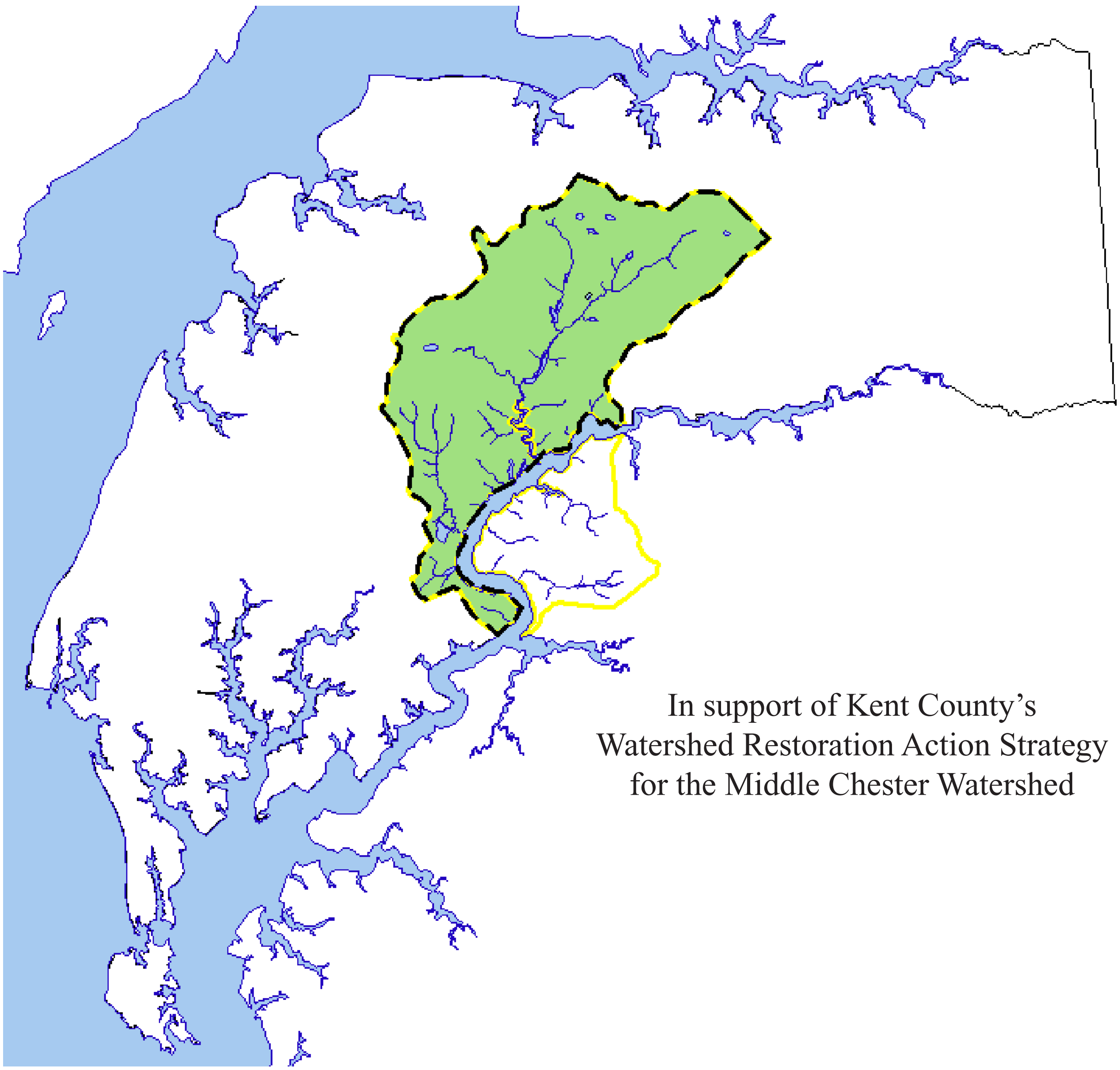
Middle Chester River Watershed Characterization

April 2001



In support of Kent County's
Watershed Restoration Action Strategy
for the Middle Chester Watershed

Product of the
Maryland Department of Natural Resources
In partnership with Kent County

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To inspire people to enjoy and live in harmony with their environment, and
to protect what makes Maryland unique – our treasured Chesapeake Bay,
our diverse landscapes, and our living and natural resources.

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EXECUTIVE SUMMARY
For the Middle Chester River Characterization

Kent County, Maryland is receiving Federal grant funding and State technical assistance to prepare a Watershed Restoration Action Strategy (WRAS) for the Middle Chester River watershed for several reasons:

– the 1998 *Maryland Clean Water Action Plan* identified the Middle Chester River watershed as a Priority Watershed "in need of restoration."

– Kent County applied for grant funding and volunteered to develop a strategy in the watershed to improve water quality using protection and restoration projects.

The purpose of the Watershed Characterization is to assist Kent County in collecting information and identifying issues that may be used as the County generates its Watershed Restoration Action Strategy.

The Middle Chester River watershed encompasses about 37,400 acres of land in Kent and Queen Annes County. Over 2,000 acres of open water in the Chester River separate the two Counties creating hydrologically distinct drainage areas on either side of the River. Approximately 29,600 acres of land are in the Kent County WRAS area. Within the WRAS area, the very rural and agricultural Morgan Creek watershed drains about 22,200 acres. The relatively developed Radcliffe Creek watershed containing Chestertown drains about 4030 acres. The remainder of the Kent County Middle Chester River WRAS area consists of minor watersheds draining directly to the Chester River.

Water Quality

The Middle Chester River does not support its designated use (water contact recreation) due to problems associated with nutrients, fecal coliforms and sediment. Nearly all of the water quality information available for the Middle Chester River watershed is for the Chester River mainstem where water quality is poor in general. In this area of the mainstem, water clarity is the worst of the Chesapeake Bay "segments" for the period 1992 through 1997. Several water quality parameters, including water clarity, algae and phosphorus, are showing a recent trend toward improvement.

Toxicity in river water and sediment from two Middle Chester River sites did not cause significant mortality for minnows or clams under laboratory conditions. However, in terms of inhibiting growth of these organisms, toxicity was ranked as high or moderately high for river water and for sediment from the sites tested. DDT and Dieldrin, which were found here, may have contributed to an observed reduction in growth rate.

Based on the relatively little information available on nontidal streams in the Middle Chester River watershed, few generalizations can be put forward. For Radcliffe Creek, low summer dissolved oxygen and assessment of benthic organisms found there suggests that high nutrient levels may be present. Very poor water quality associated with nutrients and sedimentation in Urieville Lake is a well known local condition. The Total Maximum Daily Load (TMDL) issued for the Lake in 1999 called for a 42% reduction in sediment load and an 85% reduction in total phosphorus load.

Land Use

Land in Kent County / Middle Chester River watershed is among the most productive agricultural land in Maryland. The watershed is nearly all privately owned and is about three quarters agricultural land. However, soil erodibility is high, which presents a challenge for managers of land and water quality. The majority of the forested land in the watershed is associated with wetlands and wet soil conditions. Developed lands are projected to increase over the next twenty years primarily at the expense of farm land. The majority of the limited acreage in the watershed that is protected from development is privately owned with either agricultural or conservation easements providing the protection.

Living Resources and Habitat

Submerged aquatic vegetation (SAV) has not been found in the Middle Chester River area during the period 1978 through 1999 when annual aerial survey monitoring was conducted. Long-time residents of the Chestertown area recall that SAV was abundant in the 1950s and 1960s in the Middle Chester River. Current-day SAV absence is linked to poor water clarity and other factors.

Little information is available for living resources associated with nontidal streams in the Middle Chester River watershed. Analysis of benthic organism populations and habitat was conducted at two Middle Chester River sites. Radcliffe Creek was rated as "not supporting" benthic species. Morgan Creek near Urieville Lake (but not down stream of it) was rated as "partially supporting" benthic species.

Interpretation of fish populations upstream of Urieville Lake rated the biotic integrity of two tributary streams "fair" and "good." However, fish populations in Urieville Lake itself are poor due to its eutrophic condition.

Restoration Targeting Tools

A stream corridor assessment is scheduled for Winter 2000/2001. It will identify the status of stream buffers, stream bank erosion, etc. This information will provide a foundation for targeting restoration projects.

Computerized mapping was used to demonstrate concepts for restoration targeting and to help identify areas for additional site investigation for restoration of stream buffers and wetlands. Opportunities were also identified to address fish blockages and to reduce overboard sewage discharge from boats that could potentially use marina pumpout facilities.

Additional Information

The DNR *Chester River Study* is anticipated to be available in Winter 2001. It will provide analysis of Chester River mainstem water quality and living resources.

INTRODUCTION

Watershed Selection

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

Kent County is one of five Counties participating in the first round of the WRAS program. The portion of the Middle Chester River Watershed within Kent County is the area selected for restoration. This watershed has several key physical characteristics: coastal plain location, low to moderate elevation, moderate terrain with limited areas of steep slope, and generally rural land uses with development mostly clustered in and around Chestertown.

Location

The Middle Chester River watershed is located within the Chester River basin as shown in Map 1 Regional Context. The majority of the Middle Chester River watershed is in Kent County, Maryland. This area is the focus of the Watershed Restoration Action Strategy and this Watershed Characterization. Map 2 WRAS Project Area shows the geographic location of the WRAS watershed in Maryland. In addition, about 23% of the watershed is in Queen Anne's County, Maryland. As shown in Map 3 Streams and Sub-Watersheds, the two Counties are on opposite sides of the Chester River. Therefore, their subwatersheds are hydrologically distinct.

Middle Chester River Watershed
Acreage Summary

County	Land	Water	Total
Kent	29,611	1,286	30,897
Queen Anne's	7,825	1,211	9,036
Watershed Total	37,436	2,497	39,933

Purpose of the Characterization

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

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

Additional Characterization Recommended

The Watershed Characterization is intended to be a starting point. It is part of a framework for a more thorough assessment involving an array of additional inputs:

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

Identifying Gaps in Information

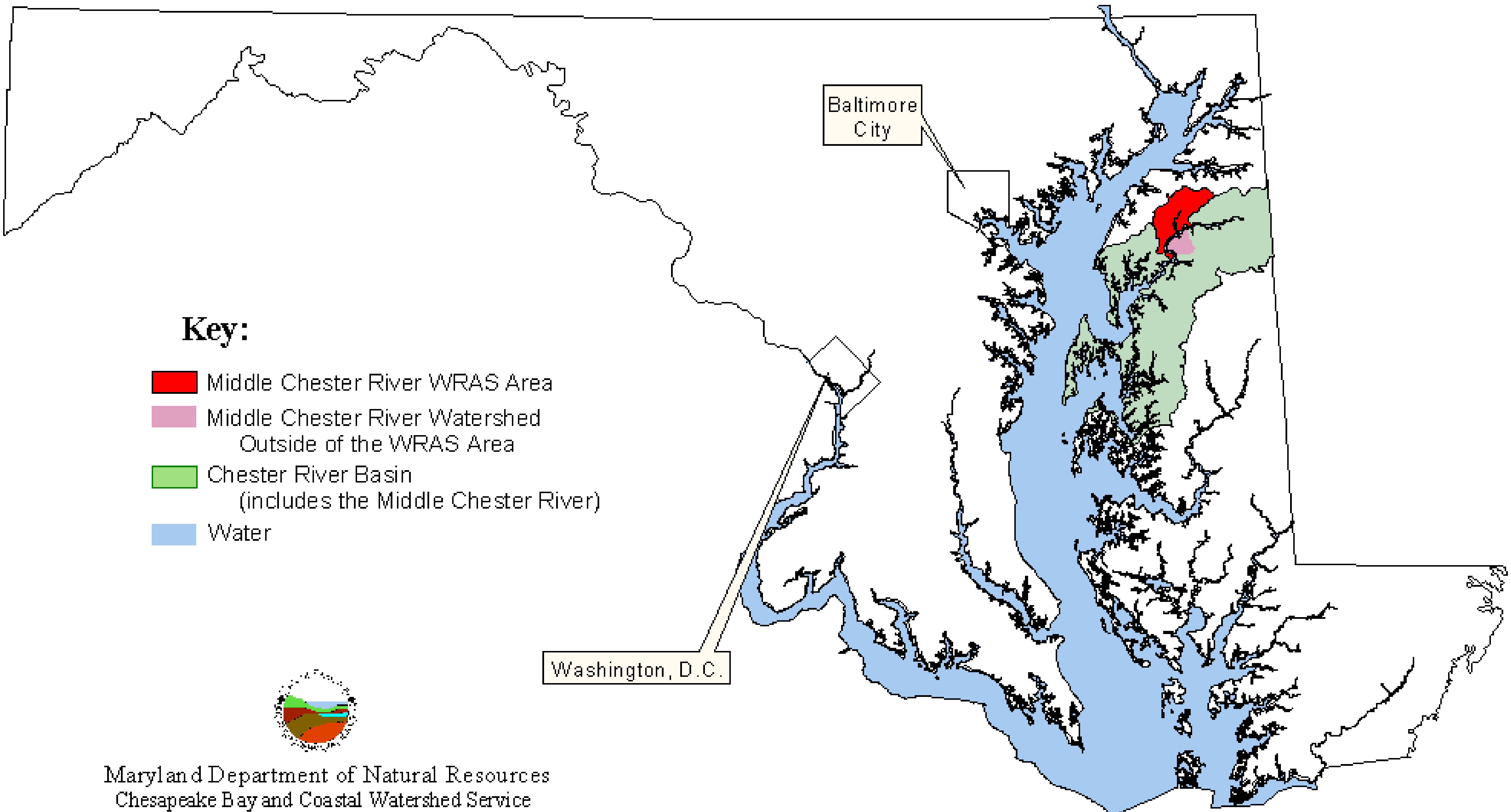
It is important to identify gaps in available watershed knowledge and gauge the importance of these gaps. One method is to review available information in the context of four physical / biological assessment categories that have been successfully applied in other watershed restoration efforts. These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

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

Adaptive Management

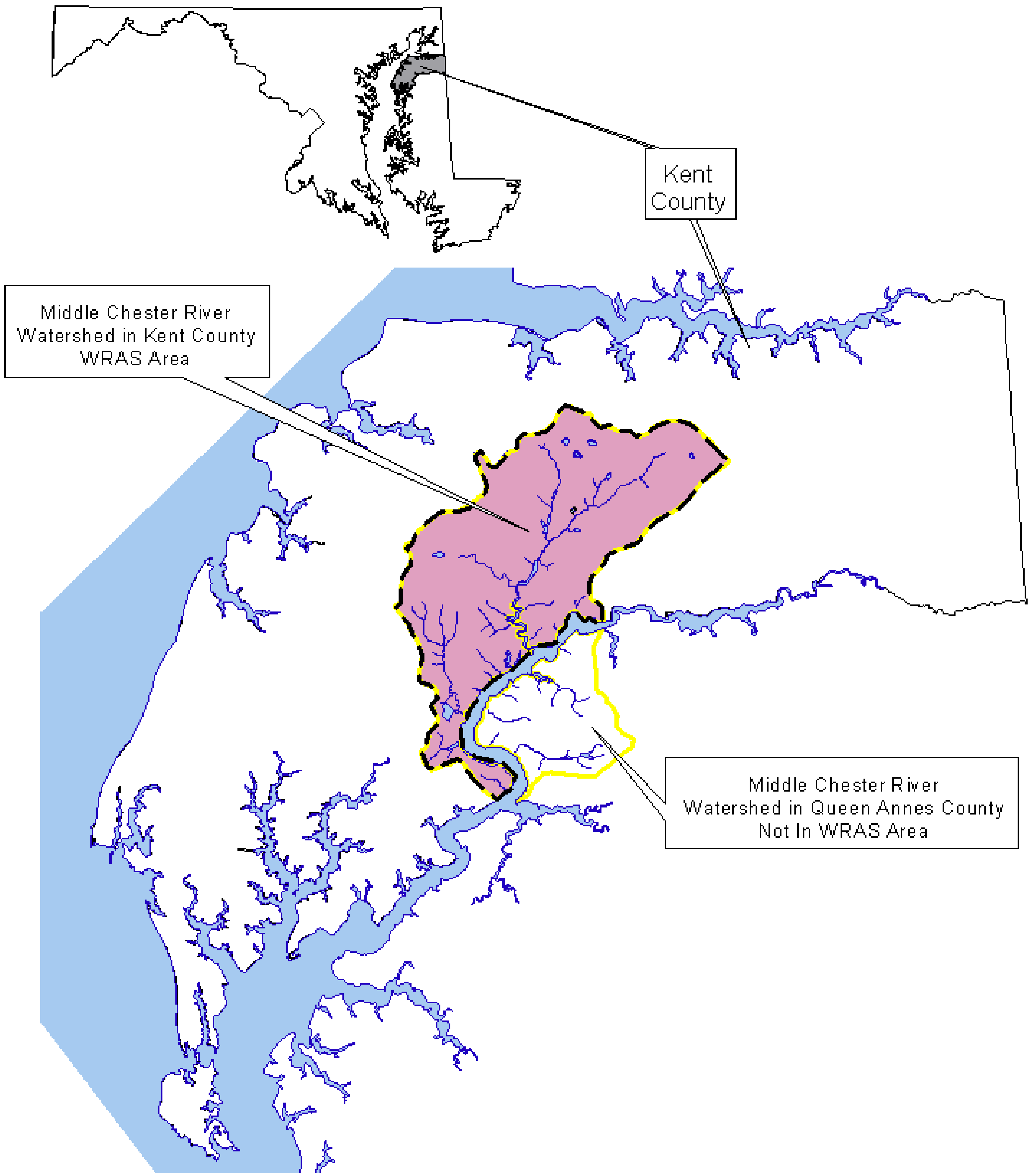
In addition, the Watershed Characterization and the Watershed Restoration Action Strategy should be maintained as living documents within an active evolving restoration process. These documents will have to be updated periodically as new, more relevant information becomes available and as the watershed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

Map 1 Regional Context
Middle Chester River Watershed In Kent County
Watershed Restoration Action Strategy (WRAS) Area

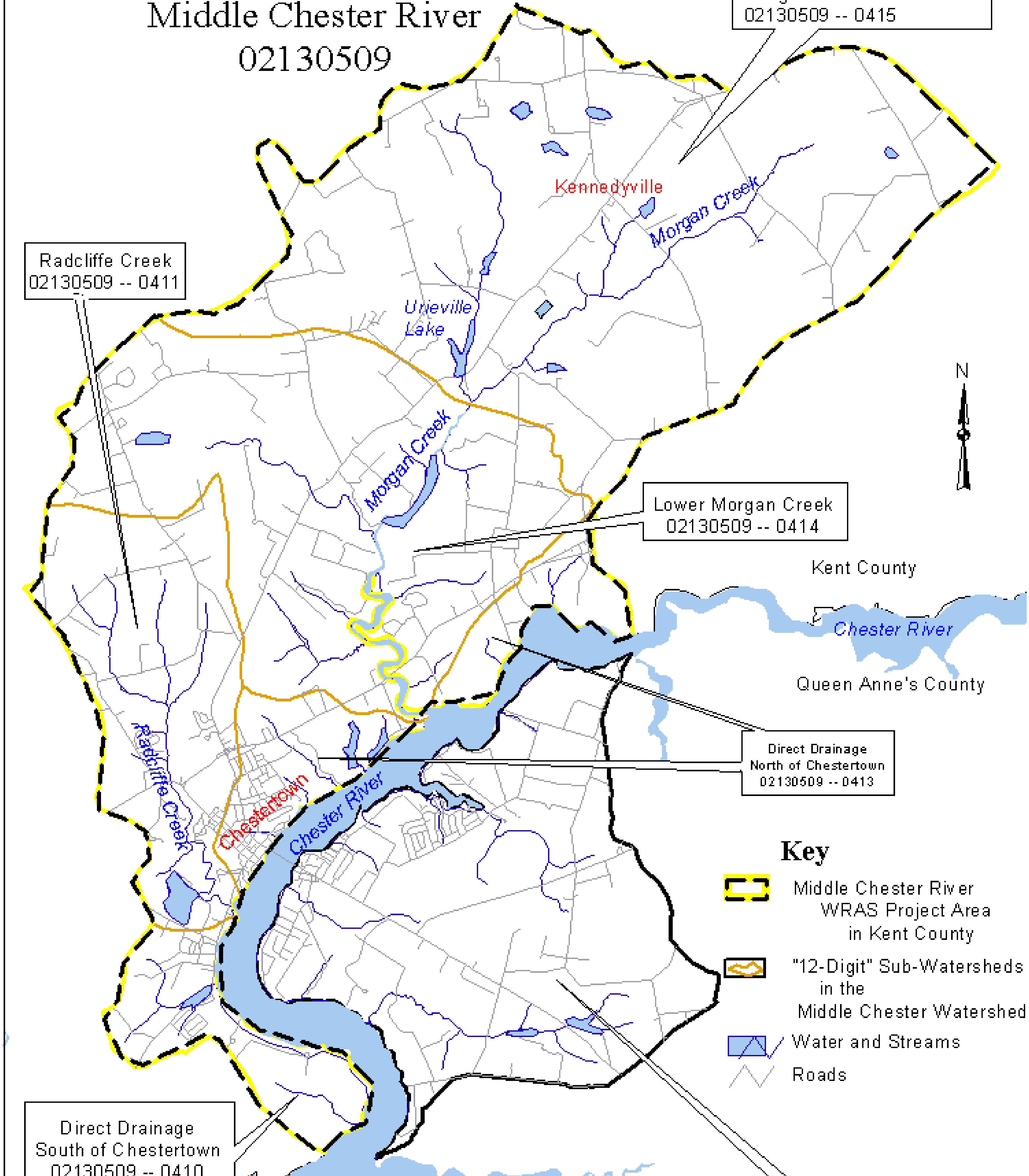


Maryland Department of Natural Resources
Chesapeake Bay and Coastal Watershed Service
Watershed Management and Analysis Division
April 2001

Map 2 WRAS Project Area
Middle Chester River Watershed In Kent County
Watershed Restoration Action Strategy (WRAS)



Map 3 Streams and Subwatersheds Middle Chester River 02130509



Maryland Department of Natural Resources
GIS: DNR CCWS, April 2001

WATER QUALITY

Designated Uses

All waters of the State are assigned a "Designated Use" in regulation, COMAR 26.08.02.08, which is associated with a set of water quality criteria necessary to support that use. A simplified summary of the Designated Uses in the Middle Chester watershed is listed below. (The Department of the Environment should be contacted for official regulatory information.) [7]

- Use I: for water contact recreation and aquatic life: All waters not designated as Use II
- Use II: for shellfish harvesting: Tidal waters downstream of Route 213.
- No other designated uses are established in the Middle Chester River watershed.

Not Supporting Designated Use – 303(d) Listings

Significant portions of the Middle Chester River either do not support their designated use or partially do not support their designated use.[2] As required under Section 303(d) of the Federal Clean Water Act, Maryland tracks waterways that did not support their designated use in a prioritized list of "Water Quality Limited Basin Segments." The Middle Chester River is referenced twice:

- *Nutrients.* In the 1996 303(d) list, the Chester River (which includes the Middle Chester River) is listed as Priority #4 among many priorities. Nutrients from point, nonpoint and natural sources are identified as the problem.
- *Nutrients, Fecal Coliform, Suspended Sediment*. In the 1996 303(d) list, the Middle Chester River is also listed separately for nutrients, fecal coliform and suspended sediment from nonpoint & natural sources.

The 303(d) priority referenced above is established by the Maryland Department of the Environment. Information considered in setting these priorities include, but is not limited to, severity of the problem and the extent of understanding of problem causes and remedies. These priorities are used to help set State work schedules various programs including total maximum daily loads (TMDLs).

Nutrients enter waterways from all types of land and from the atmosphere. The nutrients of primary concern are nitrogen and phosphorus. In general, an acre of forest land contributes the smaller amounts of nutrients than other lands. Residential land can be important contributor of nutrients depending on fertilizer use, extent of lawn and the status of septic systems. Many farmers carefully control nutrients so nutrients entering waterways from crop land varies greatly depending on management techniques. The atmosphere can contribute various forms of nitrogen arising from the burning of fossil fuels in power plants and from automobile exhaust.

Fecal coliforms are bacteria that are used as a measure of contamination from human and animal waste.

Suspended sediment arises from stream bed and bank erosion and from land that is poorly vegetated or disturbed. Construction sites, crop land and bare ground are common contributors. The amount of sediment contributed varies greatly site to site depending upon management controls that are used.

National Academy Press, Clean Coastal Waters (2000)
What Are the Effects of Nutrient Over-Enrichment? [18]

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

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

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

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

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

Water Quality Indicators

The *Maryland Clean Water Action Plan* published in 1998 listed the following water quality indicators for the Middle Chester River.[3] The Middle Chester River is also identified in the Plan as a Category 1 Priority Watershed "in need of restoration during the next two years." For more details on the *Clean Water Action Plan* see www.dnr.state.md.us/cwap/

Water Quality Indicator	**Finding**	**Rank**	**Bench Mark**
State 303(d) Impairment Number	"3"	Fail	This watershed is included in the 303(d) list. Impairment Number 3 means that additional protection is needed.
Modeled TN Load	9.66 lbs/acre	Fail	In comparison to 138 watersheds in Maryland, this watershed is among the 34 (25%) with the highest nitrogen loads.
Modeled TP Load	0.62 lbs/acre	Pass	In comparison to 138 watersheds in Maryland, this watershed is among the 104 (75%) with the lower phosphorus loads.

See Interpreting Water Quality Indicators for additional information.

Interpreting Water Quality Indicators

State 303(d) Impairment Number. This number is used to characterize watersheds relative to regulatory requirements of the Federal Clean Water Act. It is based on numerous water quality-related factors that are tracked by the State of Maryland under these federal requirements.

Modeled TN Load. TN refers to Total Nitrogen. Nitrogen Load is a measure of how much of this important nutrient is reaching streams and other surface waters. For each type of land use in the watershed, on average, stormwater tends to carry or transport a characteristic amount of nitrogen from the land to nearby streams. Based on these averages, computers can be used to estimate (model) how much nitrogen is likely to be reaching local streams. This method was applied Statewide to all the 138 watersheds in Maryland to allow comparison of "modeled total nitrogen load" among them. A rank of "fail" means that this watershed was among the 34 watersheds (25%) that had the highest estimated total nitrogen load. High nitrogen levels in tidal waters and lakes are often associated with poor water quality.

Modeled TP Load. TP refers to Total Phosphorus. It is a measure of how much of this important nutrient is reaching streams and other surface waters. The ranking for modeled TP Load was performed in parallel to the ranking for modeled TN Load above. (Note: details of the models differ.) The rank of "pass" means that this watershed was among the 104 (75%) out of 138 total watersheds in Maryland that had the lower estimated total phosphorus load.

Tributary Team Characterization

As part of the work of the Upper Eastern Shore Tributary Team, Middle Chester River water quality was characterized several parameters that are listed below. [1, 9] The status for each parameter in the table is a relative ranking at three levels: good, fair and poor. For example, poor means that the Middle Chester River ranking is poor compared to comparable Chesapeake Bay tributaries with comparable salinity. This information is taken from DNR's Internet site www.dnr.state.md.us/bay/tribstrat/index.html which includes maps of the Upper Eastern Shore of Maryland showing the status and trends for rivers near the Middle Chester River. These maps allow qualitative comparison of regional conditions.

Parameter	Status 1997 -99 data	Trend 1985 through 1999
Nitrogen: total	poor	no trend
Phosphorus: total	poor	improving (29%)
Algae: Abundance	poor	improving (22%)
Dissolved Oxygen (summer, bottom waters)	poor	no trend
Water Clarity: secchi depth	poor	improving (53%)
Suspended Solids: total	poor	no trend

Water Quality Assessment

It is anticipated that DNR will release a report, tentatively called the *DNR Chester River Study*, during Winter 2001. It will include information as described below that was collected at the sampling stations shown in Map 4 Monitoring Stations labeled as "mainstem" and "additional" stations:

– Water and Sediment samples were gathered in 1995 to establish baseline concentrations for metals and select pesticides. These samples were collected at the ten mainstem stations.
– A suite of nutrient parameters was measured monthly in 1999 at 30 sampling stations.
– Several water quality parameters were measured at each sampling station.

1. Clarity

Water clarity in the Chester River mainstem in the vicinity of the Middle Chester was the worst of any Chesapeake Bay tidal segment during the 1992-1997 time frame. [23] This condition, translated into living resource terms, indicates that submerged aquatic vegetation (SAV) can not grow in the Middle Chester River unless water clarity is improved. Based on data collected from monitoring station

ET4.1 upstream of the Middle Chester in the Chester River mainstem, this problem is arising, at least in part, upstream of the Middle Chester. For example, information is available indicating that at least one of the Upper Chester River subwatersheds contributes nutrients (total nitrogen) at a rate among the highest in the entire Chesapeake Bay watershed. [24] These nutrients would tend to drive algae growth in the River which reduces water clarity. To view data for station ET4.1, see http://www.dnr.state.md.us/bay/conditions/index.html.

2. Dissolved Oxygen

Analysis of dissolved oxygen (DO) samples collected in the Middle Chester River watershed show a range of conditions. DO in the Chester River was consistently above the water quality standard of 5.0 mg/L. [20] In very limited sampling of nontidal streams, summer DO in Radcliffe Creek fell below 5.0 mg/L water quality standard. [21] This is a level which stresses or eliminates some aquatic life. Urieville Lake DO has been found at extremely low concentrations -- as little as 0.1 mg/L. [13] Many species of aquatic life can not survive in these conditions.

Additional water quality-related data is available via the Internet. Two recommended Web sites are www.dnr.state.md.us/irc/datasets.html and www.chesapeakebay.net/wquality.htm .

3. Nutrients

In Radcliffe Creek, potentially elevated nutrient concentrations were cited in one study as a contributing factor for benthic conditions in 1992 and 1993. This study recommended Radcliffe Creek as a candidate for more exhaustive nutrient analyses. [21]

A comparison of the modeled nutrient estimates in the Water Quality Indicator section and the nutrient status and trends in the Tributary Team Characterization section shows the limitations of currently available nutrient information:

– Nutrient data for Middle Chester River tributaries was not available for the Watershed Characterization with the exception of the Radcliffe Creek data summarized above.
– The Water Quality Indicator modeled nutrient loads are based on estimated loads generated by nutrient sources in the watershed using average loading rates for each land use type.
– The Tributary Team Characterization is based on water quality data collected in the Chester River mainstem which includes nutrient loads from all sources upstream of the Middle Chester River.

For total nitrogen, the modeled indicator (fail) and Tributary Team Characterization (poor) seem consistent even though the two are measuring differing nitrogen source areas.

For total phosphorus, the modeled indicator (pass) and Tributary Team Characterization (poor) may not be inconsistent because they are measuring differing phosphorus source areas.

It is anticipated that the Chester River Study will refine the knowledge of nutrients in the Chester River mainstem. However, it is likely the modeled nutrient estimates for the watershed will remain useful until nutrient data is available for Middle Chester River tributaries.

4. Toxicity In Tidal Areas

In a December 2000 report produced by the Chesapeake Bay Program, *Chesapeake Bay Program Toxics 2000 Strategy*, portions of the Chester River, including the Middle Chester River, were classified as an "area of emphasis." The Middle Chester was one of several tidal areas around the Chesapeake Bay to receive this classification based on toxic compounds found there. The Chester River's classification was based on findings of DDT, arsenic and nickel there according to the report.

In general, toxic materials in the water and sediments of the Chesapeake Bay system are known to be localized and they are not homogeneously distributed bay-wide. Tidal rivers tend to serve as traps that accumulate the toxics which are residuals or by-products of human activities. The tidal rivers identified in the Toxics 2000 Strategy as areas of emphasis have high potential for toxic impacts and are showing early warning signs of contamination. The Toxics 2000 Strategy indicates that future efforts to address toxics will focus on these areas.

A study of toxicity in open tidal waters and sediment in the Chester River reported varying levels of toxicity to test organisms at all four sites tested in 1996. [20] Two of the four sample sites tested were in the Middle Chester River watershed as shown in Map 4 Monitoring Stations:

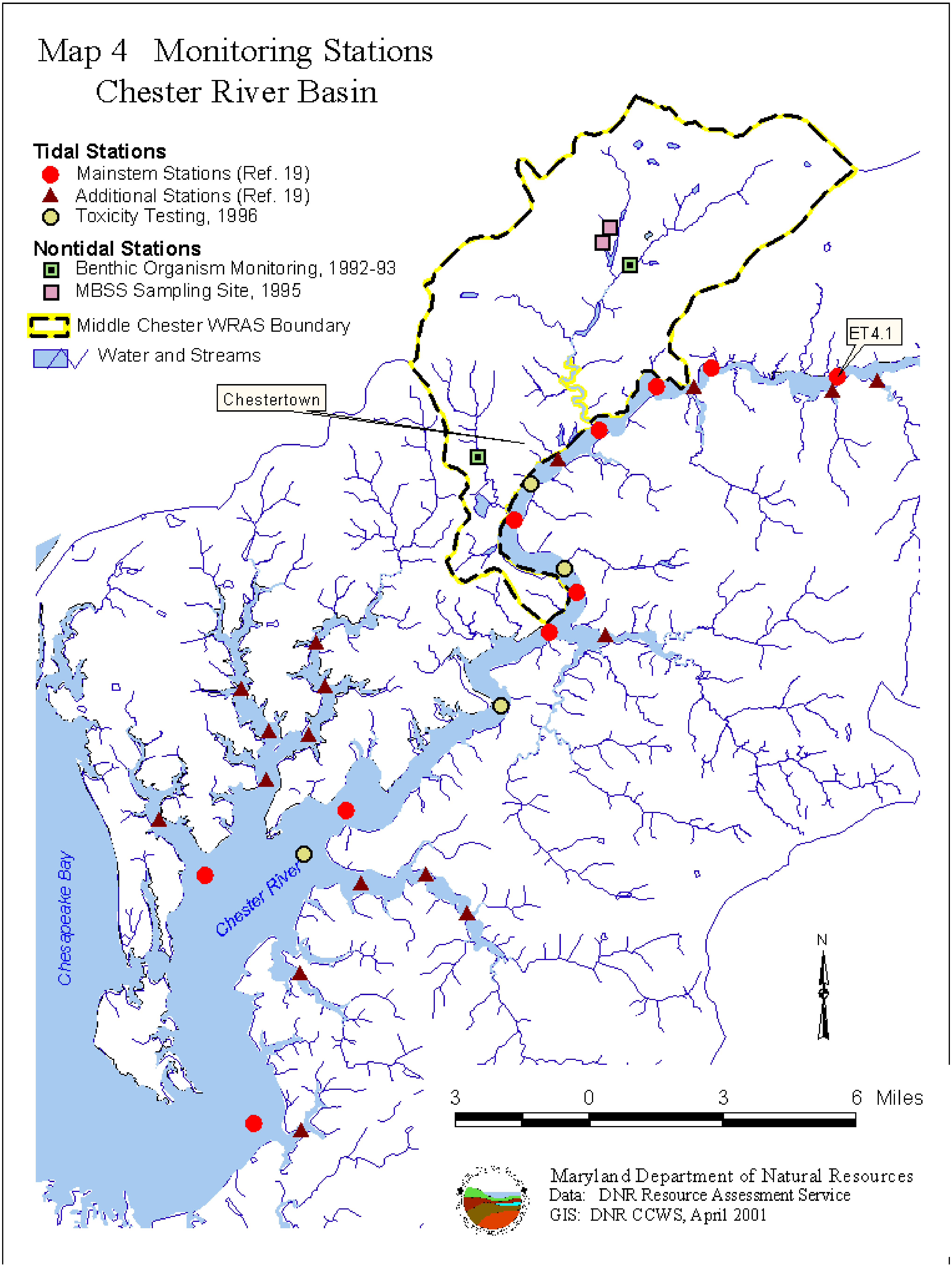
– Near Skillet Point which is near Chestertown

– Near Scotts Point down-river of Radcliffe Creek

In this study, toxicity waas measured by comparing survival and growth rates of test organisms (minnows and clams). These organisms were exposed to sample-site water or sediment collected from various sites around the Chesapeake Bay under laboratory conditions. For the Chester River sites, survival was not significantly affected but growth rates were inhibited. In summary, the Skillet Point site was found to have "high toxicity" in both the water column and in the sediment. The Scotts Point site exhibited "high toxicity" in the sediment and "low toxicity" in the water column. These findings mean that the test organisms grew at slower rates than reference sites (relatively uncontaminated areas.) The toxicity findings at the Middle Chester sites were similar those for more urbanized rivers like the James River, VA or the Magothy River, Anne Arundel County, MD.

DDT and Dieldrin were found at all four Chester River sites with the highest concentrations found at the Middle Chester River sites. The authors of the study speculated that these compounds may have contributed to their toxicity findings.

Concentrations for metals were found to be generally low at the Chester River sites. However, both Middle Chester River sites had sediment concentrations above the "Effects Range - Low" threshold for arsenic, lead and nickel. The Skillet Point site also had sediment concentrations for mercury and zinc above this threshold. These findings suggest that the on-site concentrations of these metals could cause biological effects in some organisms.


Map 4 Monitoring Stations
Chester River Basin
Tidal Stations
Mainstem Stations (Ref. 19)
Additional Stations (Ref. 19)
Toxicity Testing, 1996
Nontidal Stations
Benthic Organism Monitoring, 1992-93
MBSS Sampling Site, 1995
Middle Chester WRAS Boundary
Water and Streams
Chestertown
ET 4.1
Chesapeake Bay
Chester River
N
3 0 3 6 Miles
Maryland Department of Natural Resources
Data: DNR Resource Assessment Service
GIS: DNR CCWS, April 2001

Point Sources

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

According to the Maryland Department of the Environment (MDE) permit data base as summarized in the following table, there are six permitted surface water discharges and two permitted groundwater discharges in Kent County's portion of the Middle Chester River watershed. Not included in the table, but shown in Map 5 MDE Permits, are six "general permits" (hospital, bulk petrol, marina, farm, etc.), eight general industrial stormwater permits listed in MDE's permit data base, and five permits of various types in the Queen Anne's County portion of the Middle Chester River watershed.

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

Based on information received by the Upper Eastern Shore Tributary Team, Chestertown has agreed to upgrade its Waste Water Treatment Plant (WWTP) with Biological Nutrient Removal (BNR) technology to reduce nutrient discharge from the WWTP. This treatment technology is designed to reduce nutrients discharged during summer months when the risk of algae blooms is greatest. The greatest benefit of using BNR is reduction of total nitrogen concentration in the effluent. Control of total nitrogen in sewage effluent by other means (chemicals, etc.) is significantly more expensive in general.

POINT SOURCES: NPDES PERMITS and GROUDWATER DISCHARGE PERMITS Middle Chester River Watershed			
Facility Name	**NPDES Permit / MD Code**	**Discharge Type / MDE Permit Category**	**Location**
Chestertown Foods, Inc. Fowl Processing	MD0002232 93DP0009	Surface Water / Industrial	27030 Morgan Neck Road
Chestertown WWTP	MD0020010 95DP0592	Surface Water / Municipal	25792 John Hanson Road
Kennedyville WWTP	MD0052671 92DP1142	Surface Water / Municipal	Route 448, Kennedyville
Maryland National Guard Chestertown Armory	MD0065731 96DP2878	Surface Water / Industrial	Quaker Neck Road
Velsicol Chemical Corp. Organic Chemicals	MD0000345 93DP0014	Surface Water / Industrial	10380 Worton Road
Worton-Butlertown WWTP	MD0060585 94DP2109	Surface Water / Municipal	Chinquapin Road
Geno's Auto Services	94DP3117	Groundwater / Industrial	807 Washington Ave.
Horizon Organic Dairy Maryland Farm	97DP2562	Groundwater / Industrial	11471 Augustine Herman Hwy

Note: WWTP means Waste Water Treatment Plant primarily for treating sewage.

NonPoint Sources

A quantitative estimate of nonpoint source loads (surface water or groundwater) is not available for the Middle Chester River watershed. Anecdotal information on wildlife contributions, including the region's large goose population, has not been quantified. However, nutrients and sediment are a significant issue in the watershed based on two sources:

– listing of the river under Section 303(d) of the Clean Water Act

– modeled nitrogen summary in the *Water Quality Indicators* section in this Watershed Characterization.

Several potential approaches for addressing nonpoint source pollution in the Middle Chester River WRAS were identified in discussions between local representatives and DNR representatives:

– Supporting development of nutrient management plans.

– Promoting the marina pumpout program – especially for summer visitors on the Chester River.

– Identification of septic system problems: existing and potential.

– Supporting development of comprehensive conservation plans for agricultural operations.

1. Erosion and Sediment Transport

Soils in the Middle Chester River watershed are prone to erosion. (See the Soil Erodibility Indicator in the Land Use section.) The experience from Urieville Lake suggests that high sediment transport has been an important factor in determining the quality of aquatic habitat within the watershed. The lake currently provides poor habitat, in part, because it is largely filled by trapped sediment. Stream habitat below the lake is relatively good because of the protective function provided by the lake. [14]

The 1999 Total Maximum Daily Load (TMDL) for Urieville Lake called for over 42% reduction in sediment loading rates to protect the lake.[5] The intent of the TMDL is to reduce both the sediment and the phosphorus load that accompanies the sediment.

Based on this limited assessment, the Watershed Restoration Action Strategy may incorporate projects for education and/or incentives for erosion and sediment control.

2. Shorelines

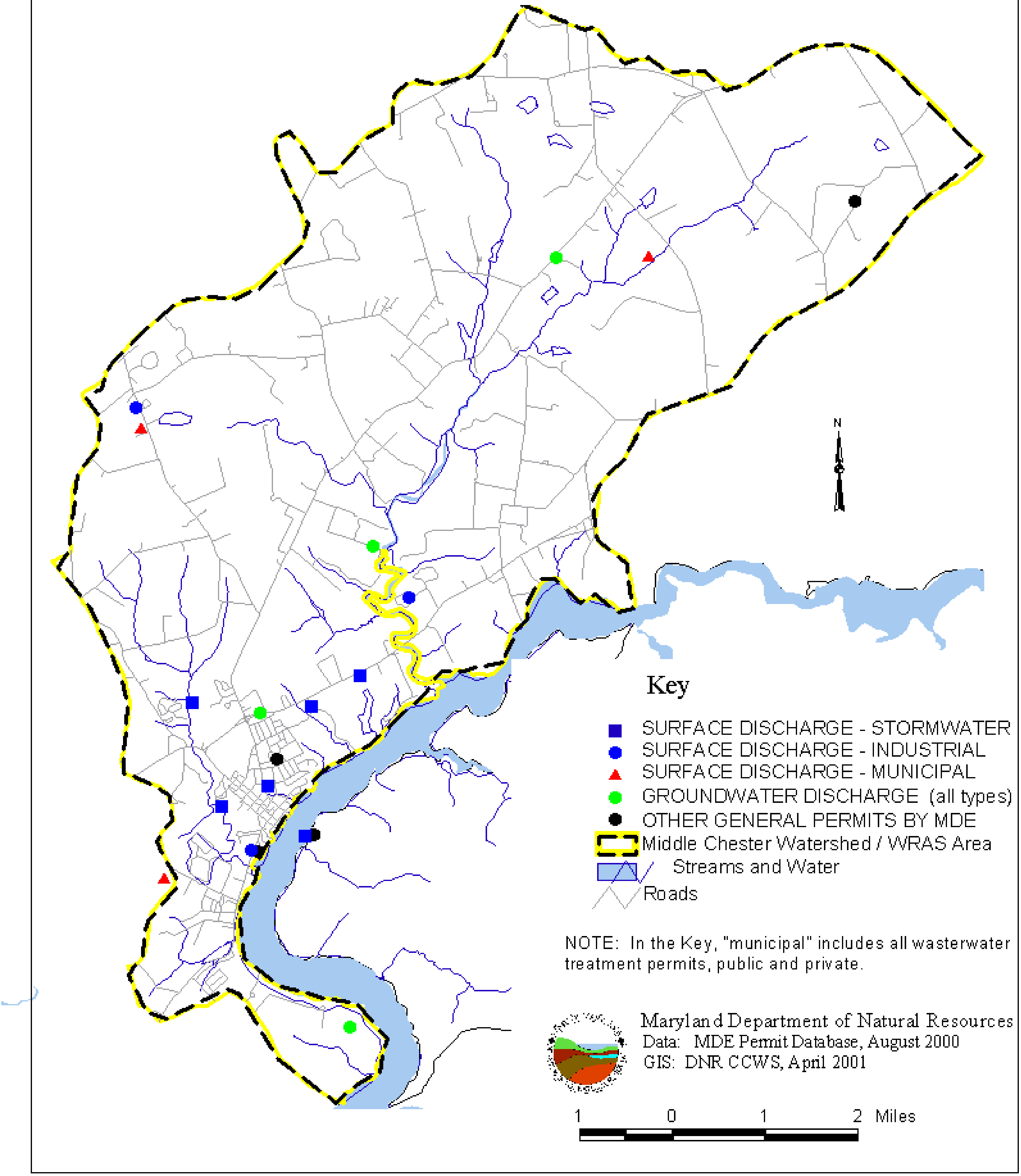
Wherever land and open water meet, change in the form of erosion or accretion of land is typically the inevitable result of natural processes. Human activity in these areas either tends to inadvertently accentuate these natural processes or purposefully attempts to control movement of water and/or loss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

Countywide shoreline erosion is summarized in the following table. [12]

Kent County Shore Erosion Rate Summary (Miles of Shoreline)				
Total Shoreline	Total Eroding Shoreline	Erosion Rate		
		0 - 2 feet / year	2 - 4 feet / year	> 4 feet / year
268	78	64	12	2

Maps of historic shoreline change were produced in 1999 by the Maryland Geological Survey (MGS) in a cooperative effort between DNR and the National Oceanic and Atmospheric Administration (NOAA). These maps included digitized shorelines for several years in Kent County. The maps show that extensive changes have occurred adjacent to all large bodies of open water which are outside of the Middle Chester River watershed. The maps also show relatively little change adjacent to smaller water bodies that are typical along the Middle Chester. Copies of these 1:24000 scale maps are available from the MGS.

Map 5 MDE Permits
Middle Chester Watershed



Total Maximum Daily Loads: Urieville Lake

Currently, Total Daily Maximum Load (TMDL) work in the Middle Chester River watershed has been completed for the subwatershed draining to the Urieville Community Lake. It can be anticipated that additional TMDL work will be conducted in the Middle Chester watershed but no schedule is currently available. As new information becomes available it can be added to this Watershed Characterization.

Urieville Community Lake is an extremely eutrophic water body on a DNR-owned property. The very poor water quality of the lake is associated with trapped sediment and nutrients. Water samples collected in 1993 found dissolved oxygen below 0.1 mg/l. Measurements of both total phosphorus and total nitrogen concentrations in the lake indicated eutrophic conditions.[13] An attempt by DNR to improve conditions in the Lake by draining and sediment removal in the middle 1990s was not successful. However, this approach proved controversial and the plan was not implemented. Currently, lake conditions remain poor.[14]

The June 1999 Final Total Daily Maximum Load (TMDL) for Urieville Community Lake verified that past / present nonpoint sources are the cause of water quality problems in the Lake. The Lake's watershed is 80% agricultural land, 18% forest and only 2% urbanized land. There are no point sources in this drainage area.[5]

The TMDLs for Urieville Lake are:

– Phosphorus = 509 lb/yr. This represents an 85% reduction.

– Sediment = "An estimated 42.45% reduction in sediment loading rates. This translates to a sediment accumulation rate of about 24% of the storage capacity in 40 years, or an estimated load of 89.2 tons/yr. This estimated load is based on estimated "suspended solids," which include organic matter, but exclude materials transported in the bed load." Therefore, this TMDL is intended to reduce sediments from land erosion but does not address stream bank erosion.

LAND USE

Middle Chester River Watershed

Landscape Indicators

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

The *Maryland Clean Water Action Plan* published in 1998 listed landscape indicators for the Middle Chester River watershed as summarized in the table below.[3] Most indicator ranking (pass / fail) is a relative measure that compares the Middle Chester River watershed with the other 137 watersheds of similar size that together cover the entire State of Maryland.

Landscape Indicator	**Finding**	**Rank**	**Bench Mark**
Impervious Surface	3.7 % of watershed is impervious	Pass	Of 138 watersheds in Maryland, this one is among the 104 watersheds (75%) with the least impervious surface.
Population Density	0.11 people per acre	Pass	Of 138 watersheds in Maryland, this one is among the 104 watersheds (75%) with the lower population density.
Historic Wetland Loss Density	13,226 acres	Pass	Of 138 watersheds in Maryland, this one is among the 104 watersheds (75%) with smaller historic losses.
Soil Erodibility	0.30 value per acre	Fail	Of 138 watersheds in Maryland, this one is among the 34 watersheds (25%) with the highest soil erodibility. (Soil erodibility is a natural condition.)

NOTE: The soil erodibility indicator accounts for natural soil conditions but not for management of the land. The naturally erodible soils of the Middle Chester River watershed are addressed by techniques called Best Management Practices (BMPs) to prevent soil loss that are typically in use on local farms. BMPs like no-till, reduced till, cover crops, field strips, and others significantly reduce erosion and sediment movement. These BMPs can be seen in use in many places in the watershed.

See Interpreting Landscape Indicators for additional information.

Interpreting Landscape Indicators Page 1 of 2

Impervious Surface. Reduction of impervious area can be a valuable component of a successful Watershed Restoration Action Strategy (WRAS). 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. Side-effects of impervious surfaces become increasingly significant as the percentage of impervious area increases. Examples include reduction of groundwater infiltration, soil and stream bank erosion, sedimentation, destabilization or loss of aquatic habitat, and "flashy" stream flows (reduced flow between storms and excessive flows associated with storms.)

Population Density. While population density may be beyond the scope of a WRAS, directing growth is a potential WRAS component. Humans are usually very successful in competing for use of land and water. As human population increases, effects of human activity tend to degrade, displace or eliminate natural habitat. Watersheds with higher populations, assuming other factors are equal, tend to exhibit greater impacts on waterways and habitat. However, growth can be directed in ways to reduce negative impacts.

Historic Wetland Loss Density. About 43% of the Middle Chester River watershed is hydric soil (about 13,000 out of 31,000 acres). The historic wetland loss estimate is based on the assumption that the hydric soils were all, at one time, wetlands. Thoughtful selective restoration of historic wetland areas can be an effective WRAS component. In most of Maryland's watersheds, extensive wetland areas have been converted to other uses by draining and filling. This conversion unavoidably reduces or eliminates the natural functions that wetlands provide. These functions include habitat and nursery areas for many aquatic organisms, flood attenuation, and uptake and redistribution of nutrients, etc. In general, watersheds exhibiting greater wetland loss tend to also exhibit greater loss of the beneficial functions that wetlands provide. Strategic replacement of wetlands can significantly improve natural function in local watershed areas.

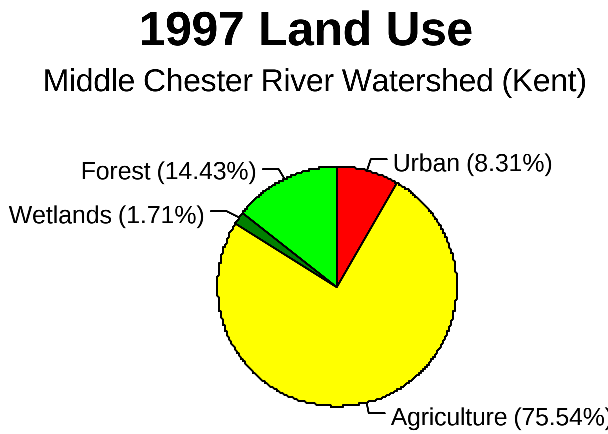
Interpreting Landscape Indicators Page 2 of 2

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

Soil Erodibility. A finding of 0.30 means that the Middle Chester River watershed has "high" soil erodibility considering soils types, steep slopes and the extent of crop land within 1000 feet of waterways. (Existing crop land management was not considered.) Watersheds with more highly erodible soils are naturally more susceptible to surface erosion, sedimentation, streambank erosion and other problems related to soil movement. These negative effects of soil erodibility on water quality can be minimized through careful management. A WRAS can reasonably promote a reduction in disturbance of erodible soils and/or effective soil conservation practices like planting stream buffers.

Land Use 1997

The following table and pie chart summarize 1997 land use for the Kent County portion of the Middle Chester River Watershed. Viewing these land uses as potential nonpoint sources of nutrients, agricultural lands are likely to dominate loads to local waterways. Map 6 1997 Generalized Land Use Map shows the distribution of lands in the watershed. Additional details on land use in the Middle Chester River watershed are prodived in the Land Use Technical Report.

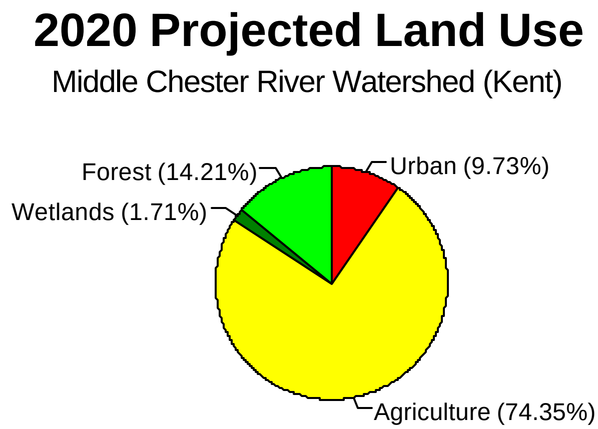


1997 Land Use Middle Chester River Watershed in Kent County		
Category	**Description**	**Acres**
Agriculture	Field, Pasture, Ag buildings	22,360
Forest	All woodlands and brush	4,272
Urban	All developed areas	2,461
Wetlands	Tidal marsh, Emergent wetlands	506
Other	Extractive and bare ground (not graphed)	26
Watershed Total	**(excluding open water)**	**29625**

Land Use Projection to 2020

The Maryland Department of Planning is projecting planning estimates for population and related factors like land use to the year 2020. Based on work completed as of October 2000, the 2020 land use estimates are shown in the pie chart and in the table below.[17]

Several 2020 projections are potentially important for WRAS planning in the Kent County portion of the Middle Chester River watershed as listed on the next page:



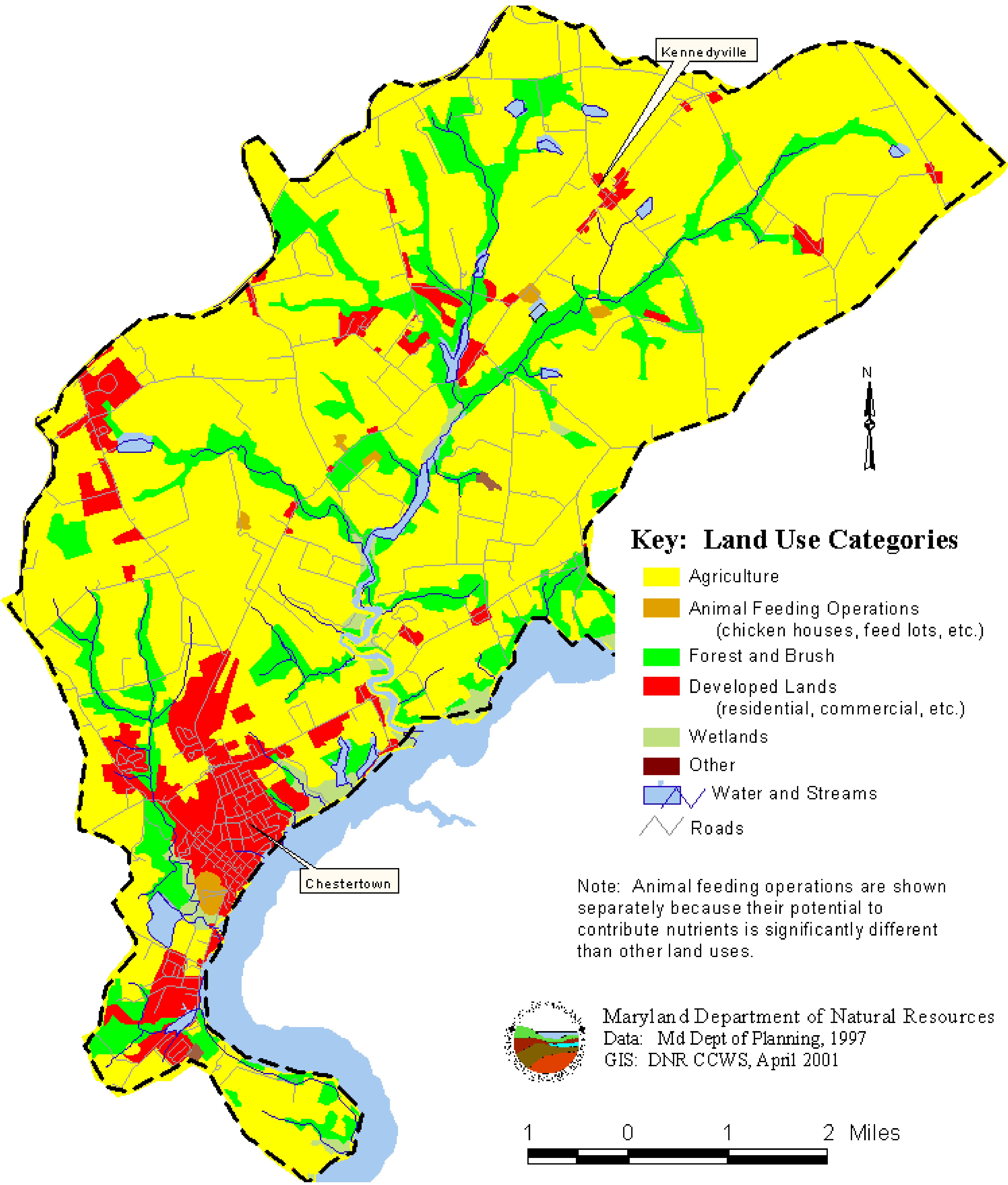
Projected Change in Land Use 1997 to 2020 Middle Chester River Watershed in Kent County		
Category	**Description**	**Acres**
Agriculture	Field, Pasture, Ag buildings	- 356
Forest	All woodlands and brush	- 67
Urban	All developed areas	423
Wetlands	Tidal marsh, Emergent wetlands	no change
Other	Extractive and bare ground	no change

– Urban land use is projected to increase 17% while agriculture and forest lands are projected to decrease about 1.5% each. The projected continuing loss of prime agricultural land is of particular concern.
– Percentage of households served by septic system are projected to increase from 31% to 39%.
– Impervious cover is projected to increase in the Radcliffe Creek subwatershed (0411) from 10% to 11%. The subwatershed encompassing the remainder of Chestertown (0413) is projected to increase from 12% to 13%. Increasing imperviousness is known to increase stress on aquatic organisms.
– Kent County Department of Planning indicates that several factors may also affect land use change over the next twenty years. [22] 1) Wet soil conditions tend to be prevalent in forested areas in the Middle Chester River watershed. This local condition may prevent conversion of some forested areas to urban use because new structures in rural areas will require on-site sewage treatment (passing soil percolation tests). Therefore, the County feels that additional pressure for development may be seen on agricultural lands that perk and potentially less pressure on wet forested land than the land use projection model suggests. (For more information on this issue, see Map 11 Wetlands, the wetlands section and hydric soils shown in Map 21 Wetland Restoration Opportunities.)
2) County-wide, forest land acreage has been increasing partially due to requirements of the Chesapeake Bay Critical Area. These factors may affect the Middle Chester area.

These projections suggest an overall trend toward increasing stress on natural systems in the watershed and particularly on aquatic life. In light of these projections, Middle Chester watershed planning could consider potential WRAS elements to help counterbalance the anticipated trends. Potential WRAS initiatives could relate to smart growth, agricultural land preservation, stream / natural area enhancement or protection, etc.

The Land Use Technical Report has additional details.

Map 6 1997 Generalized Land Use
Middle Chester Watershed



Green Infrastructure

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

Within the Green Infrastructure network, large blocks of natural areas are called hubs, and the existing or potential connections between them, called links or corridors. Together the hubs and corridors form the Green Infrastructure network which can be considered the backbone of the region's natural environment.[6]

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

Based on results so far from the Chino Farms Project in Queen Anne's County, Kent County representatives have expressed interest in potential use of the Green Infrastructure concept. Map 7 Green Infrastructure shows several significant local characteristics of Green Infrastructure:

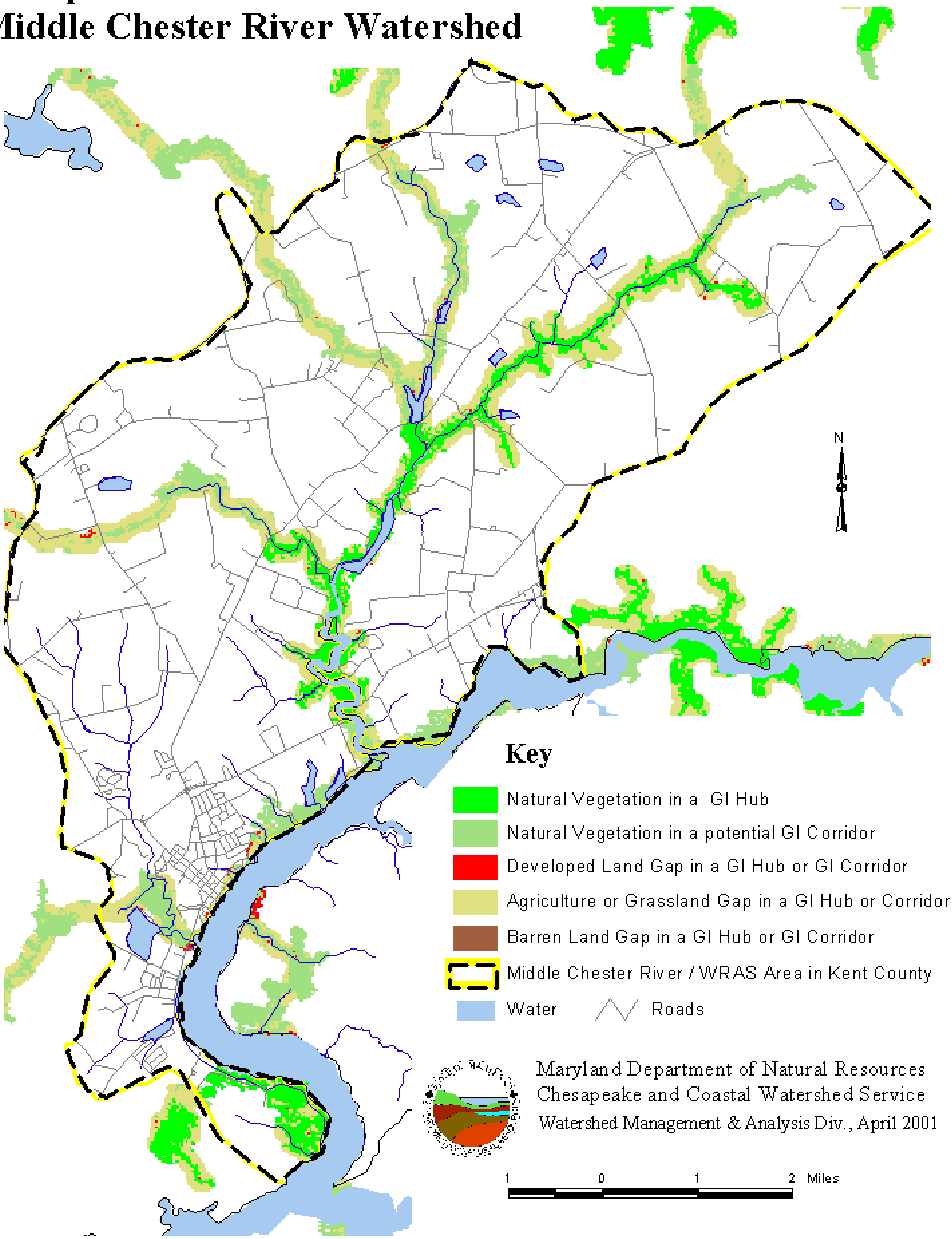
– The great majority of Kent County is in active agriculture or urban use and is therefore not identified as part of the Green Infrastructure. Other lands that may be areas of natural vegetation are not identified on the Green Infrastructure maps because they are too small to be considered of State or regional importance. However, some of these areas may be locally significant components of Green Infrastructure that should be identified for local consideration in the WRAS.

– Most Green Infrastructure in Kent County is associated with water and wetlands. For example, the largest Green Infrastructure Hub in the Middle Chester River watershed, along Morgan Creek, is mostly emergent wetlands and forest associated with wetlands and hydric soil.

– The corridors shown on the Green Infrastructure Map can be considered as existing or potential connections between Green Infrastructure hubs. Significant portions of the mapped corridors are in agricultural use. The large areas that lack natural vegetation tend to limit the corridor's contribution to the Green Infrastructure network.

The Middle Chester WRAS could potentially assess enhancement, expansion, or protection of the Green Infrastructure hubs and corridors.

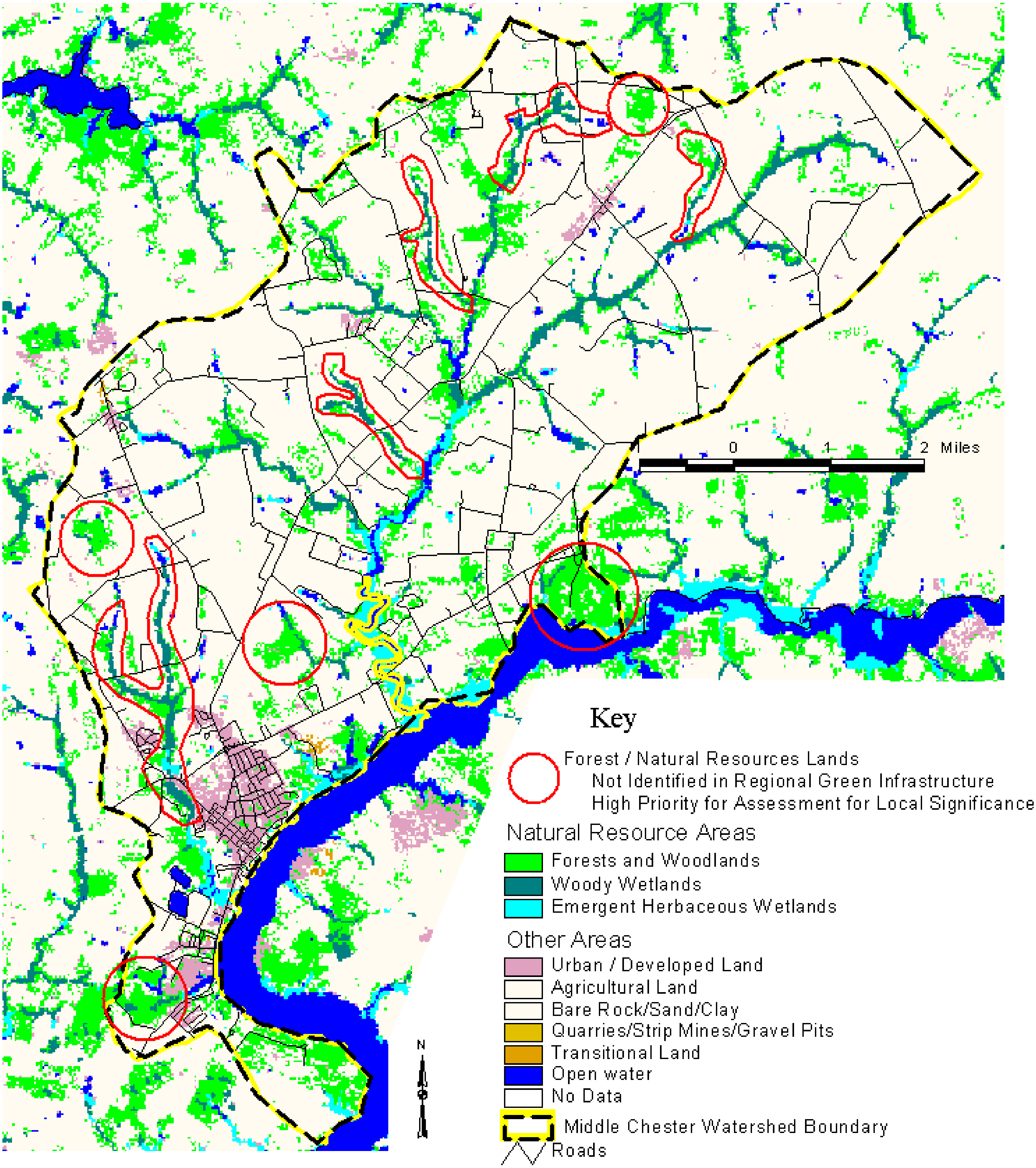
Map 7 Green Infrastructure
Middle Chester River Watershed



Natural Resource Areas at the Watershed Scale

The Green Infrastructure scenario described here, due to its Statewide or regional focus, may not identify natural resource areas that are locally significant. It is reasonable to employ GIS information at the watershed scale to help identify natural areas of potential local significance. Map 8 Natural Resource Areas of Potential Local Significance suggests numerous areas that may have local natural resource importance. This GIS map (and similar scenarios) can be used to assist in prioritizing areas for further assessment and to help clarify local interests and needs for locally important natural resource areas.

Map 8 Natural Resource Areas of Potential Local Significance
Middle Chester River Watershed



Maryland Department of Natural Resources
Data: US EPA, Md Land Cover Version 99-01, LANDSAT 1993
GIS: DNR CCWS, April 2001

1 0 1 2 Miles

Protected Lands

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

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

The following listing and Map 9 Protected Land and Smart Growth summarize the status of protected lands in the Middle Chester River watershed.

– Most land in the watershed is privately owned. Promoting opportunities available for private land owners to protect rural, agricultural and similar land values may be valuable in the Watershed Restoration Action Strategy. In preliminary discussions between County and DNR representatives, communicating opportunities for agricultural easements was raised as an interest.
– Local / County parks are concentrated in one large area at the northwest edge of the watershed or are small parcels geared to local recreational interests around Chestertown.
– DNR land is limited to a small acreage at the Urieville Community Lake.
– Land protected with the intent of continued agricultural use is concentrated on several farms northeast of Chestertown.
– Conservation easements are concentrated in two areas south and west of Chestertown.

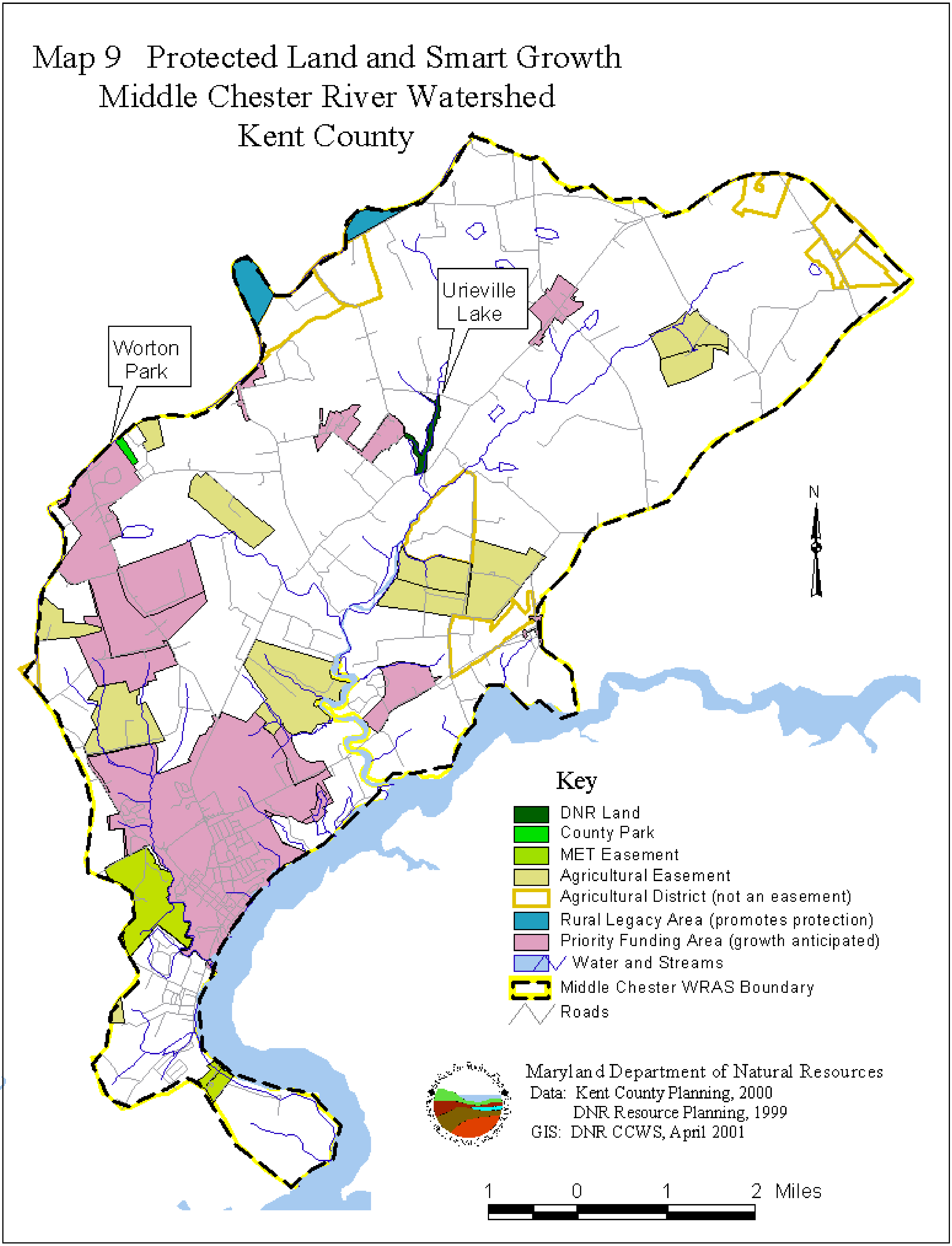
In drafting the WRAS for the Middle Chester River in Kent County, existing protected lands could be assessed as potential contributors to WRAS implementation. Various types of opportunities could be explored:
– Potential sites for implementation projects and/or demonstration projects
– Opportunities for management enhancement or additional protection
– Opportunities for expanding protection from currently protected land to adjacent parcels.

Smart Growth

Within Maryland's Smart Growth program, there are two targeting programs that should be considered as potential watershed restoration projects are considered. In Rural Legacy Areas, protection of land from future development through purchase of easements (or in fee simple) is promoted. In Primary Funding Areas, State funding for infrastructure may be available to support development and redevelopment. Both are shown in Map 9 Protected Land and Smart Growth:

- Rural Legacy Areas in the Middle Chester. Two small areas at the edge of the Middle Chester watershed up stream of Urieville Lake are part of a much larger Rural Legacy Area immediately outside of the watershed to the north. Expansion of protected land through this program could be incorporated as a component of the Watershed Restoration Action Strategy.

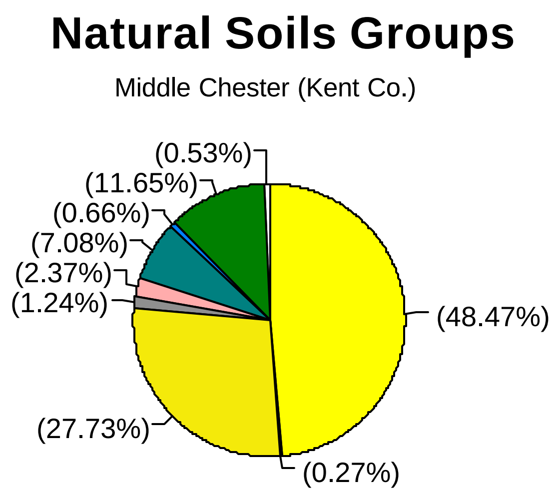
- Priority Funding Areas in the Middle Chester. About six areas in the Middle Chester watershed are designated Priority Funding Areas. The majority of the acreage is concentrated in and around Chestertown and Worton. In Priority Funding Areas, new development and/or redevelopment may be anticipated. Planning for watershed restoration projects in Priority Funding Areas, or downstream of them, needs to account for potential changing conditions during the life of the project. For example, increasing impervious area may alter stormwater conditions that a watershed restoration project will have to adequately address.


Map 9 Protected Land and Smart Growth
Middle Chester River Watershed
Kent County
Urieville Lake
Worton Park
N
Key
DNR Land
County Park
MET Easement
Agricultural Easement
Agricultural District (not an easement)
Rural Legacy Area (promotes protection)
Priority Funding Area (growth anticipated)
Water and Streams
Middle Chester WRAS Boundary
Roads
Maryland Department of Natural Resources
Data: Kent County Planning, 2000
DNR Resource Planning, 1999
GIS: DNR CCWS, April 2001
1 0 1 2 Miles

Soils of the Middle Chester River Watershed

1. Interpreting Local Conditions with Natural Soil Groups

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



In Map 10 Soils and the pie chart, prime farmland is depicted in yellow or yellow with crosshatching. Over 75% of the Middle Chester River Watershed in Kent County is prime farmland.

The green and bluegreen areas are soils with wetness conditions that limit their agricultural or development potential. These soils are concentrated along the Middle Chester River and its tributaries Morgan Creek and Radcliffe Creek. Nearly 20% of the watershed exhibit wetness-related limitations.

Also concentrated along local waterways are soils on slopes between 8% to 15% and soils that are excessively well drained.

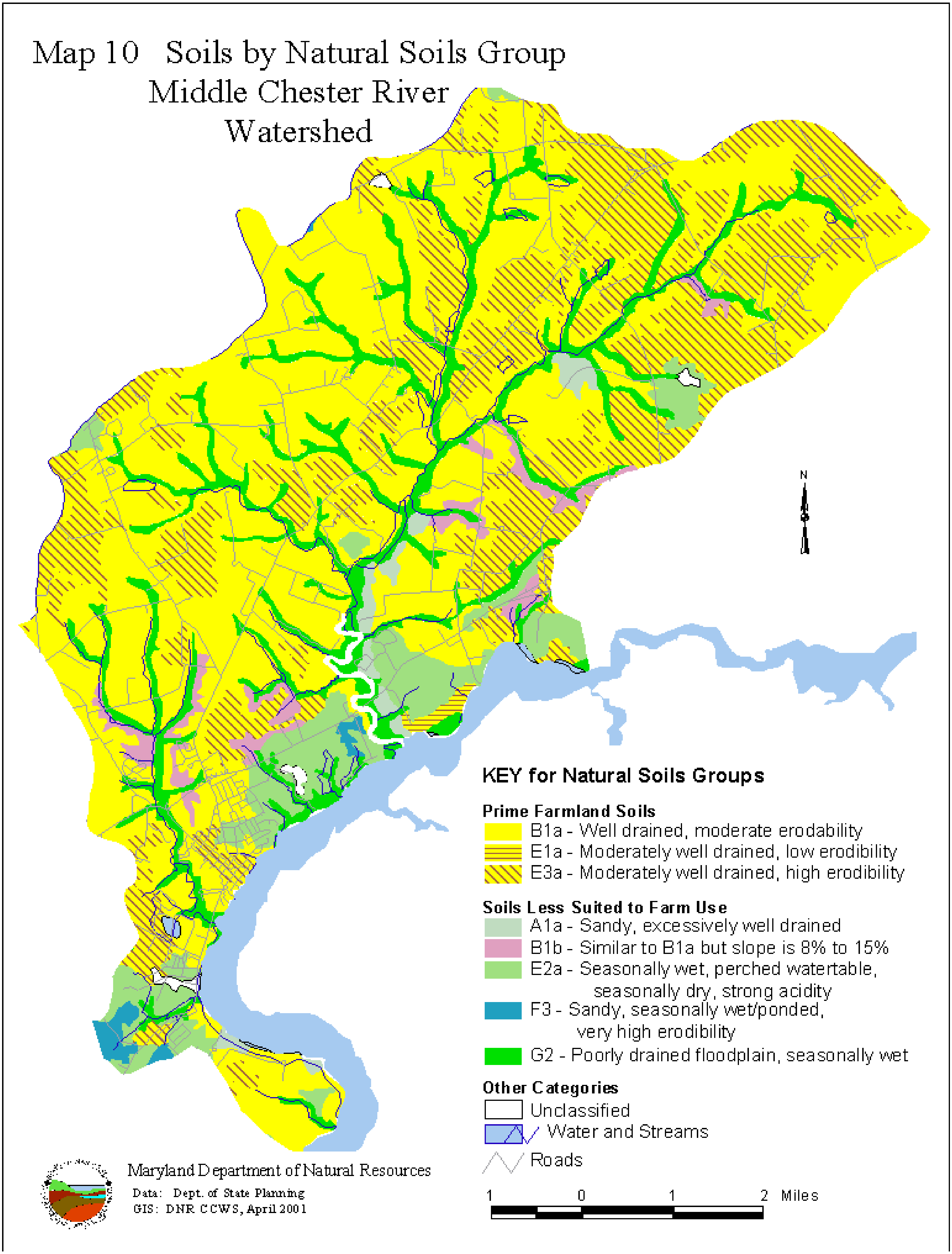
2. Soils and Watershed Planning

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

Soils with limitations related to wetness or slope naturally inhibit active use for farming or development. Land owners in the watershed have tended to leave many of these areas in natural vegetation or other low intensity use. By comparing Map 10 Soils with the three preceding maps listed below, it is apparent marginal soils and current areas of natural habitat tend to coincide:

– Map 6 1997 General Land Use
– Map 7 Green Infrastructure
– Map 8 Natural Resource Areas of Potential Local Significance

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


Map 10 Soils by Natural Soils Group
Middle Chester River
Watershed
N
KEY for Natural Soils Groups
Prime Farmland Soils
B1a - Well drained, moderate erodability
E1a - Moderately well drained, low erodibility
E3a - Moderately well drained, high erodibility
Soils Less Suited to Farm Use
A1a - Sandy, excessively well drained
B1b - Similar to B1a but slope is 8% to 15%
E2a - Seasonally wet, perched watertable,
seasonally dry, strong acidity
F3 - Sandy, seasonally wet/ponded,
very high erodibility
G2 - Poorly drained floodplain, seasonally wet
Other Categories
Unclassified
Water and Streams
Roads
1 0 1 2 Miles
Maryland Department of Natural Resources
Data: Dept. of State Planning
GIS: DNR CCWS, April 2001

Wetlands

1. Introduction to Wetland Categories [26]

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

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

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

2. Tracking Wetlands [26]

Oversight of activities affecting wetlands involves several regulatory jurisdictions. The Maryland Dept. of the Environment (MDE) is the lead agency for the State and cooperates with DNR, the Army Corps of Engineers and other Federal and local agencies. As part of its responsibility, MDE tracks State permitting and the net gain or loss of wetlands over time. As the Wetlands Regulatory Status table shows, changes tracked in the State regulatory program have been minor in the Middle Chester River watershed.

Tracking Nontidal Wetland Change
Middle Chester River Watershed
Permits Authorized = 3
Letters of Authorization Issued = 11

Wetland Class	**Acres**
Permanent Impacts	-0.36
Mitigation by Permittee	0
Other Gains (Regulatory)	8.69
Programmatic Gains	0
Net Gain/Loss	8.33

Note: Regulatory tracking for authorized nontidal wetland losses began in 1991. Comprehensive tracking of voluntary wetland gains began in 1998. Tidal wetland changes

3. Interpreting Wetland Distribution

Wetlands in the Middle Chester River watershed tend to occur along waterways as shown in Map 11 Wetlands. In comparing the wetlands map to Map 6 1997 Generalized Land Use, it can be seen that much of the forested land in the watershed is found in association with wetlands or adjacent to them.

A comparison of the two maps shows that many of the nontidal wetland areas are depicted as forest on the land use map. This difference is simply the result of two differing views of the landscape. For example, wooded nontidal wetlands can be viewed as "wetlands" from a habitat / regulatory perspective and they can be viewed as "forest" from a land use perspective.

Wetland Acreage Summary Middle Chester River Watershed [26]		
Wetland Class		Acres
Estuarine, Intertidal (E2)	aquatic bed	0
	beach bar	8
	emergent	4,635
	forested	0
	scrub shrub	272
Palustrine (P)	aquatic bed	42
	emergent	1,006
	flat	114
	forested	9,209
	scrub shrub	1,530
Riverine, Lower Perennial (R2)	beach bar	0
Riverine, Upper Perrenial (R3)	beach bar	0
Total Wetlands	National Wetlands Inventory	16,816

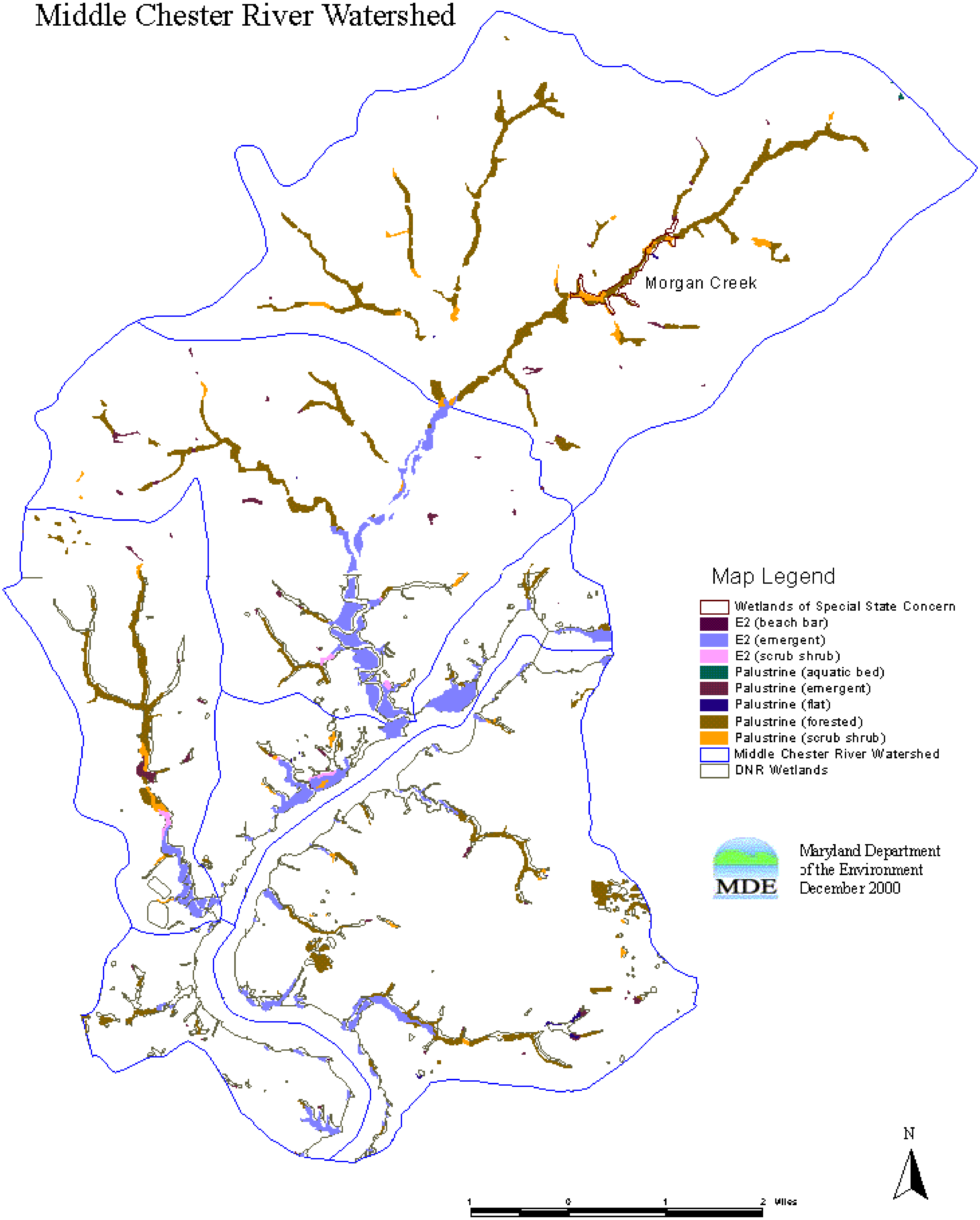
Wetlands of Special State Concern (WSSC) 75 acres

NOTE: WSSC regulations apply to selected wetlands listed in table above. See the Sensitive Species Section for discussion.

In the Middle Chester River watershed, differing perspectives on counting wetlands are significant for watershed management. From a land use perspective, 506 acres of wetlands are identified by the Maryland Department of Planning. From a habitat / regulatory perspective, there are approximately 16,816 acres of wetlands in the watershed.

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

Map 11 Wetlands
Middle Chester River Watershed



LIVING RESOURCES AND HABITAT

Overview

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

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

Living Resource Indicators

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

The *Maryland Clean Water Action Plan* published in 1998 listed the following living resource indicators for the Middle Chester River Watershed.[3] Compared to other watersheds in Maryland, the Middle Chester watershed exhibits poor conditions for submerged aquatic vegetation and for bottom-dwelling organisms in nontidal streams.

Living Resource Indicator	Score	Rank	Bench Mark (percent based on 138 watersheds)
SAV Abundance Index	1.00	Fail	Scale of 1 (worst) to 10 (best) Score of 1 yields a rank of "fail"
SAV Habitat Index	3.00	Fail	Scale of 1 (worst) to 10 (best) Score less than 7 yields a rank of "fail"
Non-Tidal Benthic Index of Biotic Integrity	3.59	Fail	Scale of 1 (worst) to 10 (best) Score less than 6 yields a rank of "fail"
Non-Tidal Fish Index of Biotic Integrity	7.50	Pass	Streams scoring less than 6 were designated Category 1 watersheds in need of restoration. Streams scoring greater than or equal to 8 were designated Category 3 watersheds in need of protection.
Non-Tidal In-stream Habitat Index	3.89	Pass	Scale of 1 (worst) to 10 (best) Of 138 watersheds in Maryland, the 34 (25%) with the lowest nontidal in-stream habitat index received a rank of "fail" and were designated as Category 1 watersheds in need of restoration. The top 34 (25%) were designated as Category 3 watersheds in need of protection.

Also see Interpreting Living Resource Indicators.

Interpreting Living Resource Indicators

General. Several of these indices rely on index rankings generated from a limited number of sampling sites which were then generalized to represent entire watersheds. Considering this limitation on field data, it may be beneficial to conduct additional assessments to provide a more complete understanding of local conditions as part of the WRAS:

SAV Abundance Index. The Finding of "1.0" means that SAV in 1996 covered 10% or less of the potential SAV habitat. This index allows comparison of watersheds based on the Submerged Aquatic Vegetation (SAV) actual/potential SAV area. To generate the number under Finding, the watershed area covered by SAV in a single year is measured using aerial survey data. The year used here was 1996. The potential SAV area, as determined by water depth, physical characteristics and historic occurrence of SAV, includes water area up to two feet deep. (This is the Tier III SAV restoration goal.)

SAV Habitat Index. An index less than 7 means that, based on available data from 1994 through 1996, habitat conditions for SAV are less than favorable. This index allows comparison of watersheds based on how well SAV habitat requirements are attained. To create this index, five measurements of habitat conditions are considered (secchi depth, dissolved inorganic nitrogen where applicable, dissolved inorganic phosphorus, Chorophyll a and total suspended solids.)

Non-Tidal Benthic Index of Biotic Integrity. This index allows comparison of streams based on the populations of bottom-dwelling "bugs" (benthic macroinvertebrate organisms) found in the stream. For coastal plain streams, this index employs seven measurements of these populations which is translated into a rank for each sampling site. An index less than 6 indicates that benthic organisms are significantly stressed by local conditions.

Non-Tidal Fish Index of Biotic Integrity. An index less than 6 indicates that improvements would be beneficial to fish populations. This index allows comparison of selected streams (first through third order nontidal streams) based on fish community health. In each sampling site where fish are surveyed, the makeup of the overall fish population is measured in nine distinct ways such as the number of native species, number of benthic fish species, percent of individuals that are "tolerant" species, etc. These nine scores are then integrated to generate an index ranking for the survey site. An index of 8 or greater indicates conditions favorable for fish.

Non-Tidal In-Stream Habitat Index. This index allows comparison of streams based fish and benthic habitat as measured by in-stream and riparian conditions. For each stream site that was assessed, visual field observations are used to score the site for substrate type, habitat features, bank conditions, riparian vegetation width, remoteness, aesthetic value, etc. These scores are then integrated to generate a single rank for each stream site.

Fish

1. Tidal Areas

Sampling at ten stations in the Chester River was conducted monthly from July through September for the years 1995 through 2000. Findings from at least four to six of these stations will be relevant to the Middle Chester River watershed. The locations of these stations are shown on Map 4 Monitoring Stations. Sampling was accomplished using beach seines and trawls. Results of this effort will be reported in the *DNR Chester River Study* anticipated to be available in Winter 2001. [19]

2. Nontidal Areas

In 1995, two sites were sampled during a Maryland Biological Stream Survey (MBSS) project on two nontidal streams that flow into the Urieville Community Lake. For these two sampling sites, the Fish Index of Biotic Integrity was considered "fair" for the Unnamed Tributary and "good" for the Upper Left Fork. [4] Also see Map 4 Monitoring Stations for the approximate site locations.

The two tributaries to Urieville Community Lake described here are only a partial representation of Middle Chester watershed conditions. Availability of additional information in the DNR fisheries database has not been confirmed at this time. To generate a more complete characterization, an inventory of other tributary areas needs to be conducted. In addition, some data may be available through other groups such as Washington College, the Friends of the Chester River and others.[11]

Fish Species Upstream of Urieville Lake, 1995

Species	Unnamed Tributary	Upper Left Fork
least brook lamprey		X
American eel	X	X
eastern mud minnow	X	X
golden minnow		X
creek chubsucker	X	X
brown bullhead	X	X
tadpole madtom	X	X
bluegill	X	X
largemouth bass	X	X
pumpkinseed	X	
redbreast sunfish	X	X
tessellated darter	X	X

Benthic Macroinvertebrates

Why Look at Benthos in Streams?

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

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

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

1. Benthos in Nontidal Streams

The most recent assessment of "bugs" living in streams (benthic macroinvertebrates or benthos) in Middle Chester River stream was conducted in early 2001 by the DNR Watershed Restoration Division. It is anticipated that results will be available in June 2001. Additional monitoring by the Maryland Biological Stream Survey (MBSS) is scheduled for the Chester River Basin to assess the in-stream aquatic community and habitat conditions in 2002 (10 sites) and in 2003 (10 sites.) [10]

In the 1990s, living resources including benthos were assessed at four Middle Chester River watershed sites shown in Map 4 Monitoring Stations.

In 1995, the first round of the MBSS included two sites in the Middle Chester River watershed. This assessment addressed the in-stream aquatic community and habitat conditions summarized in the 1995 MBSS Findings Table. The living resources and habitat at the two sites are significantly different even though both sites are in close proximity to each other upstream of Urieville Lake.

In 1992 and 1993, benthic organisms and their habitat were assessed at numerous sites in the Chester River basin.[21] One site was on Radcliffe Creek near the Route 20 crossing. Habitat quality there was ranked as the worst of the 25 sites assessed in the Chester River Basin and it was categorized as "non-supporting" of benthos. However, assessment of the Radcliffe Creek / Route 20 site based on the benthic macroinvertebrate community found the site to be "moderately impaired." Recommendations that accompanied these findings suggested that elevated nitrogen concentrations may have been a contributing factor in promoting benthos community conditions despite poor habitat conditions.

The second Middle Chester site was on Morgan Creek near the Perkins Hill Road crossing. Habitat quality and habitat condition were ranked as "partially supporting" benthos. This finding is better than the Radcliffe Creek site but it is still impaired. The assessment of the Morgan Creek / Perkins Hill Road site based on the benthic macroinvertebrate community found the site to be "moderately impaired," comparable to that found at Radcliffe Creek.

2. Benthos in Tidal Areas

Sampling of benthic (bottom dwelling) organisms was conducted in the Chester River between 1995 and 1998. In 1995 and 1996, samples were collected at ten mainstem stations as shown in Map 4 Monitoring Stations. In 1997 and 1998, samples were collected at 30 stations. Results of this effort will be reported in the *DNR Chester River Study* anticipated to be available in Winter 2001. [19]

1995 MBSS Findings * Middle Chester River Watershed In Kent County							
Station # KE-...-95	Stream Location	Fish		Benthos		Physical Habitat	
		Score	Condition	Score	Condition	Score	Condition
N-128-122	Upstream of Ur	4.0	Good	1.57	Very Poor	24.67	Poor
N-018-216	Upstream of Ur	3	Fair	3	Fair	66.87	Fair

Index Used In 1995 MBSS	Description
Fish Index of Biotic Integrity	Ranges from 1.0 (worst) to 5.0 (best)
Benthic Index Biotic Integrity	Ranges from 1.0 (worst) to 5.0 (best)
Physical Habitat Index	Range from 0 (worst) to 100 (best)

* Additional details are available at www.dnr.state.md.us. At the DNR home page:
– Click on "Bays and Streams"
– Click on "Streams" (upper left corner of page)
– Click on "Small Streams (MBSS)" (upper left corner of page)
– Click on "Results" (near top center of page)
– Scroll toward bottom of page and click on "Searchable data from first round MBSS"

Oysters

Currently, oyster beds are located in the Lower Chester River but not in the Middle Chester River watershed. Historic information gathered in a survey conducted between 1906 to 1912 indicates that oyster beds were once located in areas farther upstream than their current locations but none were so far upstream as the Middle Chester.[16]

Sensitive Species

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

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

1. Habitat Protection Categories

One way to characterize a watershed for sensitive species is to identify known habitat locations using several broad categories employed by DNR's Wildlife and Heritage Division. These categories are described in the text box Maryland's Sensitive Species Protection Categories. More details and guidance can be requested from Division staff.

Two of the three categories used to help protect sensitive species during review of applications for a State permit or approval or involve State funds are found in the Middle Chester River Watershed as shown in Map 12 Sensitive Species. For projects potentially affecting these areas, the State permit or approval will include recommendations and/or requirements to protect sensitive species and their habitat. In addition, many counties have incorporated safeguards for these areas into their permit review process.

These categories do not place requirements on any activities that do not require a permit/approval or do not involve State funds. However, there are State and Federal restrictions that address "takings" of protected species that apply more broadly. In addition, property owners are encouraged to seek advice on protecting the sensitive species / habitat within their ownership.

2. Morgan Creek Wetlands of Special State Concern

The Morgan Creek Wetlands of Special State Concern (WSSC) is a diverse swamp forest containing dense alder thickets and emergent marshes, bordered by an upland mixed hardwood-pine forest. A population of rare plant species classified as "State Rare" grows in the creek banks of this swamp forest. [24] This 75-acre WSSC is shown in Map 12 Sensitive Species.

3. Rare Fish and Mussels

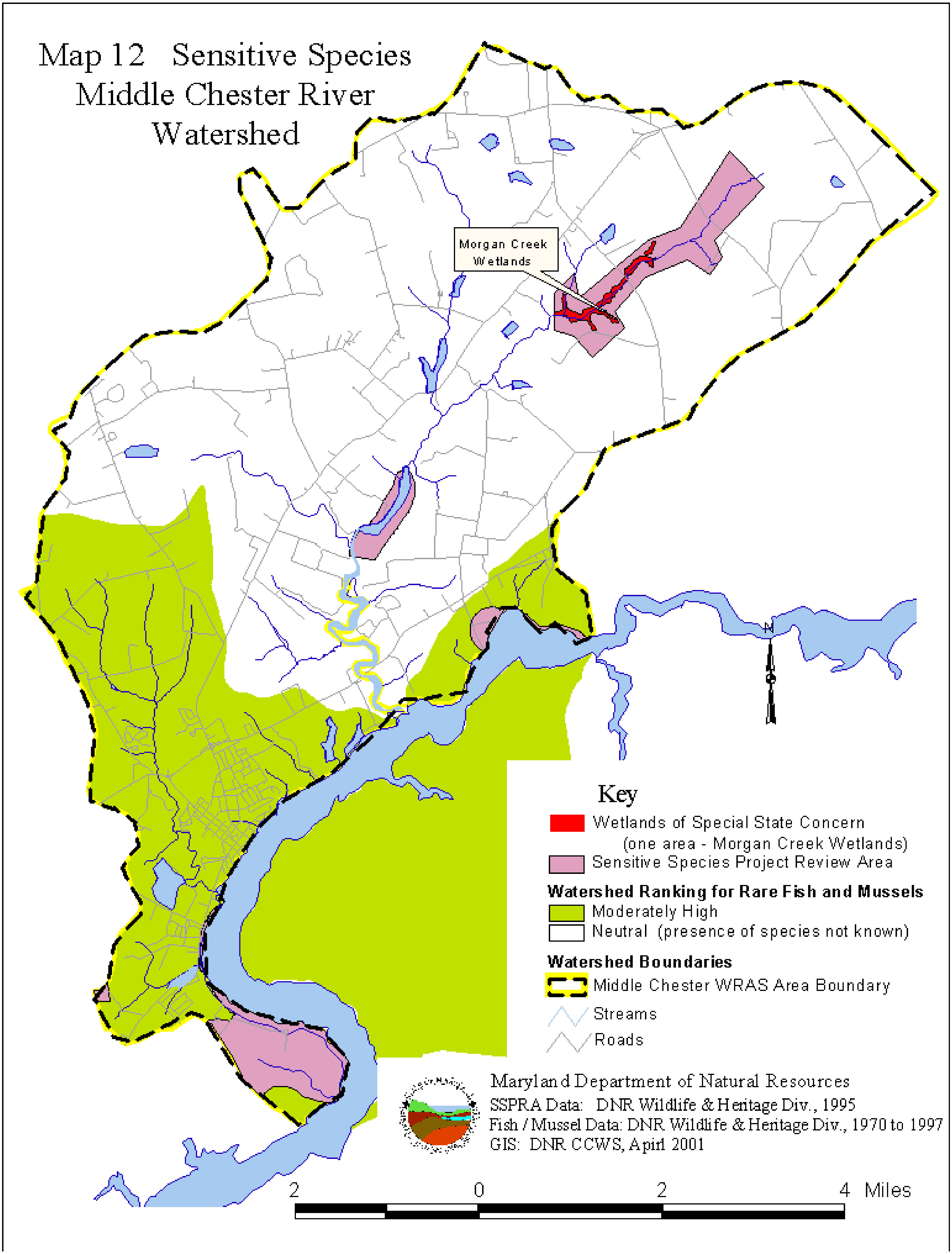
DNR recently initiated a project to rank watersheds across Maryland to aid in targeting conservation and restoration efforts to benefit known populations of rare fish and mussels. In comparison to the more than 1000 small (12-digit) watersheds identified by DNR in Maryland, several of the 12-digit sub-watersheds in Kent County's Middle Chester River watershed ranked "moderately high" and the remainder ranked "neutral." The Sensitive Species Map shows the distribution of the ranking. Map 12 Sensitive Species shows the rare fish and mussels ranking.

In general, higher ranking suggests that restoration or conservation projects in these areas may have greater potential to protect aquatic species diversity. Projects could be used to protect, enhance or expand existing aquatic habitat. A ranking of neutral indicates that information is insufficient (rather than these species are absent or that the area is low priority.) Neutral areas upstream of higher ranked areas are potentially important because they affect rare fish and mussel populations located downstream. In neutral ranked areas, it is reasonable to rely on other available criteria for targeting watershed conservation and restoration projects.

This ranking considers information from 1970 to 1997 only for rare species of fish or mussels being tracked in Maryland. Four possible ranks were used for this project: Very High, High, Moderately High and Neutral. Each rare species being tracked contributed to this ranking based on two types of criteria: 1) presence or absence, and 2) if present, weighting relative rarity on worldwide and Statewide scales.

Maryland's Sensitive Species Protection Categories

Sensitive Species Project Review Area (SSPRA)	Natural Heritage Area (NHA)	Wetlands of Special State Concern (WSSC)
At least five SSPRAs are identified in the Middle Chester River watershed. Each SSPRA contains one or more sensitive species habitats. However, the entire SSPRA is not considered sensitive habitat. The SSPRA is an envelop 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. At least one SSPRA compasses each NHA and WSSC. Also see Map 12 Sensitive Species.	No NHAs are located in the Middle Chester River watershed. NHAs are rare ecological communities that encompass sensitive species habitat. They are designated in State regulation COMAR 08.03.08.10. For any proposed project that requires a State permit or approval that may affect an NHA, recommendations and/or requirements are placed in the permit or approval that are specifically aimed at protecting the NHA.	One WSSC is designated in the Middle Chester River watershed -- the Morgan Creek Wetlands. These wetlands are associated with one or more sensitive species habitats that are in or near the wetland. For any proposed project that requires a wetland permit, these selected wetlands have additional regulatory requirements beyond the permitting requirements that apply to wetlands generally. For a listing of designated sites see COMAR 26.23.06.01 at www.dsd.state.md.us


Map 12 Sensitive Species
Middle Chester River
Watershed
Morgan Creek
Wetlands
N
Key
Wetlands of Special State Concern
(one area - Morgan Creek Wetlands)
Sensitive Species Project Review Area
Watershed Ranking for Rare Fish and Mussels
Moderately High
Neutral (presence of species not known)
Watershed Boundaries
Middle Chester WRAS Area Boundary
Streams
Roads
Maryland Department of Natural Resources
SSPRA Data: DNR Wildlife & Heritage Div., 1995
Fish / Mussel Data: DNR Wildlife & Heritage Div., 1970 to 1997
GIS: DNR CCWS, Apirl 2001
2
0
2
4 Miles

Submerged Aquatic Vegetation [8]

The well-defined link between water quality and submerged aquatic vegetation (SAV) distribution/abundance make SAV communities good barometers of the health of estuarine ecosystems. SAV is important not only as an indicator of water quality, but it is also a critical nursery habitat for many estuarine species. For example, blue crab "post-larvae" are up to 30 times more abundant in SAV beds than adjacent unvegetated areas. Additionally, several species of waterfowl depend on SAV for food when they over-winter in the Chesapeake region.

1. Criteria for Tracking SAV

The Chesapeake Bay Program has developed new criteria for determining SAV habitat suitability of an area based on water quality. The measurement called "Percent Light at Leaf" assesses the amount of available light reaching the leaf surface of SAV after being reduced in the water column and by epiphytic growth on the leaves themselves. The document describing this new model measuring SAV habitat suitability is found on the Chesapeake Bay Program website (www.chesapeakebay.net/pubs/sav/index.html). The older "Habitat Requirements" of five water quality parameters are still used for diagnostic purposes. Re-establishment of SAV is measured against the "Tier 1 Goal", an effort to restore SAV to any areas known to contain SAV from 1971 to 1990. (Also see the Executive Summary SAV Requirements for additional information.)

2. Middle Chester SAV Status

According to at least one time-time local resident, SAV beds did occur in the vicinity of Chestertown in the 1950s and/or 1960s.[29]

Since 1979 when the Chesapeake Bay-wide aerial mapping program began, SAV has never been sighted by in the Middle Chester River or other tidal fresh and low salinity (oligohaline) areas of the Chester River. However, this area has never been ground-truthed to determine if SAV beds too small to be seen in the aerial photographs may be undetected.

To due the absence of SAV, a Tier 1 Goal for SAV restoration has not been established for this portion of Chester River. (Also see www.vims.edu/bio/sav/ for extensive information or www.mdmerlin.net for annual distribution maps 1984 through 1996).

3. Comparing the Middle Chester to Nearby Areas

A comparison of SAV in the Middle Chester River watershed to other nearby areas is shown in Map 13 SAV Habitat Requirement Status and Map 14 SAV Distribution. Water quality data for the low salinity (oligohaline) region including much of the Middle Chester River has not been available. Up stream of the Middle Chester, data for the tidal fresh area near Route 290 Crumpton Road (monitoring station ET4.1) indicate that only phosphorous levels meet the SAV habitat requirements, while four other criteria fail: percent light at leaf, light attenuation, suspended solids and algae concentrations. (Nitrogen is not applicable in low salinity areas.)

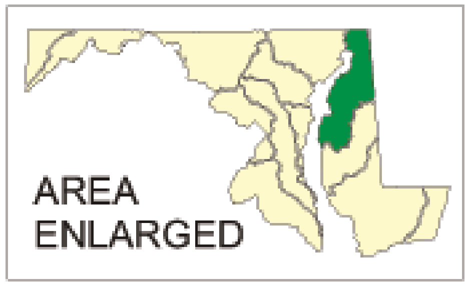
Down stream of the Middle Chester River, in the moderate salinity (mesohaline) portion of Chester River, SAV coverage has been highly variable since 1984, ranging from a low of 80 acres in

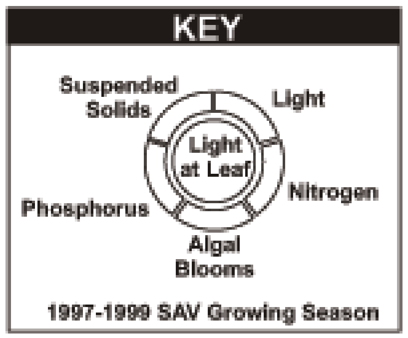
1990 to a high of 1,181 acres in 1998 (www.vims.edu/bio/sav/). The 1999 coverage was 736 acres or 20% of the Tier I goal (3,751 acres). On the Kent County side of the river, SAV beds fringe much of Langford, Greys Inn, and Church Creeks, and Eastern Neck Narrows and many of the coves around Eastern Neck Island. On the Queen Anne's County side, the largest beds are found from Macum Creek (Kent Island) extending up to and including Queenstown Creek. Ground-truthing by citizens (and the Chester River Association) and staff from Maryland DNR, Patuxent River Wildlife Center, U. S. Fish and Wildlife Service and Environmental Protection Agency has found, in order of most frequently reported, redhead grass, milfoil, elodea, widgeon grass, sago pondweed, horned pondweed, wild celery and naiads. Water quality monitoring data from the station located between the southern tip of Eastern Neck Island and Kent Narrows indicate that percent light at leaf, suspended solids and phosphorous level meet the SAV habitat requirements, while light attenuation and levels of nitrogen and algae are borderline.

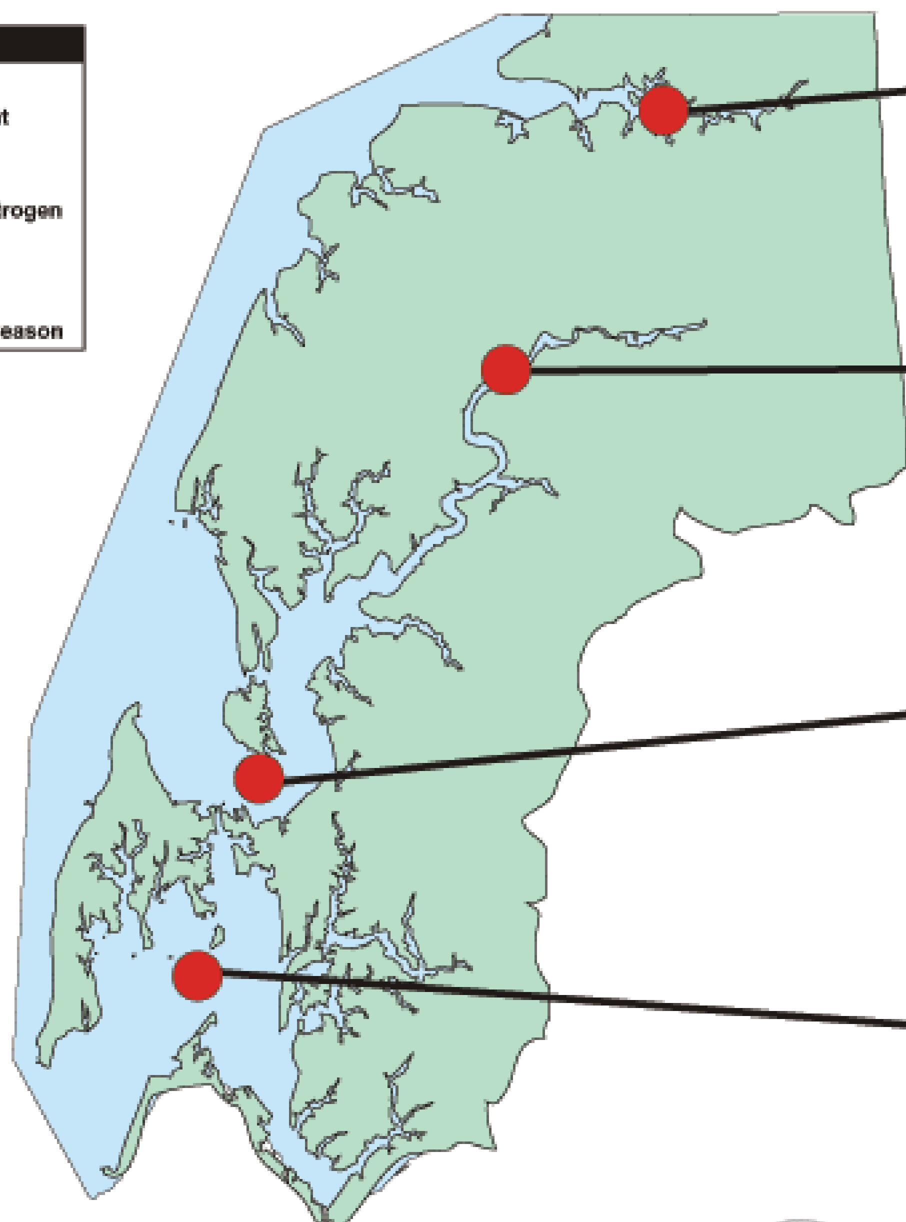
4. SAV Restoration Potential [26]

For a comparison of the Middle Chester to all other tidal segments in the Chesapeake Bay see the technical report Executive Summary SAV Requirements. The last page includes a map indicating that the Middle Chester area (oligohaline portion of the Chester River), ranked the worst compared to other segments based on failure to meet SAV requirements during the period 1992 to 1997. This finding suggests that water quality improvements are necessary in the Middle Chester mainstem to allow for eventual restoration of SAV.

Map 13 SAV Habitat Requirement Status: Upper Eastern Shore



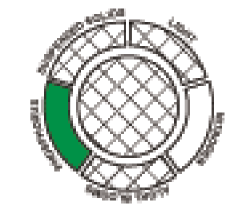
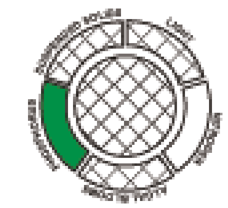
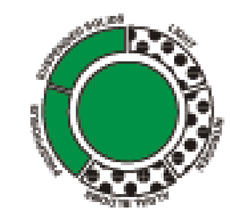
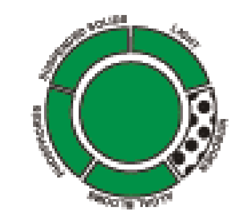




Tributary	Habitat Requirements

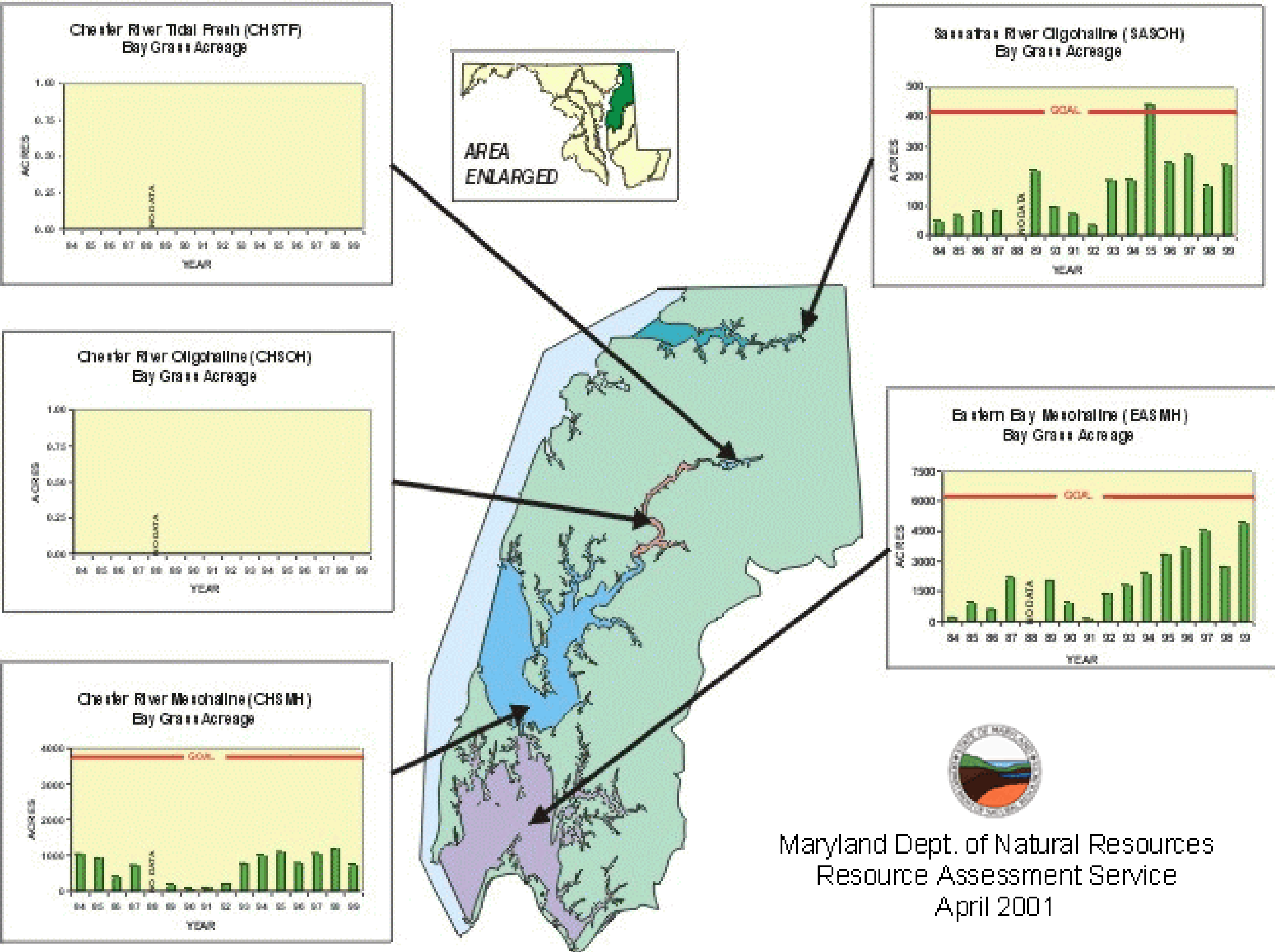
= Meets = Borderline = Fails = Not Applicable

HOW TO INTERPRET ICONS: Light at leaf (center circle) is a modelled composite indicator which determines whether suitable light reaches the SAV after penetrating the water column and being further reduced by epiphytic material on the leaf surface. Individual habitat requirements (triangles)provide status of the individual water quality components.

Tributary	Habitat Requirements
Sassafras River	
Upper Chester	
Lower Chester	
Eastern Bay	

Maryland Department of Natural Resources
Resource Assessment Service
April 2001

Map 14 SAV Distribution: Upper Eastern Shore [redacted]



RESTORATION TARGETING TOOLS

2000/2001 Stream Corridor Assessment

Using the Stream Corridor Assessment Methodology (SCAM) developed and applied by the DNR Watershed Restoration Division, valuable information can be compiled to assist in targeting restoration activities. In partnership with Kent County, DNR is conducting a Stream Corridor Assessment in the Middle Chester River watershed during Winter 2000/2001. Trained teams from the Maryland Conservation Corps will walk along streams to identify and document potential problems and restoration opportunities such as the items listed below:

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

In preliminary discussions between County and DNR representatives, several interests for stream assessment were identified:

– Potential priorities for stream assessment were for 1) Radcliffe Creek, 2) Morgan Creek and 3) other waterways in the Middle Chester River watershed.

– Identifying stream blockages to fish movement

– Identifying railroad drainage problems at stream crossings

A stream corridor assessment report will be generated, including maps and photographs, to support targeting decisions for restoration projects. Draft data summaries are expected to be available in Summer 2001 with a final report by December 2001. The results of the stream corridor assessment will provide a valuable foundation for development of the Watershed Restoration Action Strategy.

Agricultural Conservation Programs

Kent County has one of the highest levels of conservation participation in the state. Farmers in the county willingly implement management systems that address nutrient runoff and infiltration, erosion and sediment control, and animal waste utilization. The Kent Soil and Water Conservation District (KSWCD) works with farmers and landowners in the development of Soil Conservation and Water Quality plans that recommend best management practices that will prevent nutrient and sediment impact on surface and ground water. Last year 54 plans were developed for 8,665 acres, 67 plans for 13,246 acres were revised, and 273 individual BMPs were installed. Some of the conservation practices installed were grassed waterways, riparian herbaceous and riparian forested buffers, conservation cover, cover crops, shallow water wildlife areas and grade stabilization structures. The Maryland Agricultural Cost-Share program (MACS), the Conservation Reserve Program (CRP and CREP) and the Environmental Quality Incentive Program (EQIP) are some of the state and federal programs promoted and administered by the Kent SWCD and NRCS. [28]

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

Clean Marinas Program

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

Three of the six marinas located in the Middle Chester River vicinity offer pumpout facilities as shown in Map 15 Fish Blockages and Marinas. None of these marinas is currently participating in Maryland's Clean Marina Program. The Clean Marinas Program is voluntary way for marina owners to demonstrate that their pumpout service and other high quality boating services provided in accordance with Program guidelines are helping keep local waters cleaner.

Kent County representatives have expressed interest in exploring overboard discharge and clean marina related issues. One potential element of a Watershed Restoration Action Strategy (WRAS) is to encourage and/or support adding marina pumpout facilities serving the local area and increasing participation in the Clean Marina Program.

Fish Blockage Removal

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

To help prioritize stream blockages for mitigation or removal, the DNR Fish Passage Program maintains a database of significant blockages to fish movement. A summary of blockages listed in the database for the Middle Chester River watershed appears in the Fish Blockages Table and Map 15 Fish Blockages and Marinas. Of the 24 blockages listed in Kent County's portion of the Middle Chester River watershed, none are known to have been corrected. The same is true of the four blockages listed in the Queen Anne's County portion of the watershed. The listings in this database should be considered as supporting information for initiating a thorough Stream Corridor Assessment. Based on experience in other watersheds, it is likely that an assessment would identify additional potential fish blockage problems.

In general, removal of fish blockages is recommended if they would open a large stream segment containing high quality habitat with existing or potential return of significant fish populations. Most of the blockages on the map appear to be relatively near the headwaters of the streams they affect. However, several known blockages on the map that are relatively near the Chester River appear to be blocking significant stretches of stream. Based on this limited information, the following priority suggestions are offered for consideration:

– High priority: For blockages nearest to the Chester River, perform stream corridor assessments to verify potential benefit of removal.

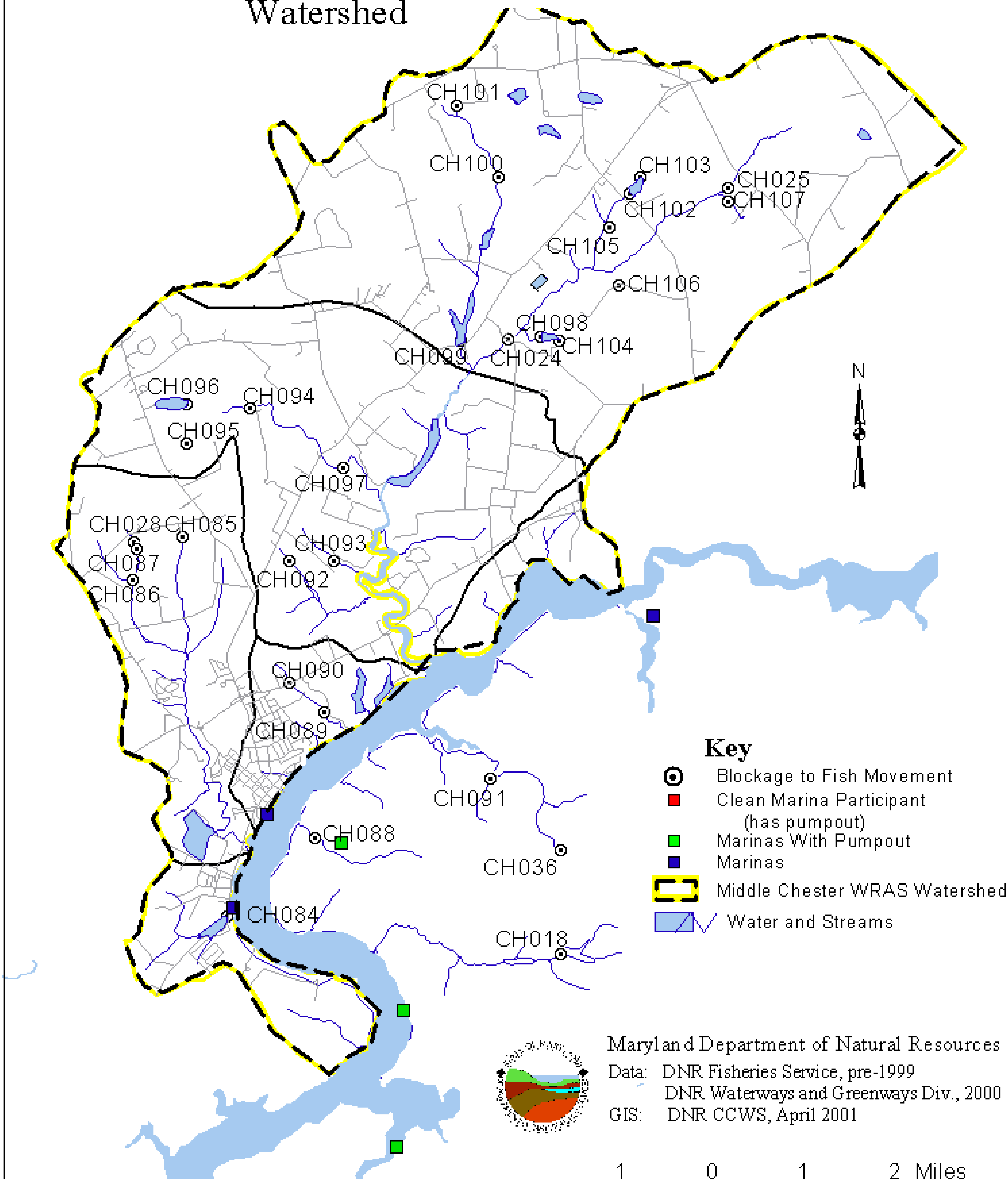
– Mid Priority: For all other blockages, perform stream corridor assessments.

Some blockages to fish movement may be structural components of farm ponds, drainage ditches, etc. If a blockage is found to be in this category, circumstances like requirements for drainage control function and public or land owner needs are considered in determining the potential for a restoration project.

Fish Blockages / Removal Opportunities in the Middle Chester River Watershed Page 1 0f 2 Radcliffe Creek and Other Subwatersheds Except Morgan Creek					
Station		**Blockage Corrected**	**Co**	**Stream**	**Name / Location**
Radcliffe Creek	CH028		KE	Radcliffe Creek	below Mary Morris Road
	CH085		KE	Radcliffe Creek	
	CH086		KE	trib to Radcliffe Creek	
	CH087		KE	trib to Radcliffe Creek	below Mary Morris Road
Chester River	CH084		KE	trib to Chester River	Route 289
	CH089		KE	trib to Chester River	0.4 miles below Route 291
	CH090		KE	trib to Chester River	Route 291
Queen Annes County	CH018		QA	Hambleton Creek	above Route 213
	CH036		QA	Rosin Creek	0.5 miles above Route 544
	CH088		QA	trib to Chester River	south of Route 213 at Truslow Road
	CH091		QA	trib to Rosin Creek	south of Round Top Road

Fish Blockages / Removal Opportunities in the Middle Chester River Watershed Page 2 of 2 Morgan Creek Subwatershed				
Station	**Blockage Corrected**	**Co**	**Stream**	**Name / Location**
CH024		KE	Morgan Creek	weir 1.0 mile above Perkins Hill Road
CH025		KE	Morgan Creek	0.2 miles below Brownstown Blacks Rd
CH092		KE	trib to Morgan Creek	0.2 miles below Route 213
CH093		KE	trib to Morgan Creek	0.3 miles below Route 213
CH094		KE	trib to Morgan Creek	near Route 561
CH095		KE	trib to Morgan Creek	0.2 miles below Route 297
CH096		KE	trib to Morgan Creek	0.4 miles below Worton
CH097		KE	Southeast Creek	0.2 miles east of Route 213 at Rt. 561
CH098		KE	trib to Morgan Creek	0.5 miles west of Perkins Hill Road
CH100		KE	trib to Morgan Creek	RR crossing
CH101		KE	trib to Morgan Creek	near headwaters
CH102		KE	trib to Morgan Creek	0.1 mile east of Route 448
CH103		KE	trib to Morgan Creek	0.3 mile east of Route 448
CH104		KE	trib to Morgan Creek	upstream of Perkins Hill Road
CH105		KE	trib to Morgan Creek	below Kenndeyville Road
CH106		KE	trib to Morgan Creek	below Kennedyville Road
CH107		KE	trib to Morgan Creek	above Route 448

Map 15 Fish Blockages and Marinas
Middle Chester River Watershed



Maryland Department of Natural Resources
Data: DNR Fisheries Service, pre-1999
DNR Waterways and Greenways Div., 2000
GIS: DNR CCWS, April 2001

Stream Buffer Restoration

1. Benefits and General Recommendations

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

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

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

2. Using GIS

Identifying the areas that need buffers planted and prioritizing them for restoration is often a time-consuming and expensive project. Fortunately, use of a computerized Geographic Information System (GIS) to manipulate remote sensing data can help save limited time and funds. To assist in this technical endeavor, DNR Watershed Management and Analysis Division has developed GIS-based tools to assist in the buffer restoration targeting process. With these tools, GIS maps and other information can be generated to help select stream segments for additional Stream Corridor Assessment, to identify geographic areas for community and land owner contact and for similar uses. Then, with an appropriate level of on-the-ground verification or "ground truthing," these GIS tools can provide an efficient first step toward stream buffer restoration.

In preliminary discussion, Kent County Representatives expressed interest in exploring the potential for targeting available funds through several programs like CRP and CREP. One tool that could be used for this targeting is prioritization of stream buffer restoration.

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

3. Headwater Stream Buffers

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

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

4. Land Use and Stream Buffers

One factor that affects the ability of stream buffers to intercept nonpoint source pollutants is adjacent land use. Nutrient and sediment loads from different land uses can vary significantly.

By identifying land uses in riparian areas with inadequate stream buffers, like crop land adjacent to streams, the potential to reduce nutrient and sediment loads can be improved. To assist in finding areas with crop land adjacent to streams, the same land use data shown in Map 6 1997 Generalized Land Use can be filtered using GIS. The new scenario shown in Map 16 Land Use Scenario for Stream Buffer Restoration focuses on the land use within 150 feet of a stream. This view, supplemented with the land use pollution loading rates, suggests potential buffer restoration opportunities that could minimize nutrient and sediment loads. (Note: DNR is encouraging stream buffers 150 feet wide on each side of the stream, which is significantly greater than minimum buffer requirement, to enhance nutrient and habitat benefits beyond minimum buffer requirements.)

Nonpoint Source Pollution Load Rates By Land Use
Chesapeake Bay Watershed Model, in kg/ha-yr

Land Use	Nitrogen	Phosphorus	Sediment
Crop land	17.11	1.21	0.74
Urban – Impervious	8.43	0.58	0.00
Urban – Pervious	10.79	1.56	0.20
Pasture	8.40	1.15	0.30
Forest	1.42	0.00	0.03

5. Nutrient Uptake from Hydric Soils in Stream Buffers

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

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

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

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

Map 17 Nutrient Retention Using Hydric Soils Scenario identifies lands adjacent to streams that are composed hydric soil and also have insufficient stream buffers in the Middle Chester River watershed. To generate the map, hydric soils (Natural Soils Group of Maryland, MDP) were grouped into two classes and rated in terms of their potential to maximize groundwater/root zone interaction: poorly drained hydric soils (high nutrient retention efficiency), and moderately well drained hydric soils (moderately high nutrient retention efficiency). An important next step in using this information is verification of field conditions. Care must be taken during field validation to evaluate any hydrologic modification of these soils, such as ditching or draining activities, which would serve to decrease potential benefits.

A refinement of the above scenario is shown in Map 18 Nutrient Retention Using Hydric Soils Associated With Cropland. The presentation in Map 18 is based on the same analysis as Map 17 except that only cropland is shown so that these areas are easier to see.

6. Wetland Associations

Wetlands and adjacent natural uplands form complex habitats that offer a range of habitat opportunities for many species. These “habitat complexes” tend to offer greater species diversity and other ecological values that are greater than the values that the wetland or uplands could offer independently. Therefore, restoring stream buffers adjacent to or near existing wetlands tends to offer greater habitat benefits than the restoration project could otherwise produce. Map 19 Wetland Proximity Scenario identifies unforested buffer zones that are in close proximity (within 300 feet) to wetlands (National Wetlands Inventory). Restoration projects in these areas may offer opportunities to enhance and expand wetland habitat in addition to providing other desirable buffer functions.

7. Optimizing Water Quality Benefits by Combining Priorities

Strategic targeting of stream buffer restoration projects can take into account many different potential benefits. Several of these scenarios are presented independently in this section. However, site selection and project design generally incorporate numerous factors to optimize benefits from the project. For example, finding a site with a mix of attributes like those in the following list could result in the greatest control of nonpoint source pollution and enhancement to living resources:

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

Two of the many ways to integrate targeting criteria to help identify candidate sites for additional investigation are shown here. One example is shown on Map 18 Nutrient Retention Using Hydric Soils Associated With Cropland Scenario. This map suggests potential stream buffer restoration areas that are likely to offer the greatest opportunity to reduce both nutrients and sediment entering the stream. Another example shown in Map 20 Prioritizing Streams Scenario prioritizes stream segments based on lack of adequate naturally vegetated buffers, land use adjacent to the stream and headwater stream status.

Targeting To Achieve Measurable Water Quality Improvement

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

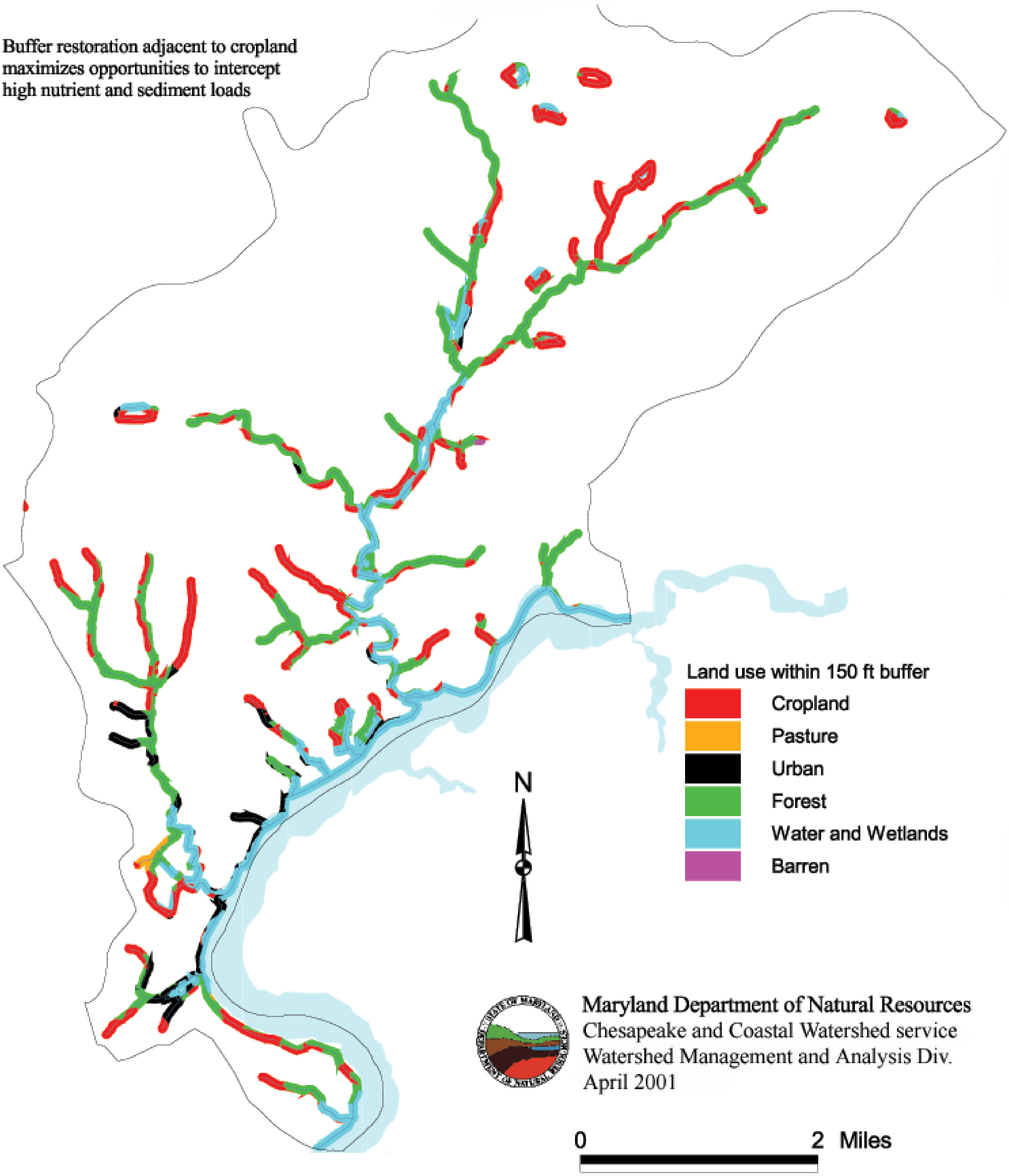
In general, targeting restoration projects to one or a few selected tributaries or small watersheds will tend to offer the greatest probability of producing measurable water quality improvement. By selecting small areas like a small first order stream for restoration, there is greater likelihood that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

In the Middle Chester River watershed, available water quality data reinforces the premise targeting restoration projects to locally generated problems is an important consideration. For example, water clarity data for the Chester River shows that the problem extends up river. The data also suggest that origins of the problem are great in magnitude and are in part outside of the Middle Chester River watershed.

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

Map 16 Land Use Scenario for Stream Buffer Restoration

Buffer restoration adjacent to cropland maximizes opportunities to intercept high nutrient and sediment loads



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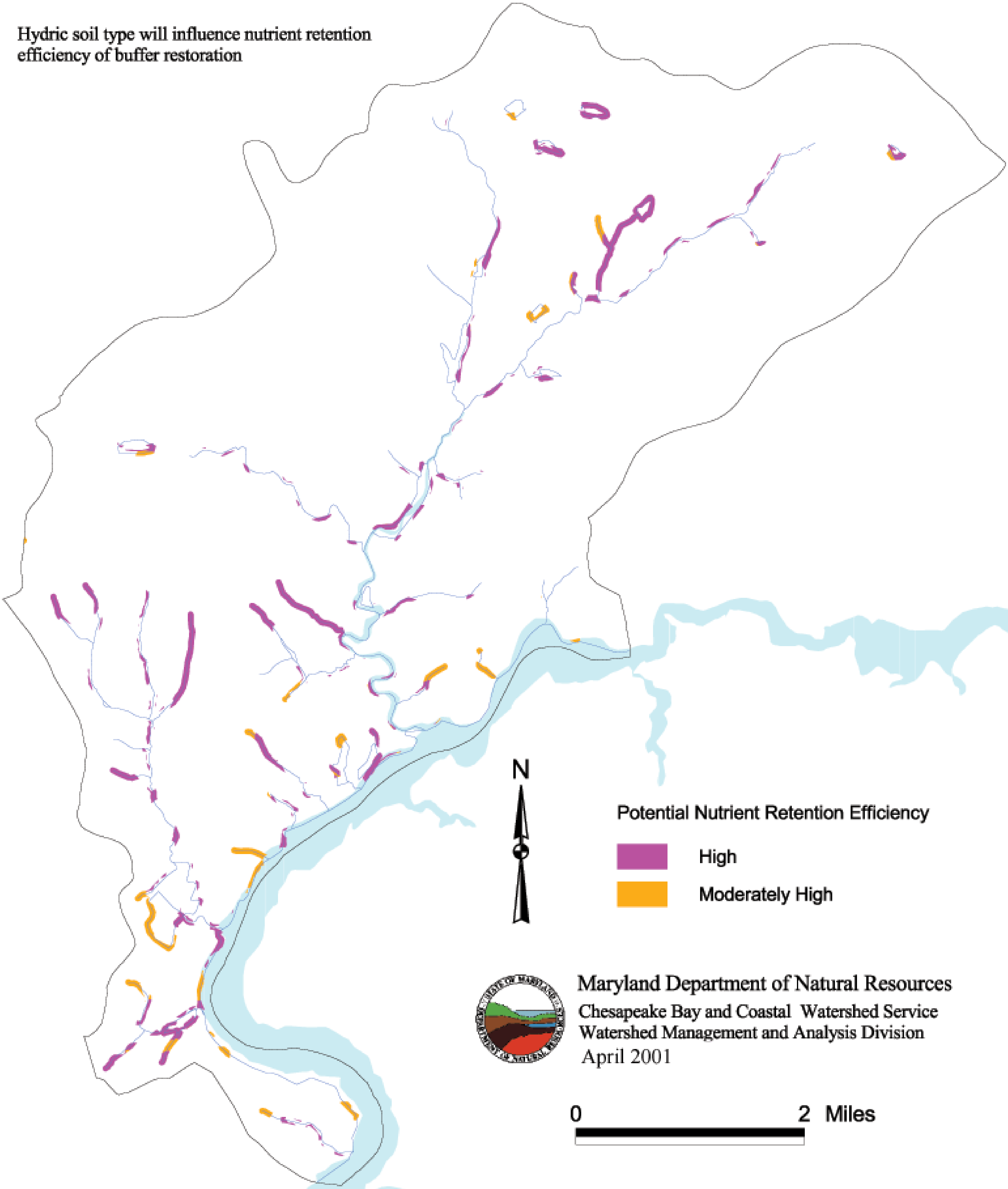
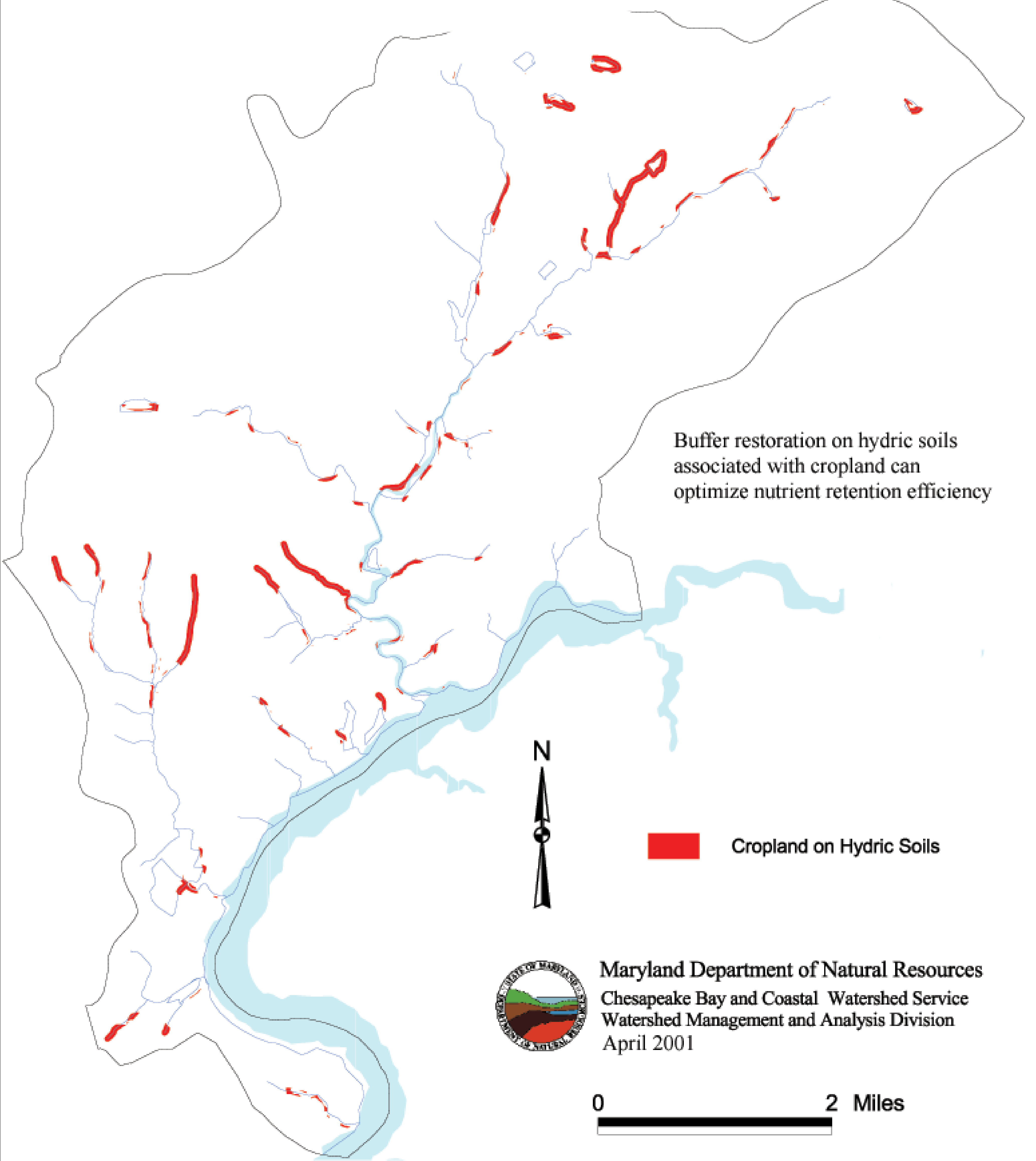
April 2001

Map 17 Nutrient Retention Using Hydric Soils Scenario for Stream Buffer Restoration

Hydric soil type will influence nutrient retention efficiency of buffer restoration

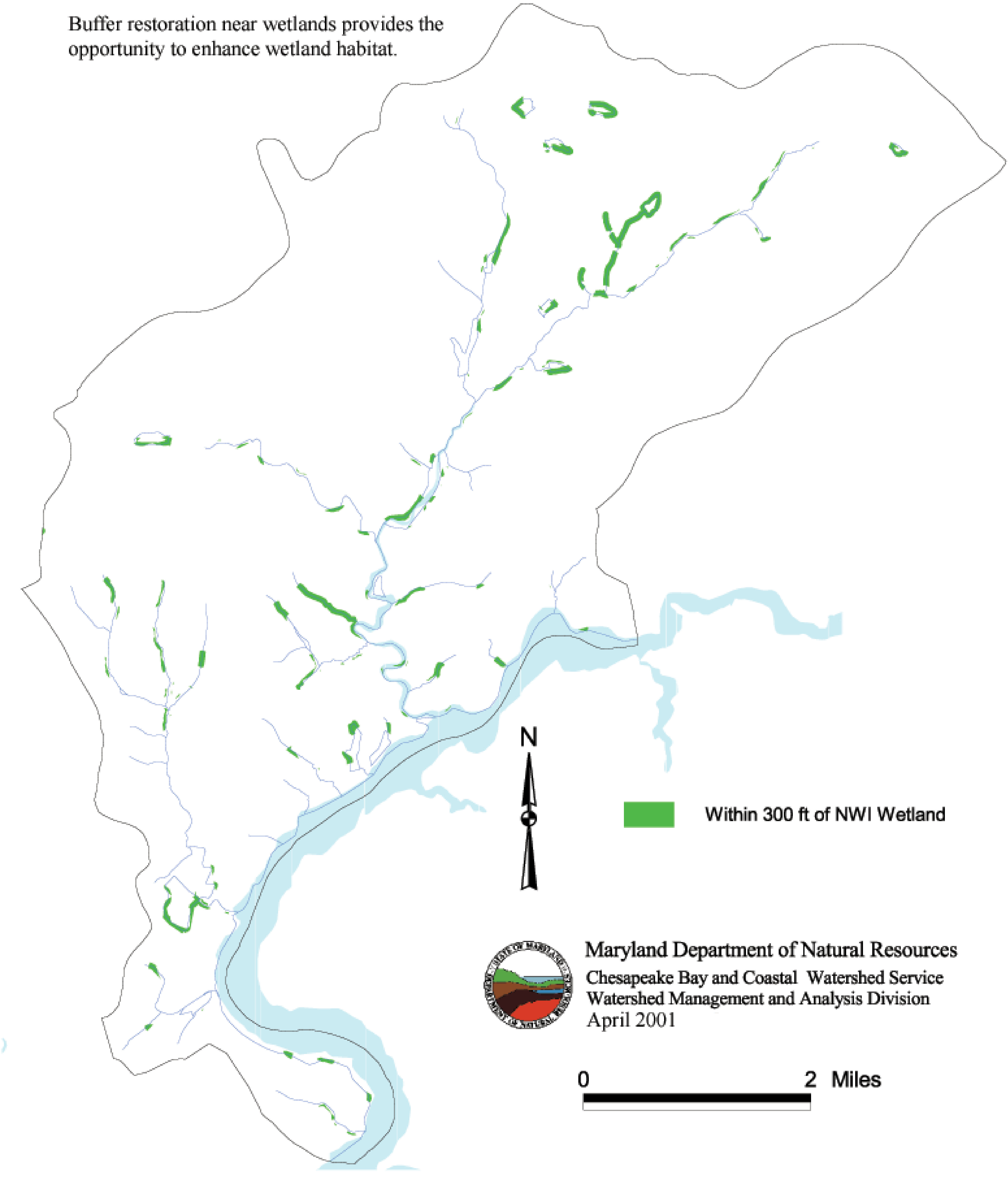


Map 18 Nutrient Retention Using Hydric Soils Associated With Cropland

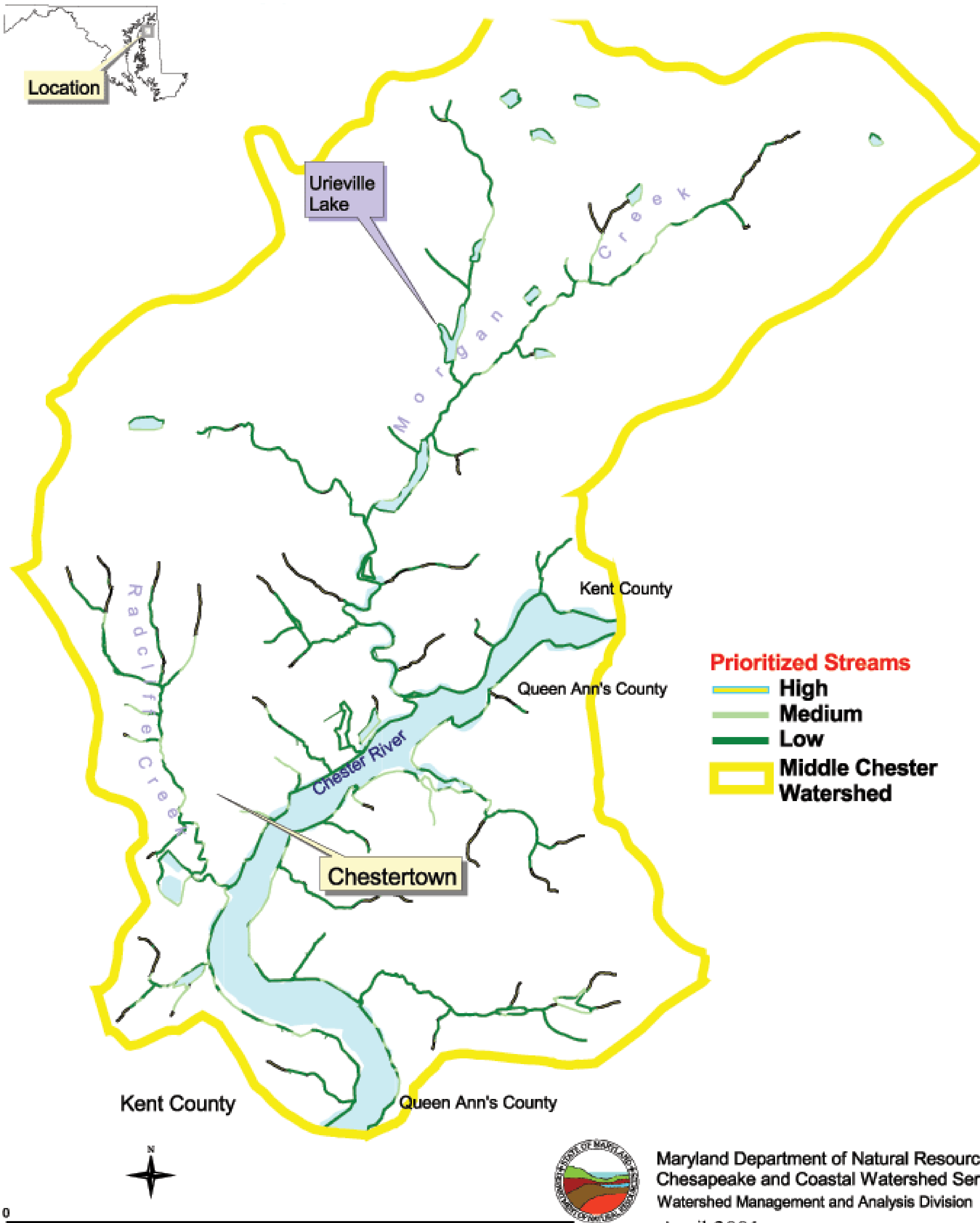


Map 19 Wetland Proximity Scenario For Stream Buffer Restoration

Buffer restoration near wetlands provides the opportunity to enhance wetland habitat.



Map 20 Prioritizing Streams Scenario



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April 2001

Wetland Restoration

Wetlands serve important environmental functions such as providing habitat and nursery areas for many organisms, facilitating nutrient uptake and recycling, providing erosion control. However, most watersheds in Maryland have significantly fewer wetland acres today than in the past. This loss due to draining, filling, etc. has led to habitat loss and negative water quality impacts in streams and in the Chesapeake Bay. Reversing this historic trend is an important goal of wetland restoration. One approach to identifying candidate wetland restoration sites involves identifying "historic" wetland areas based on the presence of hydric soils. This process can be accelerated by using GIS to manipulate soils information with other data like land use. The GIS products can then assist in initiating the candidate site search process, targeting site investigations and helping to identify land owners. To promote wetland restoration, DNR Watershed Management and Analysis Division has developed GIS capability for these purposes.

In preliminary discussions between County and DNR representatives several potential interests involving wetland restoration were identified:

– Creation of habitat or wetlands based on stream data
– Exploring assistance to landowners who participate / contribute to wetland restoration.
– Eradication of the invasive plant Phragmites: outreach/newsletter

For the Middle Chester River watershed, GIS was used to map and prioritize areas of hydric soil for potential wetland restoration. The steps and priorities used to generate the map are listed below:

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

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

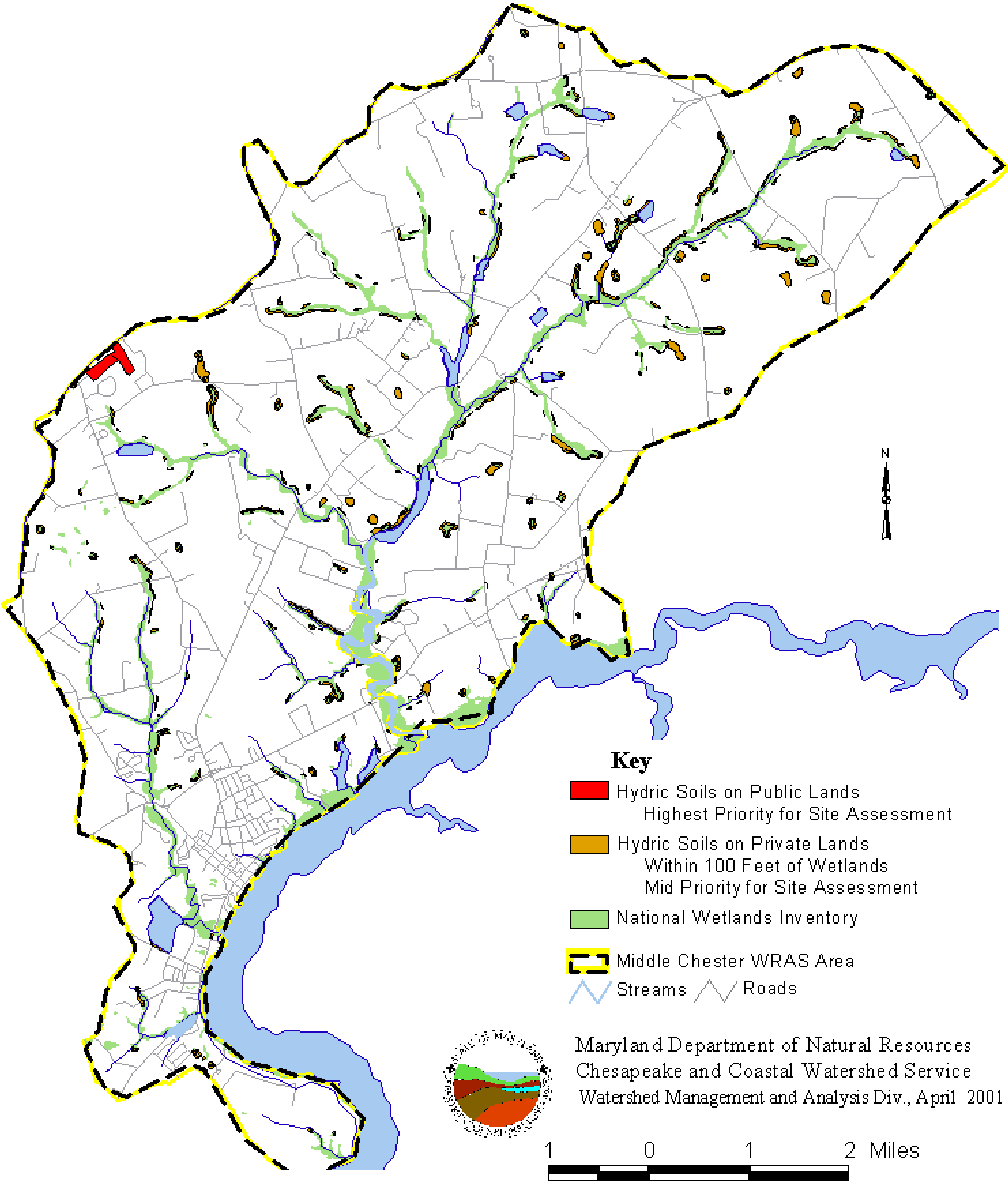
– Map 21 Wetland Restoration Opportunities shows that there are around 100 sites that fit the following criteria: 1) hydric soil, 2) on open land, and 3) within 300 feet of existing wetlands. In this scenario, opportunities on public land are suggested as high priority for investigation because their small number and relatively simple land owner issues would allow rapid assessment of viability. The much greater number of potential sites on private land will require additional screening based on land owner interests.

– Map 18 Nutrient Retention Using Hydric Soils Associated With Cropland shows numerous potential stream buffer restoration sites that may offer wetland restoration opportunities considering: 1) hydric soils, 2) on open land / agricultural fields, 3) adjacent to streams, and 4) potential to address nutrients in groundwater based on soil type.

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

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

Map 21 Wetland Restoration Opportunities
Middle Chester River Watershed



PROJECTS RELATED TO THE WRAS PROCESS

Overview

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

319(h)-Funded Projects

The Federal funding source generally known as “319" has two projects in the Middle Chester River watershed:

1- Agriculture Soil Conservation Water Quality Planning for the Upper & Middle Chester River watersheds. (319 funding for years 1999 and 2000, Coastal Zone Management funding for year 2001.)

2- Tracking Tributary Strategy Results with Volunteer Water Quality Monitors within the Chester River watershed. (319 funding for year 1997.)

Other Projects

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

1. Chesapeake Country Scenic Byway Program

This transportation-related program may offer opportunities for stream restoration at road crossings.

2. Chester River Association

The Chester River Association is private volunteer organization. In 1988, the Association sponsored a workshop facilitated by the National Park Service Mid-Atlantic Region. The workshop afforded an opportunity for the local community to express interests and concerns related to the Chester River watershed. A broad spectrum of issues and potential actions were documented.[15]

3. Conservation Reserve Program (CRP)

The Conservation Reserve Program (CRP) pays farmers rental payments over a 10 year period on a per acre basis to remove highly erodible land and other sensitive land/fields from production. One of numerous benefits from the program is reduction of sediment and nutrient movement into streams.

4. Conservation Reserve Enhancement Program

The Conservation and Restoration Enhancement Program (CREP) program pays farmers and land owners on a per acre basis to remove from agricultural production environmentally sensitive land that is located near water bodies. This program creates new or enhanced stream buffers, restores wetlands, converts highly erodible ground to protective cover and creates wildlife habitat. Landowners also have the option to place their CREP ground under a conservation easement.

5. Environmental Quality Incentive Program

The Environmental Quality Incentive Program (EQIP) offers financial assistance to farmers to install conservation practices related to local watershed concerns. The Middle and Upper Chester River watersheds in Kent County have been designated as a Geographic Priority Area which entitles the area to receive a annual funding under the program. These funds are used to provide financial assistance to farmers who are implementing Best Management Practices (BMPs) that will reduce three kinds of water quality problems:

– nutrient loadings in surface and groundwater
– sediment reaching surface water and
– pesticide contamination of surface and groundwater.

6. Forest Service Integrated Service Delivery Project

The current State Forest Service project to improve service delivery could also offer opportunities to promote stream buffer restoration.

7. Greenways

The Year 2000 edition of the Maryland Greenways Atlas identifies Greenway and Green Infrastructure projects and issues important to Kent County and the Middle Chester River watershed.

8. Wetland Restoration Projects

Ducks Unlimited, Inc. has a project to create a shallow water wetland habitat that could serve as an example for additional work

POTENTIAL BENCHMARKS FOR WRAS GOAL SETTING

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

Goals from the *Clean Water Action Plan* [3]:

– Clean Water Goals - Maryland watersheds should meet water quality standards, including numerical criteria as well as narrative standards and designated uses.

– Watersheds should achieve healthy conditions as indicated by natural resource indicators related to the condition of the water itself (e.g. water chemistry), aquatic living resources and physical habitat, as well as landscape factors (e.g. buffered streams and wetland restoration).

Water Quality Improvement Act of 1998

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

ADDITIONAL INFORMATION

Sources Used for the Characterization

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Abbreviation Key

CCWS - Chesapeake and Coastal Watershed Service (Part of DNR)
COMAR - Code Of Maryland Regulations (Maryland State regulations)
CREP - Conservation Restoration and Enhancement Program (program of MDA)
CWAP - Clean Water Action Plan (Adopted by Maryland December 1998)
DNR - Department of Natural Resources (Maryland State)
EPA - Environmental Protection Agency (United States)
MBSS - Maryland Biological Stream Survey (program in DNR RAS)
MDA - Maryland Department of Agriculture
MDE - Maryland Department of the Environment
MDP - Maryland Department of Planning
MET - Maryland Environmental Trust
MGS - Maryland Geological Survey
NHA - Natural Heritage Area (designation by DNR in COMAR)
NRCS - Natural Resource Conservation Service
NOAA - National Oceanagraphic and Atmospheric Agency
RAS - Resource Assessment Service (part of DNR)
SAV - Submerged Aquatic Vegetation
SSPRA - Sensitive Species Protection Review Area (designation by DNR)
TMDL - Total Maximum Daily Loads
USFWS - United States Fish and Wildlife Service
USGS - United State Geological Survey
WRAS - Watershed Restoration Action Strategy (funding/assistance project by DNR)
WSSC - Wetland of Special State Concern (designation by MDE in COMAR)

Contacts for More Information
Middle Chester River Watershed
Watershed Restoration Action Strategy (WRAS)

Kent County	
Dept. of Planning, Gail Owings	410-778-7468
Chestertown, William S. Ingersoll	
NRCS, Nancy Metcalf	410-778-5150 x3
Maryland Department of Natural Resources	
Watershed Restoration Action Strategy Coordinator(s)	
Statewide, Katharine Dowell	410-260-8741
Middle Chester, Louise Hanson	410-260-8774
Watershed Characterization	
Ken Shanks	410-260-8786
Watershed Restoration	
Mitch Keiler	410-260-8806
Tributary Team: Upper Eastern Shore	
Susan Phelps Larcher	410-260-8832
WRAS Internet Links	
www.dnr.state.md.us/watersheds/surf/index.html	

Technical Information Contacts by Topic (This section is optional.)

Clean Marinas Program	410-260-8770
Forest Service Upper Shore Project Office	410-758-5258 and 410-778-4439
TMDL, County Contact - no contact appointed	
State Contact - Jim George, MDE	410-631-3579

Technical Reports Accompanying the Middle Chester Characterization

Executive Summary SAV Requirements

Land Use Technical Report