1.5
UMON-229-R-2000	7.23	76.7	274.4	10.238	0.309	4.553	0.003	0.005	0.001	0.000	0.024	0.491	0.025	0.356	1.715	7.7	2.2
UMON-230-R-2000	7.23	105.3	329.2	15.080	0.411	7.500	0.001	0.003	0.000	0.000	0.010	0.533	0.030	0.244	2.170	7.5	1.6
UMON-304-R-2000	7.75	143.2	574.4	16.539	0.701	13.875	0.001	0.010	0.008	0.000	0.013	0.884	0.019	0.264	2.199	7.3	5.1
UMON-310-R-2000	7.63	179.7	812.8	15.365	2.085	14.685	0.008	0.075	0.060	0.012	0.164	2.856	0.171	1.263	6.459	9.2	7.1
UMON-322-R-2000	7.61	138.7	483.3	21.025	0.455	7.555	0.004	0.010	0.008	0.000	0.017	0.600	0.073	0.773	2.484	8.6	3.3
UMON-413-R-2000	7.74	133.4	773.4	11.673	0.657	12.358	0.002	0.011	0.008	0.001	0.019	0.776	0.039	0.264	2.547	8.2	5

Physical Habitat Condition

Site	Riparian Buffer Width Left	Riparian Buffer Width Right	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/Glide/ Eddy Quality	Extent of Pools (m)	Riffle Run Quality	Extent of Riffles (m)	Embedded-ness	Shading	Trash Rating	Maximum Depth (cm)
UMON-101-R-2000	50	50	FR	FR	10	12	8	4	25	7	50	35	98	16	14
UMON-103-R-2000	14	22	CP	CP	11	11	6	10	65	8	15	35	95	17	24
UMON-106-R-2000	0	0	PA	PA	12	7	10	10	73	7	2	90	35	9	38
UMON-115-R-2000	50	50	FR	FR	12	17	7	5	60	6	20	25	98	20	15
UMON-117-R-2000	2	50	CP	LN	11	11	8	9	65	8	10	65	95	8	32
UMON-119-R-2000	50	50	SL	SL	17	18	15	16	35	15	45	25	90	20	73
UMON-128-R-2000	50	50	FR	FR	NS	NS	NS	NS	NS	NS	NS	NS	NS	20	NS
UMON-131-R-2000	0	0	PA	PA	9	10	5	10	75	4	5	45	75	6	42
UMON-132-R-2000	50	50	FR	FR	8	9	6	8	15	0	0	20	97	20	50
UMON-134-R-2000	3	50	PV	FR	13	18	8	7	35	14	40	35	90	19	32
UMON-207-R-2000	50	50	CP	OF	18	16	15	14	30	17	45		70	17	52
UMON-221-R-2000	18	5	PA	PV	17	16	12	10	35	18	50	30	75	16	42
UMON-229-R-2000	50	50	FR	FR	12	11	8	8	35	13	45	45	80	20	35
UMON-230-R-2000	50	24	FR	PA	18	20	16	15	20	19	70	20	55	15	54
UMON-304-R-2000	12	21	PV	PV	19	16	17	18	30	19	50	30	60	19	104
UMON-310-R-2000	0	0	PA	PA	12	8	12	12	70	7	7	45	20	15	55
UMON-322-R-2000	4	50	PA	FR	19	18	15	17	35	18	55	10	80	17	102
UMON-413-R-2000	50	23	FR	PV	17	17	14	13	30	16	55	20	45	19	54

Upper Monocacy River

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
UMON-101-R-2000	N	N	N	N	Mild	None	None
UMON-103-R-2000	N	N	N	N	None	None	Moderate
UMON-106-R-2000	Y	N	N	N	Mild	Mild	None
UMON-115-R-2000	N	N	N	N	None	None	None
UMON-117-R-2000	N	N	N	N	None	Mild	Minor
UMON-119-R-2000	Y	N	N	Y	None	Mild	Minor
UMON-128-R-2000	N	N	N	N	NS	NS	NS
UMON-131-R-2000	Y	N	N	N	None	None	Minor
UMON-132-R-2000	N	N	N	N	None	None	None
UMON-134-R-2000	N	N	N	Y	Mild	None	Minor
UMON-207-R-2000	N	N	N	N	None	None	Minor
UMON-221-R-2000	N	N	N	Y	None	None	Minor
UMON-229-R-2000	N	N	N	N	Mild	Mild	Severe
UMON-230-R-2000	N	N	N	N	None	None	Minor
UMON-304-R-2000	N	N	N	N	None	None	Minor
UMON-310-R-2000	Y	N	N	N	Severe	Moderate	Moderate
UMON-322-R-2000	N	N	N	N	None	Mild	Moderate
UMON-413-R-2000	N	N	N	N	Severe	None	Minor

Upper Monocacy River

Fish Species Present

BANDED KILLIFISH
BLACKNOSE DACE
BLUEGILL
BLUNTNOSE MINNOW
BROOK TROUT
BROWN BULLHEAD
BROWN TROUT
CENTRAL STONEROLLER
COMELY SHINER
COMMON SHINER
CREEK CHUB
CREEK CHUBSUCKER
CUTLIPS MINNOW
FALLFISH
FANTAIL DARTER
FATHEAD MINNOW
GOLDEN SHINER
GOLDFISH
GREEN SUNFISH
GREENSIDE DARTER
LARGEMOUTH BASS
LONGEAR SUNFISH
LONGNOSE DACE
MARGINED MADTOM
MOSQUITOFISH
MOTTLED SCULPIN
NORTHERN HOGSUCKER
PEARL DACE
POTOMAC SCULPIN
PUMPKINSEED
REDBREAST SUNFISH
ROCK BASS
ROSYSIDE DACE
SILVERJAW MINNOW
SMALLMOUTH BASS
SPOTFIN SHINER
SPOTTAIL SHINER
SUNFISH HYBRID
TESSELLATED DARTER
WHITE SUCKER
YELLOW BULLHEAD

Exotic Plants Present

MULTIFLORA ROSE
THISTLE

Benthic Taxa Present

ACENTRELLA
ACRONEURIA
AGABUS
ALLOCAPNIA
AMELETUS
AMPHINEMURA
ANCHYTARSUS
ANTOCHA
ARGIA
BAETIDAE
BAETIS
BRILLIA
CAPNIIDAE
CERATOPOGONIDAE
CHIRONOMINI
CHLOROPERLIDAE
CRANGONYCTIDAE
CAECIDOTEA
CERATOPOGON
CHAETOCLADIUS
CHEUMATOPSYCHE
CHIMARRA
CLADOTANYTARSUS
CLINOCERA
CLIOPERLA
CNEPHIA
CONCHAPELOPIA
CORYNONEURA
CRANGONYX
CRICOTOPUS
CRICOTOPUS/ORTHOCLADIUS
CRYPTOCHIRONOMUS
CURA
DIAMESINAE
DOLICHOPODIDAE
DYTISCIDAE
DIAMESA
DICRANOTA
DIPLECTRONA
DIPLOCLADIUS
DOLOPHILODES
DRUNELLA
ENCHYTRAEIDAE
ENALLAGMA
EPEORUS
EPHEMERELLA
EUKIEFFERIELLA
EURYLOPHELLA
GOMPHIDAE
HEPTAGENIIDAE
HELENIELLA
HETEROTRISSOCLADIUS
HEXATOMA
HYDROBAENUS
HYDROPSYCHE
ISONYCHIA
ISOPERLA
ISOTOMURUS
KRENOPELOPIA
LEPTOPHLEBIIDAE
LEUCTRIDAE
LUMBRICULIDAE
LEPIDOSTOMA
LEUCTRA
LIMNOPHYES
MACRONYCHUS
MICRASEMA
MICROPSECTRA
NAIDIDAE
NEMOURIDAE
NEOPHYLAX
NIGRONIA
ORTHOCLADIINAE
OPTIOSERVUS
ORCONECTES
ORTHOCLADIINAE A
OULIMNIUS
PERLIDAE
PERLODIDAE
PYRALIDAE
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PERICOMA
PHYSELLA
POLYPEDILUM
PROSIMULIUM
PROSTOIA
PSEPHENUS
PSYCHOMYIA
PYCNOPSYCHE
RHEOCRICOTOPUS
RHEOTANYTARSUS
RHYACOPHILA
SPHAERIIDAE
SIMULIUM
STAGNICOLA
STEGOPTERNA
STEMPELLINELLA
STENACRON
STENELMIS
STENONEMA
STYGONECTES
SWELTSA
SYMPOSIOCLADIUS
SYMPOTTHASTIA
TIPULIDAE
TUBIFICIDAE
TURBELLARIA
TAENIOPTERYX
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA
TIPULA
TVETENIA
ZAVRELIMYIA

Herpetofauna Present

BULLFROG
EASTERN BOX TURTLE
EASTERN GARTER SNAKE
GREEN FROG
NORTHERN DUSKY SALAMANDER
NORTHERN SPRING SALAMANDER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG

Appendix E - Sensitive Species
Upper Monocacy River Watershed In Maryland
5 Pages

EXPLANATION OF RANK AND STATUS CODES

As of January 2003, the global and state ranking system is used by all 50 state Natural Heritage Programs and numerous Conservation Data Centers in other countries in this hemisphere. Because they are assigned based upon standard criteria, the ranks can be used to assess the range-wide status of a species as well as the status within portions of the species' range. The primary criterion used to define these ranks are the number of known distinct occurrences with consideration given to the total number of individuals at each locality. Additional factors considered include the current level of protection, the types and degree of threats, ecological vulnerability, and population trends. Global and state ranks are used in combination to set inventory, protection, and management priorities for species both at the state as well as regional level.

Blank means that no rank or status is assigned – all categories.

GLOBAL RANK

- G1 Highly globally rare. Critically imperiled globally because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
- G2 Globally rare. Imperiled globally because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
- G3 Either very rare and local throughout its range or distributed locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; typically with 21 to 100 estimated occurrences.
- G4 Apparently secure globally, although it may be quite rare in parts of its range, especially at the periphery.
- G5 Demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery.
- GH No known extant occurrences (i.e., formerly part of the established biota, with the expectation that it may be rediscovered).
- GU Possibly in peril range-wide, but its status is uncertain; more information is needed.
- GX Believed to be extinct throughout its range (e.g., passenger pigeon) with virtually no likelihood that it will be rediscovered.
- G? The species has not yet been ranked.
- _Q Species containing a "Q" in the rank indicates that the taxon is of questionable or uncertain taxonomic standing (i.e., some taxonomists regard it as a full species, while others treat it at an infraspecific level).
- _T Ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species.

STATE RANK

S1	Highly State rare. Critically imperiled in Maryland because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres in the State) or because of some factor(s) making it especially vulnerable to extirpation. Species with this rank are actively tracked by the Natural Heritage Program.
S2	State rare. Imperiled in Maryland because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres in the State) or because of some factor(s) making it vulnerable to becoming extirpated. Species with this rank are actively tracked by the Natural Heritage Program.
S3	Rare to uncommon with the number of occurrences typically in the range of 21 to 100 in Maryland. It may have fewer occurrences but with a large number of individuals in some populations, and it may be susceptible to large-scale disturbances. Species with this rank are not actively tracked by the Natural Heritage Program.
S3.1	A species that is actively tracked by the Natural Heritage Program because of the global significance of Maryland occurrences. For instance, a G3 S3 species is globally rare to uncommon, and although it may not be currently threatened with extirpation in Maryland, its occurrences in Maryland may be critical to the long term security of the species. Therefore, its status in the State is being monitored.
S4	Apparently secure in Maryland with typically more than 100 occurrences in the State or may have fewer occurrences if they contain large numbers of individuals. It is apparently secure under present conditions, although it may be restricted to only a portion of the State.
S5	Demonstrably secure in Maryland under present conditions.
SA	Accidental or considered to be a vagrant in Maryland.
SE	Established, but not native to Maryland; it may be native elsewhere in North America.
SH	Historically known from Maryland, but not verified for an extended period (usually 20 or more years), with the expectation that it may be rediscovered.
SP	Potentially occurring in Maryland or likely to have occurred in Maryland (but without persuasive documentation).
SR	Reported from Maryland, but without persuasive documentation that would provide a basis for either accepting or rejecting the report (e.g., no voucher specimen exists).
SRF	Reported falsely (in error) from Maryland, and the error may persist in the literature.
SU	Possibly rare in Maryland, but of uncertain status for reasons including lack of historical records, low search effort, cryptic nature of the species, or concerns that the species may not be native to the State. Uncertainty spans a range of 4 or 5 ranks as defined above.
SX	Believed to be extirpated in Maryland with virtually no chance of rediscovery.
SYN	Currently considered synonymous with another taxon and, therefore, not a valid entity.
SZ	A migratory species which does not inhabit specific locations for long periods of time.
S?	The species has not yet been ranked.
-B	This species is migratory and the rank refers only to the breeding status of the species. Such a migrant may have a different rarity rank for non-breeding populations.
-N	This species is migratory and the rank refers only to the non-breeding status of the species. Such a migrant may have a different rarity rank for breeding populations.

STATE STATUS

This is the status of a species as determined by the Maryland Department of Natural Resources, in accordance with the Nongame and Endangered Species Conservation Act. Definitions for the following categories have been taken from Code of Maryland Regulations (COMAR) 08.03.08.

E	Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.
I	In Need of Conservation; an animal species whose population is limited or declining in the State such that it may become threatened in the foreseeable future if current trends or conditions persist.
T	Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.
X	Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.
*	A qualifier denoting the species is listed in a limited geographic area only.
PE	Proposed Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.
PT	Proposed Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.
PX	Proposed Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.
PD	Proposed to be deleted or removed from the State Threatened & Endangered Species list.

FEDERAL STATUS

This is the status of a species as determined by the U.S. Fish and Wildlife Service's Office of Endangered Species, in accordance with the Endangered Species Act. Definitions for the following categories have been modified from 50 CRF 17.

LE	Taxa listed as endangered; in danger of extinction throughout all or a significant portion of their range.
LT	Taxa listed as threatened; likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
PE	Taxa proposed to be listed as endangered.
PT	Taxa proposed to be listed as threatened.

C Candidate taxa for listing for which the Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.

Current and Historical Rare, Threatened, and Endangered Species
Upper Monocacy River Watershed (02140303) January 2004
Frederick and Carroll County, Maryland

Scientific name	Common name	G-rank	S-rank	MD	US
Adlumia fungosa	Climbing fumitory	G4	S2	T	
Agastache scrophulariifolia	Purple giant hyssop	G4	S1S2	T	
Agrimonia microcarpa	Small-fruited agrimony	G5	SU		
Alasmidonta varicosa	Brook floater	G3	S1	E	
Amelanchier stolonifera	Running juneberry	G5	S2	T	
Aster radula	Rough-leaved aster	G5	S1	E	
Bromus ciliatus	Fringed brome	G5	SU	X	
Carex emoryi	Emory's sedge	G5	S1S2		
Carex shortiana	Short's sedge	G5	S2	E	
Chelone obliqua	Red turtlehead	G4	S1	T	
Coeloglossum viride	Long-bracted orchis	G5	S1	E	
Coptis trifolia	Goldthread	G5	S1	E	
Cornus rugosa	Round-leaved dogwood	G5	S1	E	
Cystopteris tennesseensis	Tennessee bladder-fern	G5	S1		
Dirca palustris	Leatherwood	G4	S2	T	
Dryopteris campyloptera	Mountain wood-fern	G5	S1	E	
Elliptio lanceolata	Yellow lance	G2G3	SU		
Elliptio producta	Atlantic spike	G4Q	S2S3		
Equisetum sylvaticum	Wood horsetail	G5	S1	E	
Euphorbia purpurea	Darlington's spurge	G3	S1	E	
Filipendula rubra	Queen-of-the-prairie	G4G5	S1	E	
Gentiana andrewsii	Fringe-tip closed gentian	G5?	S2	T	
Geranium robertianum	Herb-robert	G5	S1		
Glyceria acutiflora	Sharp-scaled mannagrass	G5	S1	E	
Helianthus hirsutus	Hirsute sunflower	G5	SU		
Helianthus microcephalus	Small-headed sunflower	G5	S1	E	
Houstonia tenuifolia	Slender-leaved bluets	G4G5Q	S1		
Hydrastis canadensis	Goldenseal	G4	S2	T	
Juglans cinerea	Butternut	G3G4	S2S3		
Lampsilis cariosa	Yellow lampmussel	G3G4	S1	X	
Lanius ludovicianus	Loggerhead shrike	G4	S1B	E	
Lasmigona subviridis	Green floater	G3	S1	E	
Lycopodiella inundata	Bog clubmoss	G5	S2		
Lythrum alatum	Winged loosestrife	G5	S1	E	
Melanthium latifolium	Broad-leaved bunchflower	G5	S1	E	
Mustela nivalis	Least weasel	G5	S2S3	I	
Neotoma magister	Allegheny woodrat	G3G4	S1	E	
Nymphoides cordata	Floating-heart	G5	S1	E	
Platanthera ciliaris	Yellow fringed orchid	G5	S2	T	
Platanthera flava	Pale green orchid	G4	S2		
Platanthera grandiflora	Large purple fringed orchid	G5	S2	T	

Platanthera peramoena	Purple fringeless orchid	G5	S1	T
Platanthera psycodes	Small purple fringed orchid	G5	SU	X
Pycnanthemum pycnanthemoides	Southern mountain-mint	G5	SH	X
Pycnanthemum torrei	Torrey's mountain-mint	G2	S1	E
Satyrium edwardsii	Edwards' hairstreak	G4	S1	E
Scirpus smithii	Smith's clubrush	G5?	SU	X
Scutellaria nervosa	Veined skullcap	G5	S1	E
Scutellaria saxatilis	Rock skullcap	G3	S1	E
Solidago rigida	Hard-leaved goldenrod	G5	SH	X
Spiranthes ochroleuca	Yellow nodding ladys' tresses	G4	S1	E
Stenanthium gramineum	Featherbells	G4G5	S1	T
Strophitus undulatus	Squawfoot	G5	S2	I
Thryomanes bewickii altus	Bewick's wren	G5T2Q	S1B	E
Triosteum angustifolium	Narrow-leaved horse-gentian	G5	S1	E
Vernonia gigantea	Giant ironweed	G5	SU	
Viola incognita	Large-leaved white violet	G4G5	S1	
Zanthoxylum americanum	Northern prickly-ash	G5	S1	E

Color code for rows

No color – plants
Yellow – animals (mammals, birds, etc.)

Appendix F
Generalized Zoning Category Breakdown
Maryland Department of Planning, January 2005

Maryland has 23 counties and Baltimore City, each of which has its own distinct zoning. In addition, many municipalities in Maryland have zoning responsibility. The Maryland Department of Planning created this Generalized Zoning map to display zoning at a state scale. The map is based on three categories: Resource Protection, Residential Zoning, and Other. This is a general representation of each zoning category. Each county is responsible for its own zoning. For more specific information on individual zoning districts, contact the local planning office.

Resource Protection		
Most Protected	The most restrictive rural zoning districts with an intent to protect natural resources	Max. density ≤ .05 du/acre
Moderately protected	Moderately restrictive rural zoning districts that have an intent to protect natural resources	Max. dens. >.05 and < 0.1
Least Protected	Least restrictive rural zoning districts that have an intent to protect natural resources	Max. dens. ≥ 0.1 and < 1.0
Residential Zoning		
Very Low Density Residential	The lowest density zones with a residential intent	Max. density > 0.2 du/acre and <1.0 du/acre
Low Density Residential	Low density zoning with a residential intent	Max. density ≥ 1and < 3.5 du/acre
Moderate Density Residential	Moderately density zoning with a residential intent	Max. density ≥ 3.5 du/acre < 10du/acre
High Density Residential	Highest density residential zones	Max. density ≥ 10du/acre
Other		
Commercial	Zoning districts that allow various commercial land uses such as business, offices, and retail use	N/A
Industrial	Zoning districts that allow various industrial land uses such as manufacturing, light industrial, and heavy industrial	n/a
Municipality	Any zoning district within a municipality	n/a
Other	Other specialized zones that do not fall into any of the above categories (i.e. military zones)	n/a
Mixed Use	Zoning districts that allow a mix of any of the above zoning categories	n/a

Sewer Service Areas

No planned sewer service areas (NP or NPS)

Existing Sewer Service (S1) - Areas that have existing sewer service or a system that is under construction.

Planned Sewer Service – Areas that will have future sewer service. The following is a breakdown of planned sewer service categories for Frederick County:

S2 – Areas designated for immediate sewer service by county staff

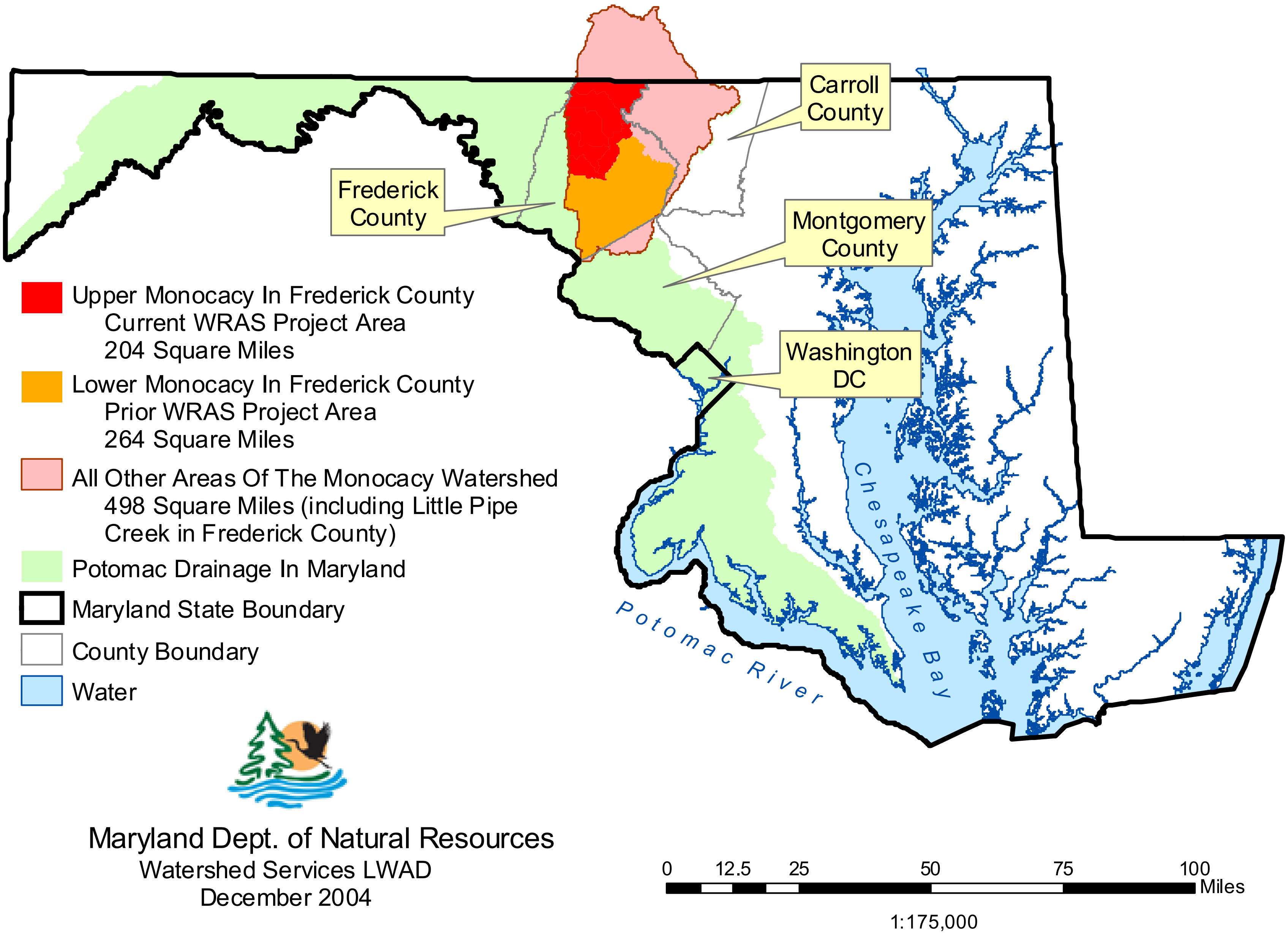
S3 – Areas programmed for sewer service within 3 years

S4 – Areas programmed for sewer service within 4 to 6 years

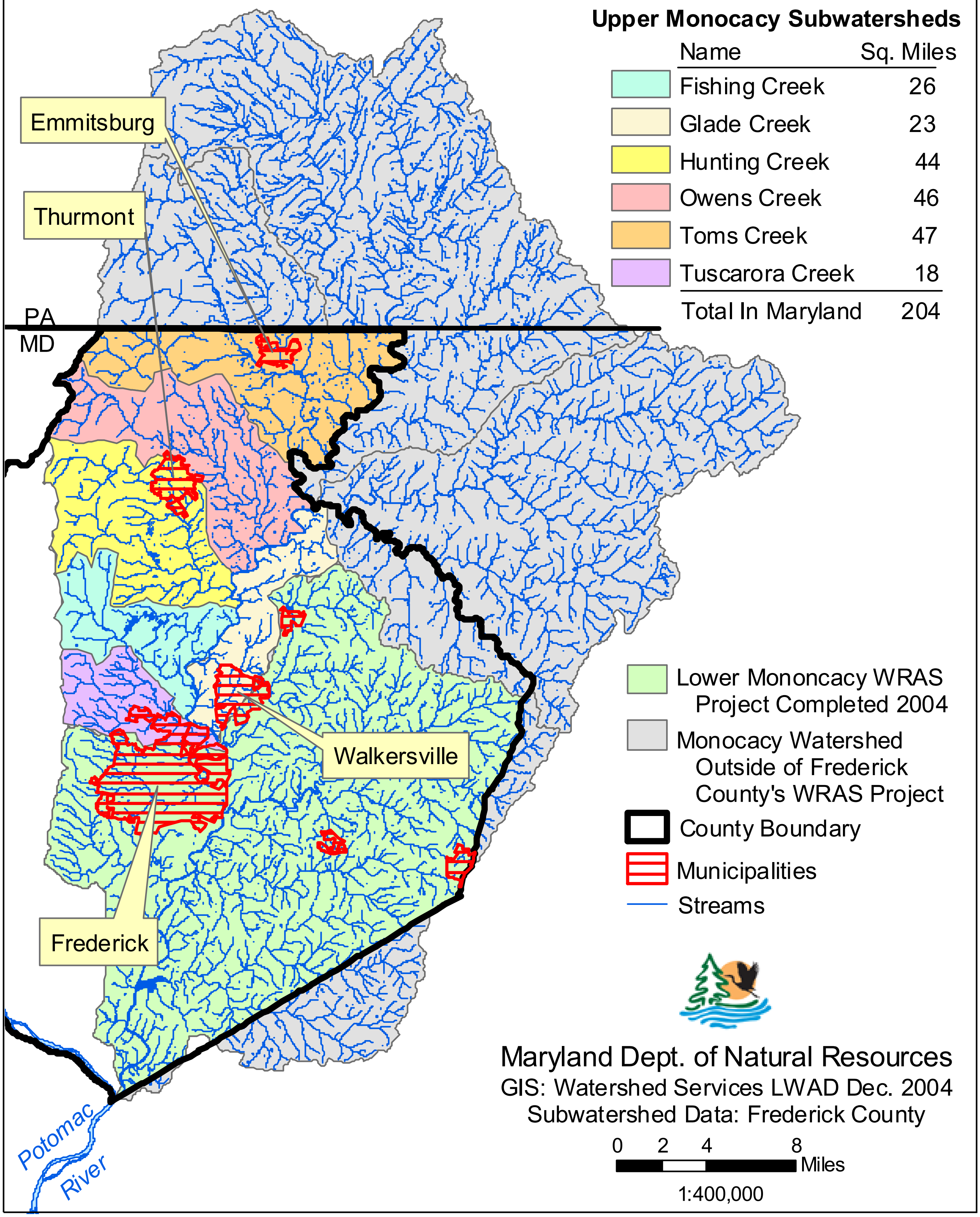
S5 – Areas programmed for sewer service within 7 to 20 years

S6 – Ultimate sewer service areas (US), no timeframe associated

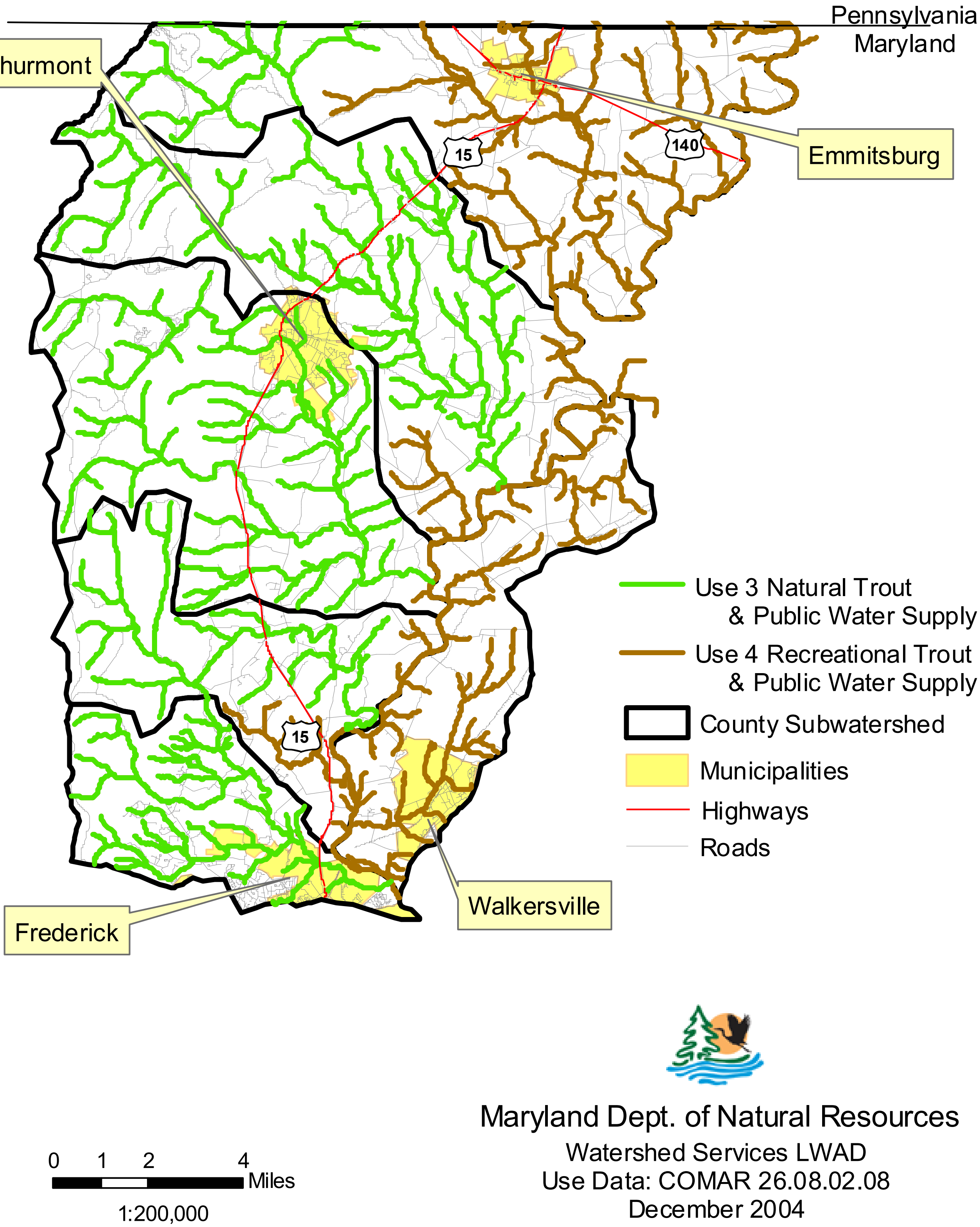
Map 1 Location: Upper Monocacy River WRAS Project Area



Map 2 Upper Moncacy River Project Area In Frederick Co. Within the Monocacy River Watershed

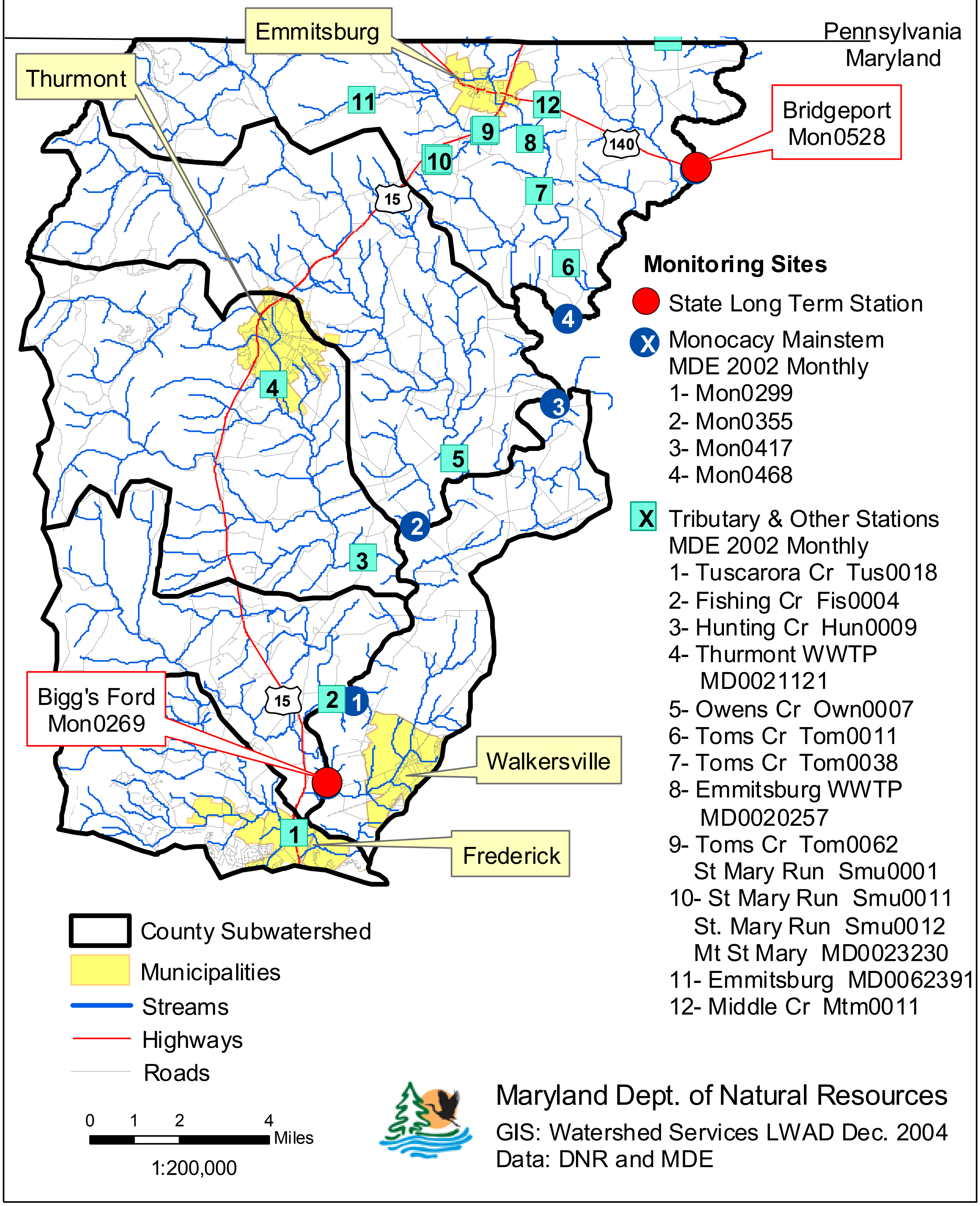


Map 3 Use Designations for Streams
Upper Monocacy River Watershed In Frederick County

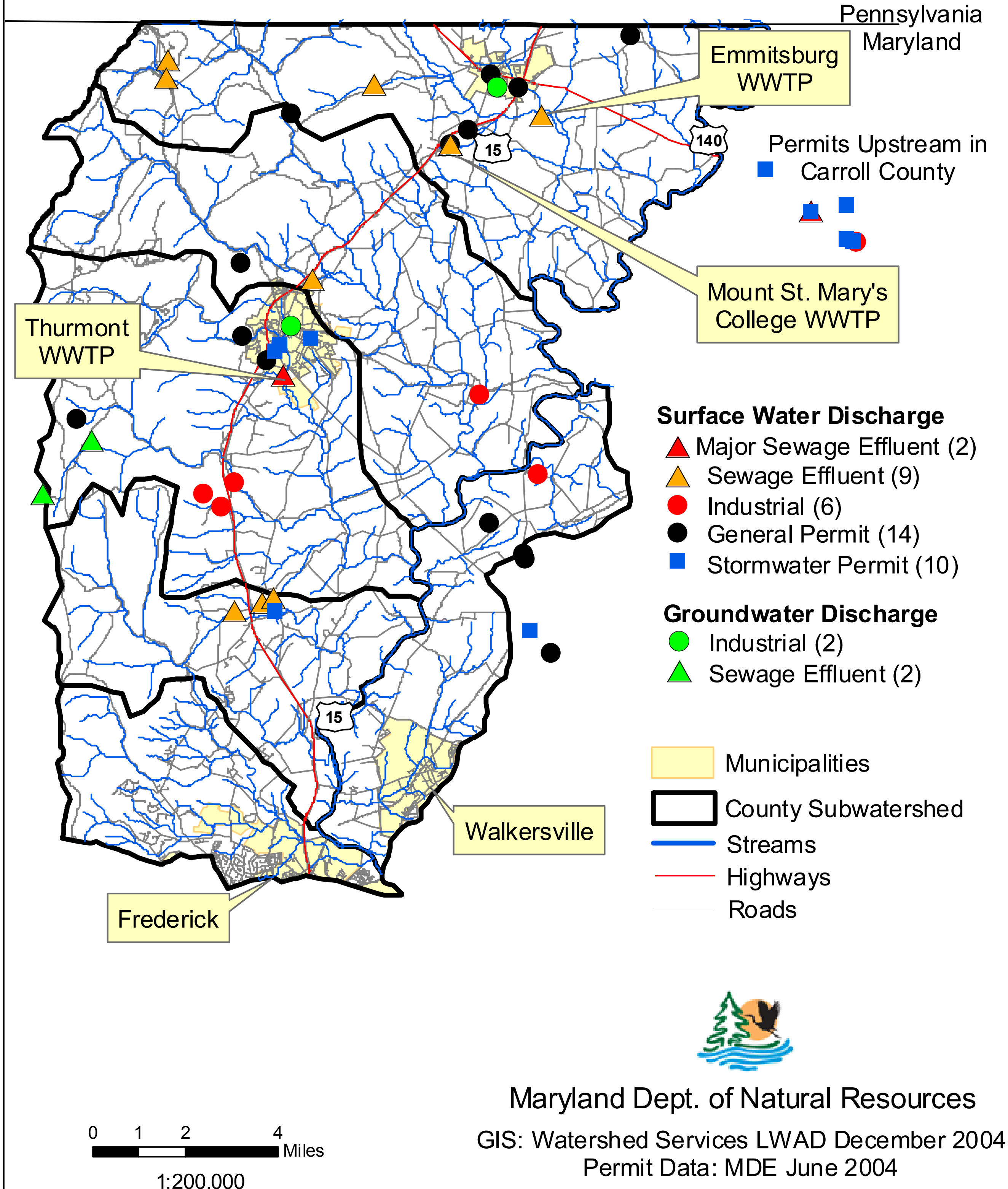


Maryland Dept. of Natural Resources
Watershed Services LWAD
Use Data: COMAR 26.08.02.08
December 2004

Map 4 Water Quality Monitoring
Upper Monocacy River Watershed In Frederick County



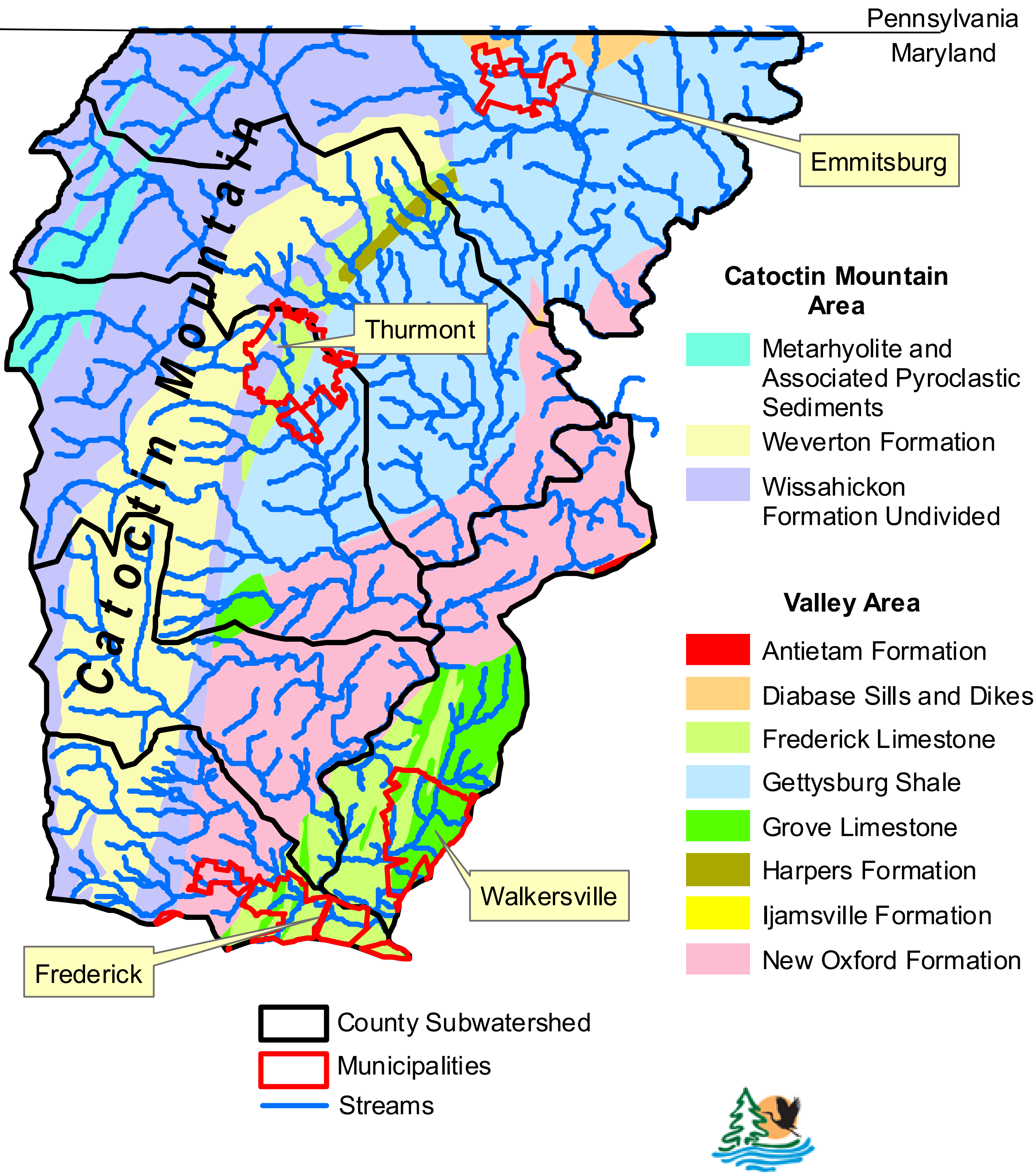
Map 5 MDE Permits
Upper Monocacy River Watershed In Frederick County



Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD December 2004
Permit Data: MDE June 2004

Map 6 Geology
Upper Monocacy River Watershed In Frederick County



0 1 2 4 Miles

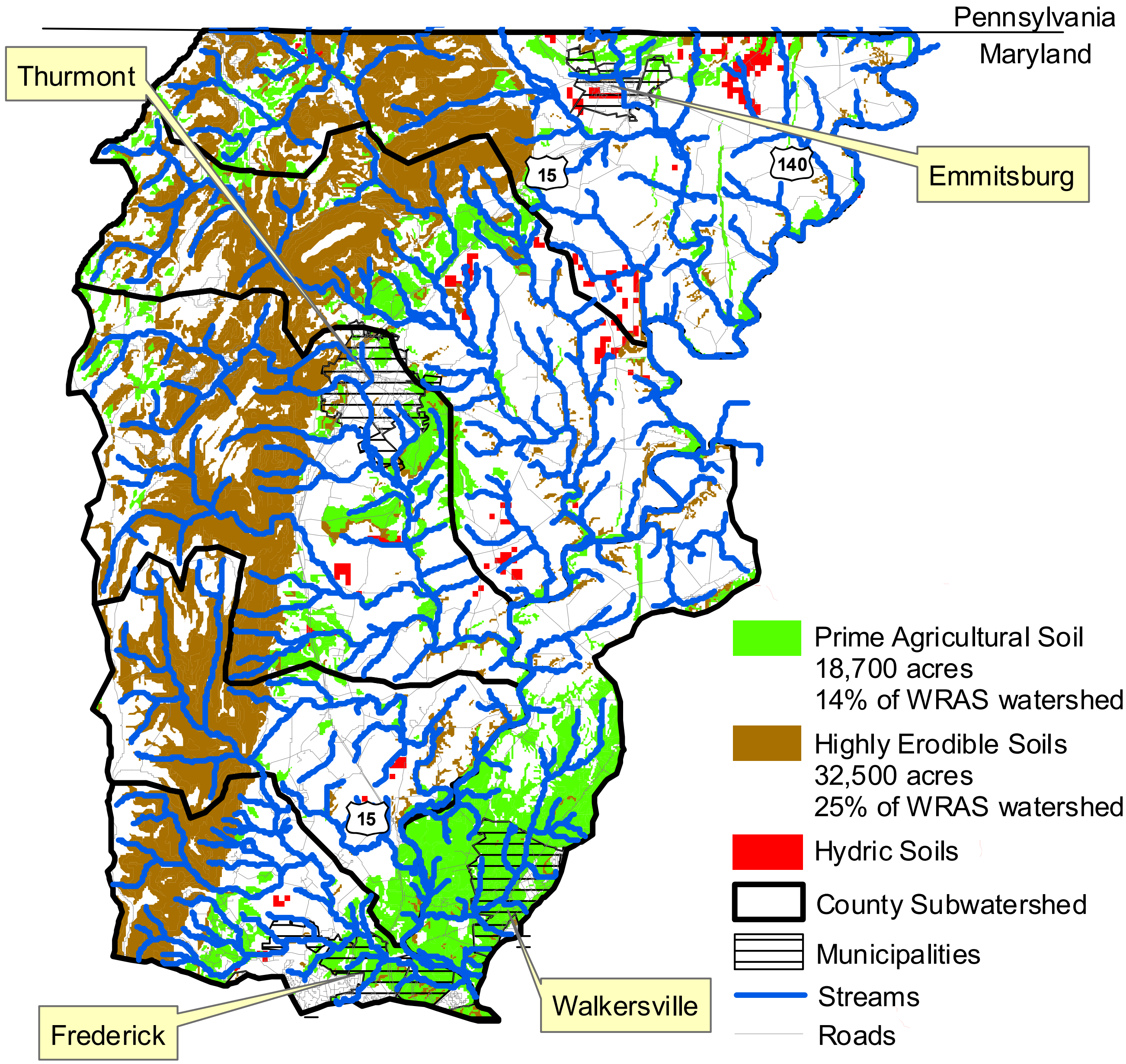
1:200,000

Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Dec. 2004

Data: Maryland Geological Survey 1968

Map 7 Soils Important for Watershed Planning
Upper Monocacy River Watershed In Frederick County



0 1 2 4 Miles

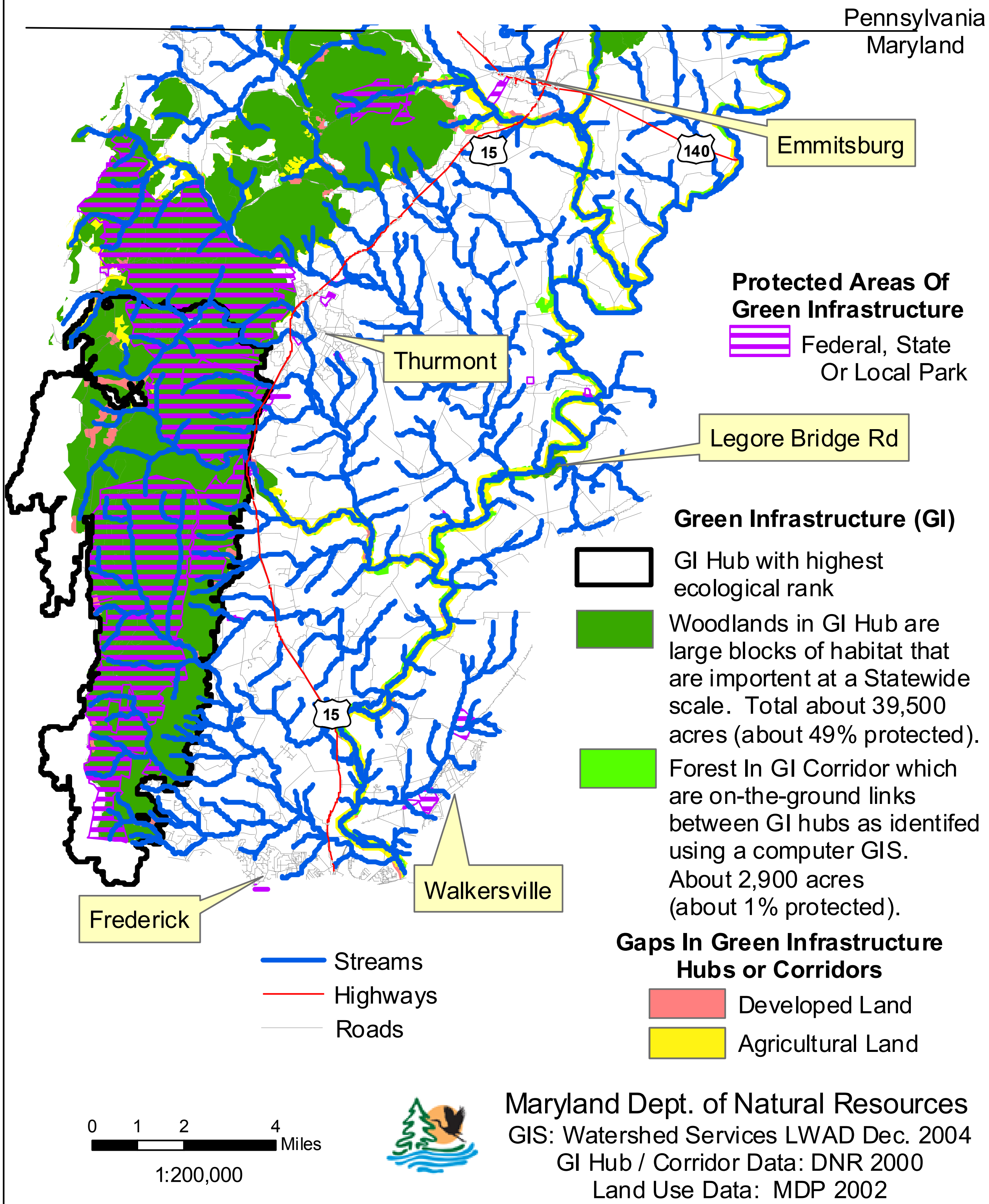
1:200,000

Maryland Dept. of Natural Resources

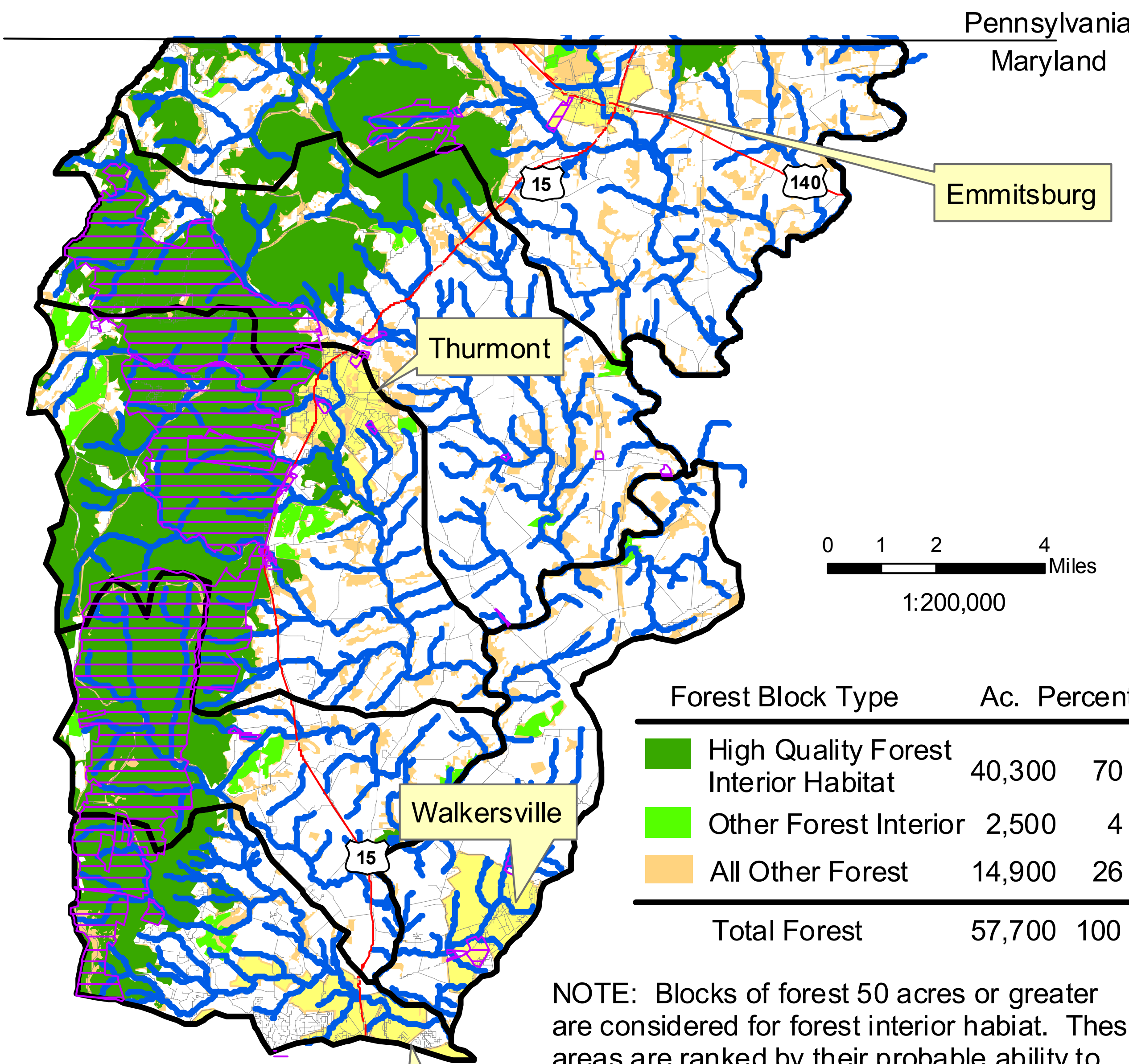
GIS: Watershed Services LWAD Dec. 2004

Data: SSURGO

Map 8 Green Infrastructure
Upper Monocacy River Watershed In Frederick County



Map 9 Large Block Forest Habitat
Upper Monocacy River Watershed In Frederick County



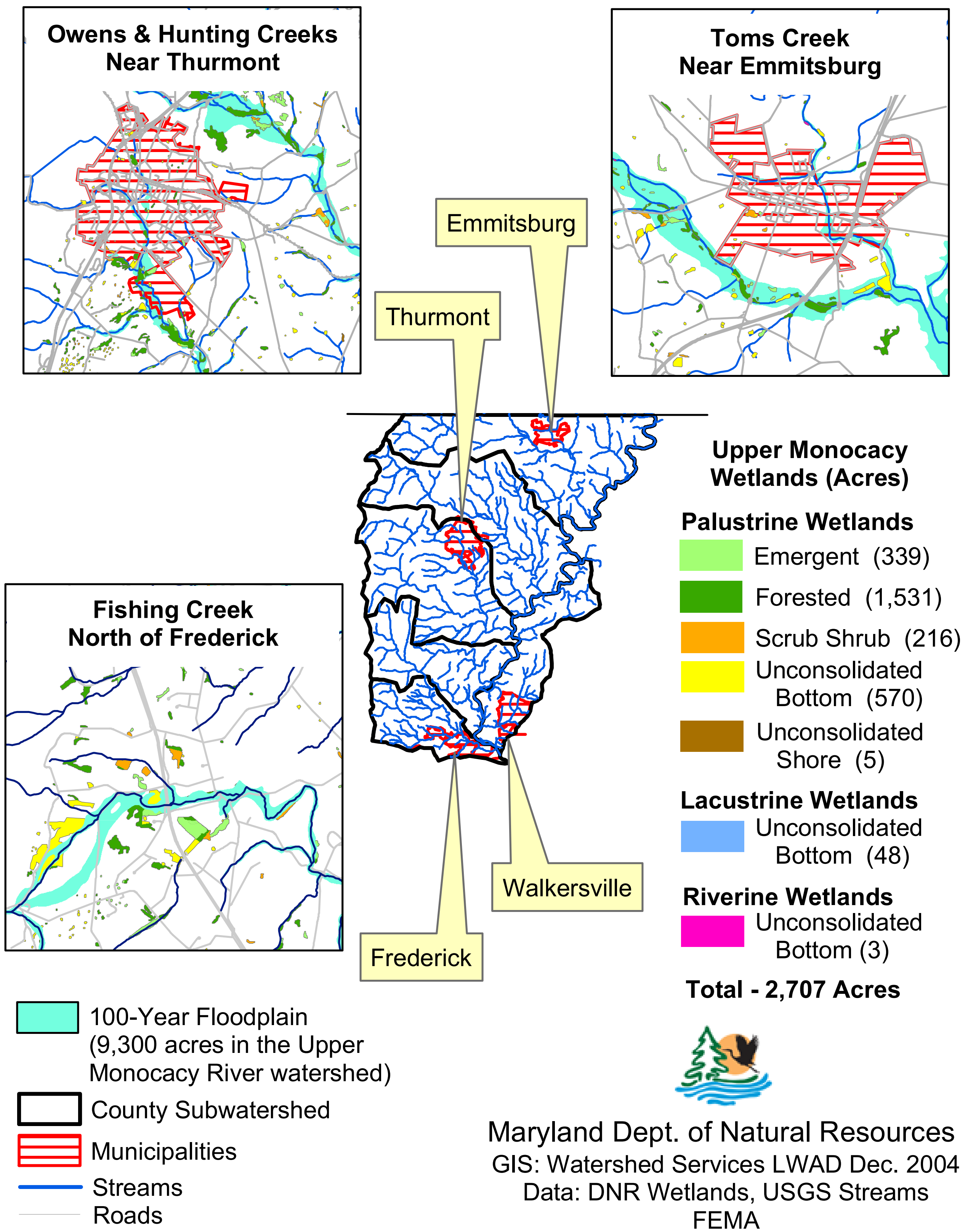
Forest Block Type	Ac.	Percent
High Quality Forest Interior Habitat	40,300	70
Other Forest Interior	2,500	4
All Other Forest	14,900	26
Total Forest	57,700	100

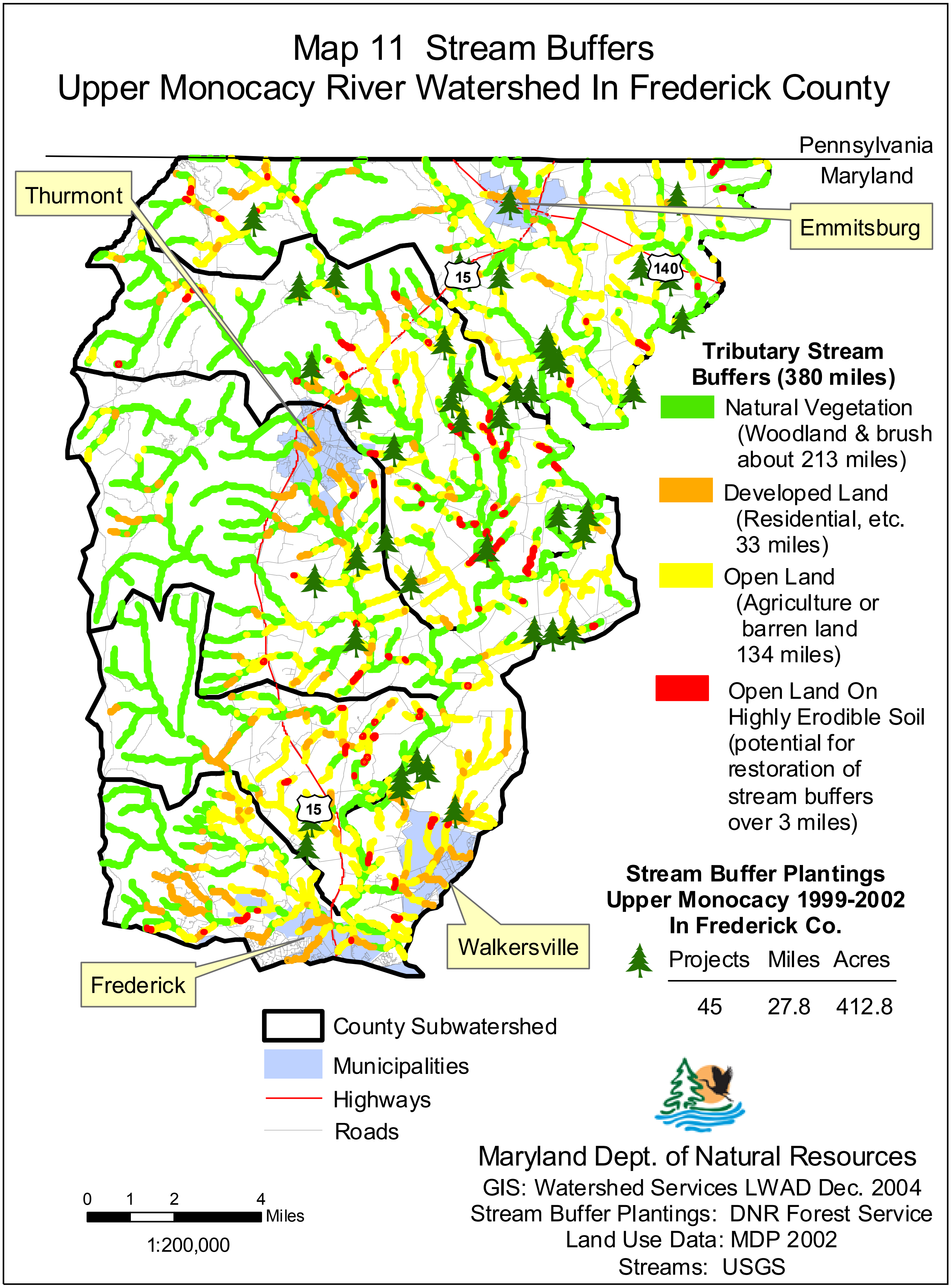
NOTE: Blocks of forest 50 acres or greater are considered for forest interior habiat. These areas are ranked by their probable ability to support forest interior dwelling species (FIDS) using computer GIS.

Public Land (Local, DNR or Federal)
County Subwatershed
Municipalities
Streams
Highways
Roads

Maryland Dept. of Natural Resources
GIS: Watershed Services LWAD Dec. 2004
Land Data: MDP 2002
Forest Habitat Data: DNR 2001

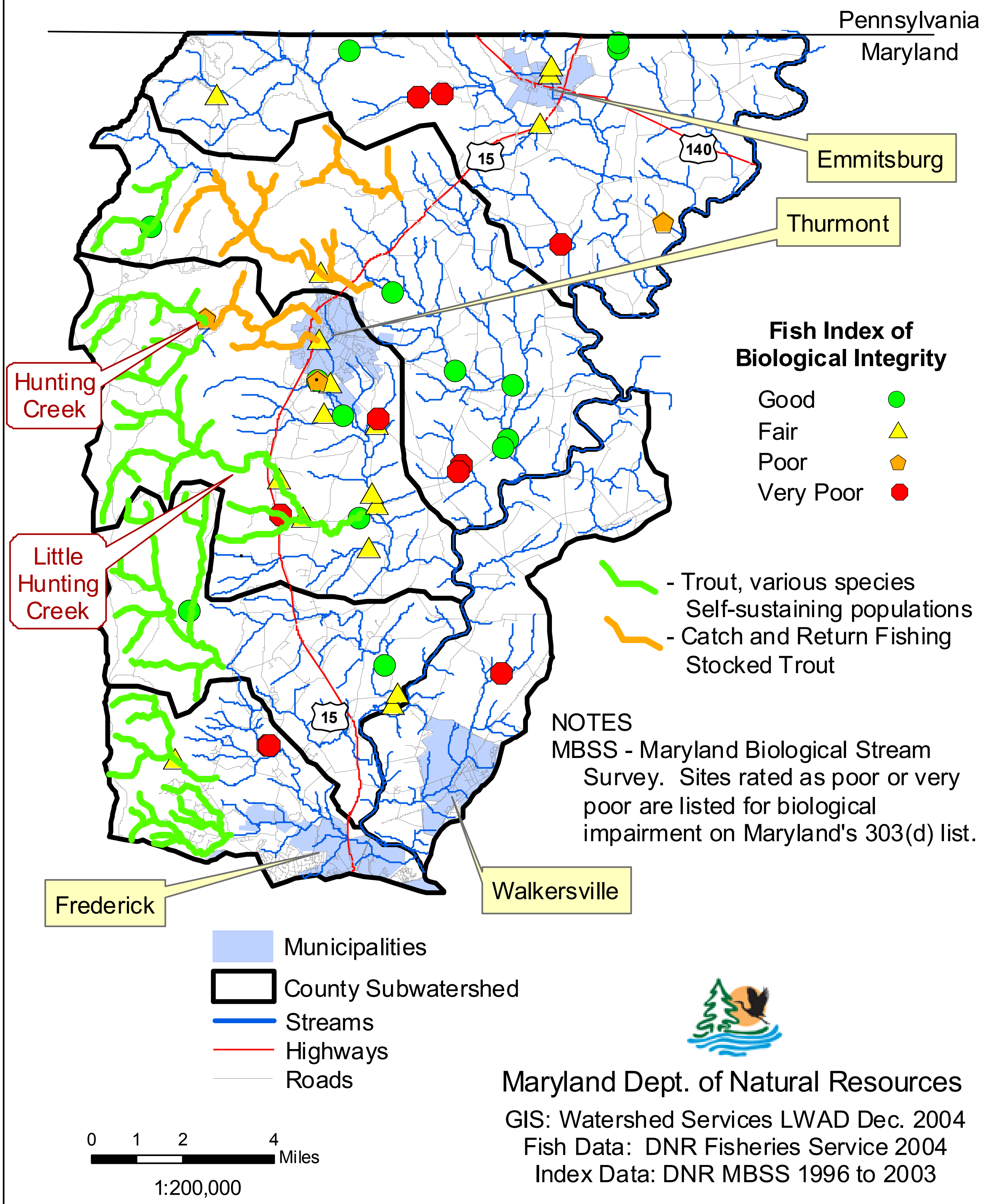
Map 10 Wetlands And Floodplains
Upper Monocacy River Watershed In Frederick County



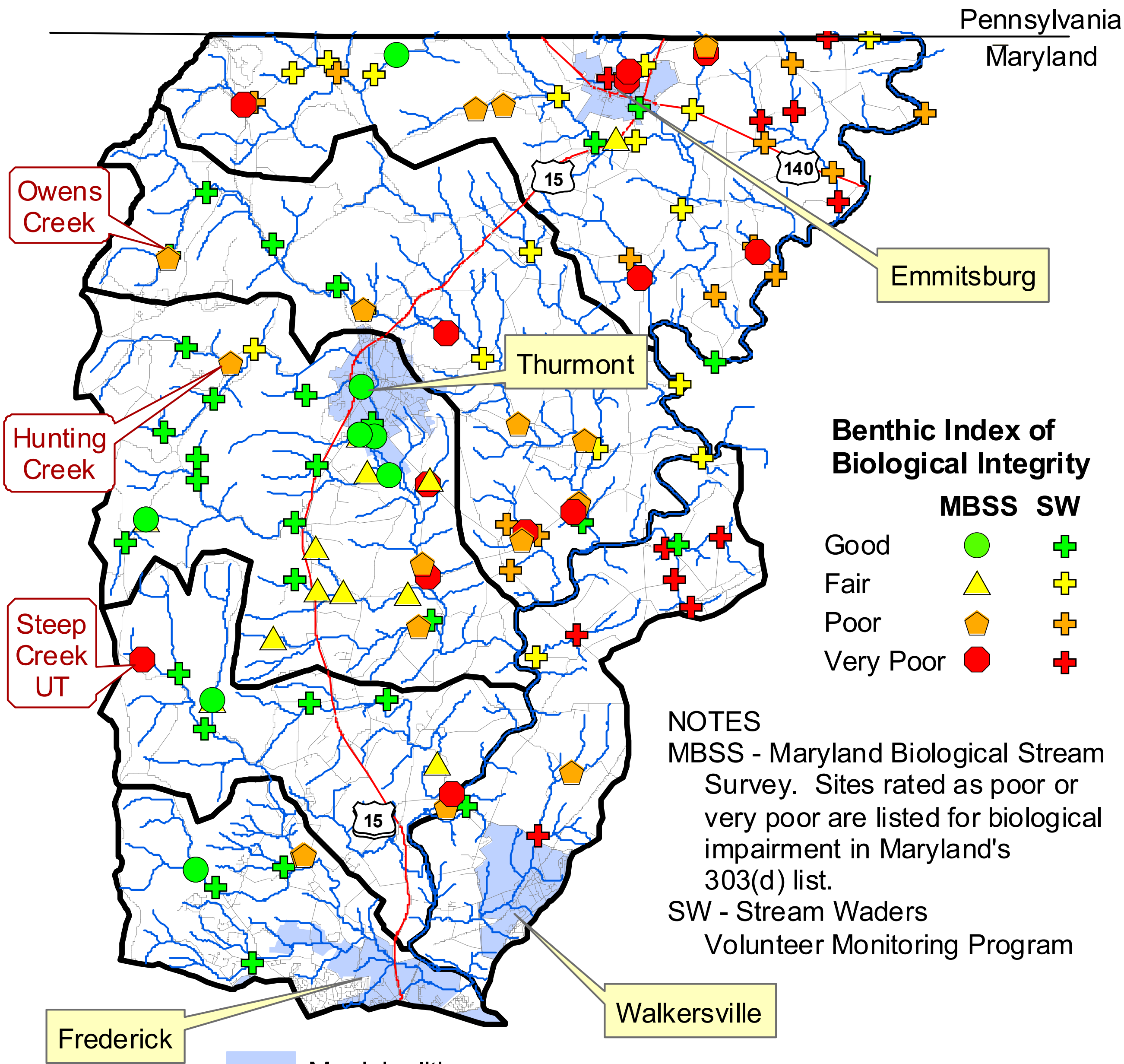


Map 11 Stream Buffers
Upper Monocacy River Watershed In Frederick County
Pennsylvania
Maryland
Thurmont
Emmitsburg
15
140
15
Walkersville
Frederick
Tributary Stream Buffers (380 miles)
Natural Vegetation (Woodland & brush about 213 miles)
Developed Land (Residential, etc. 33 miles)
Open Land (Agriculture or barren land 134 miles)
Open Land On Highly Erodible Soil (potential for restoration of stream buffers over 3 miles)
Stream Buffer Plantings Upper Monocacy 1999-2002 In Frederick Co.
Projects Miles Acres
45 27.8 412.8
County Subwatershed
Municipalities
Highways
Roads
0 1 2 4
Miles
1:200,000
Maryland Dept. of Natural Resources
GIS: Watershed Services LWAD Dec. 2004
Stream Buffer Plantings: DNR Forest Service
Land Use Data: MDP 2002
Streams: USGS

Map 12 Fish - Trout Populations And MBSS Index
Upper Monocacy River Watershed In Frederick County



Map 13 Benthos - MBSS Index
Upper Monocacy River Watershed In Frederick County



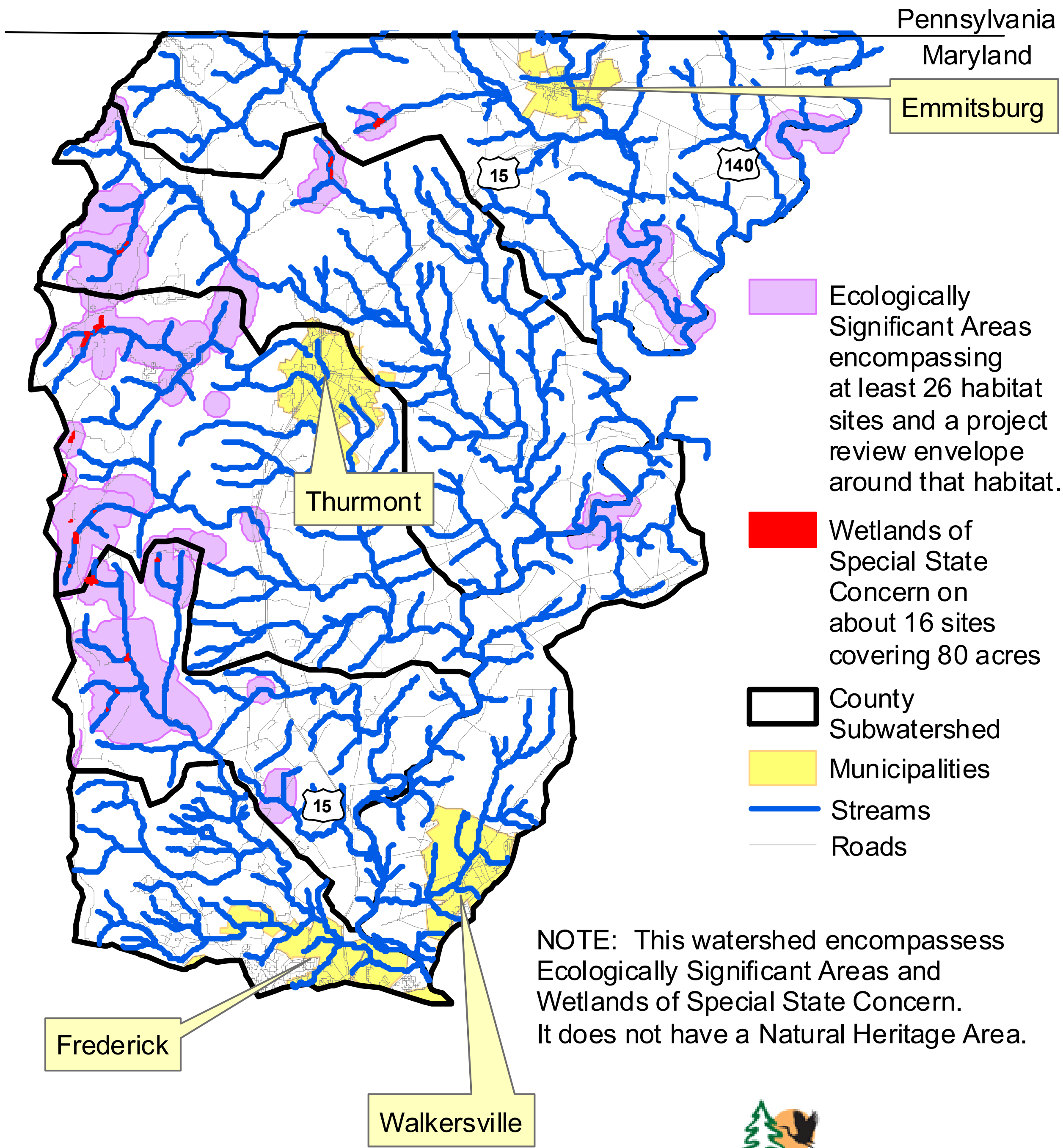
NOTES
MBSS - Maryland Biological Stream Survey. Sites rated as poor or very poor are listed for biological impairment in Maryland's 303(d) list.
SW - Stream Waders Volunteer Monitoring Program

Municipalities
County Subwatershed
Streams
Highways
Roads

0 1 2 4 Miles
1:200,000

Maryland Dept. of Natural Resources
GIS: Watershed Services LWAD Dec. 2004
MBSS Data: 1996 through 2003
Stream Waders Data: 2000

Map 14 Sensitive Species
Upper Monocacy River Watershed In Frederick County



NOTE: This watershed encompassess Ecologically Significant Areas and Wetlands of Special State Concern. It does not have a Natural Heritage Area.

0 1 2 4 Miles

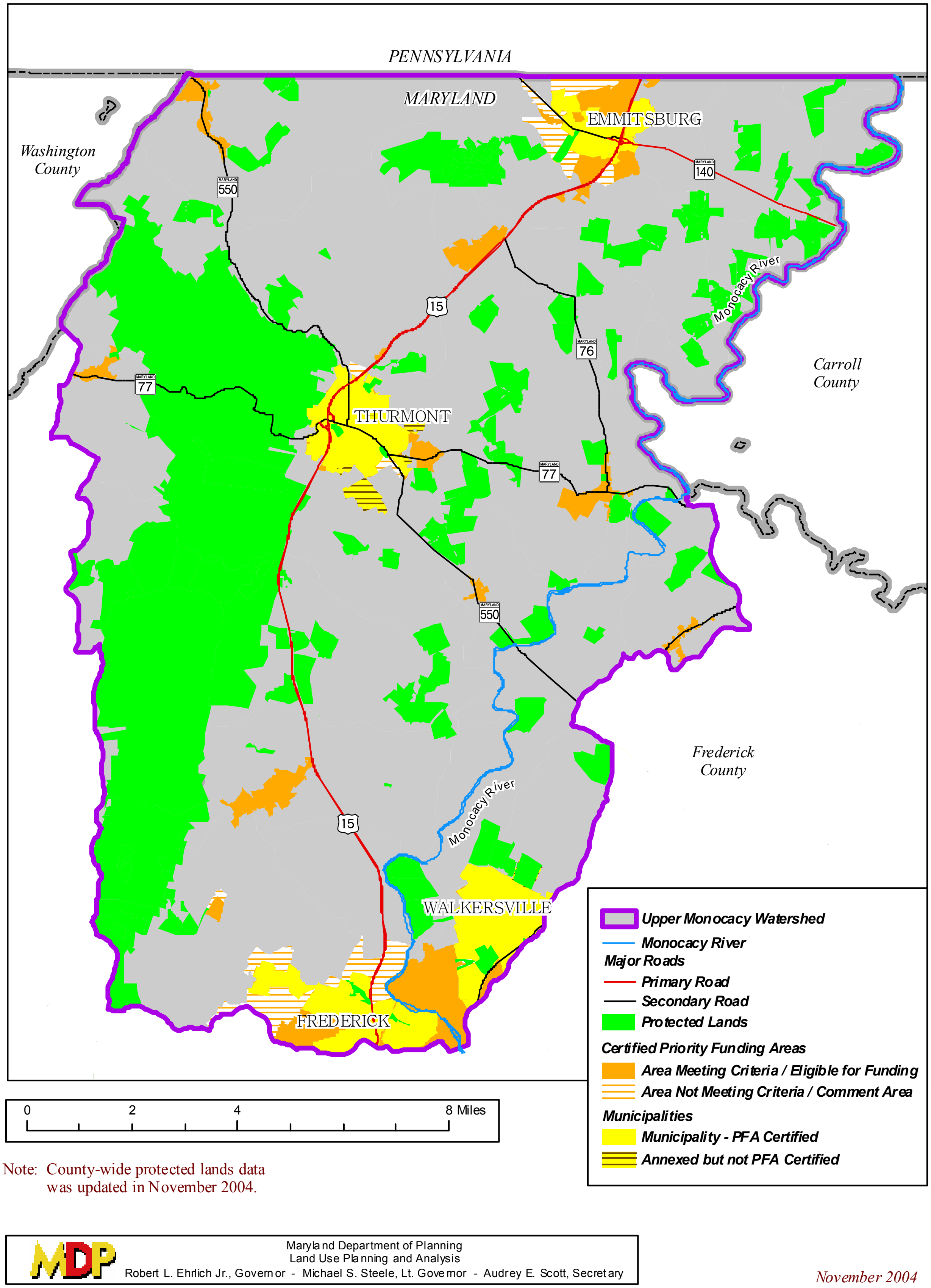
1:200,000

Maryland Dept. of Natural Resources

GIS: Watershed Services LWAD Dec. 2004
Sensitive Species Data: Jan. 2004

Upper Monocacy Watershed

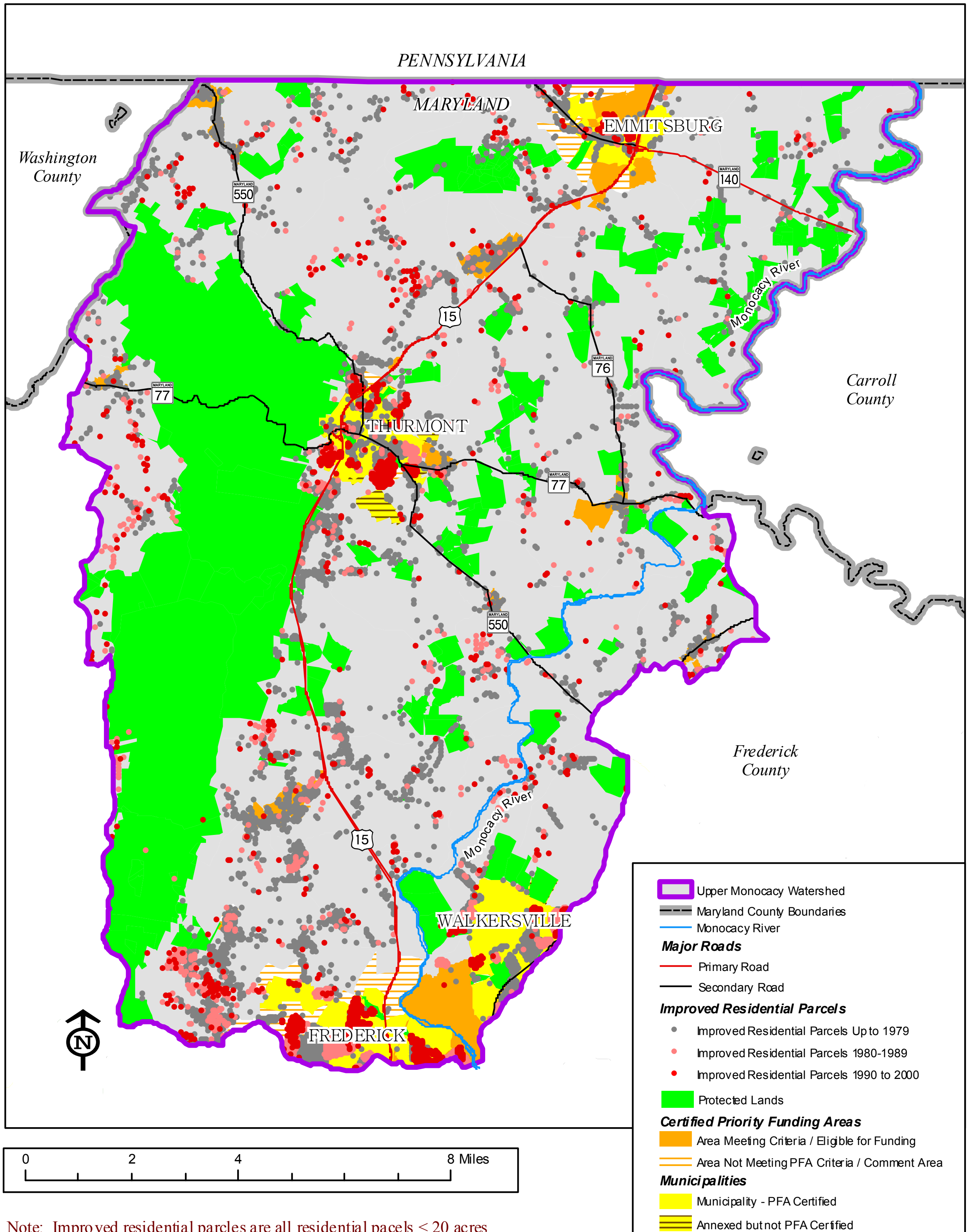
Map #15: Priority Funding Areas and Protected Lands



Note: County-wide protected lands data was updated in November 2004.

Upper Monocacy Watershed

Map #16: Improved Residential Parcels



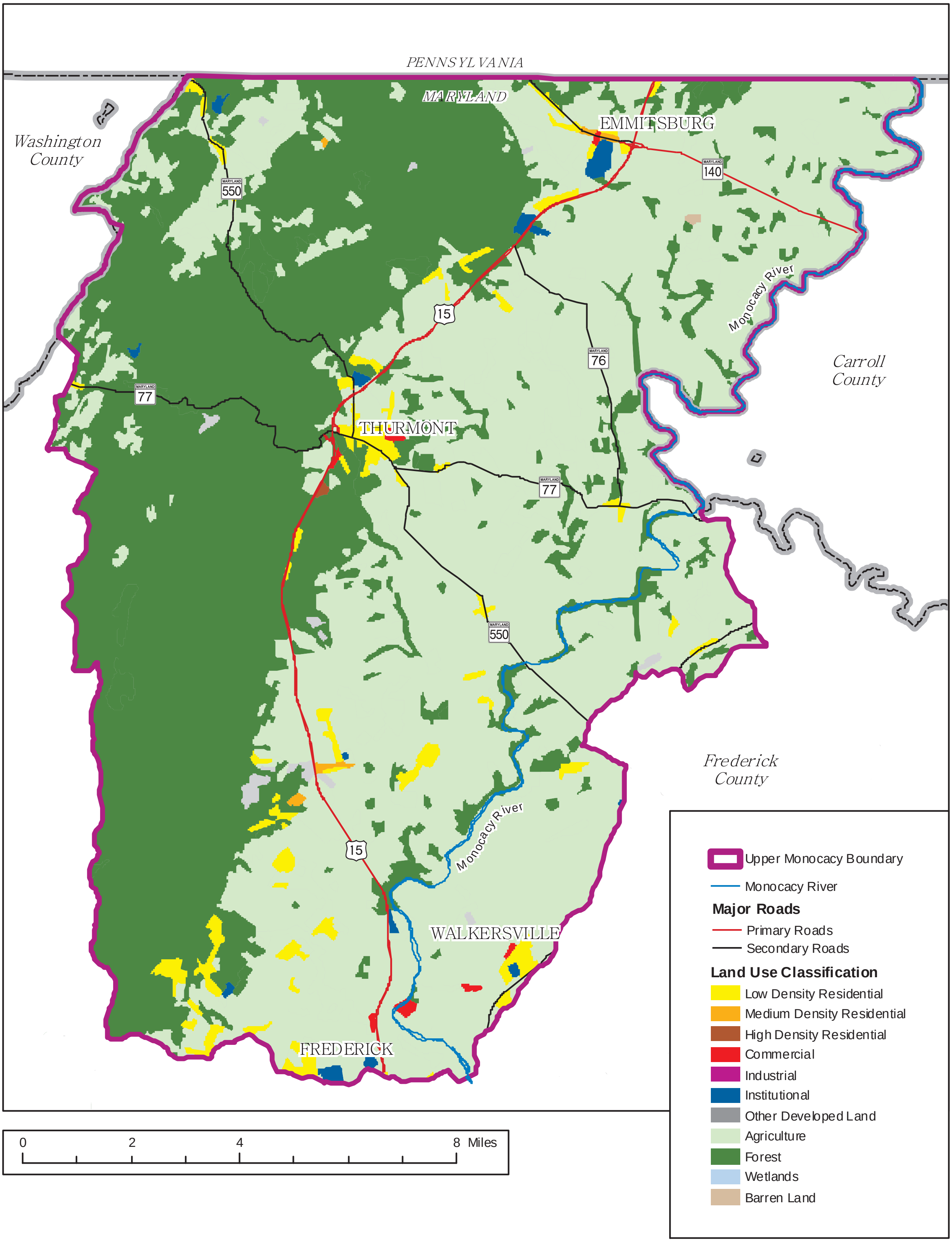
Note: Improved residential parcles are all residential pacels < 20 acres with an improvement value >= $10,000.

Maryland Department of Planning
Land Use Planning and Analysis
Robert L. Ehrlich Jr., Governor - Michael S. Steele, Lt. Governor - Audrey E. Scott, Secretary

November 2004

Upper Monocacy Watershed

Map #17: 1973 Land Use

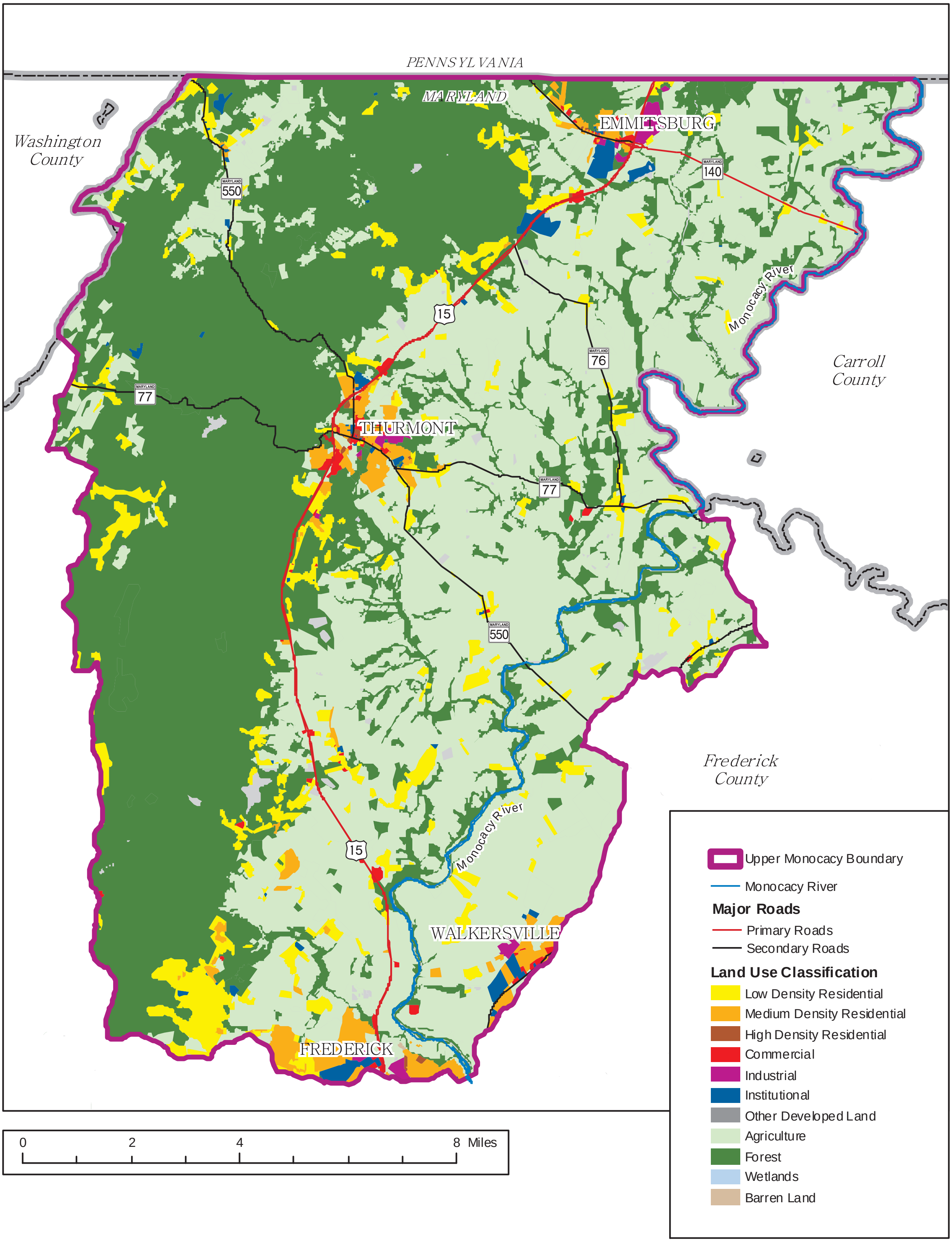


Maryland Department of Planning
Land Use Planning and Analysis
Robert L. Ehrlich Jr., Governor - Michael S. Steele, Lt. Governor - Audrey E. Scott, Secretary

November 2004

Upper Monocacy Watershed

Map #18: 2002 Land Use



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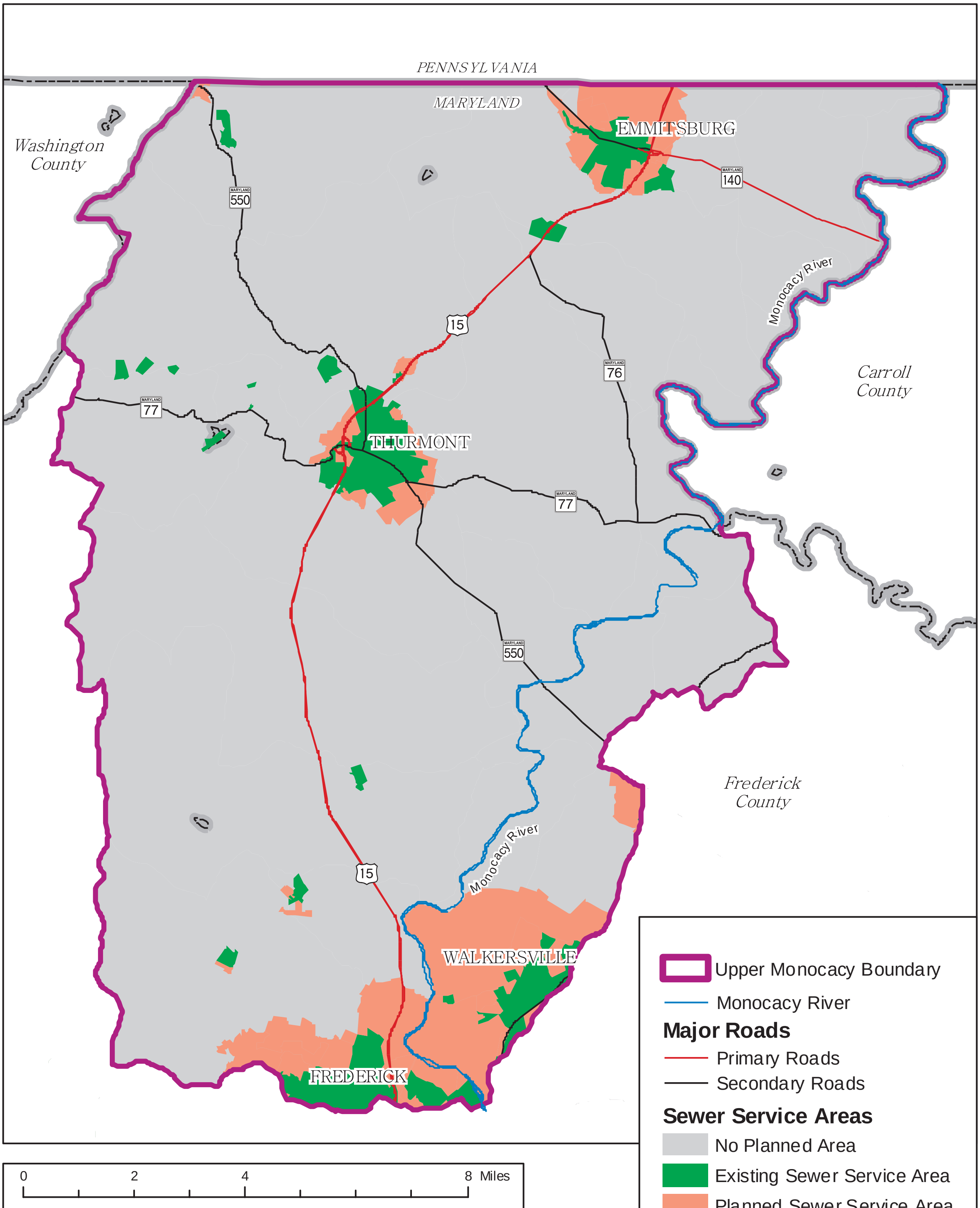
Map #19: Sewer Service Areas



Note: County-wide sewer service data was received and updated in November 2004.

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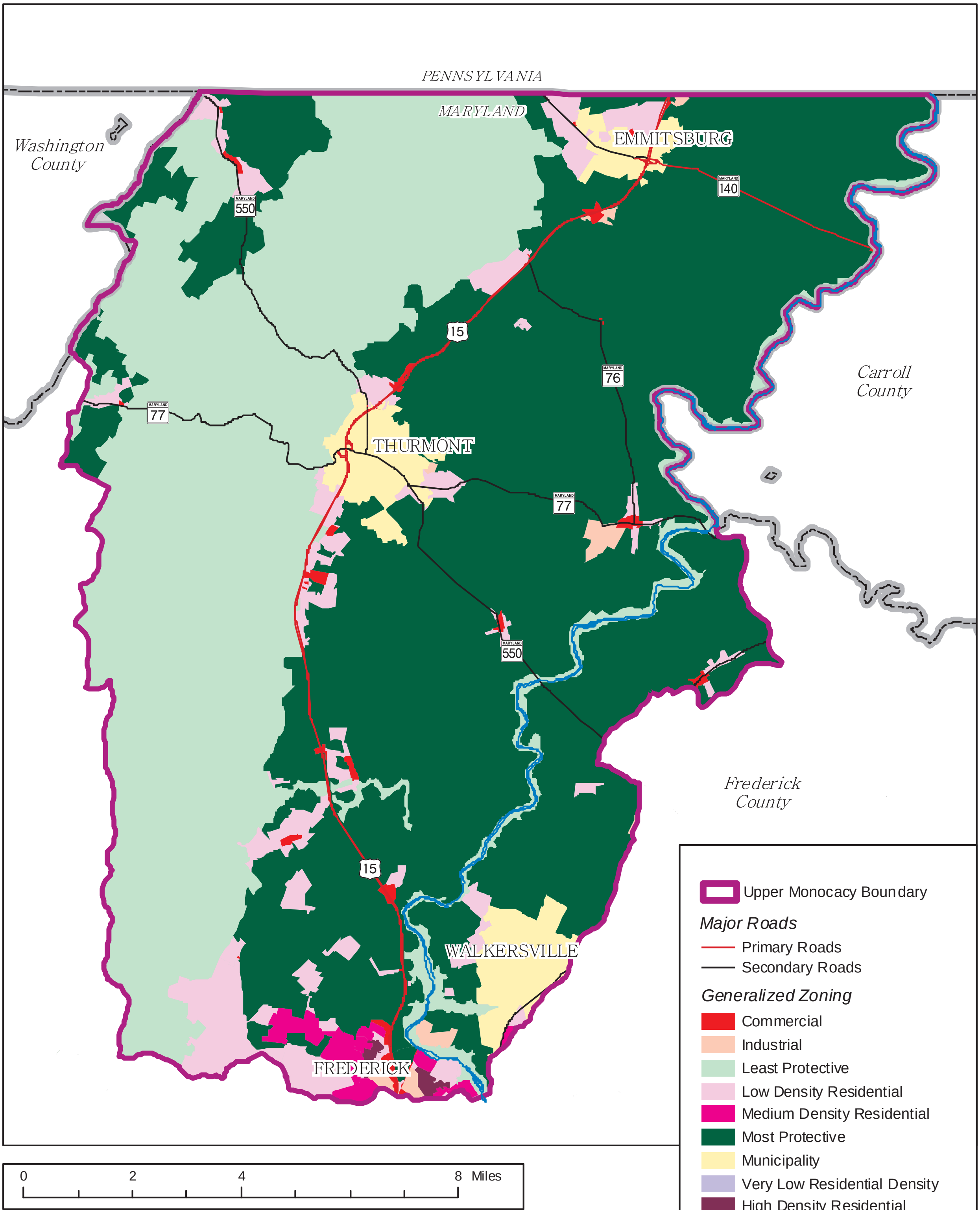
Map #20: Generalized Zoning



Note: County-wide zoning data updated in September 2004. Most and Least Protective Zones refer to rural restrictive zones that have intent to protect natural resources. See Appendix for Generalized Zoning definitions.

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Map 21 Impervious Area
Upper Monocacy River Watershed In Frederick County