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Background

Wicomico County is dominated by forest (44%) and agriculture (36%), followed by developed land (14%) and wetlands (6%) (based on MDP 2002 land use GIS data). However, it should be noted that wetland acreage estimates based on this land use data may be grossly underestimated. More accurate wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR. A large portion of the developed land is focused around Salisbury.

Sea level rise is a serious issue in this County. Studies are being conducted to predict land change based on sea level rise. These maps predict that mean high water will cover large areas of the County. Wetlands are currently being lost due to sea level rise and subsidence. However, for the same reasons, uplands are also being converted to wetlands. Salt tolerant species are encroaching into people's yards (Titus and Richman, 2000). This also leads to septic system failure. The climax communities for these new wetlands will likely be brackish high and low marsh. It is likely that land converted to wetlands will be lost to sea level rise in the long term. Therefore, designs for wetland restoration should take this into account. One idea is to use dredged material to create barrier islands just off the shoreline. These could buffer the shoreline against storm surges and wind-driven waves, and provide some protection for wetland restoration behind them (Cole, 2006, pers. comm.).

Wicomico County drains into two different State-designated 6-digit watersheds: Pocomoke River (021302) and Nanticoke River (021303). The 8-digit watersheds within the Wicomico portion of the Pocomoke River watershed include: Upper Pocomoke River (02130203), Dividing Creek (02130204), and Nassawango Creek (02130205). The 8-digit watersheds within the Wicomico portion of the Nanticoke River watershed include: Lower Wicomico River (02130301), Wicomico Creek (02130303), Wicomico River Head (02130304), and Nanticoke River (02130305).

Streams

The following information is based on the Maryland Tributary Strategies 2004 document entitled *Maryland's Lower Eastern Shore*. Maryland's Lower Eastern Shore basin includes areas in Wicomico, Caroline, Somerset, Worcester, and Dorchester Counties and the waterways Pocomoke, Wicomico, Nanticoke and Big Annemessex Rivers, Fishing Bay, Pocomoke and Tangier Sounds. Land cover is 61% forest/wetlands and 32% agriculture. About 60% of the houses are on septic. Point sources are not a major source of pollution. In 2002, sources of nitrogen, phosphorus, and sediments were from agriculture (60%, 58%, 70% respectively). Based on water quality sampling, nitrogen was good or fair in the southern portion and poor in Wicomico and Nanticoke Rivers. Phosphorus was good or fair throughout. Total suspended solids (TSS) was poor in the majority of the area, with only three sampling having fair or good TSS (South Tangier Sound, Big Annemessex River, and Pocomoke River). All areas were below the SAV restoration goal. Benthic communities were generally good, with the best communities located in Nanticoke and Wicomico Rivers. Degraded communities were likely impacted by high sedimentation. This document describes the success of implementing BMPs like this:

> Implementation of animal waste management plans, nutrient management plans,
> conservation tillage, treatment of highly erodible land, forest conservation and buffers, marine pumpouts, and structural shore erosion control and erosion and sediment control are all making good progress toward Tributary Strategy goals. For other issues, such as stormwater and urban nutrient management, cover crops, tree plantings and nonstructural shore erosion control, progress has been slower.

Wetlands

Wetland Classification

According to Tiner and Burke (1995), in 1981-1982 there were 37,761 acres of wetlands (6.3% of the State's total). The wetland types were Estuarine (14,277 acres), Palustrine (23,141 acres), Riverine (321 acres) and Lacustrine (22 acres). Comparisons of this 1981-1982 wetland acreage with historic wetland acreage (based on hydric soils) represents a 71%, or 91,404 acre, loss (MDE, 2002a).

Wetlands were identified using aerial photography by NWI and later by DNR. While these maps are the best sources of Statewide data on wetland location, they do have limitations. For this County, DNR identified large areas of wetlands that abruptly stop at the quarterquad sheet boundary. For example, there is an abrupt change between Wetipquin NE and Eden NW, with wetland acreage in Eden NW likely being underestimated. This is also true between Mardela Springs SE and Hebron SW, with wetland acreage for Hebron SW likely being underestimated.

A 1994 report from the U.S. Fish and Wildlife Service (Tiner and Foulis) estimated wetland trends in part of Wicomico and surrounding Counties for the period from 1982 to 1988-89. The study area was the U.S. Geological Survey quadrangles for Princess Anne

(Somerset), Salisbury (Somerset and Wicomico Counties) Wango (Wicomico and Worcester Counties) Delmar (Wicomico) and Pittsville (Wicomico County). There were over 187 acres of vegetated wetlands, primarily palustrine forested wetlands, that were converted to upland. Conversion to agricultural land and ditching were the primary causes. There were over 2700 acres of wetlands were converted to another wetland type, with most changes due to silvicultural practices to establish plantations for Loblolly pine (*Pinus taeda)*. Other changes resulted from forested wetland timber harvest, with the succeeding wetland types being scrub-shrub or emergent wetlands. The water regime was also altered in some wetlands.

The following wetland plant community descriptions are based on Tiner and Burke (1995).

- Estuarine wetlands can be salt or brackish tidal wetlands. Vegetation is largely dependent upon salinity and hydrology, with plant diversity increasing with decreased salinity and decreased flooding. They can be classified into five groups:
    - Estuarine intertidal flats are mud or sand shores that are exposed twice a day (at low tide) or less. These areas have sparse macrophytic vegetation.
    - Estuarine emergent wetlands have vegetation composition that is strongly influenced by salinity level and duration/frequency of inundation.
        - Brackish marshes are the most common type of Maryland Estuarine wetland, found along the Chesapeake Bay and tidal rivers. Low brackish marsh is often dominated by smooth cordgrass-tall form and water hemp while the high brackish marsh is often dominated by salt hay grass, salt grass, black needlerush, smooth cordgrass-short form, Olney three-square, switchgrass, common three-square, big cordgrass, common reed, salt marsh bulrush, seaside goldenrod, rose mallow, and narrow-leaved cattail.
        - Oligohaline marshes are only slightly saline and are located in the upper tidal rivers. Low oligohaline marshes are often dominated by arrow arum, pickerelweed, spatterdock, wild rice, soft-stemmed bulrush, narrow-leaved cattail, water hemp, and common three-square while high oligohaline marshes are often dominated by big cordgrass, common reed, narrow-leaved cattail, wild rice, broad-leaved cattail, and sweet flag.
    - Estuarine scrub-shrub swamps are often dominated by high-tide bush and groundsel bush.
    - Estuarine forested swamps are often dominated by loblolly pine. Due to sea level rise bringing in more salinity, some of these systems are being converted into salt marshes.
    - Estuarine Aquatic beds generally contain submerged aquatic vegetation, including eelgrass and widgeongrass in high salinity areas and widgeongrass and other species in lower salinity areas.
- Palustrine wetlands can be classified into four major groups depending on the dominant vegetation type: forested, scrub-shrub, emergent, and aquatic. These wetlands were described for the Maryland Coastal Plain Province.

- Palustrine forested wetlands are the dominant palustrine wetland type on the Coastal Plain and are located in floodplains, depressions, and drainage divides. They can be classified into four main groups:
    - Tidally flooded wetlands are freshwater wetlands that are tidally influenced. Common tree species may include red maple, green ash, black willow and black gum.
    - Semipermanently flooded wetlands are nontidal wetlands that are flooded for much of the growing season. These are uncommon in Maryland. Some examples, dominated by bald cypress, are along Battle Creek and the Pocomoke River. Higher elevations may be dominated by red maple, black gum, sweet bay, swamp black gum, fringe tree, ironwood, and swamp cottonwood.
    - Seasonally flooded wetlands are nontidal wetlands that are flooded for generally longer than two weeks during the growing season. Some of the more common tree dominants include red maple, sweet gum, pin oak, willow oak, loblolly pine, or swamp chestnut oak. There is often a thick shrub understory. Atlantic white cedar swamps may have been located historically in Wicomico County (Nanticoke River, Lower Wicomico River, Lower Pocomoke River, Nassawango Creek) (Dill et al., 1987). Few Atlantic white cedar swamps remain in Maryland since most have been converted to hardwood swamp.
    - Temporarily flooded wetlands are nontidal wetlands that are flooded the least of the four types, about a week. Seasonally saturated wetlands, wetlands having a high water table during the cooler months, are also included in this category. Some of these areas are managed for loblolly pine harvesting. Other tree dominants include red maple, sweet gum, black gum, willow oak, water oak, basket oak, swamp white oak, southern red oak, sycamore, black willow, American holly, sweet bay.
- Scrub-Shrub wetlands are less common than forested wetlands on the Coastal Plain. They are often dominated by buttonbush (in the wetter systems), silky dogwood, arrowwood, alder and tree saplings.
- Emergent wetlands are very diverse in the Coastal Plain region due to the occurrence of both tidal and nontidal wetlands. They can be categorized into several different types:
    - Tidal fresh marshes occur along the large coastal waterways, between the brackish marshes and tidal freshwater swamps. It is speculated that in addition to tidal flooding, temporary periods of salt water in these areas may discourage woody succession. These freshwater wetlands are often more diverse than wetlands with higher salinity levels. Vegetative dominance changes seasonally. There is often a distinct vegetative zonation pattern based on elevation. Some common dominance types according to McCormick and Somes (1982) are arrowheads, big cordgrass, bulrushes, bur-marigold, cattails, common reed, giant ragweed,

golden club, pickerelweed/arrow arum, purple loosestrife, reed canary grass, rose mallow, and smartweed/rice cutgrass
        - Interdunal wet swales have a very high water table, allowing hydrophytic plants to grow adjacent to dunes having xeric plant species. These sites are often dominated by common three-square, salt hay grass, and rabbit-foot grass.
        - Semipermanently flooded marshes are often dominated by cattail, spatterdock, arrow arum, water willow, and bur-reeds.
        - Seasonally flooded marshes include isolated depressional wetlands called "potholes" or "Delmarva Bays" (mostly in Caroline, Kent, and Queen Anne's)
        - Temporarily flooded wet meadows include areas recently timber harvested that will soon revert back to woody vegetation.
    - Aquatic beds include small ponds with vegetation on the bottom and/or surface. These are the wettest of the Palustrine types.
- Riverine wetlands are found within the channel and include nonpersistent vegetation.
- Lacustrine wetlands are associated with deepwater habitat (e.g. freshwater lakes, deep ponds, and reservoirs). They can be classified into lacustrine aquatic beds (wetlands are located in the shallow water) and lacustrine emergent wetlands (wetlands are located along the shoreline).

The document *Wetlands of Maryland* provides numerous examples of various wetland communities found within each County and complete plant lists for certain wetland types.

Tidal wetland acreage was also estimated in *The Coastal Wetlands of Maryland* (Table 1). Wicomico County had 13,588 acres of vegetated tidally-influenced wetlands (plus an additional 165 acres open water, mudflat, sandbar, and beach). The majority of the vegetated wetlands were brackish marsh (70%), with the most of the remainder being fresh marsh (18%) and wooded swamp (11%). Due to the higher stress associated with higher salinity levels, brackish marsh often has lower species richness and species diversity than fresh tidal marsh. Brackish marsh may also have quite distinct plant zonation patterns. Wooded swamp vegetation is often found in the upper tidal reaches and may form a continuum with nontidal swamp. Tidal forest swamp may contain abundant hummocks and often has smaller trees than found in nontidal forest swamp. Red maple/Ash species, the most common forest swamp vegetation category in Maryland, was the dominant forest swamp type found in this County.

Table 1 . Tidal wetland acreage within Wicomico County based on vegetation type (McCormick and Somes, 1982).

Major Vegetation Type	Vegetation Type	Acreage
Shrub Swamp *(Fresh)*	Swamp rose	0
	Smooth alder/Black willow	0
	Red maple/Ash	110
Swamp forest *(fresh except pine, which is often brackish)*	Bald cypress	0
	Red maple/Ash	1,304
	Loblolly pine	171
Fresh marsh	Smartweed/Rice cutgrass	180
	Spatterdock	352
	Pickerelweed/Arrow arum	952
	Sweetflag	146
	Cattail	400
	Rosemallow	33
	Wildrice	79
	Bulrush	3
	Big cordgrass	284
	Common reed	24
Brackish High Marsh	Meadow cordgrass/Spikegrass	1,253
	Marshelder/Groundselbush	133
	Needlerush	2,490
	Cattail	66
	Rosemallow	28
	Switchgrass	112
	Threesquare	199
	Big cordgrass	1,981
	Common reed	17
Brackish Low Marsh	Smooth cordgrass	3,271
Saline High Marsh	Meadow cordgrass/Spikegrass	0
	Marshelder/Groundselbush	0
	Needlerush	0
Saline Low Marsh	Smooth cordgrass, tall growth form	0
	Smooth cordgrass, short growth form	0
Submerged Aquatic Vegetation	Submerged aquatic plants	0

Wetland Functions

Stormwater and Flood Control

Wetlands are often credited with providing natural stormwater and flood control benefits. Inland wetlands adjacent to rivers, streams and creeks hold excess discharge and runoff during periods of increased precipitation such as tropical storms and hurricanes and during periods of rapid snow-melt in mountainous regions. Coastal wetlands also hold excess discharge from inland drainage networks as well as tidal waters during storms.

Several factors influence the effectiveness of a wetland in reducing adverse effects of stormwater and floods. Factors include the characteristics of the wetland, local land conditions, and landscape features in the surrounding larger watershed, as well as the type of storm itself. The physical structure of many wetlands, with dense vegetation, fallen trees, topography (hummocks, depressions), and complexity of stream channel systems serve as resistance features to slow flow of surface water from floods and surface runoff, the height of peak floods, and delay the timing of the flood crest. Wetlands are typically in topographically low position, which provides a natural basin for water storage. The depth of the basin and soil characteristics affect the wetland's storage capacity at surface and subsurface levels. Water is released more slowly from the wetlands, thereby reducing both erosion and damage to property and structures farther downstream. In the surrounding areas, the ability of the land to also reduce runoff may aid the wetland in its flow retention/reduction function. At the landscape level, the position of the wetland in the watershed and the ratio of size of the wetland to the size of the watershed also affect the function. Wetlands higher in the landscape and of large in size in relation to the watershed are most effective. While wetlands retain surface flows that enter the wetlands at a gradual rate, they are considered to be more effective at reducing damages from short duration storms.

Also, some water will be removed from the wetland through ground water recharge, soil retention and evapotranspiration.

The associated value of this function can be summarized as follows:

c. A decrease in the volume and velocity of flowing water.
   Value: Helps prevent stream channel and shoreline erosion, and habitat destruction.
d. Deposition and retention of fine sediment.
   Value: Helps maintain water quality and aquatic ecosystems.
e. Water storage by extending the period of time during which flood waters are released back into the drainage system.
   Value: Helps prevent the flooding of homes, property, agricultural lands, and structures such as dams, bridges, and roads.

While depressional wetlands often exhibit little elevation differences from surrounding uplands, water still moves slowly due to the generally flat topography and may thus provide retention times sufficient to transform or uptake nutrients. The ditching and channelization of streams has reduced the ability of some floodplain wetlands to perform a flood attenuation function.

Groundwater Recharge and Discharge

Functions

Wetlands facilitate the flow of water between the ground water system and surface water system. Wetlands periodically perform different functions, depending on the gradient of the groundwater table and the topography of the land surface. The relationship of the

groundwater table and the land surface dictates which function - groundwater recharge or discharge - a wetland performs.

Nearly all of Maryland's wetlands are ground water discharge areas, at least for some portion of the year (Fugro East, Inc., 1995). Variations in the depth of the ground water table, resulting from seasonal changes in climate, dictate which of these functions - discharge or recharge - a wetland will perform at a given time.

Values

Ground water discharge helps maintain a wetland's water balance and water chemistry. This wetland function is also critical to the formation of hydric soils and the maintenance of ecosystem habitats in different types of wetlands.
Ground water recharge is the primary mechanism for aquifer replenishment which ensures future sources of groundwater for commercial and residential use.

Modification of Water Quality

Water Quality Improvement

Wetlands are valued for their ability to maintain or improve quality of adjacent surface waters. This ability is primarily accomplished by the following processes:

- Nutrient removal, transformation, and retention
- Retention of toxic materials
- Storage of the sediment transported by runoff or floods.

Hydrophytic vegetation (adapted to live in water) and microbial activity in soils help remove toxic substances and excess nutrients from surface water. Dissolved solids and other constituents may be removed or degraded, such that they become inactive, or incorporated into biomass. This occurs through adsorption and absorption by soil particles, uptake by vegetation and loss to the atmosphere through decomposition and exchange between atmosphere and water.

Nutrient Cycling: Addition, Removal and Transformation

Nutrients are carried into wetlands by hydrologic pathways of precipitation, river flooding, tides, and surface and ground water inflows. Outflows of nutrients are controlled primarily by outflow pathways of waters. The inflow and outflow of water and nutrients are important processes that effect wetland productivity.

Wetland biological and chemical processes remove suspended and dissolved solids and nutrients from surface and ground water and convert them into other forms, such as plant or animal biomass or gases. Debris and suspended solids (fine sediment or organic matter) may be removed by physical processes, such as filtering and sedimentation.

Soil characteristics, landscape position, and hydrology all contribute to the relative ability of a wetland to perform nutrient removal and transformation. Sufficient organic matter must be present for microorganisms in the soil to consume or transform the nutrients. Wetlands are often depressions in the landscape that hold water, transported sediment, and attached or dissolved nutrients for a longer period of time than a sloping area or areas

with relatively higher elevations. A longer retention time allows for chemical interactions and plant uptake to occur.

Nitrogen undergoes some chemical transformations and may be taken up in soluble form, absorbed by plants through their roots, or consumed by anaerobic microorganisms that convert the nitrogen to organic matter (Mitsch and Gosselink, 2000). Anaerobic microbes may also convert the nitrogen from a nitrate form to nitrogen gas. Phosphorus is often bound to clay particles, and these fine sediments are transported into wetlands by riparian flooding and tidal action. Phosphorus may be stored in a wetland attached to the clay particles, however, phosphorus becomes available for plant uptake in its soluble form after flooding, saturation and anaerobic conditions typical of a wetland occur. Nutrient processes vary seasonally. Cooler temperatures slow microbial activity and plant uptake while higher flows of water transport more materials out of non-isolated wetland systems. The transported organic material is critical for downstream food chain support.

Tidal wetlands are highly effective sinks and/or transformers of nutrients, as nutrients are taken up and stored by plants or released as nitrogen gas into the atmosphere. However, the uptake and transformation occurs on a seasonal basis during the growing season. At the end of the growing season, as plants die and decompose, nutrients are released back into the aquatic system.

Wetlands are most effective at nutrient transformation and uptake when there are seasonal fluctuations in water levels (Tiner and Burke, 1995). Wetlands that are temporarily flooded (saturated or inundated for brief periods early in the growing season) and those that are permanently inundated would generally be less effective than seasonally wet areas (saturated or inundated for longer periods during the early-mid growing season but are drier by the end of the growing season).

The loss of marshes from erosion due to nutria herbivory and sea level rise may increase water quality problems as loose sediments and attached nutrients are released into the water column.

Toxics Retention

Retention of heavy metals has been reported most often in studies of tidal wetlands, though most wetlands are believed to serve as sinks for heavy metals. Accumulation is primarily in soils, with plants playing a more limited role (Mitsch and Gosselink, 2000). Plants such as cattails, bulrushes, and *Phragmites* are among the more effective and commonly used plants for uptake of toxic materials such as metals. As is the case for nutrient transformation and sediment retention, soil characteristics, landscape position, vegetation, and hydrology all contribute the relative ability of a wetland to retain toxic materials. The longer the duration that water and transported materials remain in the wetland, the greater the likelihood that the materials will be retained. Many wetlands have been constructed as part of stormwater management facilities to treat surface runoff.

Sediment Reduction

Wetlands along rivers, streams and coastal areas are important for removing sediment from surface and tidal waters. During large flood events, rivers frequently overtop their banks and water flows through adjacent floodplains and wetlands. Flood waters carry

large volumes of suspended sediment, mostly fine sand, silt and clay. Because floodplains and wetlands provide resistance to flow - from dense vegetation, microtopography, and woody debris - the flow of water is slowed and sediment is deposited and stored in these areas. Similarly, coastal marshes and estuaries retain sediment brought in by tides and residual suspended sediment from rivers.

The ditching and channelization of streams may have limited the access of flood waters to floodplains and adjacent wetlands in Wicomico County. Lack of dense vegetation in some floodplains, and narrow width of floodplains, would reduce the ability of wetlands to slow velocities of floodwaters and allow settling of transported sediments.

Wildlife Habitat/Biodiversity

Wetlands provide important habitat for fish, wildlife, and plant species, including rare species. Large contiguous areas of wetland, forest or other relatively undisturbed land are most likely to support sensitive species and diverse, microhabitats. Habitat and biodiversity are threatened not only by direct impacts such as filling, drainage, sediment, and land clearing, but by introduction of exotic and invasive species. Wetlands that are important for habitat and biodiversity often require a relatively undisturbed adjacent buffer to protect the species and habitat from direct and indirect disturbance.

Numerous tidal wetlands in Wicomico County have been identified as reference sites as the best examples of certain herbaceous, shrub, and forested community types. These wetlands range of tidal inundation and salinity from irregularly flooded, freshwater systems to wetlands flooded daily with slightly brackish, oligahaline waters. These wetlands are described in the sections for individual watersheds.

Nontidal Wetlands of Special State Concern

There are a few State-designated Nontidal Wetlands of Special State Concern scattered through the County. These are described in the section for the individual watersheds.

General Restoration Considerations

According to the NRCS SSURGO GIS data, this County is dominated by hydric soil. These soils can indicate were wetlands are currently or where they once existed. Areas with hydric soils that are currently not wetlands are often good areas for wetland restoration. Soils classified as very poorly drained are focused along the Nanticoke River, the mouth of the Wicomico River, and a large portion of the eastern part of the County. Poorly drained soils are scattered through much of the remaining area, except a large area in the center of the County (including around Salisbury). Somewhat poorly drained soils in this County are not classified as hydric soil but still offer the possibility for relatively easy wetland creation due to a high water table. These soils are scattered throughout the County.

Wetland restoration and preservation may be another useful tool for achieving TMDL requirements. Wetland restoration designed to achieve maximum water quality benefits towards the TMDL should be focused at the head of tide and upstream. The headwater zone of tidal waterbodies tends to be the location of maximum algal concentrations for several reasons. The tidal headwaters are more stagnant because they tend to be shielded from the wind-generated mixing. This zone is also the depositional area of nutrients from the tidal river's primary nontidal stream system. Finally, this area tends to be shallow. As a consequence, the water tends to be slightly warmer, which increases the rate of algae growth. Additionally, less water volume is available to dilute nutrient fluxes from the bottom sediments (George, 2006, pers. comm.).

Since it is estimated that sea level rise will result in high amounts of land loss in this County, wetland restoration and preservation should consider the long-term effects, as discussed previously.

As would be expected, there is a high amount of prior converted wetland now in agricultural use. Public Drainage Association ditches and artificial drainage are important for the local economy, since the soil is generally too wet to farm without drainage. Many of the soils are ditched. The removal of these ditches would improve wetland function, though may be in conflict with other goals. Wetland restoration and mitigation may be possible along PDA ditches. However, it is important that any wetland restoration/creation along the PDAs does not alter upstream agricultural drainage. To restore the hydrology, the wetland drains can be plugged (on-line) or the wetland can be built adjacent to the ditch (off-line) using a low-level berm (Nichols, pers. comm.). The ideal sites would be those created by plugging the drain. This may be possible at the top of the artificial drainage system or where these wetlands will not negatively impact upstream agriculture. Unfortunately, in most cases, there is either a perceived or real threat that the upstream drainage will be reduced by restoring an on-line wetland. In these instances, building small berms around the wetland and keeping them off-line (connected through the ditches by an outlet rather than having the wetland encompass the ditch) may prevent the wetland from altering upstream drainage of agricultural land. This second approach is generally more expensive and does not provide as large of a watershed for the wetland, and therefore the wetland provides lower function potential. Water entering the wetland is primarily from stream/ditch overflow during high flow periods and from groundwater.

Since this County is dominated by soils requiring artificial drainage for agriculture and development, it may be especially important to avoid creating/restoring wetlands on soils with good drainage or soils classified as Prime Farmland. Prime Farmland is located throughout the County. However, some of these soils require irrigation or drainage to be especially productive. Areas of Prime Farmland when irrigated are centered around Salisbury. Most of this area also falls within the Priority Funding Area for focused development, so may not be preserved as farmland. Most of the area with Prime Farmland not requiring irrigation or drainage (and therefore the most desirable of the Prime Farmland category) is located west and outside of the Salisbury area, while other smaller spots are located east of Salisbury. There are large amounts of Prime Farmland

that requires drainage to be productive, located mainly in the eastern portion of the County. Wetland restoration/mitigation should not occur on Prime Farmland (including "Prime Farmland When Drained").

Vegetated stream buffers have the potential to intercept and remove nutrients, sediments, and other pollutants. Peterson et al. (2001) found that the smallest headwater streams, which are often found in association with springs and groundwater discharge wetlands, have the most rapid uptake and transformation of inorganic nitrogen (ammonium and nitrate) in comparison with other surface waters. The authors believed that the large surface to volume ratio in small streams resulted in rapid nitrogen uptake and processing. An excess of discharges to overload these systems would result in nitrogen being transported farther down the drainage systems to rivers and estuaries. Forested stream buffers can also improve down steam biodiversity by contributing organic matter to the food web, providing woody debris which increases diversity of physical habitat, and reducing stream temperature. Headwater streams are thought to be the most beneficial at these processes. Therefore, wetlands adjacent to streams should be high priority for restoration/preservation, with emphasis on headwater stream systems. Wetlands adjacent to Scenic Rivers and around all tributaries of waterways used for drinking water (COMAR Use P) should also be ranked higher.

DNR assessed the development risk for all land within Maryland. Wetlands within areas of high development risk should be higher priority for preservation.

Wetland restoration may be more desirable in land uses that contribute high pollution, currently provide relatively low amounts of biodiversity, and are easy to convert to wetlands. As a general rule, agriculture fits these criteria more than other land use types. Forested land is generally not as high of a pollutant source and it also provides better habitat for plants and wildlife. For these reasons, converting upland forest to wetland may provide fewer benefits than converting agriculture to wetlands. However, projects that have converted artificially drained forest to wetland have resulted in beautiful wetlands with diverse ecology. Additionally, wetlands may be built in urban land use, but they are generally much smaller and sometimes more costly. Urban areas may provide good potential for wetlands designed for storm water management.

MDE has designated some areas as Wellhead Protection Areas (WPAs). In some WPAs, the water table is near the surface, with only a few feet of soil to filter any water entering the ground. Excavation of a few feet would significantly reduce the filtering capacity of the soil, allowing the wetland to act as a direct pathway for nutrients and other pollutants to enter the groundwater. Therefore, wetland creation designs within WPAs should consider the impact to groundwater quality. Wetland restoration within the Paliochannel should also be conducted with caution, do to the same reasons. This Paliochannel starts just northeast of Mardela Springs and runs southeast to the northern portion of Salisbury. Wicomico County has delineated the Paliochannel on a GIS layer.

Sensitive Resources

Several source water assessments were completed within the watershed. For the 53 transient systems sampled, some of the water systems drawing from the unconfined aquifer were vulnerable to nitrates, volatile organic compounds, and microbiological contamination. Descriptions of the non-transient water systems can be found in the individual watershed section. Wetland restoration should not be completed in wellhead protection areas or within the Paleochannel (in the Salisbury region). Wetland restoration which increases water movement into the ground water in these areas may also be a conduit for pollutant transport.

Floodplains

There is a wide 100-year floodplain around the Nanticoke River (starting near the confluence with Quantico Creek and continuing to the Delaware State line). This floodplain extends inland even beyond the large wetland systems along the River. Another wide 100-year floodplain is at the confluence of the Nanticoke River and the Wicomico River (extending inland beyond Ellis Bay WMA). There are additional narrower floodplains along the other waterways, including the upper portion of the Wicomico River.

Other Relevant Programs

Green Infrastructure and Greenways

The State-designated Green Infrastructure network is densest in the western and southeastern parts of this County. Main areas not included within Green Infrastructure hubs are around Salisbury and Fruitland. Areas within the GI network that are currently unprotected should be protected. There are small areas designated as vegetated Green Infrastructure corridors, located mainly in the central (north of Salisbury) and northeastern parts of the County (around Parsonburg and Willards). There are also small sections of Green Infrastructure considered to be "gaps," currently in development, agriculture, or barren land, within these corridors. It is desirable to restore these areas back to natural vegetation, as they can provide a wildlife corridor, a protective buffer, and may be especially important along the waterways. For more detailed information, refer to section on the individual watershed.

Ecologically Significant Areas

DNR designates areas that contain habitat for rare, threatened and endangered species and rare natural community types. These areas are buffered to create the "sensitive species project review areas" GIS layer, intented to assist in assessing environmental impacts and reviewing potential development changes. This layer generally includes designated Natural Heritage Areas, Wetlands of Special State Concern, Colonial Waterbird Colonies, and Habitat Protection Areas.

Natural Heritage Areas

There is one State-designated Natural Heritage Area within this County called Upper Nanticoke River. It is located within the Nanticoke River watershed and Marshyhope Creek watershed (in Dorchester County) and is partially protected by The Nature

Conservancy land and DNR-owned Plum Creek Swamp. To get this designation, an area must contain threatened or endangered species and be the best Statewide examples.

Rural Legacy Program
Designated Rural Legacy land is located along Quantico Creek in the watersheds Nanticoke River and Lower Wicomico River. For detailed information on this program, refer to the individual watershed section.

Priority Funding Areas
The main priority funding area is located around Salisbury, stretching north-south from Delaware to Worcester County. There are smaller PFAs throughout the County, with some being around Mardela Springs, Hebron, along the mouth of the Nanticoke River, Pittsville, and Willards. Wetland restoration should not be conducted in the PFAs.

Stakeholders in wetland management may have conflicting goals for wetlands in Priority Funding Areas. Some may advocate preserving wetlands in these areas as greenways, for aesthetics, or as unique communities in a developing area. Other interests may seek flexibility and expedited review of proposals to impact wetlands due to other goals for growth and economic development in a designated area. There may be benefits to protecting and restoring wetlands for water quality in a growth area, particularly as an offset against future or existing TMDLs. Preservation of biodiversity may be more of a challenge due to possible increases in nonpoint source pollution and fragmentation. Stormwater management associated with growth may also reduce certain nonpoint source impacts to wetlands in PFAs.

Protected Areas
Protected areas are located in the eastern and western portions of this County, with some of the largest areas being Ellis Bay WMA, Chesapeake Forest Land, and Nanticoke River WMA.

Some properties are within agricultural easements. Some are permanent and some are shorter-term. There is some controversy about conducting wetland restoration within agricultural easements. Most would agree that it is desirable to preserve good farmland. However, properties within these easements may also contain spots of soil with lower productivity due to wetness. These low productivity spots may be a hassle to the farmer and may be good areas for wetland restoration. First, the property owner may be able to benefit from an additional program for that low productivity area, resulting in the owner getting more money for the land and utilizing the land to its full extent. Since these property owners are already involved in a preservation program, they may be more likely to consider additional programs. Second, since some of these agricultural easements are temporary, after the agricultural easement expires, the land owner may decide to get out of agriculture, and a wetland program could help to preserve some of the land from development.

Watershed Information

Information on individual State-designated 8-digit watershed basins is as follows.
Upper Pocomoke River (02130203)

Background

The Wicomico County portion of this watershed has roughly 44,201 land acres (based on MDP 2002 land use GIS data). The majority of land use is either agriculture (50%) or forest (44%), with a small amount of developed land (5%). The largest wetland areas occur along major waterways: the Pocomoke River, the confluence of North and South Fork Green Run, and Cambell Ditch. Other smaller linear wetlands occur along other waterways: Adkins Race, the bottom of Savanna Branch, Burnt Mill Branch, Murray Branch (near the confluence of Burnt Mill Branch), the mouth of Truitt Branch, Givens Branch, the mouth of Rohn Ditch, Asherwood Branch, Gordys Branch, and Aydylotte Branch. These wetlands likely provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Other small wetlands are present throughout. There is a large wetland complex that does not appear to be associated with a waterway, northwest of Mount Pleasant. These wetlands are also very important for water quality improvement, including removing and cycling nutrients, removing sediment and other pollutants. They are also important for wildlife habitat. While many of these smaller wetlands are associated with streams, many are not. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Wicomico County portion of this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). There are large portions of "very poorly drained" soil, that are not currently wetlands. These areas may be high priority for restoration.

The Pocomoke River begins in the Great Cypress Swamp north of the MD-DE State line. In Maryland, it meanders southwest for 54 miles before draining into the Pocomoke Sound. Some of the northernmost Bald Cypress swamps and other wetlands border the river along its entire length. This river is the intersection for many northern and southern plant species. In most places, the river only has a loosely defined bank and is often buffered by dense forest swamp (MDP, 1981). Much of the swamp in the upper Pocomoke River has been channelized and ditched (Sipple, 1999). This river is home to the Delmarva fox squirrel, wood ducks, and other waterfowl. The river is tidal between the Pocomoke Sound to above Whiton's Crossing (roughly 41 miles). The area between Porter's and Whiton's Crossings is where the river gets smaller and meanders through thick forest with relatively healthy cypress patches. As of 1981, the portion just south of Whiton's Crossing to the Delaware State Line had evidence of channel modification. The high amount of recreation occurring on the River may become a threat to the resource (MDP, 1981).

Estimates of wetland acreage for the entire Maryland portion of the watershed, based on DNR mapped wetlands, are as follows:

- Palustrine
    - Emergent: 63 acres

  - Scrub shrub: 779 acres
  - Forested: 17,310 acres
  - Unconsolidated bottom: 150 acres
  - Farmed: 431 acres
- Total: 19,309 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for the entire Maryland portion of the watershed, there has been a gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130203	-3.80	2.87	50.00	0	49.07

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated Use I, water contact recreation and protection of aquatic life.

Water Quality

There are several small wellhead protection areas within this watershed.

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. Since it is a "Priority" Category 1 watershed, this watershed was selected as being one of the most in need of restoration within the next two years since it failed to meet at least half of the goals. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include high modeled nitrogen and phosphorus loading, low non-tidal benthic IBI and low non-tidal instream habitat index, high amount of historic wetland loss (80,903 acres), high soil erodibility (0.30), and being on the 303(d) List for water quality impairments. Indicators for Category 3 include a high imperiled aquatic species indicator, a high percent watershed forested (53%), and State-designated Wildlands (8 acres).

According to the *2002 Maryland Section 305(b) Water Quality Report*, water quality results for the Upper Pocomoke River and tidal tributaries above Snow Hill were inconclusive. Nontidal wadeable tributaries had some portions that failed to fully support all designated uses (29.2 mi^2 fully support, 43.2 mi^2 failed to support, 37.4 mi^2 had inconclusive results) due to a poor benthic community from siltation by municipal discharge and changes in hydrology/channelization. These portions included Truitt Branch, Burnt Mill Branch, and Green Run (DNR, 2000).

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Upper Pocomoke River* (non-tidal); nutrients, suspended sediments.
- *Adkins Pond*; A TMDL has been completed for nutrients and sediments.
- *Aydylotte Branch* (021302030653 non-tidal in Wicomico County); poor biological community.
- *Libertytown North Branch* (021302030646 non-tidal in Wicomico County); poor biological community.
- *Timmonstown Branch* (021302030646 non-tidal in Worcester County); poor biological community.
- *Truitt Branch* (021302030648 non-tidal in Wicomico County); sedimentation.
- *Murray Branch* (021302030652 non-tidal in Wicomico County); sedimentation.
- *Burnt Mill Branch* (021302030652 non-tidal in Wicomico County); sedimentation.
- *Cambell Ditch* (021302030648 non-tidal in Wicomico County); poor biological community.
- *North Fork Green Run* (021302030654 non-tidal in Wicomico County); sedimentation.
- *North Fork Green Run* (021302030655 non-tidal in Wicomico County); poor biological community.
- *South Fork Green Run* (021302030655 non-tidal in Wicomico County); poor biological community.

The following information was summarized from the document entitled *Total Maximum Daily Loads of Phosphorus and Sediment to Adkins Pond in the Pocomoke River Watershed, Wicomico County, MD*. Adkins Pond is a 11.9 acre impoundment (was 17.2 acres when build in 1940) near Powellville that receives water from two main tributaries: a northern tributary - from Truitt Branch, Savanna Branch, and Campbell Ditch, and a Western tributary - Givens Branch. It drains into the Adkins Race River, a tributary of the Pocomoke River. The watershed is forest (46%) and agriculture (54%). It is designated Use I, and is used as a recreational reservoir for warm-water fishing, boating, and picnicking. This pond does not support these uses due to occasional dissolved oxygen levels below 5.0 ug/l, excessive amounts of sediment leading to reduced water volume, and algal blooms due to high phosphorus. Since there are no point sources discharging into this pond, nonpoint sources need to be addressed. The TMDL requires a 77% reduction in phosphorus loads.

MBSS sampling found FIBI was generally fair, but ranged from good to poor. BIBI also had many sites ranked as fair, but had many sites ranked as very poor. Some locations of sites ranked as very poor were Cambell Ditch, Burnt Mill Branch, Murray Branch, and Duncan Ditch.

Restoration/Preservation

The main Green Infrastructure hubs are in the southern part of the watershed, south of Pittsville. A moderate amount of this land is protected, since it is State-owned land (Wicomico Demonstration Forest and Chesapeake Forest land), but there is still some unprotected land (e.g. along Adkins Race and tributaries, Asherwood Swamp, and along

the Pocomoke River). Portions of this hub that are agriculture (e.g. west of Powellville) may be restored to natural vegetation. There is a relatively large GI corridor north of Pittsville, that also has gaps in natural vegetation. According to the Maryland Greenways Commission, there are three proposed greenways within this watershed:

- *Pocomoke River Regional Greenway*. This is a proposed wildlife corridor.
- *Pocomoke River Water Trail*. This is a proposed water trail that would connect with Nassawango Creek and Lower Pocomoke water trails.
- *Salisbury/Pocomoke River Greenway*. This is a proposed on-road bicycle connector.

A partnership of the Department of Natural Resources, U.S. Fish and Wildlife Service (FWS), and the Nature Conservancy established a goal to protect and restore riparian habitat on the mainstem and tributaries of the Pocomoke River in Wicomico, Worcester, and Somerset Counties. In March 2006 Maryland submitted a North American Wetland Conservation Act (NAWCA) Grant Proposal to FWS to purchase conservation easements from three willing landowners on properties with a total of 1187.5 acres of riparian forest, forested wetlands, and farmland. Approximately 655 acres of forested wetland will be enhanced by breaching a berm to allow improved access of the river to its floodplain (Murphy, 2006, pers. comm.).

The Pocomoke River was designated as a Scenic River by the Maryland General Assembly.

There are two State-designated Wetland of Special State Concern and four additional potential WSSC in this watershed. Information on the existing WSSC is from the DNR document entitled *Ecological Significance of Nontidal Wetlands of Special State Concern: Wicomico County*.

- *Campbell Powerlines (DNR name: Campbell Complex)*: This acidic wetland is a sphagnum meadow containing a healthy populations of a State-endangered species and another uncommon plant. Right-of-Way maintenance has taken the place of historic periodic fires in limiting succession to woody vegetation, resulting in the unusual wet meadow habitat. This wetland provides food for birds and serves as an amphibian breeding ground. The adjacent forests also provide good habitat (DNR, 1991). This wetland is partially protected by State-owned Chesapeake Forest land.
- *Delaware Wildlands*: While the majority of this wetland is within Worcester County, a portion is also within northeastern Wicomico. This 500-acre wooded wetland contains three animal species "In Need of Conservation," including a bird that requires forest interior dwelling habitat, an insect, and an amphibian. It also contains a State rare shrub (DNR, 1991). Only a small portion of this site is protected by Chesapeake Forest land, the remainder is unprotected.
- *Potential WSSC*: This site is along Warren Road and is protected by DNR-owned Chesapeake Forest land.
- *Potential WSSC*: This site is along Powell Road and is protected by DNR-owned Chesapeake Forest land.

- *Potential WSSC*: This site is between Sixty Foot and Mt. Herman Roads and is partially protected by Chesapeake Forest land and Wicomico Demonstration Forest. A portion still remains unprotected.
- *Potential WSSC*: This site is a large wetland along the Pocomoke River near Whiton and Duncan Ditches. A large portion of this site is also within Worcester County. This site is mostly protected through DNR-owned Pocomoke River Corridor NHCP.

Specific Restoration Recommendations:

- Restore wetlands and streams within the headwaters.
- Portions of the Green Infrastructure hub and corridors that are agriculture (e.g. west of Powellville) can be restored to natural vegetation.
- Create wetlands upstream of Adkins Pond designed to remove sediment and the accompanying phosphorus from the water.
- Restore ditched or channelized swamp along the Upper Pocomoke River.
- Avoid areas of Prime Farmland (e.g. around Powellville).
- Restore riparian habitat on the mainstem and tributaries of the Pocomoke River.

Specific Preservation Recommendations:

- Protect wetlands and streams within the headwaters.
- Protect land within designated Green Infrastructure (e.g. along Adkins Race and tributaries, Asherwood Swamp, and along the Pocomoke River).
- Protect any portions of the WSSCs and surrounding buffer that are not currently protected.
- Protect remaining Bald Cypress Swamp (e.g. along Pocomoke River).
- Protect the riparian habitat of the Pocomoke River and tributaries.
- Protect additional wetlands within State-designated Ecologically Significant Areas.

<u>Dividing Creek (02130204)</u>

Background

The Wicomico County portion of this watershed has 2,693 land acres (based on MDP 2002 land use GIS data). Most of the land use is forest (63%) or agriculture (32%), with a small amount of developed land (5%). Wetlands are scattered throughout this watershed. These wetlands likely provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. While some of these wetlands are associated with streams, many are not. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Wicomico County portion of this watershed, over half of the soil is classified as hydric, with few of these areas currently being wetlands (e.g. a good portion of Dividing Creek) (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). Most soils are “poorly drained,” but there are also areas of “very poorly drained.”

Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Palustrine
    - Emergent: 127 acres
    - Scrub shrub: 360 acres
    - Forested: 9,200 acres
    - Unconsolidated bottom: 22 acres
    - Farmed: 56 acres
- Total: 9,765 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight loss in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130204	-0.11	0	0	0	-0.11

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated Use I, recreation contact and protection of aquatic life.

Water Quality

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include a high amount of historic wetland loss (34,709 acres), high soil erodibility (0.28), and being on the 303(d) List for water quality impairment. Indicators for Category 3 include a high amount of headwater streams occurring in Interior Forests (35%) and a high percent of the watershed being forested (73%).

According to the *2002 Maryland Section 305(b) Water Quality Report*, water quality results for Dividing Creek and tributaries were inconclusive.

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Dividing Creek* (non-tidal); fecal coliform.
- *Dividing Creek* (tidal); nutrients, suspended sediments.
- *Tony Creek* (021302040663 non-tidal in Somerset County); poor biological community.
- *Miller Branch* (021302040665 non-tidal in Worcester County); poor biological community.

Restoration/Preservation

Since the amount of this watershed within Wicomico County is small, the amount of Green Infrastructure is also small. The Green Infrastructure is located in the eastern part of the watershed (around Snow Hill Road) and is mostly unprotected except for some DNR-owned Chesapeake Forest land.

The Pocomoke River was designated as a Scenic River by the Maryland General Assembly.

There are no State-designated Nontidal Wetlands of Special State Concern in this watershed.

Specific restoration recommendations:

- Restore wetlands and streams within the headwaters.
- Restore riparian habitat on the mainstem and tributaries of the Pocomoke River.

Specific protection recommendations:

- Protect wetlands and streams within the headwaters.
- Protect the currently unprotected Green Infrastructure.
- Protect the riparian habitat of the Pocomoke River and tributaries.
- Protect additional wetlands within State-designated Ecologically Significant Areas.

Nassawango Creek (02130205)

Background

The Wicomico County portion of this watershed has 17,959 land acres (based on MDP 2002 land use GIS data). Nearly two-thirds of this land use is forest (64%), nearly a third is agriculture (30%), and most of the remaining is developed (6%). Wetlands are associated with Nassawango Creek, Widow Hawkins Branch, Beach Island Creek, Horsebridge Creek, Lawes Ditch, Sturges Creek, and Waste Gate Creek. These wetlands provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Other fairly large wetlands exist that do not appear to be directly associated with a waterway. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Wicomico County portion of this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). There is a lot of soil classified as “very poorly drained” and not being wetland, located mainly in the northeast portion. These soils may be especially desirable to restore to wetlands. There are also many large areas with “poorly drained” soils. Some waterways with hydric soils but few wetlands include Forest Grove Branch, the upstream portion of Horsebridge Creek, the upstream portion of Wango Branch, and the upstream portion of Beach Island Creek.

Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Palustrine
  - Emergent: 358 acres
  - Scrub shrub: 300 acres
  - Forested: 11,364 acres
  - Unconsolidated bottom: 37 acres
  - Farmed: 191 acres
- Riverine
  - Emergent: <1 acre
  - Unconsolidated bottom: 2 acres
- Total: 12,252 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight loss in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130205	-0.37	0	0	0	-0.37

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated Use I, water contact recreation and protection of aquatic life.

Water Quality

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include low non-tidal benthic IBI, high amount of historic wetland loss (34,332 acres), and being on the 303(d) List for water quality impairment. Indicators for Category 3 include a high imperiled aquatic species indicator, a high percent of headwater streams in Interior Forests (32%), and a high percent of the watershed being forested (68%).

According to the *2002 Maryland Section 305(b) Water Quality Report*, the nontidal wadeable tributary Forest Grove Branch failed to fully support all designated uses (16.6 mi^2 fully support, 7.0 mi^2 failed to support, 17.5 mi^2 had inconclusive results) due to a poor benthic community from siltation, channelization, and low oxygen.

The 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Nassawango Creek* (tidal); nutrients, suspended sediments.

- *Nassawango Creek* (021302050669 non-tidal in Wicomico County); poor biological community.
- *Forest Grove Branch* (021302050669 non-tidal in Wicomico County); sedimentation.

MBSS sampling found FIBI of mostly fair (with one poor) and BIBI ranging from fair to very poor. Very poor sites were located along Forest Grove Branch and Nassawango Creek.

Restoration/Preservation

Most of this watershed is designated as Green Infrastructure, with the highest GI density being in the southern portion. There are several protected properties owned by the State (Johnson WMA and Chesapeake Forest land) and The Nature Conservancy, but there are still large unprotected areas throughout the GI. Portions of the GI hubs that are agriculture (e.g. south of Johnson WMA and north of Johnson Road) may be restored to natural vegetation. According to the Maryland Greenways Commission, there are two proposed or existing greenways within this watershed:

- *Nassawango Creek Preserve*. This partly established ecological greenway provides habitat for several important species including bald cypress, seaside alder, and many varieties of orchids and warblers.
- *Salisbury Urban Greenway*. This existing greenway leads north and southeast from Salisbury.

There are several State-designated Nontidal Wetlands of Special State Concern in this watershed and four additional potential WSSC. Information on the existing WSSC is summarized from the DNR document *Ecological Significance of Nontidal Wetlands of Special State Concern: Wicomico County*.

- *Horsebridge Creek Bog (DNR name: Adkins VI – Horsebridge Creek Bogs)*. This acidic nutrient-poor sphagnum wetland contains four rare species (one endangered, two threatened, and one rare), one uncommon species, and four additional rare species present in past surveys but not reported recently (that may still be present). Right-of-way maintenance takes the place of historic fires and flooding in suppressing woody vegetation and maintaining an open habitat. There is a drainage ditch that lowers the water table. A State-owned Chesapeake Forest property is located on the west side of Horsebridge Creek.
- *Lawes Ditch (Also called Nassawango Creek)*. This wetland is located along Beech Island Creek and Lawes Ditch and is included in Nassawango swamp forest. Nassawango swamp is a very important ecological area and includes many rare species. Among the important species that reside in Lawes Ditch are a songbird and a butterfly (ranked as in need of conservation), a threatened fern species, and an uncommon woody plant. The surrounding uplands contain three more rare species, including an endangered wildflower and butterfly, and a threatened plant.
- *Lower Sturges Creek Bog (Appears to now be called Bear Swamp by DNR)*. This site is along Mt. Olive Church Road. While the majority of this large wetland is in

Worcester County, a portion is also in Wicomico County. This site contains a wide variety of habitat, with some examples being seasonal ponds, wet meadows, sphagnum seeps, swamp forest, and bogs. There are 16 rare or uncommon plant species, including eight State endangered and one State threatened plant species. The diverse habitat found at this site also encourages species recolonization and interesting wildlife (DNR, 1991). This site is currently unprotected.

- *Nassawango Creek (A portion is called Bear Swamp by DNR)*. Nassawango Swamp is a very important ecological area. This site contains many diverse habitats including bogs, emergent marsh, shrub and white cedar swamp, and mature relatively healthy Bald cypress-Blackgum swamp. There are at least 30 State rare, threatened, or endangered species and 30 uncommon species documented within this swamp and surrounding upland area. It provides habitat for a diversity of bird species, including forest interior breeding birds and a species in need of conservation. The lower portion of this creek system (in Worcester County) is a State-designated Natural Heritage Area, a diverse relatively undisturbed ecosystem that is considered to be one of the best examples in the State. Some of the area is preserved by the Nature Conservancy. It is recommended that the area upstream of the Natural Heritage Area (NHA) be preserved in order to preserve the quality of the NHA itself.
- *Spearin Road Powerlines Site*. Powerline right-of-way maintenance which suppresses woody vegetation has replaced historical fires and flooding in maintaining an open habitat. This site contains four State endangered plant species and two uncommon plant species. There is also an endangered wildflower in the adjacent upland meadow and very high plant richness. It is likely that this uncommon habitat also contains rare moths and butterflies. This wetland is largely unprotected, but is adjacent to State-owned Johnson Wildlife Management Area.
- *Widow Swamp*. This is a sedge meadow wetland occurring along the side of the road. The removal of woody vegetation during roadside right-of-way maintenance results in an open habitat similar to that caused by historical fires and flooding. There are three State endangered plant species at this site, with one of these being nationally rare. Since these species are located in only a small area, they are very vulnerable to any surrounding disturbance, such as ditching, road widening, or negative changes in roadside maintenance. This wetland is partially protected by State-owned Chesapeake Forest land.
- *Potential WSSC*. This small wetland is located near the intersection of Twilleys Bridge Road and Wango Road. It is protected by The Nature Conservancy's Nassawango Creek Preserve.
- *Potential WSSC*. This site is located along Island Creek and is currently unprotected.
- *Potential WSSC*. This site is located within the Johnson WMA.
- *Potential WSSC*. This site is located between Sixty Foot and Mt. Herman Roads, and extends into Upper Pocomoke River watershed. A portion of this site is protected by Chesapeake Forest land and Wicomico Demonstration Forest. The remainder (within Upper Pocomoke River watershed) is unprotected.

The Nature Conservancy listed Nassawango Creek as a high priority for conservation. They describe this area as "one of the last true pieces of wilderness on the Eastern Shore." It's shorelines contain 18-miles of century-old bald cypress trees.

Specific restoration recommendations:

- Restore wetlands and streams within the headwaters.
- Portions of the Green Infrastructure hubs that are agriculture (e.g. south of Johnson WMA and north of Johnson Road) may be restored to natural vegetation.

Specific preservation recommendations:

- Protect wetlands and streams within the headwaters.
- Protect unprotected WSSC and their buffers
- The area upstream of the Nassawango Creek Natural Heritage Area (NHA) should be preserved.
- Preserve the bald cypress trees surrounding the Nassawango Creek.
- Protect unprotected areas within the Green Infrastructure network.
- Protect additional wetlands within State-designated Ecologically Significant Areas.

Lower Wicomico River (02130301)

Background

The Wicomico County portion of this watershed has 74,616 land acres (based on MDP 2002 land use GIS data). Land use is mostly divided between forest (37%), agriculture (28%), and developed land (26%), with a smaller amount of wetland (9%). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR. There is a large wetland at the mouth of the Wicomico River, including Ellis Bay WMA. Other substantial wetlands occur further up along the bends of the Wicomico River, west of Whitehaven Road, and between Rte. 349 and Rte. 352. Smaller wetlands are associated with most of the other waterways. With the exception of the downstream portion of the watershed and the headwaters of Beaverdam and Perdue Creeks, most wetlands are associated with waterways. These wetlands likely provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). Much of this is "poorly drained" soil. Large areas of nonwetland land use on hydric soils occur around Ellis Bay WMA, in the remaining Southwest portion of the watershed, and in the headwaters of Beaverdam and Perdue Creeks.

This waterway is roughly 18.8 miles from Ellis Bay and Monie Bay to the headwaters (MDE, 2001a). Portions of this watershed are also in Wicomico County, MD and Sussex County, Delaware. It drains to Tangier Sound and then to the Chesapeake Bay. The area

between Whitehaven and Fruitland/Salisbury is developing rapidly, which will continue to impact the river.

Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
    - Emergent: 6,343 acres
    - Scrub shrub: 98 acres
    - Forested: 394 acres
    - Unconsolidated shore: 32 acres
- Palustrine
    - Emergent: 1,011 acres
    - Scrub shrub: 988 acres
    - Forested: 9,041 acres
    - Unconsolidated bottom: 299 acres
    - Farmed: 195 acres
- Riverine emergent: 162 acres
- Total: 18,563 acres

As mentioned previously, wetlands were identified using aerial photography by NWI and later by DNR. While these maps are the best sources of Statewide data on wetland location, they do have limitations. Within this watershed, DNR identified large areas of wetlands that abruptly stop at the quarterquad sheet boundary. For example, there is an abrupt change between Wetipquin NE and Eden NW, with wetland acreage in Eden NW likely being underestimated. This is also true between Mardela Springs SE and Hebron SW, with wetland acreage for Hebron SW likely being underestimated. The most obvious example within this watershed is north of Whitehaven Road, just west of Greenhill Yacht and Country Club. In this location, the wetland area stops abruptly along the DOQQ border (with much less wetland identified in the east).

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130301	-5.24	6.97	0	1.57	3.29

Code of Maryland Regulations

All Maryland stream segments are categorized by Sub-Basin and are given a “designated use” in the Code of Maryland Regulations 26.08.02.08. Waterways not specifically designated in COMAR are classified as Use I, water contact recreation and protection of aquatic life. All estuarine portions (except Wicomico River and tributaries above ferry crossing at White Haven) are designated Use II, shellfish harvesting.

Water Quality

There are several wellhead protection areas within this watershed. The largest, for the water supply of Salisbury, extends beyond the city. Source water assessments were completed for some water systems in this watershed. The water system and the susceptibility are as follows:

- *City of Salisbury*: VOC, synthetic organic compounds, nitrates (Salisbury's Park).
- *City of Fruitland*: nitrate (from fertilizer), iron (natural in Quaternary aquifer).

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. Since it is a "Priority" Category 1 watershed, this watershed was selected as being one of the most in need of restoration within the next two years since it failed to meet at least half of the goals. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include high nutrient concentrations, high nitrogen and phosphorus loads, low SAV abundance, low SAV habitat index, high amount of historic wetland loss (42,358 acres), high soil erodibility (0.29), and being on the 303(d) List for water quality impairment. Indicators for Category 3 include five migratory fish spawning areas and a high amount of wetland-dependent species.

According to the *2002 Maryland Section 305(b) Water Quality Report*, tidal sections of the Lower Wicomico River and tributaries (below Johnson Pond) fail to fully support all designated uses due to low oxygen and elevated levels of bacteria from sources of non-point and natural eutrophication. Nontidal wadeable tributaries had some portions (Walston Branch subwatershed; DNR,2000) that failed to fully support all designated uses (33.0 mi^2 failed to support, 4.2 mi^2 had inconclusive results) due to a poor biological community from siltation by changes in habitat and hydrology. Coulbourn Pond, Mitchell Pond #2, Mitchell Pond #3, Schumaker Pond, and Tony Tank Pond fully supported all uses. Tony Tank Lake failed to support all designated uses due to nutrients and siltation from sources of agriculture, nonpoint, upstream, and natural.

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Lower Wicomico River* (tidal); fecal coliform, suspended sediments. A TMDL was completed for nutrients.
- *Tony Tank Lake*; A TMDL was completed for nutrients and sediments.
- *Walston Branch* (021303010560 non-tidal in Wicomico County); sedimentation.
- *Beaverdam Creek* (021303010562 non-tidal in Wicomico County); poor biological community.
- *Morris Pond* (021303010558 non-tidal in Wicomico County); poor biological community.
- *White Marsh Creek* (021303010558 non-tidal in Wicomico County); poor biological community.
- *Perdue Creek* (021303010562 non-tidal in Wicomico County); poor biological community.

- *South Prong Wicomico River* (021303010561 non-tidal in Wicomico County); poor biological community.

The following information is summarized from the MDE document entitled *Total Maximum Daily Loads of Nitrogen, Phosphorus, and Biochemical Oxygen Demand for the Lower Wicomico River, Wicomico County and Somerset County, Maryland*. This TMDL was conducted for the three 8-digit watersheds, Lower Wicomico (02130301), Wicomico River Head (02130303), and Wicomico Creek (02130304), since Wicomico River Head and Wicomico Creek flow into the Lower Wicomico. The following information refers to these three watersheds. The Lower Wicomico River above Whitehaven is designated Use I while the section below Whitehaven is Use II. These waterways do not support these uses because dissolved oxygen occasionally drops below 5.0ug/l and water quality is not adequate to maintain recreation due to high chlorophyll a (and algal blooms) inhibiting fishing and swimming. Sources of nutrients include: nitrogen – agriculture (32%), urban (32%), forest/herbaceous (23%), point sources (10%), and atmospheric deposition (3%); phosphorus – agriculture (51%), urban (21%), forest/herbaceous (14%), point sources (11%), and atmospheric deposition (3%). Point sources are mainly in the headwaters and include Salisbury WWTP and Fruitland WWTP. Other point sources are located above Johnson Pond (including Delmar WWTP). Although they are directly addressed in the Johnson Pond TMDL, they are modeled in the current TMDL as background upstream nutrients. Water samples (from the mouth of the Lower Wicomico River to Johnson Pond and to the mouth of Wicomico Creek) show water quality impairment in the upstream sections of Lower Wicomico River. High levels of chlorophyll a and low dissolved oxygen were found in sections >6 miles upstream and highest dissolved inorganic nitrogen was found in sections >8 miles upstream. The TMDL requires a 40% reduction in controllable nonpoint source for total nitrogen and total phosphorus during low flow conditions for some of the subwatersheds, including Johnson Pond and Tony Tank Lake basins.

The following information is summarized from the 1999 MDE document entitled *Total Maximum Daily Loads of Phosphorus and Sediments to Tony Tank Lake, Wicomico County, Maryland*. The County-owned Tony Tank Lake is between Salisbury and Fruitland is meant to provide recreation. The Coulbourne and Morris Mill Ponds drain into the Tony Tank Pond, and then into the Tony Tank Lake. The 41-acre lake then drains into Tony Tank Creek and into Wicomico River. The drainage area is roughly 14 mi^2 and is dominated by forest/herbaceous (54%), followed by urban (26%) and agriculture (20%). This lake is classified as Use I, but it is likely that dissolved oxygen levels drop below 5.0 at night. There is also sedimentation filling in the lake and eutrophication, with associated algae blooms and high plant growth, limiting recreational use. Water quality sampling also found high total phosphorus and low secchi depth. There are no point sources in the watershed releasing phosphorus or sediment, so these pollutants have nonpoint sources. The TMDL requires a 63.5% reduction in phosphorus and an associated 31.8% reduction in sediment.

MBSS sampling found FIBI of good to poor, with many of the poor sites being on the eastern side of Salisbury. BIBI ranged from fair to very poor. Poorer sites were located

along White Marsh Creek, Walston Branch, Beaverdam Creek, Perdue Creek, and Rockawalkin Creek.

Restoration/Preservation

Designated Green Infrastructure hub surrounds the lower portion of this watershed, from the mouth of the River to the outskirts of Salisbury. Some of this hub is agriculture. These areas may be good locations for restoration to natural vegetation. There are a few corridors around Salisbury. There are several protected properties within the GI hub (mainly DNR-owned land of Ellis Bay WMA and Chesapeake Forest land), but a lot of unprotected GI hub land still remains along the River. These properties should be high priority for protection. According to the Maryland Greenways Commission, there are several proposed or existing greenways within this watershed:

- *Ellis Bay Water Trail*. This is a proposed water trail.
- *Lower Wicomico River Greenway*. This is an existing ecological greenway with some recent development from White Haven to Salisbury.
- *Salisbury-Hebron Rail Trail*. This is a potential rail trail currently owned by the State.
- *Salisbury Urban Greenway*. This existing greenway leads north and southeast from Salisbury.
- *Salisbury/Pocomoke River Greenway*. This is a proposed on-road bicycle connector.
- *Wicomico River Water Trail*. This proposed water trail would run north from Salisbury.

The following information is based on the document *Rural Legacy FY 2003: Applications and State Agency Review*. The sponsors are Wicomico County, The Lower Shore Land Trust, and The Conservation Fund. Approximately 13,637 acres in the western side of Wicomico County are designated Rural Legacy. Total acreage of protected land includes 3,292 acres. 4,500 acres (33%) of the area is already developed. This area contains one of the most pristine Chesapeake Bay tributaries. The goal of this preservation effort is to preserve the rural character, natural heritage and natural resources of the area, while protecting it from development. The sponsors also intend to protect properties along Quantico Creek, part of the Nanticoke Watershed Greenway and to maintain the natural resource industries (e.g. forestry, agriculture, fishing, recreation). The report also includes a list of property owners who are interested in selling an easement and the priority of acquiring these easements. Since the Rural Legacy Program funds are not always adequate enough to support all of these requests, other programs should consider preservation of these sites.

A tidal freshwater shrub wetland along Wicomico River was identified as a reference area as the best example of a distinct and rare plant community of Seaside alder (*Alnus maritimus*) and Sweetflag *(Acorus calamus)*. The community is a distinct ecotone between the tidal freshwater emergent wetland and tidal fresh swamp (Harrison and Stango, 2003).

A forested tidal wetland community of *Pinus taeda/Morella cerifera/S. patens* (Loblolly pine/Wax Myrtle/Saltmeadow cordgrass) is found near Ellis Bay. This is another mesohaline system that is usually flooded less than once daily. A forested tidal wetland community site along the Wicomico River is dominated by *Fraxinus profunda-Nyssa biflora/Ilex verticillata/Polygonum arifolium* (Pumpkin ash-Swamp blackgum/Winterberry/Halberd-leaved tearthumb. This community type is flooded daily or irregularly by fresh water, with occasional pulses of higher salinity water from spring high tides or low river flow (Harrison et al., 2004). The wetlands are often found between uplands and emergent tidal wetlands, with variable microtopography of hollows and hummocks (Harrison et al., 2004).

There are several State-designated Nontidal Wetlands of Special State Concern and one potential WSSC located within this watershed.

- *Bell Marsh (DNR name: Upper Wicomico River)*. This site is located on the north shoreline of the Wicomico River, within the Critical Area. It appears that only a portion of this site is protected by a County-owned property. The remainder, most of the area along the Wicomico River, is unprotected.
- *Parker Pond (DNR combined with Schumaker Pond)*. This old millpond has a shrub swamp complex and is surrounded by forest and low density housing. This site contains a State rare plant species, limited to only two geographic areas worldwide – in Oklahoma and on the Delmarva Peninsula. It also contains two additional unusual plant species (DNR, 1991). This area appears to currently be unprotected.
- *Schumaker Pond*. This is an old millpond along Beaverdam Creek. It is forested on one side and contains three rare plant species. One of the State rare plant species is limited to only two geographic areas worldwide – in Oklahoma and on the Delmarva Peninsula. In addition to one of the State rare plant species inhabiting the pond, the invasive nonnative plant Southern Pond Lily Waterweed is also present (DNR, 1991). This area appears to currently be unprotected.
- *Stock Creek Marshes (DNR name: Upper Wicomico River)*. This site is located along the southern shore of the Wicomico River, within the Critical Area. This area appears to currently be unprotected.
- *Potential WSSC*. This site is located near the intersection of Rte. 50 and Watson Switch Road and is currently unprotected.

Specific Restoration Recommendations:

- Restore wetlands and streams within the headwaters.
- Create wetlands in the drainage area of Tony Tank Lake, designed to reduce nitrogen, phosphorus and associated sediment entering the Lake.
- Create wetlands in the drainage area of some subwatersheds within Lower Pocomoke River watershed, including Johnson Pond, designed to reduce nitrogen and phosphorus entering the waterways.
- Restore designated Green Infrastructure hub (e.g. surrounding the lower portion of this watershed, from the mouth of the River to the outskirts of Salisbury) from agriculture to natural vegetation.

Specific Preservation Recommendations:

- Protect wetlands and streams within the headwaters.
- Protect WSSC and their buffers.
- Protect land within the rural legacy area, starting with high priority properties.
- Protect currently unprotected designated Green Infrastructure hub, especially land along the River.
- Protect additional wetlands within State-designated Ecologically Significant Areas.
- Protect tidal wetlands used as reference sites in DNR's study of wetland vegetative communities (Harrison and Stango, 2003).

Wicomico Creek (02130303)

Background

The Wicomico County portion of this watershed has roughly 7,742 land acres (based on MDP 2002 land use GIS data). The majority of land use is agriculture (45%) or forest (42%). There is also some developed land (8%) and wetland (4%). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR. There is a large wetland complex along the bends of Wicomico Creek. Other wetlands occur along Collins Gut, Back Creek, portions of Passerdyke Creek, and Stephens Branch. Other wetlands are scattered throughout that do not appear to be directly associated with a waterway. These wetland provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Wicomico County portion of this watershed, there is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). Much of this is classified as "poorly drained" soil, but there are some sections of "very poorly drained" soil, that are not currently wetlands. These areas may be high priority for restoration.

Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
    - Emergent: 584 acres
    - Scrub shrub: 22 acres
- Palustrine
    - Emergent: 488 acres
    - Scrub shrub: 268 acres
    - Forested: 1,999 acres
    - Unconsolidated bottom: 72 acres
    - Farmed: 95 acres
- Total: 3,528 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight loss in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130303	-0.15	0	0	0	-0.15

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated Use I, recreation contact and protection of aquatic life.

Water Quality

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. It is also classified as a Category 3, a watershed in need of protection. Failing indicators include a high amount of historic wetland loss (16,422 acres), a high soil erodibility (0.31), and being on the 303(d) List for water quality impairment. Indicators for Category 3 include a high imperiled aquatic species indicator, four migratory fish spawning areas, and a high percent of the watershed forested (55%).

According to the *2002 Maryland Section 305(b) Water Quality Report*, water quality results for the tidal sections of Wicomico Creek and tributaries were inconclusive. The nontidal wadeable tributaries had some portions (Passerdyke Creek sub-watershed; DNR, 2000) that failed to fully support all designated uses (6.0 mi^2 failed to support, 2.7 mi^2 had inconclusive results) due to a poor biological community from siltation by changes in habitat and hydrology. Allen Pond fully supports all uses.

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Wicomico Creek* (tidal); suspended sediments. A TMDL was completed for nutrients.
- *Passerdyke Creek* (021303030565 non-tidal); sedimentation.

The following information is based on a 2000 MDE document entitled *Total Maximum Daily Loads of Nitrogen and Phosphorus for the Wicomico Creek, Wicomico and Somerset County, Maryland*. Allen Pond drains to Wicomico Creek which drains into Wicomico River. This Creek has a high amount of sedimentation due to the limited amount of tidal flushing. Beef cattle and poultry operations are present in the upper reaches and poultry waste is applied to row crops throughout the watershed. Agricultural drainage ditches are also common in the upper reaches. Violations of the Use I classification include occasional low dissolved oxygen in the upper and lower reaches, and elevated chlorophyll a in the upper reaches. Nutrients are from the following sources:

nitrogen – agriculture (57%), forest/herbaceous (26%), urban (14%), atmospheric deposition (3%); phosphorus – agriculture (80%), forest/herbaceous (9%), urban (8%), atmospheric deposition (3%). Water quality sampling found the highest chlorophyll a in the center of the creek. Dissolved oxygen was below 5.0mg/l at the mouth and in the pond. The TMDL requires a 30% reduction in low flow controllable nonpoint nitrogen and phosphorus in some subwatersheds. It also requires a 35% or 55% reduction in average annual controllable nonpoint nitrogen and phosphorus, depending on the subwatershed.

MBSS sampling found FIBI of poor and BIBI of very poor.

Restoration/Preservation

Although the amount of this watershed within Wicomico County is small, a fair amount of it is within designated Green Infrastructure. The largest hub is in the west (around Collins Wharf Road) and is mostly unprotected except for some DNR-owned Chesapeake Forest land and some METs. Portions of this hub that are agriculture (e.g. between Yacht Club Road and Noble Farm Road), especially around waterways, should be restored to natural vegetation.

There is one proposed Nontidal Wetland of Special State Concern located within the Wicomico County portion of this watershed. It is located along Allen Road and is currently unprotected.

Specific Restoration Recommendations:

- Restore wetlands and streams within the headwaters.
- Restore wetlands in the drainage to Wicomico Creek, designed to reduce nitrogen and phosphorus entering the waterway.
- Restore portions of the Green Infrastructure that are currently in agriculture (e.g. between Yacht Club Road and Noble Farm Road, especially around waterways) to natural vegetation.

Specific Preservation Recommendations:

- Protect wetlands and streams within the headwaters.
- Protect currently unprotected Green Infrastructure, especially along Wicomico Creek and tributaries.
- Protect additional wetlands within State-designated Ecologically Significant Areas.

<u>Wicomico River Headwaters (02130304)</u>

Background

The Wicomico County portion of this watershed has approximately 24,757 land acres (based on MDP 2002 land use GIS data). These are divided between forest (38%), agriculture (35%), and developed land (27%). Most of the wetlands are associated with

waterways. These wetlands provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Some wetlands are not associated directly with waterways, including some relatively large wetlands near Greenland and other small wetlands scattered throughout the eastern portion of the watershed. These wetlands are also very important for water quality improvement, including removing and cycling nutrients, removing sediment and other pollutants, and for wildlife habitat. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. There is a large amount of hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). Much of this is "poorly drained," but there are some "very poorly drained" (in addition to "poorly drained") soils with non-wetland land use in the eastern portion of the watershed. These "very poorly drained" areas may be high priority for restoration. Other "poorly drained" soils that are not currently in wetland land use are located in the headwaters of Little Burnt Branch and Connelly Mill Branch.

Estimates of wetland acreage for the entire Maryland portion of the watershed, based on DNR mapped wetlands, are as follows:

- Palustrine
    - Emergent: 86 acres
    - Scrub shrub: 133 acres
    - Forested: 2,200 acres
    - Unconsolidated bottom: 70 acres
    - Farmed: 91 acres
- Total: 2,581 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight loss in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130304	-5.52	3.93	0	0	-1.59

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. This watershed is designated as Use I, water contact recreation and protection of aquatic life.

Water Quality

There are several wellhead protection areas within this watershed. Salisbury wellhead protection area is the largest, and extends beyond the City of Salisbury. Based on the source water assessment, the city of Salisbury is vulnerable to VOCs, synthetic organic compounds, and nitrates (Salisbury's Park).

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. Since it is a "Priority" Category 1 watershed, this watershed was selected as being one of the most in need of restoration within the next two years since it failed to meet at least half of the goals. Failing indicators include high modeled nitrogen and phosphorus loads, high historic wetland loss (16,145 acres), high soil erodibility (0.35), and being on the 303(d) List for water quality impairment.

According to the *2002 Maryland Section 305(b) Water Quality Report*, portions of the nontidal wadeable Wicomico River tributaries did not fully support all designated uses (20.3 mi. failed to support, 11.4 mi. inconclusive) due to poor biological community. Johnson Pond also failed to support all designated uses (104 acres) due to nutrients and siltation from municipal discharge, agricultural, non-point and natural sources. Leonards Mill Pond does fully support all designated uses (45.9 acres).

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Wicomico River Headwaters*; fecal coliform.
- *Middle Neck Branch* (021303040566 non-tidal); poor biological community.
- *Morris Branch* (021303040569 non-tidal); poor biological community.
- *Johnsons Pond*; A TMDL has been completed for sediments and nutrients.

The following information is summarized from the 2001 MDE document *Total Maximum Daily Loads of Phosphorus and Sediment to Johnson Pond in the Upper Wicomico Watershed, Wicomico County, Maryland*. Johnson Pond is a 136-acre impoundment in Salisbury receiving water from the Upper Wicomico River. There are three main tributaries: the northern tributary which is comprised of Little Burnt Branch, Connelly Mill Branch, and Leonard's Pond Run, the northeastern tributary of Brewington Branch, and the Eastern tributary which is comprised of Middle Neck Branch and Peggy Branch. The drainage area is 24,993 acres. It is designated Use I and is used for recreation, including warm-water fishing. Problems in the reservoir include sedimentation, algal blooms, excessive plant growth, foul odors, and low dissolved oxygen levels. Phosphorus is assumed to be the limiting nutrient. The soils in the watershed are highly erodible. Point sources include Delmar WWTP (discharging into Wood Creek) and Perdue Farms, Inc., Salisbury, WWTP (discharging into Peggy Branch). The TMDL requires a 39% reduction in phosphorus from the total amount (including a 49% reduction from nonpoint sources). This phosphorus reduction through soil conservation and water quality plans should lead to a 34.3% reduction in sediment.

A Draft TMDL was completed in 2005 for fecal bacteria in some portions of the Wicomico River Headwaters, including upstream of Leonard Mill Pond, and between Leonard Mill Pond and Johnson Pond. The area of Leonard Mill Pond and upstream of the pond have very high populations of resident and migratory Canada geese. There are also some septic systems in the area and the Delmar WWTP servicing the area on the pond. The area upstream of the pond is largely forest, with some soybean crops. For the

area between Leonard Mill and Johnson Pond, the Leonard Mill Visitor Center may be a potential source of bacteria from humans, domestic animals, and Canada geese. Many septic systems are located throughout the watershed. The Perdue Farms Industrial WWTP discharges into Peggy Branch, draining into Middle Neck Branch. Sources of fecal bacteria were highest from wildlife, followed by domestic animals, humans, and livestock.

MBSS sampling found FIBI of fair and BIBI ranging from good to very poor, with very poor sites located on Burnt Branch, Leonard Pond Run, and Morris Branch.

Restoration/Preservation

There are some small Green Infrastructure hubs and corridors in this watershed. The largest hub is east of Delmar and Salisbury and is mostly unprotected (with the exception of some DNR-owned Chesapeake Forest land). According to the Maryland Greenways Commission, there are several proposed or existing greenways within this watershed:

- *Wicomico River Water Trail*. This proposed water trail would run north from Salisbury.
- *Winterplace Park and Rail-Trail*.
- *Salisbury Urban Greenway*. This existing greenway leads north and southeast from Salisbury.
- *Salisbury/Pocomoke River Greenway*. This is a proposed on-road bicycle connector.
- *Nassawango Creek Preserve*. This partly established ecological greenway provides habitat for several important species including bald cypress, seaside alder, and many varieties of orchids and warblers.

There are two State-designated Nontidal Wetlands of Special State Concern and three potential WSSC within this watershed.

- *Johnson Pond*. This site is located in the upper Wicomico River, in Salisbury. It contains a large uncommon vegetative community – an Atlantic White Cedar Swamp – and a State endangered plant species. The adjacent upland habitat contains two additional State endangered and State Rare plant species. Further surveys may reveal additional RTE plant species, which are often found in Cedar swamps (DNR, 1991). This site is currently unprotected.
- *Williams Pond*. This site is located on the North Prong of Leonard Pond Run, just north of Leonard Pond. This system contains a large swamp forest with an open water pond containing a fish "In Need of Conservation." This fish requires quiet, acid water and is usually found in the more southern States (DNR, 1991). This site is currently unprotected.
- *Potential WSSC*. This site is located between Gordy Mill Road and Rum Ridge Road and is partially protected by DNR-owned Chesapeake Forest land.
- *Potential WSSC*. There are two small sites, both located along Tilghman Branch and unprotected.

Specific Restoration Recommendations:

- Restore wetlands and streams within the headwaters.
- Restore wetlands in drainage to Leonard Mill Pond and Johnson Pond, designed to remove fecal bacteria from the water column.
- Restore wetlands in drainage to Johnson Pond, designed to remove phosphorus and sediment from the water column.

Specific Preservation Recommendations:

- Protect wetlands and streams within the headwaters.
- Protect currently unprotected Green Infrastructure.
- Protect WSSC and surrounding buffers.
- Protect additional wetlands within State-designated Ecologically Significant Areas.

Nanticoke River (02130305)

Background

The Wicomico County portion of this watershed has approximately 74,039 land acres (based on MDP 2002 land use GIS data). Nearly half of the land use is forest (48%), followed by agriculture (34%), wetland (10%), and developed land (8%). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR. There are extensive wetland areas along the bends of the Nanticoke River. Other smaller wetlands are associated with the tributaries. There are also some large wetlands not directly associated with waterways (e.g. between Rewastico Creek and Manumsco Creek and between Quantico Creek and Wetipquin Creek). These wetland provide the functions of water quality improvement, flood attenuation, stream recharge, and wildlife habitat. Hydric soil suggests where wetlands are currently or were historically. Areas having hydric soil, but that are no longer wetlands, have the potential to be good wetland restoration sites. Within the Wicomico County portion of this watershed, there is some hydric soil that is not wetland (based on GIS data: NRCS SSURGO, DNR wetlands, NWI wetlands). Most of this is "poorly drained," but some are classified as "very poorly drained" soil. Soils classified as "very poorly drained," that are not currently wetlands, should be high priority for restoration.

The fresh and brackish estuarine marshes of the Blackwater-Nanticoke area have large numbers of waterfowl. The four major types of waterfowl habitat present are: fresh estuarine bay marsh (along upper Blackwater River), brackish estuarine bay marsh (around upper portion of Fishing Bay – also draining into bay – and upper estuarine bay of Nanticoke River from Ragged Point to Chapter Point), estuarine river marsh (upper portion of Transquaking River and Chicamacomico River, and Nanticoke River north of Chapter Point to near Riverton), and brackish estuarine bay (upper part of Fishing Bay and upper part of estuarine bay in Nanticoke River). The Nanticoke River marshes between Savannah Lake and Elliot Island has excellent wintering and transient concentration areas of black ducks (Sipple, 1999).

Upper Nanticoke River is a designated Natural Heritage Area within this watershed. To get this designation, an area must contain threatened or endangered species and be the best Statewide examples. Both the Chesapeake Bay Foundation and The Nature Conservancy are putting special emphasis on preserving the Nanticoke River watershed. The meanders of the Nanticoke River have resulted in extensive wetlands on the inside bends (Sipple, 1999).

Estimates of wetland acreage for the entire Maryland portion of the watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
    - Emergent: 14,050 acres
    - Scrub shrub: 345 acres
    - Forested: 523 acres
    - Unconsolidated bottom: 7 acres
    - Unconsolidated shore: 120 acres
- Palustrine
    - Emergent: 2,532 acres
    - Scrub shrub: 1,408 acres
    - Forested: 18,367 acres
    - Unconsolidated bottom: 241 acres
    - Unconsolidated shore: 5 acres
    - Farmed: 280 acres
- Total: 37,878 acres

As mentioned previously, wetlands were identified using aerial photography by NWI and later by DNR. While these maps are the best sources of Statewide data on wetland location, they do have limitations. Within this watershed, DNR identified large areas of wetlands that abruptly stop at the quarterquad sheet boundary. For example, there is an abrupt change between Wetipquin NE and Eden NW, with wetland acreage in Eden NW likely being underestimated. This is also true between Mardela Springs SE and Hebron SW, with wetland acreage for Hebron SW likely being underestimated. The most obvious examples within this watershed are: south of Nanticoke Road and west of Nebo Road, just west of the intersection between Athol Road and Quantico Roads, and west of the intersection between Mill Branch Road and Riggin Road. In these locations, wetland areas stop abruptly along the DOQQ border (with much less wetland identified in the east).

Watershed-based Wetland Characterization Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report (Tiner et al., 2000) classified wetlands in the 8-digit watersheds Nanticoke River, Marshyhope Creek, and the Coastal Bay watersheds using a classification scheme that bridged the NWI classification to the HGM classification. This method is described in the document entitled *Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors* (Tiner, 2003a). As a base map, they used the wetlands identified in the National Wetland Inventory (NWI). They modified this NWI map by photointerpretating 1998 1:40,000 black and white aerial photography and incorporating

State digital wetland maps (from 1989 photography), digital submerged aquatic vegetation data, and Natural Resource Conservation Service digital hydric soil data. Additionally, investigators conducted a limited amount of field surveying. In the Tiner et al. (2000) document, they acknowledge that palustrine forested wetlands may be overestimated using this method due to difficultly in distinguishing between forests that are currently wetlands and ones that were drained but still have hydric soils.

These wetlands were classified into HGM types based on landscape position, landform, and water flow direction of the wetlands, determined by comparing the wetland maps with topographic maps and aerial photos. Wetlands in these watersheds were classified into five groups depending on their landscape positions, or their relationship to an adjacent waterbody: marine, estuarine, lotic (adjacent to freshwater streams and rivers), lentic (associated with lakes), and terrene (isolated or headwater) (Figure 1). Within the Nanticoke and Marshyhope Creek watersheds, over half of the wetlands were classified as terrene (53%), a large percentage as estuarine (35%), and the remaining as lotic (13%) and lentic (<1%). These wetland types were further subdivided based on where they occur within these classifications and their water flow path.

Tiner et al. (2000) then assessed the potential ability of each wetland classification to provide a given function in the process called "Watershed-based Preliminary Assessment of Wetland Function." This assignment of function based on wetland type is described in the document entitled *Correlating Enhanced National Wetlands Inventory Data with Wetland Functions for Watershed Assessments: A Rationale for Northeastern U.S. Wetlands* (Tiner, 2003b). The evaluated functions included: surface water detention, streamflow maintenance, nutrient transformation, sediment and particulate retention, coastal storm surge detention and shoreline stabilization, inland shoreline stabilization, fish and shellfish habitat, waterfowl and waterbird habitat, other wildlife habitat, and conservation of biodiversity. Wetlands along the Nanticoke River, Marshyhope Creek, and tributaries have a high potential for surface water detention, nutrient transformation, and sediment and particulate retention. The estuarine and lotic river portions had high potential for coastal storm surge detention and shoreline stabilization. Many of the terrene wetlands were estimated to have moderate to high potential for surface water detention. Wetlands along the Marshyhope Creek and tributaries had high potential for streamflow maintenance and inland shoreline stabilization. The Nanticoke River and lower tributaries had high potential for fish and shellfish habitat, and waterfowl and waterbird habitat. They also identified wetlands significant for other wildlife habitat: large wetlands ($\geq$20 acres) and small diverse wetlands (10-20 acres having $\geq$2 different covertypes). Many of the diverse wetlands were already designated as WSSC and were within Marshyhope Creek watershed (Dorchester and Caroline Counties) or associated with Chicone Creek (Dorchester County). They then identified wetlands thought to significant for biodiversity. These included: the large middle and upper estuarine wetlands of Nanticoke River (oligohaline in the middle), the large lotic river wetland along Marshyhope Creek, the large terrene wetland area near Finchville (Dorchester County), the large terrene wetland area between Chicone Creek and Marshyhope Creek (Dorchester County), the large terrene wetland just north of Mardela Springs (Wicomico County), the large terrene wetland important to forest breeding avifauna encompassing

Athol, Rewastico, and Quantico (Wicomico County), and the large terrene wetland between Royal Oak, Head of the Creek, and Wetipquin (Wicomico County). More intensive fieldwork may produce different results, since some HGM types are difficult to distinguish from one another. In addition, some functions rely on characteristics only seen in the field, such as micro-topography.

For the combined Nanticoke River and Marshyhope Creek watersheds, the land cover for the 100m buffer around wetlands and waterbodies was estimated to be 34% natural vegetation, 59% agriculture, and 7% developed. There are a large number of channelized streams and ditches (Tiner et al., 2000).

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130305	-2.16	4.17	0	2.16	4.16

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a "designated use" in the Code of Maryland Regulations 26.08.02.08. Waterways not specifically designated within COMAR are classified Use I, water contact recreation and protection of aquatic life. All estuarine portions (except Nanticoke River and tributaries above Runaway Point and Long Point) are designated: Use II, shellfish harvesting.

Water Quality

There are several wellhead protection areas in the watershed. Source water assessments were completed for some water systems in this watershed. The water system and the susceptibility are as follows:

- *City of Salisbury*: VOC, synthetic organic compounds, nitrates (Salisbury's Park).
- *Sharpstown*: above 50% MCL - nitrate, lead, total trihalomethanes, and radon.

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. It is also classified as a "Selected" Category 3, a pristine or sensitive watershed most in need of protection. Failing indicators include high nutrient concentrations, low SAV abundance, low SAV habitat index, poor non-tidal fish IBI and poor non-tidal instream habitat index, high amount of historic wetland loss (54,807 acres), and being on the 303(d) List for water quality impairment. Indicators for Category 3 include high tidal fish IBI, high imperiled aquatic species indicator, six migratory fish spawning areas, high anadromous fish index, and high amount of wetland-dependent species.

According to the *2002 Maryland Section 305(b) Water Quality Report*, portions of the tidal Nanticoke River and tributaries fail to support all designated uses (22.0 mi^2 supports, 6.3 mi^2 fails to support) due to bacteria from nonpoint and natural sources. Nontidal wadeable tributaries fully support all designated uses (19.8 mi. support, 26.3 mi. inconclusive).

The 2004 303(d) List contains basins and subbasins that have measured water quality impairment and may require a TMDL. The basin/subbasin name, subbasin number (if applicable), and type of impairment are as follows:

- *Nanticoke River* (tidal); fecal coliform, poor biological community.
- *Nanticoke River Unnamed Tributary* (021303050584 non-tidal in Wicomico County); poor biological community.
- *Rewastico Creek* (021303050581 non-tidal in Wicomico County); poor biological community.
- *Dennis Creek* (021303050587 non-tidal in Dorchester County); poor biological community.
- *Plum Creek* (021303050584 non-tidal in Wicomico County); poor biological community.
- *Plum Creek Unnamed Tributary* (021303050584 non-tidal in Wicomico County); poor biological community.
- *Chicone Creek* (021303050586 non-tidal in Dorchester County); poor biological community.
- *Chicone Creek Unnamed Tributary* (021303050586 non-tidal); poor biological community.
- *Cove Road Beach*; fecal coliform.
- *Barren Creek* (021303050583 non-tidal in Wicomico County); poor biological community.

MBSS sampling found most FIBI sites of fair and very poor. BIBI samples ranged from good to very poor, with the worst samples being located on unnamed tributaries near Santo Domingo and Athol.

Restoration/Preservation

Most of this watershed is designated Green Infrastructure hub. Areas excluded from this designation are around Hebron and at the mouth of the Nanticoke River. Large areas of this hub, south of Mardela Springs, are in agriculture and should be high priority for restoration to natural vegetation. There are a number of small protected areas (mainly DNR-owned land of Nanticoke River WMA and Chesapeake Forest land) within this GI. Even with these numerous protected properties, most of the GI hub remains unprotected. According to the Maryland Greenways Commission, there are several existing or proposed greenways within this watershed:

- *Nanticoke River Greenway*. This is a ecological greenway that is partially developed.

- *Nanticoke River Water Trail*. This potential water trail would follow the Nanticoke River and tributaries Wetipquin Creek, Quantico Creek, Rewastico Creek, and Barren Creek.
- *Salisbury-Hebron Rail Trail*. This is a potential rail trail currently owned by the State.

The following information is based on the document *Rural Legacy FY 2003: Applications and State Agency Review*. The sponsors are Wicomico County, The Lower Shore Land Trust, and The Conservation Fund. Approximately 13,637 acres in the western side of Wicomico County are designated Rural Legacy. Total acreage of protected land includes 3,292 acres. 4,500 acres (33%) of the area is already developed. This area contains one of the most pristine Chesapeake Bay tributaries. The goal of this preservation effort is to preserve the rural character, natural heritage and natural resources of the area, while protecting it from development. The sponsors also intend to protect properties along Quantico Creek, part of the Nanticoke Watershed Greenway, and to maintain the natural resource industries (e.g. forestry, agriculture, fishing, recreation). The report also includes a list of property owners who are interested in selling an easement and the priority of acquiring these easements. Since the Rural Legacy Program funds are not always adequate enough to support all of these requests, other programs should consider preservation of these sites.

A partnership of the Nature Conservancy, Maryland Department of Natural Resources, U.S. Fish and Wildlife Service, and the Eastern Shore Land Conservancy has a goal to protect and restore habitat in the Nanticoke - Blackwater watershed in Wicomico and Dorchester Counties. Several thousand acres have been protected through the years. In March 2006 DNR submitted a FWS Section 6 (Endangered Species) Recovery Land Acquisition grant proposal to purchase a conservation easement on 1,429 acres of forest, forested wetland, and farmland in the Little Blackwater River watershed to protect habitat for the Delmarva Fox squirrel.

As part of an ongoing project to classify the vegetative communities in Maryland, DNR created the document entitled *Shrubland Tidal Wetland Communities of Maryland's Eastern Shore* (Harrison and Stango 2003). In this document, they categorize nine shrubland tidal wetland communities, including some in Wicomico County. The reference shrub community *I. frutescens/S. cynosuroides* (Marsh elder/Big cordgrass) is also found in Wetipquin Creek in oligohaline to mesohaline waters, with daily to irregular tidal inundation. A tidal freshwater shrub wetland along Barren Creek was identified as a reference area as the best example of a distinct and rare plant community of Seaside alder (*Alnus maritimus*) and Sweetflag *(Acorus calamus)*. The community is a distinct ecotone between the tidal freshwater emergent wetland and tidal fresh swamp (Harrison and Stango, 2003).

A reference tidal wetland herbaceous community of *S. cynosuroides* is found along the Nanticoke River. This community type is flooded daily by oligohaline or mesohaline waters (Harrison 2001).

A forested tidal wetland community site along Barren Creek is dominated by *Fraxinus profunda-Nyssa biflora/Ilex verticillata/Polygonum arifolium* (Pumpkin ash-Swamp blackgum/Winterberry/Halberd-leaved tearthumb. This community type is flooded daily or irregularly by fresh water, with occasional pulses of higher salinity water from spring high tides or low river flow (Harrison et al., 2004). The wetlands are often found between uplands and emergent tidal wetlands, with variable microtopography of hollows and hummocks (Harrison et al.,, 2004).

There are several State-designated Wetlands of Special State Concern in this watershed and four additional potential WSSC. Much of the following information is from the DNR document entitled *Ecological Significance of Nontidal Wetlands of Special State Concern: Wicomico County*.

- *Barren Creek (including the old WSSC name Mockingbird Pond)*: This site, encompassing Mockingbird Pond and Barren Pond, is located along upper Barren Creek. It runs from the headwaters of Barren Creek to the boundary of the Critical Area. This site contains at least four old millponds, with one being an open-water pond. The open water area provides excellent habitat for birds and amphibians. These ponds mimic habitat once created by beaver: wetlands with an open canopy. Since this type of habitat is now rare in Maryland, it can support many rare species. The moist banks and exposed soils of the previously flooded ponds support healthy reproducing populations of a rare woody species. This plant is only known to exist in two geographic regions worldwide – in Oklahoma and on the Delmarva peninsula. Healthy seeps provide habitat for a diverse group of plants, including one State rare and one uncommon plant. Wetlands around lower Barren Creek, from the mouth of the Nanticoke River to Mardela Springs are WSSC within the Chesapeake Bay Critical Area. This area has been designated as Habitat Protection Area for Locally Significant Habitat in the Chesapeake Critical Area Program, as it also contains the State rare woody species. Therefore, protection of the upper Barren Creek should help protect this area (DNR, 1991). This site is not currently protected.
- *Middle Plum Creek (DNR combined with Plum Creek Cedar Swamp)*: This site is located along Plum Creek, just south of the Sharpstown town center. This is an Atlantic White Cedar Swamp surrounded by a Red Maple/Sweet Gum swamp. Within the relatively uncommon Cedar swamp are five additional plant species, including a State threatened species, a State rare species, and three uncommon species (DNR, 1991). The downstream portion of this site is protected by The Nature Conservancy, called Upper Nanticoke River Preserve. However, the majority is still unprotected.
- *Plum Creek Bog (DNR name: Plum Creek Cedar Swamp)*: This site is located in the headwaters of Plum Creek. This is a “high quality sphagnum bog” having an acidic, wet, nutrient-poor habitat that only allows specially adapted plants to survive. For this reason, this site has diverse vegetation and five important plant species. Sphagnum bogs are relatively uncommon on the Eastern Shore. Many of the wetland plants growing here require an open canopy to thrive. In the past, this open canopy was maintained through beaver or fire activity. Now these areas are

mainly kept opened through powerline rights-of-way maintenance (DNR, 1999). This site is currently unprotected.

- *Quantico Creek (DNR name: Upper Quantico Creek)*: This site is located along Quantico Creek, just west of Quantico Road. It is currently unprotected.
- *Sharpstown Bog*: This is a sphagnum bog, a wetland having an acidic, wet, nutrient-poor habitat that only allows specially adapted plants to survive. For this reason, this site has diverse vegetation. In summer 1987, it was found to contain 13 rare (8 being State endangered) or uncommon plant species, with most of these being healthy reproducing populations. Sphagnum bogs are relatively uncommon on the Eastern Shore. Many of the wetland plants growing here require an open canopy to thrive. In the past, this open canopy was maintained through beaver or fire activity. Now these areas are mainly kept opened through powerline rights-of-way maintenance. In fall 1987, upstream clearcutting occurred and timber was dragged through this powerline clearing. This action destroyed 80% of the bog and created long-lasting soil ruts. After this catastrophy, it appeared that 9 of the original 13 rare or unusual species still survived, but populations were severely decimated. In addition to the direct physical disturbance caused by the upstream logging operations, indirect effects included loss of upstream forest canopy, increased sedimentation, altered wetland hydrology, and likelihood of increased invasion by weedy species (DNR, 1991). This site is currently unprotected.
- *Upper Nanticoke River, Marshes and Swamps NHA*: This is part of a large WSSC along the Nanticoke River. While the majority of this system is within Dorchester County, there is still a large area within Wicomico County, extending from Hollering Point to the Delaware State Line. A portion of this is protected by DNR-owned Plum Creek Swamp NHCP and The Nature Conservancy Upper Nanticoke River Preserve. There are still many large sections within Wicomico County that are unprotected.
- *Wetipquin Pond (includes the incorrectly named Litsea Pond)*: This site is a Delmarva Bay surrounded by shrub swamp and Red Maple swamp forest. As a Delmarva Bay, it is a seasonally flooded “shallow, centripetally-drained” pond. These once-common landscape features are now uncommon on the Eastern Shore, and therefore provide unique habitat for rare plant species. This site is relatively undisturbed and as such, is one of the best State-wide examples. This site contains two State endangered plants, with one qualifying for federal listing. There is a forested buffer immediately around the pond and ~10 year old forest surrounding that (DNR, 1991). This site, called Wetipquin Pond Preserve, is protected by The Nature Conservancy.
- *Potential WSSC*: This site is near the intersection of Snethen Church Roads. A portion of this site is protected within DNR-owned Chesapeake Forest land.
- *Potential WSSC*: This site is along Riverton Road.
- *Potential WSSC*: This site is between Rte. 50 and Deerfield Road and is unprotected.
- *Potential WSSC*: This site is located within the DNR-owned Nanticoke River WMA.

In the document entitled *Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report*, Tiner et al., (2000) proposed wetland restoration sites in the Nanticoke River and Marshyhope Creek watersheds totaling 22,506 acres. These sites were classified into two categories: former wetlands (Type 1) and existing impaired wetlands (Type 2). Type 1 sites included filled wetlands (without any buildings on them), farmed wetlands, and those converted to deepwater. There were only 360 acres of Type 1 sites, scattered throughout the two watersheds. The Type 1 estimate is conservative because they did not include areas having hydric soils that were effectively drained, and now appeared to be productive farmland. These areas were indistinguishable from the surrounding land in aerial photographs and the likelihood of landowner interest is low. However, since identified Type 1 sites are generally surrounded by effectively drained areas, restoration potential acreage is larger than it may first appear. About a third of the existing wetlands within these two watersheds are designated as Type 2 sites, degraded wetlands. Most of these wetlands were ditched palustrine (98%), but some were tidally restricted, impounded, or excavated. There were 22,146 acres classified as Type 2 sites. While these sites are scattered throughout the watersheds, larger Type 2 wetland restoration opportunities include:

- Between the Chicone Creek and Marshyhope Creek (Marshyhope Creek and Nanticoke River watersheds - Dorchester County)
- East of Lecompte WMA (Dorchester County)
- North of Mardela Springs (Wicomico County)
- Between Athol, Rewastico, and Quantico (Wicomico County)
- Between Head of Creek and Royal Oak (Wicomico County)

Specific restoration recommendations:

- Restore wetlands and streams within the headwaters.
- Restore areas within the Green Infrastructure hub, currently in agriculture, to natural vegetation (including south of Mardela Springs).

Specific protection recommendations:

- Protect wetlands and streams within the headwaters.
- Protect areas currently unprotected areas within Green Infrastructure, especially areas along the Nanticoke River.
- Protect land within designated rural legacy area, starting with highest priority properties.
- Protect WSSC, potential WSSC, and their buffers.
- Protect additional wetlands within State-designated Ecologically Significant Areas.
- Protect tidal wetlands used as reference sites in DNR's study of wetland vegetative communities (Harrison and Stango, 2003).
- Protect habitat for the Delmarva Fox squirrel