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Background

Anne Arundel County has roughly 114,008 acres of open water and 265,348 acres of land. The land acres are divided as follows: urban 111,821 (42%), agriculture 42,260 acres (16%), forest 108,877 acres (41%), wetlands 1,646 (1%) and barren land 743 (<1%) (MDP, 2002). More accurate estimates of wetland acreage are based on DNR wetlands data, as described later.

Soil classified as prime farmland (based on NRCS SSURGO GIS data) is scattered throughout the County. In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland.

There are three 6-digit watersheds and twelve 8-digit watersheds in this County, all draining into the Chesapeake Bay. Patapsco River (021309) includes Bodkin Creek (02130902), Baltimore Harbor (02130903) and Patapsco River Lower North Branch (02130906); West Chesapeake Bay (021310) includes Magothy River (02131001), Severn River (02131002), South River (02131003), West River (02131004) and West Chesapeake Bay (02131005); Patuxent River (021311) includes Patuxent River Lower (02131101), Patuxent River Middle (02131102), Patuxent River Upper (02131104), and Little Patuxent River (02131105).

Streams

The Maryland Tributary Strategies document *Patuxent River Basin Summary Final Version for 1985-2002 Data: January 29, 2004* describes the Patuxent River Watershed (an area containing parts of St. Mary's, Anne Arundel, Prince George's, Calvert, Charles Howard, Montgomery). As of 1998, some BMP goals for this basin have been met (marine pumpouts, shore erosion, septic connections, and stormwater management retrofits) but some have not been met (controlling erosion and sediment, urban nutrients, septic pumping, enhanced stormwater management, forest practices). The Patuxent River receives water from the Little Patuxent, Middle Patuxent and Patuxent. This watershed has over 100 species of fish. Land use for the entire basin is dominated by forest (44%), followed by urban (30%), and agriculture (26%). About 70% of the houses are on municipal sewage and 81% are on public water. The main nitrogen, phosphorus, and sediment sources within the Upper Potomac River basin were point sources (34%, 30%, 0%, respectively), urban (32%, 36%, 28%, respectively), and agriculture (21%, 22%, and 55%, respectively). Tributary stations had total nitrogen levels mostly ranked as good and levels were generally improving since 1985. The two sites ranked poor were located at the northern portion (MD Route 97 and MD Route 4). Total phosphorus, total suspended solids, and algae were ranked poor to good, with most stations improving for phosphorus but not as much for the other parameters. Stations ranked poor were located in the middle portion of the river. Of the three sites sampled for SAV abundance, two (the upper and middle portion of the river) exceeded SAV goals during the period between 1984 and 2002.

The Maryland Tributary Strategies document *Maryland Lower Western Shore Final Version for 1985-2002 Data: February 2, 2004* describes the success of BMPs in the Lower Western Shore Watershed (an area containing parts of Anne Arundel and Calvert Counties) like this:

> BMP implementation for structural shore erosion control, marine pumpout installation, septic connections and denitrification, and nutrient management plans are all making good progress toward Tributary Strategy goals. For other issues, such as stormwater and urban runoff management,

> forest conservation, forested and grassed buffers, and stream protection, progress has been slower and in some cases, non-existent.

Surface water is generally slow-moving due to the low elevations in the basin. Land use for the entire basin is largely forest (46%) and urban (40%), followed by agriculture (14%). Roughly 62% of the houses are on municipal sewage and 59% are on public water. The main nitrogen, phosphorus, and sediment sources within the Lower Western Shore basin were urban (40%, 63%, and 27%, respectively), point sources (40%, 20% and 0%, respectively) and agriculture (9%, 7%, and 59%, respectively). Tributary stations sampled had total nitrogen ranked fair. Levels had improved at most station during the period 1985-2002. Total phosphorus was mostly ranked fair. All stations had improved during the period 1985-2002. Total suspended solids were ranked fair to good. Abundance of algae was generally ranked as poor. Dissolved oxygen was ranked as poor to fair, with poor sites being located in the northern portion of the basin (Magothy, Severn, and South Rivers). Of the five sites sampled for SAV abundance between 1984 and 2002, only one site exceeded SAV goals during portions of that period (Severn River Mesohaline). In 1995-2000, benthic communities were better at South and West Rivers than at Severn and Magothy Rivers.

The Maryland Tributary Strategies document *Patapsco/Back River Final Version for 1985-2002 Data: January 29, 2004* describes the success of BMPs in the Patapsco/Back River Watershed (an area containing Baltimore City and parts of Anne Arundel, Baltimore, Carroll, and Howard Counties) like this:

> BMP implementation for shore and soil erosion control, agricultural nutrient management plans, for buffers, marine pumpout installation, septic connections, and stormwater management are all making progress toward Tributary Strategy goals. Progress has been slower for other issues, such as stream protection, forest conservation and tree plantings, grassed buffers, animal waste management, runoff control, septic pumping, and urban nutrient management.

Land use for the entire watershed is dominated by urban (55%), followed by forest (24%) and agriculture (21%). About 95% of the houses are on public water and 93% are on municipal sewage. There are six municipal sewage plants in this basin. Of these, three have Biological Nutrient Removal (BNR) and two others are planned to get BNR installed by 2010. The main nitrogen, phosphorus, and sediment sources within the entire basin were point sources (75%, 51%, and 0%, respectively), urban sources (19%, 41% and 53%, respectively) and agriculture (4%, 4%, and 32%, respectively). Tributary stations sampled had total nitrogen generally ranked as poor to fair. Poor sites were located at North Branch Patapsco River (MD Rte. 91), Patapsco River, and Back River. Levels had improved at most stations during the period 1985-2002. Total phosphorus was ranked poor to good. Sites ranked poor were Patapsco River (mouth) and Back River. Most stations had improved during the period 1985-2002. Total suspended solids were ranked good except at Patapsco River (near the mouth) and Back River. Abundance of algae was ranked poor at the two sites sampled. Dissolved oxygen was ranked as poor at Patapsco River (near the mouth). SAV abundance was way below the SAV goals. In 1995-2000, benthic communities were severely degraded along Patapsco River and moderately degraded along Back River.

Wetlands

Mapped wetlands (based on DNR and NWI GIS data) occur along the shoreline as tidal wetlands, in floodplains of streams, at the heads of drainageways, and in isolated depressions. Some large wetlands systems occur along the Little Patuxent River and Patuxent River and south of West River. Nontidal wetland hydrology is supported by groundwater discharge, overbank flooding, or a combination of both sources. In some areas, increases in surface runoff has resulted in the downcutting of stream channels, resulting in less frequent overbank flooding and less water to the wetland. Nontidal wetlands are primarily forested.

Isolated wetlands are also found in depressions in the County. Hydrology of these wetlands may be from impervious layers that impede infiltration, surface runoff, or groundwater seeps.

Wild rice is found in the Patuxent River near Jug Bay. The area around Jug Bay on the Prince George's County side of the river has been extensively treated to control Phragmites.

Wetland classifications

According to Tiner and Burke (1995), in 1981-1982 there were 16,156 acres of wetlands (2.7% of the State's total). The wetland types were Estuarine (2,774 acres), Palustrine (13,202 acres), Riverine (157 acres), and Lacustrine (23 acres). Comparisons of this 1981-1982 wetland acreage with historic wetland acreage (based on hydric soils) represents a 58%, or 22,649 acre, loss (MDE, 2002).

A 1991 study by the U.S. Fish and Wildlife Service (Tiner and Foulis) reported a loss of 179 acres of vegetated wetlands between 1981-82 and 1988-90. Most were converted to uplands. Over 150 acres of ponds were created, mostly in uplands. Approximately 30% of these ponds were created as a result of sand and gravel mining. Within Anne Arundel County, the watersheds Severn, South, and Magothy have experienced the worse wetland loss (Anne Arundel, 2003). These watersheds should be high priority for wetland restoration.

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

- Estuarine wetland 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.
        - 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).

This same 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). Anne Arundel County had 2,299 acres of vegetated tidally-influenced wetlands (excluding SAV). A large amount of vegetated wetland is brackish high and low marsh. There is also a fair amount of fresh marsh and smaller amounts of shrub and wooded swamp. Due to the high 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.

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

Major Vegetation Type	Vegetation Type	Acreage
Shrub Swamp *(Fresh)*	Swamp rose	35
	Smooth alder/Black willow	84
	Red maple/Ash	32
Swamp forest *(fresh except pine, which is often brackish)*	Bald cypress	0
	Red maple/Ash	16
	Loblolly pine	1
Fresh marsh	Smartweed/Rice cutgrass	228
	Spatterdock	43
	Pickerelweed/Arrow arum	31
	Sweetflag	14
	Cattail	151
	Rosemallow	6
	Wildrice	113
	Bulrush	0
	Big cordgrass	0
	Common reed	23
Brackish High Marsh	Meadow cordgrass/Spikegrass	315
	Marshelder/Groundselbush	313
	Needlerush	0
	Cattail	369
	Rosemallow	12
	Switchgrass	9
	Threesquare	21
	Big cordgrass	21
	Common reed	82
Brackish Low Marsh	Smooth cordgrass	380
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	1,232

A pasture seep is a small fresh nontidal wetland that may be overgrazed and dominated by soft rush or in less disturbed sites may contain a diverse mix of sedges, rushes, forbs, and grasses. These sites provide wintering/migratory bird habitat and amphibian and insect breeding habitat. Examples of pasture seeps are located along Rte. 50, between Annapolis and I-495 (Sipple, 1999).

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 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:

a. A decrease in the volume and velocity of flowing water.
   Value: Helps prevent stream channel and shoreline erosion, and habitat destruction.
b. Deposition and retention of fine sediment.
   Value: Helps maintain water quality and aquatic ecosystems.

c. 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.

The topography in most of the West Chesapeake Bay sub-basin rises sharply adjacent to streams, resulting in a relatively narrow floodplain. The width of the floodplain greatly influences the amount of water that can be temporarily stored or slowed, so the flood attenuation function has probably moderate to low benefits. Most structures are located beyond the edge of the ravines bordering the wetlands.

In the southern part of the sub-basin, the topography is more flat, and the tidal wetlands transition into broad expanses of forested nontidal wetlands.

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).

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.

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.

Isolated wetlands may exist as vernal pools. Vernal pools are often seasonal ponds that dry up every year, or may be dry only in drought years. They may or may not be nontidal wetlands under State law, depending on the presence of vegetation, and extent and duration of ponding. Vernal pools are critical habitat for amphibians and certain invertebrates.

<u>Nontidal Wetlands of Special State Concern (WSSC)</u>

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.

Wetland Restoration Considerations

Hydric soils suggest where wetlands are currently or were historically. There are many "poorly drained" hydric soils that are not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands). While these are scattered throughout the County, they are largely in the headwaters of the streams. There is a large section south of West River. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration. While not classified as hydric soil, there are additional "somewhat poorly drained" soils that may be good areas for wetland creation.

Since the highest losses of wetlands have occurred in the Severn, South, and Magothy watersheds, the County feels that these watersheds are high priority for wetland restoration. However, it has been difficult finding sites within these watersheds.

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.

In order to maintain water quality of surface water reservoirs, wetlands within the watersheds of surface water reservoirs 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.

Many portions of this County (and Prince Georges County) are underlain by sulfidic material at some depth. This material is found in virtually all geologic formations in the County, so the location is hard to predict (Davis, 2005). Sulfidic material historically formed in soils that were continuously saturated, generally by brackish water. While they often occur in coastal marshes, near the mouths of the rivers, they may also occur in freshwater marshes. Upland areas may have buried sulfidic materials that formed in the past. While these materials are often deeper than in lower landscape positions, highly disturbed upland areas may have sulfidic material close to the surface. Two known locations where there are concentrations of sulfidic material near the surface include Crofton and Bowie. When these soils are exposed to aerobic conditions, sulfuric acid is formed and the pH drops significantly, even to below three (Davis, 1999). While they do often correlate with glauconite in the soil, they are not always found together. Since we will likely not be excavating very deeply for a wetland creation/restoration project and no good map exists of the location of sulfidic material present near the surface, soil borings should be taken before the wetland is excavated. Absence of sulfidic material should be verified before construction begins, using the identification fact sheet for sulfidic material. If sulfidic material does exist, a two foot depth soil buffer should be kept between the bottom of the excavation and the sulfidic material (Davis, 2005).

Sensitive Resources

Source water assessments (SWAs) were completed for a number of water systems within the County. From a study of 24 community water systems having confined aquifers, they were found to not be susceptible to landuse source contaminants. However, some of them were susceptible to natural contaminants of cadmium, iron, radiological contaminants and radon (depending on the final Maximum Contaminant Level adopted). A SWA was conducted for 441 non-community water systems, with some wells withdrawing from confined and some from unconfined aquifers. Most wells were not susceptible to source contaminants. However, some were susceptible to nitrate, chloride, or volatile organic compounds (VOCs). Some were susceptible to microbiological contamination (dependent upon well construction and condition). Most wells in the northern portion of the County were susceptible to naturally occurring radium. SWAs focusing on a smaller area are described in that watershed section.

There is a fairly wide 100-year floodplain around the Patuxent and Little Patuxent Rivers, especially near the Patuxent Wildlife Research Center. Other narrower floodplains are found along the tributaries to these waterways and to the larger river estuaries on the east side of the County.

Wateshed management master plans are being created for the 12 major watersheds within this County. The first plan was for the South River watershed. This plan identified areas impacted by stormwater runoff, under current and future conditions. It then addresses the environmental issues of soil erosion and sedimentation, flooding, and pollutants. Small Area Plans (SAPs) have been completed for the County. Some reccmmendations from these SAPs are as follows:

- Increase environmental review of wetlands outside the critical area to reduce wetland loss.
- Encourage soft shoreline protection methods.
- Conduct stream restoration.
    - Reduce impacts from storm water runoff (e.g. along Cabin Branch Creek in the Cedar Hill area).
    - Address issues of streambank erosion, sedimentation, nutrients and bacteria.
    - Restore Howard's Branch.
- Grow oysters
- Preserve, restore, create and enhance sensitive land, including:
    - Forest (especially contiguous forest and along stream buffers). Large contiguous forest: Green Cathedral and headwaters of South River.
    - Wetlands.
    - Rare, threatened, and endangered species habitat.
    - Steep slopes.
    - Floodplains.
    - Stream buffers.
        - Implement a 100-foot buffer minimum to all perennial and intermittent streams in the County.
        - Establish a minimum 200-foot wide corridor along the Cabin Branch Creek greenway segment, as recommended in the County's *Greenways Master Plan*.
        - Encourage reforestation, especially in riparian buffers along the Patapsco River and Cabin Branch Creek.
    - Sensitive areas (Severn Run, Arden Bog and its recharge areas). Restore Brewer Creek (beach strand, tidal fringe marsh, and other shoreline measures).
    - Natural greenways, including reforestation of streams and corridors.
    - Critical Area.
- Protect and restore water quality of:
    - Surface water and groundwater.
    - Streams and wetlands in the Patapsco River watershed.
- Preserve agricultural land and maintain rural character.
- Improve stormwater management (e.g. Lynnbrook community).

Other Relevant Programs

<u>Green Infrastructure</u>

State-designated Green Infrastructure is located throughout the County, with examples of significant hubs located southeast of Laurel (including Fort Meade) and along the Patuxent River (DNR, 2000-2003). Smaller hubs and connecting corridors are scattered throughout. Areas within the Green Infrastructure network that are currently unprotected should be protected. There are also small sections of Green Infrastructure considered to be "gaps," currently in development, agriculture, or barren land. 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.

The Anne Arundel County Greenways Master Plan was adopted in 2002. This plan locates areas that are currently or have the potential to meet the criteria. Criteria included: habitat value, size, connections to other land with ecological value, potential to create greenways where that are not currently, and national and countywide greenways. A hub is an "ecologically significant natural area of at least 250 acres with a high ratio of interior versus edge habitat" while a corridor is "a natural area at least 200 feet wide" that connects hubs. The plan focuses largely on the ecological aspects, but also considers countywide multi-use trails. The plan incorporated recommendations from the State Green Infrastructure, the General Development Plan and Small Area Plans, and the Land Preservation and Recreation Plan. The proposed network covers roughly a quarter of the County, located throughout. About half of the network is currently protected. This Greenways network does not include all land that is considered ecologically sensitive or should be protected. While many of the identified areas are similar to those identified in the State-designated Green Infrastructure network, the County Greenways plan has some differences. The County plan incorporates additional sites that are significant at the County level, it relocates some corridors based on which are more viable, and it eliminates some hubs and corridors that did not meet the County criteria.

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 are a few State-designated Natural Heritage Areas (NHA) located in the watersheds Magothy River and Middle Patuxent River. These areas 1) Contain species considered to be threatened, endangered, or in need of conservation; 2) Have unique geology, hydrology, climate or biology; and 3) Are among the best Statewide examples.

Rural Legacy

Designated Rural Legacy is located in the southern portion of the County, within the watersheds West River, Patuxent River Upper, and Patuxent River Middle. It may be

desirable to restore and protect wetlands within this area. More detailed information on this area can be found within those individual watershed sections.

Priority Funding Areas

Priority funding areas are located in the majority of the northern half of the County, including around the South River and Annapolis, the south side of the Magothy River, Glen Burnie, Fort Meade, and Crofton. Wetland restoration/creation may not be as desirable in these areas slated for development.

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.

Other programs

The Emergent Grasses Program grows and distributes emergent grasses for voluntary planting by community groups and individuals (Anne Arundel County DPW, 2004).

Some areas 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 prioritization

The County prioritized watersheds, based on water quality, that are in need of further study as follows:

- Group 1
    - Herring Bay
    - Severn River
    - South River
    - Upper Patuxent River

- Group 2
    - Bodkin Creek
    - Little Patuxent River
    - Middle Patuxent River
    - Patapsco River, nontidal
    - Patapsco River, tidal
    - West River
- Group 3
    - Magothy River
    - Rhode River

Restoration in this County involved identifying and prioritizing areas in the various watershed plans. There was a Watershed Management Master Plan completed in 1995. Following this was the South River Watershed Management Master Plan in 2000. The Severn River watershed plan is being completed. A WRAS was completed for the Upper Patuxent River watershed. There has also been a Weems Creek watershed study (Anne Arundel County DPW, 2004).

Anne Arundel County completed the document entitled *A GIS-Based Preliminary Evaluation of Potential Wetlands Mitigation Sites in the Severn, South, and Magothy River Watersheds* (2003). This project used the following selection criteria:

- Hydric soils
- Land use = government/institutions, agriculture, or recreation
- Not already mapped wetlands (NWI wetlands layer)

This resulted in roughly 200 potential sites, distributed between the three watersheds. Resulting larger sites were further evaluated based on forest cover (i.e. eliminated if they were actually forested), fragmentation from other natural systems (e.g. eliminated if they were extremely isolated due to roads), agricultural preservation easements (eliminated), and existing wetlands missed in the NWI wetlands mapped layer (eliminated). During this project, they did not determine property owners interest. This second evaluation resulted in 24 sites, mostly within the South and Severn River watersheds. These are discussed within the individual watershed sections.

Many retrofit projects have been completed in the watersheds Patapsco, Severn, and Magothy. It is estimated that BMP implementation has reduced the total County nutrient loads entering the Chesapeake Bay by five to ten percent (Anne Arundel County DPW, 2004).

Watershed Information

Bodkin Creek (02130902)

Background

Based on MDP 2002 GIS land use data, the Bodkin Creek watershed has 896 acres of open water and 5,683 acres of land. The land acres are divided as follows: urban 2,730 acres (48%), agriculture 176 acres (3%), forest 2,761 acres (49%), and wetlands 16 acres

(<1%). Since estimates of wetland acreage based on this data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

The Bodkin Creek watershed is in the Patapsco River sub-basin and the Patapsco/Back River Tributary basin. The Patapsco/Back River Tributary basin drains 630 square miles of land within Maryland's Western Shore. This area includes all of Baltimore City and portions of Anne Arundel, Baltimore, Carroll, and Howard Counties. The majority of the basin lies in the Piedmont physiographic province, but the immediate area surrounding Baltimore Harbor lies in the Coastal Plain province (Basin Summary Team and CBP, 2004b). The Bodkin Creek watershed is entirely within the Coastal Plain.

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

- Estuarine
    - Emergent: 55 acres
    - Unconsolidated shore: 18 acres
- Palustrine
    - Emergent: 16 acres
    - Scrub shrub: 5 acres
    - Forested: 136 acres
    - Unconsolidated bottom: 32 acres
- Total: 261 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 increase in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02130902	-0.11	0.40	0	0	0.29

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. Waters in Bodkin Creek are designated as Use I: water contact recreation and aquatic life.

Water Quality

The *1998 Clean Water Action Plan* classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resource 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 percent impervious surface (15%), high population density, and being on the 303d list. Wetland loss was estimated to be 358 acres. Additionally, there is a high percent of the watershed in forest (67%).

The 2002 305(b) report reports inconclusive findings for waters supporting all uses in tidal embayments, tidal tributaries, and nontidal, wadeable tributaries (DNR, 2002b).

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

- *Bodkin Creek* (tidal portion); copper, lead, zinc, nutrients, sediments.
- *Main Creek Unnamed Tributary* (021309021000 - nontidal) - poor biological community.

Development of TMDLs are ranked as a low priority.

Patapsco River water quality was poor for all six parameters (total nitrogen, total phosphorus, algal abundance, total suspended solids, water clarity, and dissolved oxygen). Water quality status was poor in the mesohaline portions of Back River, while status was usually fair or good in the upper portions of the watershed. This was the case for total nitrogen and total phosphorus concentrations. However, improving trends for nutrient concentrations were detected throughout most of the watershed. Total suspended solids concentrations were poor at the Patapsco River station, but were relatively good or fair throughout the rest of the watershed. At the mesohaline stations in Back River, status was poor for abundance of algae and Secchi depth. No strong trends were detected for either parameter. Summer dissolved oxygen status was poor at the Patapsco River station (depth of 14 meters) but good at the shallower Back River station (depth of 2 meters). A degrading trend in dissolved oxygen values was also detected in the Patapsco River (Basin Summary Team and CBP, 2004b).

In the Patapsco River watershed, total nitrogen, dissolved inorganic nitrogen, and total phosphorus concentrations are all relatively poor but are improving (decreasing); dissolved inorganic phosphorus concentration is fair. The ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus is decreasing; this ratio is relatively high in the winter and spring and is relatively low in the summer and fall. These patterns indicate that reductions in both nitrogen and phosphorus will be useful for limiting phytoplankton growth (Basin Summary Team and CBP, 2004b).

No sites were sampled in the Anne Arundel County portion of the watershed under the Maryland Biological Stream Survey in 1995-1997 or 2000-2002. An unnamed tributary to Main Creek in Baltimore County was sampled in 2000-2002. Fish and benthic scores received rankings of poor. The sole fish species found, Eastern mudminnow, is classified as a pollution tolerant species. Physical habitat condition scores ranged from marginal to poor.

No SAV was reported in Bodkin Creek during the 1984-2001 sampling period by the Virginia Institute of Marine Sciences (VIMS). No ground truthing data was available. There were some wild celery *(Vallisneria americana*) transplants in 1999, 2000, 2001 and 2002 in Long Creek (near the launch ramp at Rocky Point Park, Back River Neck area, near the mouth of Back River) that have performed very well. Ground-truthing has found

7 species of SAV in the Patapsco, frequently in beds too small to be mapped by the aerial survey, located in Shallow, Marley, Stony and Rock Creek, adjacent to the Bodkin Creek watershed. In order of occurrence, these species are: Eurasian watermilfoil, horned pondweed, elodea, redhead grass, wild celery, curly pondweed and coontail. Water quality data from the monitoring station located near the Key Bridge and Fort Carroll island indicates suspended solid levels meet the habitat requirements for SAV and phosphorous concentrations are borderline, while light attenuation, nitrogen and algae level fail (Basin Summary Team and CBP, 2004b).

Restoration/Preservation

There are small Green Infrastructure hubs (around Compass Pointe Golf Club and around Boyd Pond and Letha Ponds) and corridors which are unprotected (DNR, 2000-2003). Protected land includes some County-owned properties.

Three Nontidal Wetlands of Special State Concern are found in the watershed: *Fresh Pond, Letha Pond, and Boyd Pond*. Fresh Pond was also designated as an Area of Critical State concern in 1981. The site includes a pond and surrounding shrub swamp, cranberry bog, and unusual or rare plants such as sundew, leatherleaf, pipewart, and yellow-eyed grass. Threats include increased runoff and sedimentation from development (DNR, 1991). Runoff from surrounding lawns has raised nutrient levels in the pond and wetlands. An impoundment has also raised water levels and destroyed some of the bog mat, but the mat is beginning to recover. Fresh Pond is also being degraded by the spread of the invasive plant water willow (Cole, 2003; 2004). These WSSC are not protected. Bog-like conditions have also been observed at South Hines Pond, though the site is not currently a designated Nontidal Wetlands of Special State Concern.

There are additional high quality bogs in this watershed, including around Paradise Beach and in the headwaters of Main Creek.

Specific Restoration Recommendations:

- Restore “gaps” in designated Green Infrastructure hub to natural vegetation.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect WSSC and buffers.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected.
- Protect high quality bogs.
- Protect headwater stream/wetland complexes and a buffer area.

Baltimore Harbor (02130903)

Background

Based on MDP 2002 GIS land use data, the Anne Arundel County portion of the Baltimore Harbor watershed has 6,717 acres of open water and 30,284 acres of land. The land acres are divided as follows: urban 20,837 acres (69%), agriculture 770 acres (3%), forest 8,460 acres (28%), wetlands 106 acres (<1%) and barren land 111 acres (<1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

The Baltimore Harbor watershed is located to the south and east of Baltimore City, and includes numerous small tributaries of the Patapsco River. Since a large portion of this watershed is within Baltimore County, please refer to the section on that County as well. The tributaries drain to tidal estuaries. The watershed is entirely within the Coastal Plain and streams tend to be short and tidally influenced. Many streams in the industrial area have been channelized and the natural drainage pattern has been altered (e.g., cooling water for Bethlehem Steel is withdrawn from Jones Creek and discharged to Bear Creek). Smaller tributaries feeding the Harbor are the Gwynns Falls (upper Middle Branch of the Harbor), Jones Falls (Northwest Branch of Baltimore Harbor), Bear Creek, and Curtis Creek (MDE, 2001).

The Harbor estuary is highly developed with a mix of urban residential, commercial, and industrial/manufacturing uses. Land use in the large harbor tributaries shifts from industrial/commercial to high/low density residential and eventually rural/agricultural in the uppermost reaches of some of these drainages (MDE, 2001).

Sawmill Creek in Anne Arundel County has sandy, highly permeable, and very erodible soils. The sub-watershed has significant groundwater recharge despite the amount of impervious surface. The creek formerly had one of the highest baseflows per square mile of drainage area of any stream in the region (Lubbers and Bartholomew, 1992).

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

- Estuarine
    - Emergent: 383 acres
    - Scrub shrub: 5 acres
    - Unconsolidated shore: 107 acres
- Palustrine
    - Aquatic bed: 1 acre
    - Emergent: 289 acres
    - Scrub shrub: 54 acres
    - Forested: 280 acres
    - Unconsolidated bottom: 249 acres
    - Unconsolidated shore: 7 acres
    - Farmed: 1 acre

- Total: 1,377 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 gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02130903	-12.50	6.61	8.50	0	2.61

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. Waters in Anne Arundel portion of Baltimore Harbor are designated as Use I: water contact recreation and aquatic life.

Water Quality

A source water assessment was completed for the Glen Burnie water supply. Wells withdrawing from the confined aquifer had a moderate susceptibility to naturally occurring radionuclides while wells withdrawing from the semi-confined aquifer had a low to high susceptibility to naturally occurring radionuclides. This semi-confined aquifer is also susceptible to human contaminant sources and VOCs.

The *1998 Clean Water Action Plan* classified the watershed as a "priority" Category 1, a watershed not meeting clean water and other natural resource 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 pristine or sensitive watershed that needs an extra level of protection. Failed water quality indicators included presence on the 303(d) list, modeled nitrogen loadings, modeled phosphorus loadings, and tidal habitat index among the worst ranked 25% of watersheds. Failed aquatic living resources indicators were: SAV abundance, SAV habitat index, tidal benthic index, nontidal biotic and benthic indices of integrity, all of which ranked among the lowest 25% of watersheds. Landscape indicators which failed to meet minimum criteria are percent impervious surface, population density, and percent unforested stream buffer. Category 3 indicators for a pristine or sensitive watershed that meet or exceed benchmarks or goals are presence of migratory fish spawning areas and State Wildland Acres.

According to the 2002 305b report, chlordane, PCBs, metal, low oxygen, and bacteria in the tidal waters were attributed to industrial and municipal discharges, nonpoint sources, poor tidal flushing, and unknown sources (DNR, 2002b). In nontidal waters, siltation resulted in some areas failing to meet all designated uses due to urban runoff, habitat alteration, and channelization. Fish consumption advisories were issued in 1986 and expanded in 2001 for chlordane, PCBs, and dieldrin.

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:

- *Baltimore Harbor* (tidal); poor biological community, nutrients, sediments, PCBs (in sediments).
- *Furnace Creek* (021309031008 – tidal in Anne Arundel County); fecal coliform.
- *Marley Creek* (021309031008 - tidal); fecal coliform,
- *Marley Creek* (021309031008 – non-tidal); poor biological community.
- *Marley Creek Unnamed Tributary 2* (021309031008 – non-tidal in Anne Arundel County); poor biological community.
- *Marley Creek Unnamed Tributary 3* (021309031008 - non-tidal in Anne Arundel County); poor biological community.
- *Marley Creek Unnamed Tributary 5* (021309031008 - non-tidal in Anne Arundel County); poor biological community.
- *Northwest Harbor Unnamed Tributary 1* (021309031010 - non-tidal in Baltimore County); poor biological community.
- *Sawmill Creek* (021309031009 - non-tidal in Anne Arundel County); poor biological community.
- *Cabin Branch Unnamed Tributary 1* (021309031008 - non-tidal in Anne Arundel County); poor biological community.
- *Unnamed tributary to Sloop Cover* (021309031006 - non-tidal in Anne Arundel County); sediments.
- *Bear Creek* (tidal); chromium (in sediments), zinc (in sediments), PCBs (in sediments).
- *Northwest Branch Inner Harbor* (tidal); lead (in sediments), chromium (in sediments), zinc (in sediments), PCBs (in fish tissue).
- *Curtis Creek* (tidal); zinc (in sediments), PCBs (in sediments and fish tissue).
- *Furnace Branch* (tidal); PCBs (in fish tissue).
- *Middle Harbor* (tidal); zinc (in sediments), PCBs (in fish tissue).

A TMDL for chlordane was approved in 2000. Although Baltimore Harbor is also impaired by mercury, copper, nickel, cyanide, a TMDL is not required for these pollutants since other controls will likely result in attainment of water quality standards in the near future.

There are other impairments from mercury, nickel, copper, and cyanide that do not require TMDLs because other pollution abatement requirements are expected to result in an attainment of water quality standards.

A Draft Water Quality Analysis was completed for fecal coliform in Rock Creek. This study found that designated uses related to fecal coliform were being met. Therefore, Rock Creek should be removed from the 303d list for impairment due to fecal coliform.

The Maryland Biological Stream Survey (MBSS) collected data from eight sites in Anne Arundel County and one site in Baltimore City in 2000-2002. Six sites were in Marley

Creek, and one site each was sampled in Sawmill Creek, Northwest Harbor, and Cabin Branch. Two sampling sites in Marley Creek had benthic IBIs in the fair category, two sites also had fish IBIs in the fair category, as did one site in Sawmill Creek. All other fish and benthic IBI scores were in the poor category. Eight sites were sampled in the watershed in 1995-1997, all in Marley Creek, Sloop Cove, and Sawmill Creek in Anne Arundel County. The two sites in Marley Creek received scores of poor or very poor for both fish and benthics. Sloop Cove received a poor score for benthics. Three of the five sites sampled in Sawmill Creek received fair scores for the fish IBI, three of five sites also received poor benthic IBI scores. Two sites in Sawmill Creek received fair scores for benthic IBIs.

Restoration/Preservation

Sawmill Creek in Anne Arundel County was designated as one of four "targeted watersheds" in 1989 and a management plan was prepared for the watershed. The watersheds were selected because they were threatened by multiple sources of degradation from urbanization or contributed disproportionately high nutrients to Chesapeake Bay. The management plan noted the need to improve the highly disturbed natural hydrology by managing high flows from stormwater, as well as managing water withdrawals to maintain baseflow for aquatic life. Sediment loadings were attributed primarily to streambed erosion. The watershed was divided into three segments for planning purposes. Segment 1 included the headwater areas, and was dominated in 1991 by rural and light residential development. Habitat quality was considered to be fair, the best in the Sawmill Creek watershed. Segment 2 included the mainstem and tributaries farther downstream and was dominated by commercial and light industrial land uses. This segment contains Muddy Bridge Branch, for which numerous restoration activities were recommended. Habitat quality was poor for this segment. Segment 3 included the mainstem to the confluence with Furnace Branch, and included developed, residential, and high density land uses. Habitat quality was fair in the mainstem and poor in the tributaries. Segment 3 included Wagner's Pond, a large area of marsh and forested wetlands that was the site of the sawmill dam for which the stream is named (Lubbers and Bartholomew, 1992).

State designated Green Infrastructure is located between Marley Creek and Nabbs Creek. This Green Infrastructure network is unprotected, except for a small County-owned property (DNR, 2000-2003). Other protected land, located outside of the Green Infrastructure network, include several additional County-owned properties. According to the Maryland Greenways Commission, existing greenways include Baltimore and Annapolis Trail Park and BWI trail (Maryland Greenways Commission, 2000).

A Nontidal Wetlands of Special State Concern, *Freetown Swamp*, is located in the Anne Arundel County portion of the watershed at the headwaters of Stony Creek. Two significant plant communities were described in 1991 for this site. One community is a red maple-sweet bay swamp growing in an acidic, sphagnum-covered soils. A globally rare plant, most often found in pine barren communities, is found at this site. A mature pine–oak forest, unusual for its age, is found in adjacent uplands (DNR, 1991). This site

is unprotected. An additional potential WSSC is located just east of Freetown Swamp, and is unprotected.

Water quality improvement projects and stream restoration projects have taken place on Muddy Bridge Branch in Sawmill Creek. Water quality improvements have included treatment of deicer discharges and other chemicals from BWI airport (Lubbers and Bartholomew, 1992).

Specific Restoration Recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.
- Stream restoration, removal of fish blockages in Sawmill Creek (Lubbers and Bartholomew, 1992).
- Water quantity management, baseflow restoration in Muddy Bridge Branch (Lubbers and Bartholomew, 1992).
- Retrofits in Segment 3: Developed, Residential and High density area of Sawmill Creek (Lubbers and Bartholomew, 1992).
- Baseflow restoration (Lubbers and Bartholomew, 1992).
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected.
- Protect WSSC and buffers.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected, including potential WSSC.
- Freetown Swamp
- Riparian buffers of Sawmill Creek particularly in Segment 1: Headwaters, Rural and light residential areas (Lubbers and Bartholomew, 1992)
- Protect headwater stream/wetland complexes and a buffer area.

<u>Patapsco River Lower North Branch (02130906)</u>

Background

Based on MDP 2002 GIS land use data, the Anne Arundel County portion of Patapsco River Lower North Branch watershed has 172 acres of open water and 15,017 acres of land. The land acres are divided as follows: urban 8,014 acres (53%), agriculture 715 acres (5%), forest 6,033 acres (40%), wetlands 118 acres (1%) and barren land 136 acres (1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

Approximately half of the watershed is in Baltimore County, and the Patapsco River forms a boundary between Baltimore, Carroll, Howard, and Anne Arundel Counties. Please refer to the sections on those Counties as well. Most of the watershed is in the Piedmont Province. A small area near the Baltimore Harbor, Deep Run, and northern Anne Arundel County is in the Coastal Plain. Channel morphology changes near the

boundary of the Piedmont/Coastal Plain physiographic regions. Significant sediment deposition normally occurs in the transition area downstream of the boundary. This is caused as the material, which had been carried by the higher velocity flows from the Piedmont, settles out since it can no longer be transported by the slower flows of the flatter Coastal Plain province.

Wetlands are typically found in relatively narrow floodplains of streams. The primary source of hydrology in the wetlands is high ground water. Overbank flooding, though it does occur, apparently is not of sufficient duration to be the primary source of hydrology in wetlands. The concentrated development in this part of Howard County has also often resulted in incised stream channels, further reducing the likelihood of overbank flooding (Follweiler, 2004 pers comm.). Some wetlands are also supported by seepage of water from the bases of slopes adjacent to the floodplains. A few wetlands may be found in upland depressions. In the small Coastal Plain portion of the watershed in Howard County, wetlands may be found on relatively wide flat landscapes, in comparison with wetlands in the Piedmont region.

Most wetlands are forested, dominated by oak, sweetgum, red maple, and in some places willow and alder (Matthews and Hershberger, 1968). The 1968 Howard County Soil Survey reported that some wetlands were drained to create pasture land. These areas would represent opportunities for restoration, though the extent of any converted pasture area is probably very limited. There is a wetland on pasture formerly operated as a University of Maryland Horse Farm that may benefit from enhancement, such as removal of multiflora rose and plugging of ditches, if present (Boellner, 2004 pers comm.). There appears to be limited areas to restore floodplain access in much of the watershed due to adjacent development.

In comparison with the very poorly drained soils most often found on lower Coastal Plain, soils in this watershed are seasonally wet for shorter periods of time, and have less organic matter. Wetlands in the Patapsco watershed are thus likely to have a lower capability to transform nutrients than wetlands with lengthy periods of saturation and inundation. However, vegetated wetlands on floodplains still may reduce flood flows and retain surface waters, allowing some sediments and nutrients to settle, providing some water quality improvement. The high ground water and seepage from slopes may also contribute to base flow maintenance and food chain support for streams. Wetlands that extend up the side of slopes, in contrast to depressions in floodplains, do not significantly retain water, thus providing only limited flood attenuation and water quality improvement functions.

Soil Associations include loamy and clayey land-Lenoir-Beltsville Association and Legore-Aldino-Neshaminy Association. Most soils are moderately eroded, well drained to moderately well drained with a subsoil of silty clay loam and a fragipan in the Legore-Aldino-Neshaminy Association. Minor soils in this association that occur on the floodplain include Codorus and Hatboro. The loamy and clayey land-Lenoir-Beltsville Association is characterized by nearly level to steep land of sandy loam to clay loam over

clay or a subsoil of silty clay loam and silt loam. Soils are moderately to somewhat poorly drained.

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

- Estuarine
  - Emergent: 121 acres
  - Scrub shrub: <1 acre
  - Unconsolidated shore: 15 acres
- Lacustrine unconsolidated shore: 2 acres
- Palustrine
  - Aquatic bed 1 acre
  - Emergent: 222 acres
  - Scrub shrub: 40 acres
  - Forested: 564 acres
  - Unconsolidated bottom: 192 acres
  - Unconsolidated shore: 5 acres
  - Farmed: 1 acre
- Riverine
  - Emergent: 1 acre
  - Unconsolidated shore: 44 acres
- Total: 1,207 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 gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02130906	-18.53	22.80	0	0.21	4.48

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. Waters in the Anne Arundel County portion of Patapsco River Lower North Branch are designated as Use I: water contact recreation and aquatic life.

Water Quality

The 1998 Clean Water Action Plan classified the watershed as both Category 1, a watershed not meeting clean water and other natural resource goals and therefore needing restoration and Category 3, a pristine or sensitive watershed that needs an extra level of protection. Failed indicators include being on the 303(d) list, nontidal benthic scores, impervious surface and population density among the highest 25% of watersheds, and soil erodibility measure above the benchmark. Category 3 positive indicators that are met

include presence of migratory fish spawning areas, imperiled aquatic species, drinking water intakes, and State Wildland Acres.

According to the 2002 305b report, a portion of nontidal wadeable tributaries fail to support all uses, shown by a poor biological community, due to urban runoff, habitat alteration, and channelization.

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:

- *Patapsco River* (non-tidal); metals, nutrients, sediments.
- *Patapsco River Unnamed Tributary 1* (021309061017 non-tidal); poor biological community.
- *Patapsco River Unnamed Tributary 3* (021309061019 non-tidal); poor biological community.
- *Patapsco River Unnamed Tributary* (021309061012 non-tidal); poor biological community.
- *Deep Run* (021309061014 non-tidal); poor biological community.
- *Deep Run Unnamed Tributary* (021309061014 non-tidal); poor biological community.
- *Deep Run Unnamed Tributary 1* (021309061015 non-tidal in Howard); poor biological community.
- *Deep Run Unnamed Tributary 2* (021309061015 non-tidal in Howard); poor biological community.
- *Soapstone Branch* (021309061016 non-tidal in Baltimore County); poor biological community.
- *Tiber Run* (021309061017 non-tidal); poor biological community.
- *Falls Run* (021309061019 non-tidal in Baltimore Run); poor biological community.

Field surveys also noted siltation, streambank instability, channelization, agricultural runoff, and hydromodification as factors that may affect the aquatic community. (DNR, 2000) There are some areas closed to shellfish harvesting due to pollution from nonpoint source runoff (DNR, 2002b).

A Draft Water Quality Analysis was completed for metals in Lower North Branch Patapsco River. Metal levels are not exceeding those required based on water quality designations, except Herbert Run (021309061012), with a single exceedance of copper. It is recommended that Lower North Branch Patapsco River (except Herbert Run) be removed from the 303d list for impairment by heavy metals.

The Maryland Biological Stream Survey (MBSS) sampled one site (Deep Run) in the Anne Arundel County portion of the watershed during the 2000-2002 period. Fish species diversity was relatively high with 17 species and the Fish IBI ranking was “good.” Species included Swallowtail shiner, Blacknose dace, Mottled sculpin, Tesselated darter, Green sunfish, Central stoneroller, White sucker, Rosyside and Longnose dace. Fewer than one-third of the species were found to be pollution tolerant. The Benthic IBI score

was "poor." Two sites in the watershed, located on an unnamed tributary to Deep Run and on Stony Run, were sampled in the MBSS in the 1995-1997 period. Fish IBI scores indicated that these stream reaches were generally comparable to the reference condition, particularly for Deep Run tributary, but the Stony Run reach showed some degradation to certain biological characteristics found in minimally impacted streams (DNR, 1995-1997; 2000-2002).

Restoration/Preservation

The State-designated Green Infrastructure shows a nearly continuous corridor and hub system along Patapsco Valley State Park on the border of Baltimore, Howard, Carroll, and Anne Arundel Counties, from the dam for Liberty Reservoir to the southern tip of Baltimore County. Other smaller linear Green Infrastructure network runs along Old Piney Run and west and south of BWI Airport (DNR, 2000-2003). A portion of the Green Infrastructure within this County is protected by Patapsco Valley State Park and County-owned properties. An additional protected area, located outside of the Green Infrastructure network, is Buckingham State Forest. An ecological greenway exists along part of Deep Run in Patapsco Valley State Park in Howard and Anne Arundel Counties. According to a 2000 Maryland Greenways Commission document, existing or proposed greenways include BWI Trail and Patapsco Regional Greenway.

A Nontidal Wetlands of Special State Concern, *Stony Run*, is located in the Anne Arundel County portion of the watershed. This wetland contains some unusual plant communities for its location in the Upper Coastal Plain: a red maple/pitch pine swamp with herbaceous plants usually found in mountains or in the Piedmont region. In 1991, there was also a notable absence of invasive, non-native species. Several plants are listed as being endangered or threatened in the State, one (swamp pink) is also designated as federally threatened (DNR, 1991). By 2005, significant invasion by Japanese stiltgrass was observed throughout the wetlands and adjacent disturbed areas. Beaver activity has also been observed and is expected to raise water levels (Cole, 2006 pers. comm.). This site is unprotected. Additional potential WSSC are located in the southern part of this watershed, and are currently unprotected.

Specific Restoration Recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.
- Maintain agricultural land that is in under agricultural protection/preservation programs.
- Prohibit land use changes in 100-year floodplains.
    - Five retrofit projects were proposed in residential subdivisions. Projects included wetland creation as part of the retrofits (KCI Technologies, Inc.1999).
    - Reforestation in undeveloped floodplain of Patapsco Valley State Park (DNR, 1981).
    - Fish passage and fish habitat improvement (DNR, 1981).

- Flooding does occur in the Ellicott City vicinity, however, there may not be opportunity to restore floodplain access due to infill development (Follweiler, 2004 pers. comm.).
- Wetlands in stormwater retrofits may present the best opportunity to re-create wetlands in the watershed. Permittees have found it difficult to locate mitigation sites to replace lost wetlands and some stream restoration projects have been proposed as an alternate form of mitigation (Follweiler, 2004 pers comm.).
- Allow beaver activity to alter water levels in Stony Run Nontidal Wetlands of Special State Concern to aid in control of invasive species, provided that infrastructure is not damaged.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect WSSC and buffers.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected.
- Deep Run (Howard County).
- Stony Run WSSC (Anne Arundel County).
- Forested riparian corridors.
- Protect headwater stream/wetland complexes and a buffer area.

<u>Magothy River (02131001)</u>

Background

The Magothy River is part of the West Chesapeake Area sub-basin. The entire sub-basin is within the Coastal Plain and includes portions of Anne Arundel and Calvert Counties. In many areas, the hilly terrain forms the cliffs along the shoreline (Cole, 2003; 2004). Based on MDP 2002 GIS land use data, the Magothy River watershed has 5,788 acres of open water and 22,654 acres of land. The land acres are divided as follows: urban 15,710 acres (69%), agriculture 583 acres (3%), forest 6,339 acres (28%) and barren land 22 acres (<1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

The watershed is part of the Lower Western Shore Tributary Basin. Maryland's Lower Western Shore drains 305 square miles of land in Anne Arundel and Calvert Counties. The main rivers in the basin are the Magothy, Severn, South, Rhode, and West Rivers. The entire basin lies in the Coastal Plain Province. In many areas near tidal waters, the hilly terrain forms cliffs along the shoreline. As a result of low elevations in the basin, surface waters generally flow sluggishly in winding courses, often through wetlands before reaching the Bay. The Lower Western Shore of the Chesapeake Bay in Maryland is largely forested or urban. The dominant land use in the basin is classified as forest

(46%). Urban area comprises the second largest land use at 40%. About 14% of the basin is devoted to agriculture. Barren land accounts for less than 1% of the basin (Basin Summary Team and CBP, 2004a).

Cypress Creek Swamp and Eagle Hill Bog are designated Natural Heritage Areas within this watershed. To get this designation, an area must 1) Contain species considered to be threatened, endangered, or in need of conservation; 2) Have unique geology, hydrology, climate or biology; and 3) Be among the best Statewide examples. These sites are both unprotected.

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

- Estuarine
    - Emergent: 152 acres
    - Unconsolidated shore: 37 acres
- Palustrine
    - Aquatic bed: 5 acres
    - Emergent: 38 acres
    - Scrub shrub: 14 acres
    - Forested: 417 acres
    - Unconsolidated bottom: 66 acres
    - Farmed: 2 acres
- Total: 731 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 (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131001	-2.45	0.95	0	0.50	-1.00

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. Waters in the Magothy River are designated as

- Use I: water contact recreation and aquatic life; all portions except those described below.
- Use II: shellfish harvesting; All estuarine portions of tributaries except: Magothy River and tributaries above Henderson Pt. (which is Use I).

Water Quality

A source water assessment was completed for the Glen Burnie water supply. Wells withdrawing from the confined aquifer had a moderate susceptibility to naturally occurring radionuclides while wells withdrawing from the semi-confined aquifer had a low to high susceptibility to naturally occurring radionuclides. This semi-confined aquifer is also susceptible to human contaminant sources and VOCs.

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resource goals and therefore needing restoration. It is also classified as a Category 3, a pristine or sensitive watershed in need of protection. Failing indicators include high nitrogen loading rates, poor SAV abundance, poor tidal fish IBI, high percent impervious surface (20%), high population density, and being on the 303d list. Wetland loss was estimated to be 1,255 acres. Indicators for Category 3 include high imperiled aquatic species indicator and presence of migratory fish spawning area.

There are two permanent monitoring sites on the Magothy River at Stonington and Whitehurst. The 2002 305(b) report listed 8.4 square miles of tidal embayment and tributaries as failing to support all designated uses. Pollutants were nutrients, low oxygen, and bacteria from nonpoint sources, urban runoff, eutrophication, and poor tidal flushing. There were 16 miles of nontidal, wadeable tributaries that fail to support all uses. Pollutants were low oxygen and siltation which were affecting the biological community. Sources were urban runoff, sewage systems, and hydromodification. Results were inconclusive for 7 miles of nontidal, wadeable tributaries. Results were also inconclusive in the impoundment of Lake Waterford.

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:

- Magothy River (tidal); fecal coliform, nutrients, sediments, poor biological community.
- Magothy River (021310011005 non-tidal); sediments.
- Unnamed Tributary of Magothy River (021310011005); sediments.
- Tar Cove (021310011004 tidal); fecal coliform.
- Deep Creek (021310011003 tidal); fecal coliform.
- Forked Creek (021310011003 tidal); fecal coliform.
- Blackhole Creek (021310011004 non-tidal); sediments.

A Draft TMDL was completed in 2005 for fecal coliform in the restricted shellfish harvesting areas in Magothy River, Tar Cove, and Forked Creek (MDE, 2005b). The criteria for fecal coliform is not being met in these waterways. Other than stormwater discharge, there are no permitted point sources discharging fecal coliform in to the restricted shellfish harvesting areas. Nonpoint sources of fecal coliform within these basins are as follows:

Basin	Livestock %	Pets %	Human %	Wildlife %
Magothy River Basin	11	65	2	22
Tar Cove Basin	10	54	3	33
Forked Creek Basin	<1	86	1	13

A Draft Water Quality Analysis was completed in 2005 for fecal coliform in Deep Creek (MDE, 2005b). This analysis found the fecal coliform water quality criteria was being met in Deep Creek. Therefore, they recommend removal of Deep Creek from the 303(d) List for fecal coliform impairment.

Sites with failing benthic IBI in the Magothy River from 1995-2000 were located throughout the estuary, but were particularly concentrated in the upper southern shore. Eight sites were severely degraded and two sites were moderately degraded. Three of the severely degraded sites were associated with very low dissolved oxygen conditions (<0.7 mg/l) at time of sampling, but not all failing sites could be attributed to low dissolved oxygen. Two sites exhibited very high abundance with low biomass of pollution-sensitive organisms, suggesting that, in addition to low dissolved oxygen, other water quality factors such as the observed high nutrient and chlorophyll concentrations or the poor water clarity (low Secchi depths) may contribute to poor benthic condition (Basin Summary Team and CBP, 2004a).

The highest dissolved oxygen concentrations (1992-1996 data) were observed near the mouth of the River. Dissolved oxygen concentrations in the Magothy were lowest at several shallow, upstream stations, as well in the deep water near DNR's Magothy River station. Historical data collected by the Chesapeake Bay Institute in 1958 also recorded anoxia and hypoxia in the Magothy's upstream areas (Basin Summary Team and CBP, 2004a).

Dissolved inorganic nitrogen concentrations (1192-1996 data) in the Magothy were high both upstream and near the mouth. High dissolved inorganic nitrogen levels upstream are likely due to proximity to sources and less dilution from the river. Elevated dissolved inorganic nitrogen levels near the mouth of the river may be due to the influence of the Susquehanna River or outfalls from nearby wastewater treatment facilities (Basin Summary Team and CBP, 2004a).

Total nitrogen and total phosphorus concentrations are relatively fair and dissolved inorganic nitrogen and dissolved inorganic phosphorus concentrations are relatively good. Total nitrogen, dissolved inorganic nitrogen and total phosphorus concentrations are all improving (decreasing). The ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus is decreasing. Continued reductions in nitrogen would further limit phytoplankton growth at this station, while continued reductions in phosphorus will help bring the system into better balance, particularly in the winter and spring (Basin Summary Team and CBP, 2004a).

The Magothy River has shown an increasing trend in SAV coverage from 1993 to 1998 (www.vims.edu/bio/sav/), reaching 198 acres in 1998, or attaining 34% of the Tier I goal of 585 acres. Tier I goals are an effort to restore SAV to any areas known to contain SAV from 1971 to 1990. In 1999 there was a decline in SAV coverage to 65 acres (incomplete aerial photography for that year), rebounding to 90 acres in 2000. Extensive ground-truthing by U.S. Fish and Wildlife Service found 13 different species throughout the river, with horned pondweed, widgeon grass and milfoil being the most common. Water quality data from the monitoring station located between North and South Ferry Points indicate that the SAV habitat requirements are met for suspended solids and phosphorous concentrations. Light attenuation, percent light at leaf, nitrogen and algae levels are borderline (Basin Summary Team and CBP, 2004a).

Three sites in the watershed were sampled during the Maryland Biological Stream Survey 1995-1997 sampling period: Blackhole Creek, an unnamed tributary to the Magothy River, and the Magothy River. The Magothy River reach received a ranking of good and contained the following species: American eel, Black crappie, Bluegill, Brown bullhead, Golden shiner, Goldfish, Largemouth bass, Pumpkinseed, Redfin pickerel, Spottail shiner, Tessellated darter, and Yellow perch (DNR, 1995-1997).

Restoration/Preservation

Some of the projects in which the Magothy River Association was involved include: water quality sampling, SAV habitat sampling, restoring SAVs, restoring oysters, restoring fish habitat, and riparian tree plantings (Anne Arundel County DPW, 2004).

The main State-designated Green Infrastructure hubs are located between Blackhole Creek and Grays Creek and on Sandy Point State Park (DNR, 2000-2003). These Green Infrastructure areas are largely protected. Additional protected land, located outside of the Green Infrastructure network, are several County-owned properties, including Kinder Park and Waterford Park. According to a 2000 Maryland Greenways Commission document, existing or proposed greenways include Baltimore and Annapolis Trail Park, Broadneck Peninsula Trail, and Magothy River Greenway.

The project entitled *A GIS-Based Preliminary Evaluation of Potential Wetlands Mitigation Sites in the Severn, South, and Magothy River Watersheds* (2003) used the following selection criteria:

- Hydric soils
- Land use = government/institutions, agriculture, or recreation (not forest)
- Not already wetlands (NWI wetlands layer)
- Not agricultural preservation easements
- Not too fragmented from other natural systems.
- During this project, they did not determine property owners interest.

Potential projects within the Magothy River watershed include Kinder Farm Park (17.5 acres).

There are nine Nontidal Wetlands of Special State Concern in the watershed and three potential WSSC, as described below:

- *Blackhole Creek Bog* is a small evergreen shrub bog dominated by leatherleaf. Coastal Plain bogs are rare on the Western Shore and Blackhole Creek Bog is particularly unusual because it is believed to have formed naturally. In the 1980's, the surrounding forest was clear-cut, resulting in altered hydrology and possibly changes in species composition in the bog. There are seven rare or uncommon plant species in the bog and surrounding uplands, including a State-Threatened shrub and two State-Threatened sedges (DNR, 1991). The clear-cut has caused expansion of a rare shrub and has also resulted in additional vernal pools. The wetland is perched on top of a thick clay lens (Cole, 2003; 2004; Sipple, 1999). This site is part of the recently acquired Magothy Greenway and is County parkland.
- *Cockey Creek Swamp* consists of a Coastal Plain bog, formed from a millpond, and a shrub swamp with deep organic soils. There is a large population of a threatened grass, near the northern limit of its range, which occurs in the bog, shrub, swamp, and floodplain forest of this wetland complex (DNR, 1991). The abandoned dam structure has blown out, and the bog vegetation is being replaced by other plants. A restoration plan is under development. The site includes the wetlands previously referred to as Cockey Creek Swamp and Cockey Creek Bog. Immediately downstream of the dam is a population of Atlantic white cedar. This site is unprotected.
- *Cypress Creek Swamp* has areas of emergent wetland, Atlantic white cedar swamp, and red maple-dominated forested wetland, described in a 1984 report. Route 2 bisects the savanna portion from a larger stand of Atlantic white cedar. As of 2003, there may be opportunity for restoration and stormwater retrofits on the west side of Rte. 2. Garbage is also present. On the east side of Rte. 2, the site is degraded and supports a community of *Phragmites*. There may also be some saltwater intrusion. The complex on the east side of Rte. 2 has been referred to as the Cypress Creek Savanna and the west side as the Cypress Creek Swamp. While both complexes have cedar as a dominant species, they are very different. This site is unprotected.
- *Eagle Hill Bog* is a Nontidal Wetlands of Special State Concern and was designated as an Area of Critical State Concern in 1981. Unusual or rare vegetation in the bog includes sundew, meadow beauty, leatherleaf, and cranberry. Tidal wetlands are also part of the complex (MDSP, 1981). As of 2003, this wetland was in good condition (Cole, 2003; 2004). This site is unprotected, but is private community open space.
- *Magothy Peninsula Bogs*
    - *North Grays Bog* contains a State-Endangered plant species, two State-Threatened plant species, and four additional uncommon plants(DNR, 1991). It was described as having leatherleaf and sundew among other plants in 1977 and 1980 (Sipple, 1999). Since then there are reports of substantial degradation due to increases in water levels, and most of the hummocks and bog-type plants had disappeared. However, the bog mat currently now floats above the new water level with cranberry and

leatherleaf in good condition. Downstream restoration to lower the water level approximately 2 feet is still planned. In the North Grays Bog complex, the bogs' recharge area is under threat of development. There is also opportunity for enhancement by removing willows. Some of the site was partially filled in the 1960's, so restoration and expansion of the Nontidal Wetlands of Special State Concern is possible. A County-approved restoration plan was implemented in 2005. *Phragmites* and dredged spoil were removed and the area was planted with native species. A retrofit and additional restoration are also being pursued (Cole, 2003; 2004; 2006). This site is unprotected, but is a community recreational space.

    - *South Gray's Bog* was formed in a remnant pond. Species include leatherleaf, spatulate leaf sundew, and large cranberry. In 1998, encroachment of red maple was observed. In 2005, much giant cane died as a result of flooding due to a blocked outlet. The blockage has been removed. The bog is protected as part of the Magothy River Greenway.
    - *Main Creek Bog* has a floating mat of vegetation supporting bog species such as leatherleaf, sundew, and a contiguous alder swamp (Sipple, 1999).
- *Shady Pond*. This site is unprotected.
- *Upper Magothy Marshes*. This site is unprotected.
- *Potential WSSC*. There are three potential WSSC located near Chelsea Beach (just west of Cockey Creek Swamp), Pasadena (within protected land), and Robinson.

There are additional high-quality bogs in this watershed, located near Cypress Creek Swamp WSSC, in the headwaters of Cockey Creek, in the headwaters of Blackhole Creek (including within Magothy Greenway Natural Area), and in the headwaters of Grays Creek.

Specific Restoration Recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.
- Restore or enhance Magothy Peninsula Bogs: Cockey Creek Swamp (Bog) and North Grays Bog complex.
- Restore and retrofit for Cypress Creek Swamp.
- Restore 585 acres of SAV.
- Restore wetlands and streams within the headwaters.
- Kinder Farm Park (17.5 acres) (Anne Arundel County, 2003).

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect WSSC and buffers, especially Cypress Creek Swamp and Eagle Hill Bog Natural Heritage Areas.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected, including potential WSSCs.
- Protect Magothy Peninsula Bogs
- Protect recharge areas.

- Protect headwater stream/wetland complexes and a buffer area.

Severn River (02131002)

Background

The Severn River watershed is within the Coastal Plain. Shorelines are low near the mouth of the river, and experience high wave action. The shoreline around the mouth is highly urbanized and has extensive bulkheads. Upstream of the mouth, the shorelines are higher, forming cliffs near the edge of the water, and the river is more sheltered. Shorelines decrease in elevation around the area of Round Bay, and above Round Bay the shorelines abruptly rise and the river narrows and becomes more shallow (DNR, 1982).

The topography ranges from level to very steep, with elevations near sea level at the Chesapeake Bay shoreline up to 300 feet in other areas. There are steep slopes along the headwater tributaries and downstream floodplains, with deep v-shaped valleys where streams have cut into the land. Floodplains are broad (KCI Technologies, Inc, 2002).

Soil associations in the watershed are Evesboro-Rumford-Sassafras, Monmouth-Collington, and Elkton-Othello-Mattapex. Evesboro-Rumford-Sassafras contains excessively well drained to well drained sandy and loamy soils. Monmouth-Collington Association contains well drained sandy and loamy soils with glauconite "greensand." Elkton-Othello-Mattapex contains level, poorly drained and moderately well drained silty and loamy soils.

The Severn River was designated as a State Scenic River in 1971. The watershed includes the nine-mile long Severn Run tributary, a Use IV water that is stocked for recreational trout fishing. Severn Run is the southernmost Use IV water in Maryland. Severn Run was also previously stocked with yellow perch. Jabez Branch, the only Use III water in the Coastal Plain, has a reproducing brook trout population. This may be due to the cool water from the springs and thick forest cover (KCI Technologies, Inc, 2002). The Severn Run Natural Environmental Area was designated as an Area of Critical State Concern by the Department of State Planning in 1981 and contains a Nontidal Wetlands of Special State Concern.

Based on MDP 2002 GIS land use data, the Severn River watershed has 7,589 acres of open water and 44,155 acres of land. The land acres are divided as follows: urban 24,646 acres (56%), agriculture 3,767 acres (9%), forest 15,558 acres (35%), wetlands 79 acres (<1%) and barren land 106 acres (<1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

The Severn River watershed is part of the Lower Western Shore Tributary Basin of the Chesapeake Bay in Maryland. The basin is largely forest and urban. The dominant land use for the entire basin is classified as forested (46%). Urban areas comprise the second largest land use at 40%. About 14 % of the basin is devoted to agricultural use. Barren land accounts for less than 1 % of the basin (Basin Summary Team and CBP, 2004a).

A greenway strategy was completed in 1982 for Weems Creek, in Annapolis. Considering this creek is within the Annapolis area, it is relatively undisturbed. This creek contains beautiful natural resources such as brackish marsh, steep slopes and bluffs, and diverse wildlife, but is vulnerable to future development. The wetlands on this creek provide water quality improvement, habitat, recreational opportunities, aesthetic value, and help buffer against the wake. There were six emergent wetland areas identified in 1970, three on the Hock Property, and three at the confluence (between the Severn and Ridgely Avenue Bridge). In 1970, SAV was present off of Priest Point and Wardour. The large forested Hock Property (owned by SHA) and Priest Point (owned by the Redemption Order) are significant natural resources that are recommended for preservation. The headwaters of Weems Creek has problems with sedimentation, runoff, and eroding slopes and inlets. There are no buffers between the wetlands and development.

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

- Estuarine
  - Emergent: 280 acres
  - Scrub shrub: 11 acres
  - Unconsolidated shore: 41 acres
- Palustrine
  - Aquatic bed: 7 acres
  - Emergent: 57 acres
  - Scrub shrub: 88 acres
  - Forested: 869 acres
  - Unconsolidated bottom: 120 acres
  - Unconsolidated shore: 1 acre
  - Farmed: <1 acre
- Total: 1,475 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 (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131002	-4.75	0.58	0	0.67	-3.50

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.

- Use I: water contact recreation and aquatic life; All waterways except those described below

- Use II: shellfish harvesting; All estuarine portions of tributaries except: Severn River and tributaries above mouth of Forked Creek
- Use III: natural trout water; Jabez Branch and all tributaries
- Use IV: recreation trout water; Severn Run and all tributaries above Rte. 3

Water Quality

A source water assessment was completed for the Glen Burnie water supply. Wells withdrawing from the confined aquifer had a moderate susceptibility to naturally occurring radionuclides while wells withdrawing from the semi-confined aquifer had a low to high susceptibility to naturally occurring radionuclides. This semi-confined aquifer is also susceptible to human contaminant sources and VOCs.

The 1998 Clean Water Action Plan classified the watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resource 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 pristine or sensitive watershed in need of protection. Indicators that exceed benchmarks or goals include presence on the 303(d) list, poor SAV abundance, poor SAV habitat index, poor anadromous fish index, poor nontidal fish index, and poor nontidal benthic index, high percent impervious surface (17%), and high population density. Wetland loss was estimated to be 6,226 acres. Indicators for Category 3 include presence of migratory fish and trout spawning areas.

The 2002 305(b) report indicates that 10.9 square miles of waters in the tidal portions of the Severn River and its tidal tributaries fail to support all designated uses. Pollutants are nutrients, low oxygen, and bacteria. Sources of the pollutants include nonpoint sources, urban runoff, eutrophication, and naturally poor tidal flushing. In nontidal, wadeable tributaries, 24.4 miles of streams met all designated uses, while 26.8 miles of nontidal waters failed to meet designated uses. The biological community was listed as being affected by siltation from urban runoff, sewerage systems, habitat alteration, and hydromodification.

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:

- Severn River (tidal); fecal coliform, nutrients, sediments.
- Meredith Creek (021310020997 tidal); fecal coliform.
- Whitehall Creek (021310020997 tidal); fecal coliform.
- Mill Creek (021310020997 non-tidal in Anne Arundel County); fecal coliform, poor biological community.
- Severn Run (021310021002 non-tidal in Anne Arundel County); poor biological community.
- Severn Run (021310021001 non-tidal in Anne Arundel County); poor biological community.

- Unnamed Tributary to Deep Ditch Branch (021310020998 non-tidal in Anne Arundel County); poor biological community.
- Jabez Branch (021310021001 non-tidal in Anne Arundel County); poor biological community.
- Schultz Run (021310021002 non-tidal in Anne Arundel County); poor biological community.

From 1995 through 2000, benthic community condition in Lower Western Shore basin tributaries was best in the South and West Rivers and worst in the Magothy and Severn Rivers. All sites with degraded benthos in the Severn River were located in the upper portion of the estuary, above the long-term water quality monitoring station (WT7.1). Although the water quality at station WT7.1 indicates fair dissolved oxygen status, all failing benthic samples but one in the upper Severn were azoic or nearly azoic (1 species), with dissolved oxygen readings at the time of sampling of less than 1.1 mg/l. In addition to the randomly located sites, a fixed long-term benthic monitoring station (#204) is also located mid-estuary in the Severn River. This location exhibits good benthic community condition with no significant trend, suggesting that benthic degradation is limited to the upper portion of the estuary, where severe hypoxia or anoxia appears to be a problem (Basin Summary Team and CBP, 2004a).

On an annual basis from 2000-2002 sampling results, phytoplankton growth is nitrogen limited (excess of phosphorus) and phosphorus limited (excess of nitrogen) about 40% of the time each. Total nitrogen concentration is relatively fair and total phosphorus, dissolved inorganic nitrogen and dissolved inorganic phosphorus concentrations are relatively good. Total nitrogen, dissolved inorganic nitrogen and total phosphorus concentrations are all improving (decreasing). The ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus ratio is relatively high in the spring, indicating that reductions in phosphorus would reduce spring phytoplankton growth; this ratio is relatively low in the summer and fall, indicating additional reductions in nitrogen concentrations will further limit phytoplankton growth during these seasons (Basin Summary Team and CBP, 2004a).

Numerous sites in the watershed were sampled by the Maryland Biological Stream Survey in 1995-1997. Sites were located on the following streams: Saltworks Creek (3), Severn Run (17), unnamed tributaries to Severn Run (6), Gumbottom Branch (2), Plum Creek (4), Jabez Branch unnamed tributaries (2), Schultz Run, Jabez Branch mainstem, and an unnamed tributary to Deep Ditch Branch. However, data is unavailable for many of these sites or no fish were seen. Data was most commonly available for Severn Run sites. Among these sites, fish IBIs were mostly fair, with some sites receiving poor rankings. Benthic IBIs were all ranked good. Physical habitat was generally good, though a few sites received fair or poor rankings. Fish IBIs in Mill Creek, Schultz Run, Jabez Branch were fair or poor. Benthic IBIs in these streams and Deep Ditch Branch were all good. Physical habitat rankings ranged from poor to good. Fish species included Eastern mudminnow, Brown bullhead, American eel, Tessellated darter, bluegill, chain pickerel, blacknose dace, pumpkinseed, Yellow perch, Green sunfish, Largemouth bass, striped bass, and rainbow trout (DNR, 1995-1997).

Water quality was generally good in the free-flowing tributaries (KCI Technologies, Inc, 2002).

Adverse human impacts reported in 1981 included pollutants from malfunctioning sewage pumping stations, stormwater runoff, and improper oil disposal. Use of bulkheads for shoreline stabilization was also reported as a concern in 1981, but the practice of using bulkheads for shoreline stabilization continues (Environmental Systems Analysis, 2003).

There are also concerns that toxic metals are accumulating in the sediments. Other Chesapeake-Bay related issues include high nutrient loadings, algae, low dissolved oxygen, and loss of SAV. There continues to be development pressure from both the commercial and residential sectors. In order to maintain and improve habitat, reduce flooding, and improve water quality, impacts from existing and future development must be addressed (KCI Technologies, Inc, 2002).

Restoration/Preservation

A stream assessment was completed for 152 miles of the Severn River watershed. This survey should provide areas in need of protection and areas in need of restoration. Based on the results, GIS maps were created showing stream ranking for indicators physical habitat, buffer, erosion, headcut, trash dumping, infrastructure, and road crossings. These streams were then given a final reach score which integrated stream habitat, infrastructure, hydrology, and hydraulics (Searing, 2005).

In 2003, a rapid stream assessment technique was used to identify mitigation and restoration opportunities. Scores were highest in Jabez Branch, with similar but slightly lower scores in the sub-watersheds of Beaver Creek, Broad Branch, Jackson Grove, and Picture Spring Branch. Overall assessment scores for Middle Severn, upper Severn, and Wells Branch were rated fair and were noticeably more degraded than other reaches. In the subwatersheds of Broad Branch and Middle Severn Run, instream pumps used for irrigation, an illicit discharge, and vagabonds had degraded the channel and riparian buffer, as reported in 2003. There is also an exposed sewer line in Picture Spring Branch. A channelized, concrete section of stream channel is in the Upper Severn Run downstream of Lake Marian (Environmental Systems Analysis, 2003).

The Severn River Watershed Management Plan characterized current conditions (including for each subwatershed) and modeled future conditions based on drainage and water quality. It resulted in the development of a Watershed Management Tool (WMT). This tool helps County staff make informed decisions, by running models of how changes in land use, zoning, management, and watershed conditions will affect the Severn River and tributaries (KCI Technologies, Inc, 2002; www.severn-river-watershed.com). This plan will identify potential restoration opportunities (Anne Arundel County DPW, 2004) and resulted in a prioritization of subwatersheds within the Severn River watershed that

are most in need of restoration (Figure 1; Searing, 2005), based on the following indicators:

- Stream habitat (final habitat score)
- Impervious cover
- BMPs
- Forested stream buffer
- Wetland/hydric soils
- Critical area
- Water quality (TN, TP, TZ, TSS)
- Water quantity

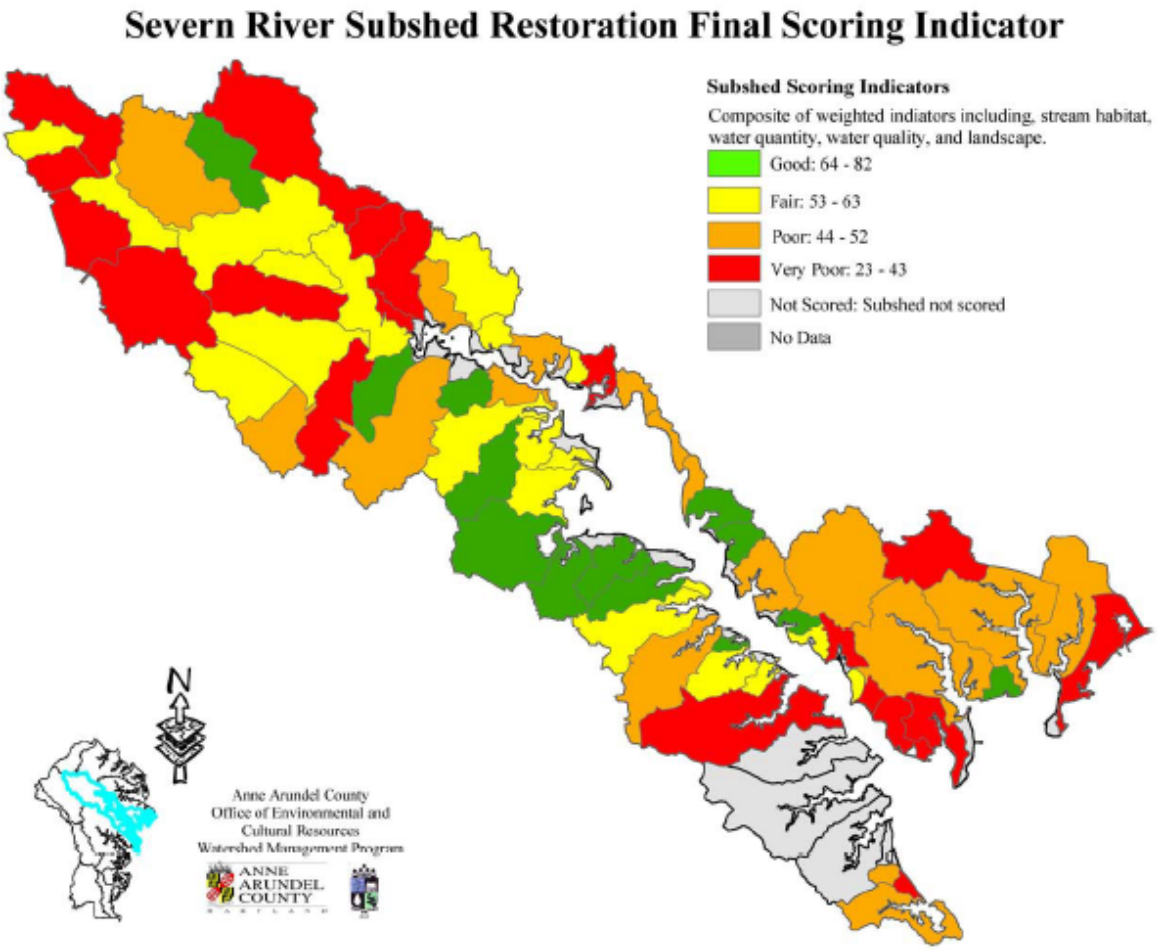

Figure 1. Prioritization of subwatersheds within the Severn River watershed that are most in need of restoration (Searing, 2005).

This plan then prioritized subwatersheds for preservation (Figure 2; Searing, 2005), using the following indicators:

- Stream habitat
- Trout spawning
- Anadromous spawning
- Impervious cover

- Forest cover
- Wetlands
- Headwater streams
- Greenway
- SSPRA
- Bog
- Critical area (RCA)
- Protected lands

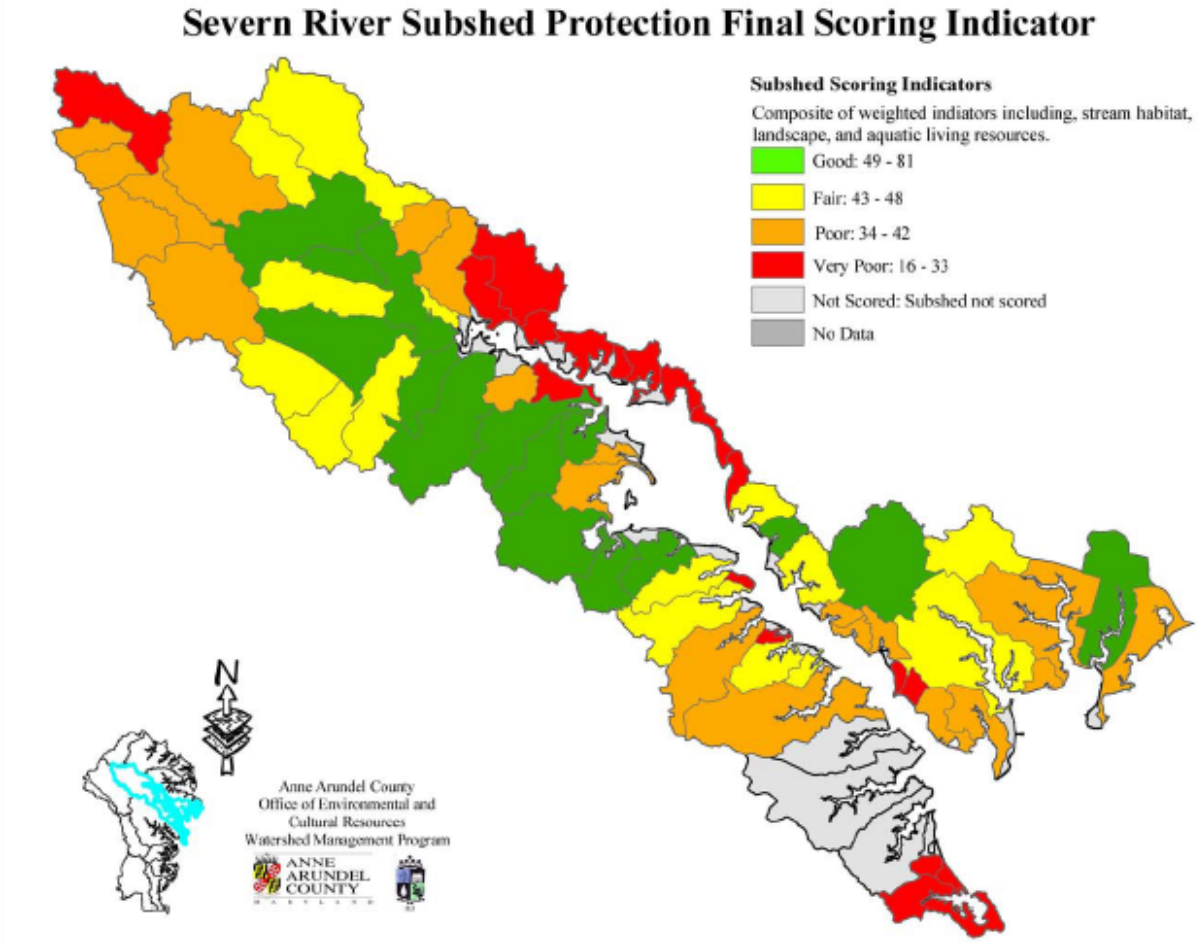

Figure 2. Prioritization of subwatersheds within the Severn River watershed for preservation (Searing, 2005).

Some completed restoration projects in the Severn River watershed include:

- The Severn River Association restored a portion of Howards Branch, an abandoned water reservoir, to a more natural State by restoring stream morphology and establishing native wetland/stream fauna (including Atlantic White Cedar) along portions. Work was also being completed on the tidal interface of Howards Branch and Brewer Creek. Over 1,000 Atlantic white cedar

trees were planted along Howard's Branch, adjacent to Sherwood Forest and the Downs in Crownsville, by volunteers in 2001 (KCI Technologies, Inc, 2002).

- The Severn River Association encourages the use of "Living Shorelines" (Anne Arundel County DPW, 2004).
- The Weems Creek Conservancy preserved land along Weems Creek at Priest Point, oyster bars and living shoreline projects. They are also implementing a Weems Creek Watershed Study (Anne Arundel County DPW, 2004).
- There are numerous oyster restoration projects (Environmental Systems Analysis, 2003) in the river. The projects included planting oyster shells to improve the historic remnant habitat, followed by a planting of hatchery seed oysters. The hatchery seed oysters were disease free when planted, but became infected over time. As a result of the 4-year drought (1999-2002), which heightened the infection levels, many of the projects are suffering high mortality due to disease. Oyster reproduction and recruitment (spat set) is low to zero, with only a very light spat set being seen in drought years when salinity increase enough to support reproduction. A lack of significant recruitment, combined with elevated mortality levels, limits the ability of the oyster population to increase. Mortality declines when rainfall increases, but then recruitment is severely reduced. Many of the historic oyster bars have been lost due to sedimentation and the natural remaining oyster bars are now highly degraded (Cole, 2003).

The project entitled *A GIS-Based Preliminary Evaluation of Potential Wetlands Mitigation Sites in the Severn, South, and Magothy River Watersheds* (2003) used the following selection criteria:

- Hydric soils
- Land use = government/institutions, agriculture, or recreation (not forest)
- Not already wetlands (NWI wetlands layer)
- Not agricultural preservation easements
- Not too fragmented from other natural systems.
- During this project, they did not determine property owners interest.

Potential projects within the Severn River watershed include:

- Park and recreational land
  - Severn River Swim Club (0.6 acres).
  - Old Severna Park Improvement Association (0.5 acres).
  - Anne Arundel County Recreation and Parks Land – near Isabella Court (1.2 acres)
- School/institutional land
  - ANS/Greenbury Point – federally owned (3.4 acres)
  - Central Elementary School – includes many non-hydric soils (3.2 acres)
  - David Taylor Property/Bennion Road (2.2 acres)
  - Grace Independent Baptist Church (3.9 acres)
  - David Taylor Property/Alder and Holly Roads (2.2 acres)
  - USGS Station/Thomas Point Road (0.7 acres)
- Agriculture
  - Hoppa Road and Waterbury Road (3.3 acres)
  - Whitehall Creek (7.9 acres)

- Jabez Branch headwaters (7.1 acres)
- Holly Beach Farm (6.9 acres)
- Meredith Creek (4.4 acres)
- Severn Run headwaters (4.6 acres)

The State-designated Green Infrastructure identified the Severn River/Severn Run ecological greenway on the west side of the Severn River (DNR, 2000-2003). The greenway begins at the Severn Run Natural Area and includes the Arlington Echo Outdoor Education Center and Whitney's Landing Farm. There are gaps in the Green Infrastructure between these large hubs. Additional protected land included some Maryland Environmental Trust holdings, County-owned property, a portion of Fort Meade, U.S. Naval Academy, and U.S. Naval Surface Warfare Center. According to a 2000 Maryland Greenways Commission document, existing or proposed greenways include Severn River/Severn Run Greenway, Baltimore and Annapolis Trail Park, Broadneck Peninsula Trail, South Shore Trail, Poplar Trail, Spa Creek Trail, and Washington Baltimore and Annapolis Trail.

A partnership of DNR, Maryland Environmental Trust, South River Federation and Scenic Rivers Land Trust has a goal to protect and restore riparian habitat in the South and Severn River watersheds. Purchase of a conservation easement for a farm in the South River watershed is under negotiation (Murphy, 2006, pers. comm.).

Nontidal Wetlands of Special State Concern and potential WSSC in the watershed are the following:

- *Benfield Bottomland* - The area includes part of the Severn Run Natural Environmental Area. There are excellent examples of deciduous and mixed pine-deciduous bottomland forests. The large contiguous forest provides excellent habitat for forest interior birds. There are two threatened plant species. There is also mixed pine-oak forest, on the adjacent uplands, an unusual community on the Western Shore (DNR, 1991). Severn Run is a Use IV recreational trout water and is stocked with trout. The stream is also important for yellow perch, but spawning may be inhibited by blockages from dams that are periodically built by children to create a swimming hole (Cole, 2003). Some invasive species are present. Threats are increased runoff and siltation from development. In 1981, Severn Run and several of its tributaries were designated as Areas of Critical State Concern (MDP, 1981). This site is partially protected by Severn Run NEA.
- *Gumbottom wetland* - The complex includes tidal marsh, shrub swamp, floodplain forest, steep slopes, and ravine bottom (MDP, 1981). There is also Arden Bog, one of the most significant Coastal Plain bogs on the Western Shore. Arden Bog is believed to be a natural opening, possibly part of an old oxbow (Sipple, 1999). Saturated conditions are maintained by seeps on the adjacent slopes and by an old road serving as a dam. There are three carnivorous plants, including an extensive population of pitcher plants, and eleven rare species. The shrub swamp provides important habitat for migratory and resident birds and for amphibians (DNR, 1991). Adverse impacts from storm drain discharges are believed to have been

corrected by storm drain removal (Sipple, 1999). This site is protected by Severn Run NEA.

- *Iliff's Ravine and Rucker's Ravine* - These wetlands are surrounded by steep slopes and covered by a dense canopy that creates cool, shaded micro-climate conditions. There is a diverse assemblage of ferns, fern allies, and wildflowers. The area is also important for neotropical forest interior birds and salamanders. Presence of invasive and non-native species such as kudzu was noted in 1986. Rucker's Ravine contains the largest spring in the watershed. Rare and uncommon plant species included Glade fern, floating marsh pennywort, Clinton's Fern, and yellow passionflower. This site is unprotected.
- *Jabez Branch* - Jabez Branch formerly supported the only native brook trout population located entirely within the Coastal Plain. Thermal discharges and sediment from highway construction eliminated the native population, though the stream has successfully been restocked and now supports a reproducing trout population. Much of the floodplain is relatively dry, but some shrub wetlands also exist. Plants include sheep laurel, leatherleaf, Chinquapin, and sand hickory. This site is unprotected.
- *John Wesley Church* - The area includes part of the Arlington Echo Outdoor Education Center. The complex includes tidal marsh, shrub swamp, forested wetland, and floodplain forest. Rare species include climbing fern. Atlantic white cedar are also present (MDP, 1981). The forested wetland is of unusually high quality and the vegetation is very diverse. The site also offers excellent nesting and feeding habitat for migratory songbirds, shorebirds, and waterfowl (DNR, 1991). This site is partially unprotected.
- *Round Bay Bog* - Coastal Plain bogs are an unusual habitat type in Maryland (DNR, 1991). The actual bog is confined to the right-of-way of an overhead transmission line along Deep Ditch Branch. It contains an unusual plant community on its sphagnum moss, including cranberry. A diverse wooded swamp surrounds the area and the complex includes one of the most intact tidal marshes in the watershed (MDP, 1981). There are four rare plant species: a vine, sedge, fern, and wildflower (DNR, 1991). Numerous insectivorous plants (sundew and pitcher plant species) have been introduced to the site (Sipple, 1999). This site is unprotected.
- *Severn Run East* - In 1981, Severn Run and several of its tributaries were designated as Areas of Critical State Concern, including the Benfield Bottomland and Severn Run East (MDSP, 1981) The State threatened plant leatherleaf is found here (Cole, 2003). This site is protected by Severn Run NEA.
- *Potential WSSC* - There are two potential WSSC, in Benfield and Severna Park. These are both unprotected.

There are high quality bogs within this watershed that qualify as WSSC, including Dicus Mill, Arlington Echo, Cypress Creek, Lakewood, Carrollton, Forked Creek and Sullivan's Cove. These areas provide water quality improvement and habitat for rare, threatened and endangered species (KCI Technologies, Inc, 2002).

A significant waterfowl staging area in the watershed is Sullivan Cove Marsh. Protection of the steep slopes is essential for maintaining the quality of the marsh. According to the 1982 Scenic River Plan, Sullivan's Cove also supported small stands of Atlantic white cedar.

Existing specific management recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.
- Remove exotic species in Rucker's/Iliff's Ravines.
- Manage runoff at Rucker's Ravine
- Remove red maples in Round Bay Bog right of way
- Improve stormwater management in Beaver Creek, Jabez Branch, Middle Severn Run, Picture Spring Branch, Wells Branch
- Conduct stream restoration along Broad Branch, Jabez Branch, Middle Severn Run, Picture Spring Branch, Upper Severn Run, Wells Branch.
- Conduct stormwater retrofits at Jackson Grove, Picture Spring Branch, Upper Severn Run.
- Conduct wetland enhancement along Broad Branch, Middle Severn Run
- Conduct reforestation along Beaver Creek, Broad Branch, Jabez Branch (particularly in headwaters), Middle Severn Run, Upper Severn Run
- Remove fish blockages at Hog Farm Road and other culverts in Jabez Branch, Middle Severn Run, Picture Spring Branch
- Conduct invasive species management along portions of Jabez Branch and the beaver dam along Jabez Branch
- Remove trash along Jabez Branch, Beaver Creek, Picture Spring Branch, Upper Severn
- Conduct additional plantings in Jackson Grove wetlands to improve thermal controls
- Preserve wetlands along Weems Creek, including emergent wetland areas on the Hock Property and at the confluence (between the Severn and Ridgely Avenue Bridge).
- Evaluate recommendations for mitigation priorities (Environmental Systems Analysis, 2003) along Jabez Branch, focusing on water quality improvement, stream restoration, and reforestation. Further investigation is required.
    - Wells Branch – 1 area, stormwater management and stream restoration
    - Upper Severn Run – 1 area, stormwater management
    - Picture Spring Branch – 3 areas, stormwater management, protection of exposed utility structures, stream restoration
    - Broad Branch – 1 area, riparian buffer plantings
- Follow recommendations based on stream assessment of the Severn River watershed.
- Restore wetlands and streams within the headwaters.
- Potential sites (Anne Arundel, 2003):
    - Severn River Swim Club (0.6 acres).
    - Old Severna Park Improvement Association (0.5 acres).

- Anne Arundel County Recreation and Parks Land – near Isabella Court (1.2 acres)
- ANS/Greenbury Point – federally owned (3.4 acres)
- Central Elementary School – includes many non-hydric soils (3.2 acres)
- David Taylor Property/Bennion Road (2.2 acres)
- Grace Independent Baptist Church (3.9 acres)
- David Taylor Property/Alder and Holly Roads (2.2 acres)
- USGS Station/Thomas Point Road (0.7 acres)
- Hoppa Road and Waterbury Road (3.3 acres)
- Whitehall Creek (7.9 acres)
- Jabez Branch headwaters (7.1 acres)
- Holly Beach Farm (6.9 acres)
- Meredith Creek (4.4 acres)
- Severn Run headwaters (4.6 acres)

Preservation

- Protect Nontidal Wetlands of Special State Concern and expanded buffers.
- Protect portions of Green Infrastructure that are not currently protected, especially along waterways and hubs.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected.
- Protect high quality bogs.
- Conserve existing forest along Beaver Creek, Broad Branch.
- Protect headwater stream/wetland complexes and a buffer area (including headwaters of Broad Branch).
- Sullivan Cove Marsh.

<u>South River (02131003)</u>

Background

The South River is part of the Lower Western Shore Tributary Basin. Maryland's Lower Western Shore drains 305 square miles of land in Anne Arundel and Calvert Counties. The main rivers in the basin are the Magothy, Severn, South, Rhode, and West Rivers. The entire basin lies in the Coastal Plain Province. In many areas near tidal waters, the hill-terrain forms cliffs along the shoreline. Because of low elevations in the basin, surface waters generally flow sluggishly in winding courses, often through wetlands before reaching the Bay (Basin Summary Team and CBP, 2004a).

Based on MDP 2002 GIS land use data, the South River watershed has 5,766 acres of open water and 36,528 acres of land. The land acres are divided as follows: urban 14,251 acres (39%), agriculture 5,472 acres (15%), forest 16,669 acres (46%), wetlands 132 acres (<1%) and barren land 4 acres (<1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

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

- Estuarine
  - Emergent: 244 acres
  - Unconsolidated shore: 13 acres
- Palustrine
  - Aquatic bed: 1 acres
  - Emergent: 143 acres
  - Scrub shrub: 87 acres
  - Forested: 1,211 acres
  - Unconsolidated bottom: 102 acres
  - Unconsolidated shore: 1 acre
  - Farmed: 5 acres
- Total: 1,807 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 (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131003	-4.10	0.28	0	0.37	-3.45

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.

- Use I: water contact recreation and aquatic life; All portions except those described below
- Use II: shellfish harvesting; All estuarine portions of tributaries except South River and tributaries above Porter Pt.

Water Quality

The source water assessment for Annapolis found that wells withdrawing from the confined aquifer had a low susceptibility to contaminants.

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resource 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 pristine or sensitive watershed in need of protection. Failing indicators include high phosphorus and nitrogen loadings, poor SAV abundance, poor SAV habitat index, poor nontidal benthic IBI, high percent impervious surface (10%), high population density, high soil erodibility (0.33) and being on the 303d list. Wetland loss was estimated to be 2,495 acres. Indicators for

Category 3 include presence of migratory fish spawning areas and high percent headwater streams within Interior Forest (37%).

Surface waters in the watershed are designated Use I: for water contact recreation and aquatic life or Use II: for shellfish harvesting. The 2002 305(b) report identified 9.4 square miles of tidal river and tributaries that failed to support designated uses. Pollutants were PCBs and bacteria from nonpoint sources, urban runoff, failing septics, eutrophication , unknown sources, and poor tidal flushing. No tidal waters were identified as fully supporting all uses. In nontidal, wadeable tributaries, results were inconclusive for 12.4 miles of streams. There were 23 miles of nontidal, wadeable streams showing effects of pollution on the biological community from habitat alteration (DNR, 2002b).

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:

- *South River* (tidal); fecal coliform, nutrients, sediments, PCBs (in fish tissue).
- *South River Unnamed Tributary 1* (021310030992 non-tidal); poor biological community.
- *Duvall Creek* (021310030990 tidal); fecal coliform.
- *Selby Bay* (021310030989 tidal); fecal coliform.
- *Ramsey Lake* (021310030989 tidal); fecal coliform.
- *Bell Branch Unnamed Tributary 1* (021310030994 non-tidal); poor biological community.
- *Tarnans Branch* (021310030994 non-tidal); poor biological community.
- *North River* (021310030994 non-tidal); poor biological community.
- *Bacon Ridge Branch* (021310030995 non-tidal); poor biological community.
- *Bacon Ridge Branch Unnamed Tributary* (021310030995 non-tidal); poor biological community.
- *Flat Creek* (021310030992 non-tidal); poor biological community.

A Draft TMDL was completed in 2005 for fecal coliform in the restricted shellfish harvesting areas in South River, Duvall Creek, Selby Bay, and Ramsey Lake (MDE, 2005c). Permitted point sources discharging into this basin include Alliant Techsystems Inc. and R.S. Leitch Company. However, these do not discharge fecal coliform. The only permitted point sources discharging fecal coliform are the stormwater discharges. Nonpoint sources are as follows:

Basin	Livestock %	Pets %	Human %	Wildlife %
South River (24B_A)	30	54	1	16
South River (24B_B)	23	41	1	35
South River (24B_C)	0	63	2	34
South River (Total)	22	43	1	34
Duvall Creek Basin	15	68	<1	17
Selby Bay (24D1_A)	0	52	4	44
Selby Bay (24D1_B)	0	76	<1	24
Selby Bay (Total)	0	63	2	35
Ramsey Lake Basin	0	63	<1	37

Living resource communities in the Lower Western Shore watershed, particularly in the upper portions of the tributaries and feeder creeks, are being negatively impacted by poor water quality. Three major stressors in the watershed are low dissolved oxygen levels, algal blooms and sediment inputs to small creeks and streams. Algal growth fueled by high nitrogen and phosphorus concentrations are largely responsible for the low dissolved oxygen levels, while the sediment inputs and algal blooms are largely responsible for SAV habitats impacts. Total suspended solids levels are relatively fair to good and improving, but water clarity (Secchi depths) are relatively poor. Dissolved oxygen levels are poor at the Magothy, Severn, and South River stations and have worsened in the Magothy and the Severn (Basin Summary Team and CBP, 2004a).

The South River showed an increasing trend in SAV coverage (www.vims.edu/bio/sav/), beginning in 1994 and ending in 1998, where SAV coverage was 54 acres, exceeding the Tier I goal of 51 acres. SAV coverage was down to 17 acres in 1999 and no SAV was reported in 2000, again most likely due to algae blooms. In 2001 there were 27 acres of SAV (52% of Tier I). Most SAV beds have been located between Mayo and Larrimore Points, primarily on the southern shore. There has been extensive ground-truthing of this area by citizens, and they have identified 6 species, listed here in order of occurrence: horned pondweed, widgeon grass, slender pondweed, curly pondweed, wild celery and 1 unidentified species. Data from the water quality monitoring site located near Shadow Point indicates that the SAV habitat requirements are met for suspended solids and nitrogen concentrations and are borderline for phosphorous levels and percent light at leaf. The river fails for light attenuation and algae concentrations (Basin Summary Team and CBP, 2004a).

From 1995 through 2000, benthic community condition in Lower Western Shore basin tributaries was best in the South and West Rivers and worst in the Magothy and Severn Rivers. The South River had overall good benthic with failing sites only moderately degraded. Patterns of degradation could not be linked to low dissolved oxygen. The majority of sampling sites in the South River were concentrated in the lower half of the estuary, where hypoxia did not appear to be a problem. The long-term water quality monitoring station is located in the upper half of the estuary where average summer bottom dissolved oxygen levels are below 2 mg/L (status is poor) (Basin Summary Team and CBP, 2004a).

The Maryland Biological Stream Survey (MBSS) sampled six tributaries to the South River during the 2000-2002 period. Fish indices, where available, generally showed poor scores with poor to marginal or suboptimal physical stream indicator conditions. Tributaries included Flat Creek and Tarnans Branch. Tarnans Branch was the only sampled reach with a "good" ranking for its diverse fish community. Fewer than one-third of the species were found to be pollution tolerant, in contrast to the majority of other sites, in which the majority of fish were pollution tolerant. Fish species found in the sample sites included Blacknose Dace, Tesselated Darter, Eastern mudminnow, Least Brook Lamprey, Creek chubsucker, Bluespotted sunfish, Golden shiner, Redfin pickerel, and Bluegill. Benthic indicator scores generally were poor (DNR, 2000-2002).

Restoration/Preservation

A watershed plan, including potential wetland restoration sites, was completed for South River watershed in 2000. A potential wetland restoration project identified in the South River Watershed Plan was implemented within Warehouse subwatershed. The South River federation and partners built oyster reefs in Aberdeen Creek and Harness Creek, and restored tidal marsh along Fullerton Beach (Anne Arundel County DPW, 2004).

The project entitled *A GIS-Based Preliminary Evaluation of Potential Wetlands Mitigation Sites in the Severn, South, and Magothy River Watersheds* (2003) used the following selection criteria:

- Hydric soils
- Land use = government/institutions, agriculture, or recreation (not forest)
- Not already wetlands (NWI wetlands layer)
- Not agricultural preservation easements
- Not too fragmented from other natural systems.
- During this project, they did not determine property owners interest.

Potential projects within the South River watershed include:

- Park and recreational land - Anne Arundel County Fairgrounds (8.6 acres)
- School/institutional land
    - Hillsmere Elementary School – near Duvall Creek (3.7 acres)
    - Annapolis Middle School – near forested area (4.4 acres)
- Agriculture
    - Bacon Ridge Branch headwaters – head water, stream channel restoration (24.1 acres)

- Pocahontas Creek – riparian area restoration (7.8 acres)
- Flat Creek headwaters (7.1 acres)
- Baldwin Hills – stream channel restoration (3.0 acres)
- Masque Farm – stream channel restoration (5.4 acres)

There are several Green Infrastructure hubs and corridors in this watershed (DNR, 2000-2003). The main Green Infrastructure hubs are along Glebe Branch, Bacon Ridge Branch, North River, Annapolis Water Supply, and Quiet Waters Park. Some of the connecting corridors have gaps in natural vegetation. These gaps may be desirable areas for restoration to natural vegetation. These hubs and connecting corridors are largely unprotected, with the exception of Annapolis Water Supply, Quiet Water Park, and other small County-owned properties. According to a 2000 Maryland Greenways Commission document, existing or proposed greenways include South Shore Trail and South River Greenway.

The headwaters of the South River were designated as an Area of Critical State Concern in 1981. North River and Bacon Ridge Branch are main tributaries to the South River in this designated area. At the time of the report, the area included diverse communities of upland woods, forested wetland, and freshwater tidal marsh (MDP, 1981).

A partnership of DNR, Maryland Environmental Trust, South River Federation and Scenic Rivers Land Trust has a goal to protect and restore riparian habitat in the South and Severn River watersheds. Purchase of a conservation easement for a farm in the South River watershed is under negotiation (Murphy, 2006, personal cxommunication).

Two Nontidal Wetlands of Special State Concern are found in the watershed:

- *Watershed Woods*. This site includes, narrow, temporarily flooded wetlands along the streams of a mature, large forest. Trees are of an unusual size for the Upper Coastal Plain. The lack of disturbance to the forest has led to development of a rich, loamy soil that supports a diverse and abundant herbaceous layer. A spring wildflower is found at the site that is endangered in the State (DNR, 1991). This site is partially protected by Annapolis Waterworks Park.
- *Orchid Woods*. This site is unprotected.

Specific Restoration Recommendations:

- Reduce nitrogen and phosphorus, preventing soil erosion, sediment runoff, and shoreline erosion (Basin Summary Team and CBP, 2004a).
- Implement agricultural BMPs (Basin Summary Team and CBP, 2004a).
- Restore “gaps” in designated Green Infrastructure hub to natural vegetation.
- Conduct non-structural shoreline stabilization, where feasible (Basin Summary Team and CBP, 2004a).
- Restore wetlands and streams within the headwaters.
- Potential projects (Anne Arundel, 2003):
    - Anne Arundel County Fairgrounds (8.6 acres)
    - Hillsmere Elementary School – near Duvall Creek (3.7 acres)
    - Annapolis Middle School – near forested area (4.4 acres)

- Bacon Ridge Branch headwaters – head water, stream channel restoration (24.1 acres)
- Pocahontas Creek – riparian area restoration (7.8 acres)
- Flat Creek headwaters (7.1 acres)
- Baldwin Hills – stream channel restoration (3.0 acres)
- Masque Farm – stream channel restoration (5.4 acres)

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect WSSC and buffers.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands.
- Protect headwater stream/wetland complexes and a buffer area.
- Protect land designated as an Area of Critical State Concern: the headwaters of the South River (MDP, 1981).

West River (02131004)

Background

The West River is also part of the Lower Western Shore Tributary Basin. Maryland's Lower Western Shore drains 305 square miles of land in Anne Arundel and Calvert Counties. The main rivers in the basin are the Magothy, Severn, South, Rhode, and West Rivers. The entire basin lies in the Coastal Plain Province. In many areas near tidal waters, the hill- terrain forms cliffs along the shoreline. Because of low elevations in the basin, surface waters generally flow sluggishly in winding courses, often through wetlands before reaching the Bay (Basin Summary Team and CBP, 2004a).

Based on MDP 2002 GIS land use data, the West River watershed has 3,595 acres of open water and 16,270 acres of land. The land acres are divided as follows: urban 3,260 acres (20%), agriculture 5,471 acres (34%), forest 7,410 acres (46%), and wetlands 129 acres (1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

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

- Estuarine
  - Emergent: 320 acres
  - Unconsolidated shore: 7 acres
- Palustrine
  - Aquatic bed: 8 acres
  - Emergent: 60 acres
  - Scrub shrub: 28 acres

  - Forested: 1,557 acres
  - Unconsolidated bottom: 45 acres
  - Unconsolidated shore: <1 acre
  - Farmed: 1 acre
- Total: 2,024 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 (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131004	-2.77	2.60	0	0	-0.17

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. Waters in West River are designated as Use I: water contact recreation and aquatic life.

Water Quality

The 1998 Clean Water Action Plan classified the watershed as Category 1, a watershed not meeting clean water and other natural resource goals and therefore needing restoration, and Category 3, a pristine or sensitive watershed that needs an extra level of protection. Category 1 failed indicators included poor SAV abundance, poor SAV habitat index, high population density, high soil erodibility (0.30), and being on the 303(d) list. Indicators for Category 3 included three migratory fish spawning areas and presence of wetland-dependent species. Historic wetland loss was estimated at 8,056 acres.

The 2002 305(b) reported 5.7 square miles of the West and Rhode River tidal tributaries failed to meet all designated uses. Pollutants were nutrients, low oxygen, and bacteria. Sources of the pollution were nonpoint runoff, failing septics, and natural source of poor tidal flushing. In nontidal, wadeable tributaries, 14.8 miles of streams failed to meet the biological community standard. Results were inconclusive in 1 mile of nontidal, wadeable tributaries (DNR, 2002b).

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:

- *West River* (tidal); fecal coliform, nutrients, sediments.
- *Parish Creek* (021310040984 tidal); fecal coliform.
- *Cadle Creek* (021310040986 tidal); fecal coliform.
- *Bear Neck Creek* (021310040986 tidal); fecal coliform.
- *Johns Creek Unnamed Tributary* (021310040983 non-tidal); poor biological community.

- *Smith Creek Unnamed Tributary* (021310040983 non-tidal); poor biological community.
- *Muddy Creek Unnamed Tributary* (021310040985 non-tidal); sediment.
- *Mill Swamp Branch* (021310040985 non-tidal); poor biological community.
- *Mill Swamp Branch Unnamed Tributary* (021310040985 non-tidal); sediment.
- *Williamson Branch* (021310040985 non-tidal); poor biological community.
- *Bruejay Branch* (021310040985 non-tidal); poor biological community.

A Draft TMDL was completed for fecal coliform in restricted harvesting areas in Bear Neck Creek, Cadle Creek, West River, and Parish Creek (MDE, 2005a). There are no permitted point sources of fecal coliform discharging into this basin, other than NPDES stormwater discharge. Nonpoint sources were estimated to be as follows:

Basin	Livestock %	Pets %	Human %	Wildlife %
Bear Neck Creek Basin	46	34	<1	20
Cadle Creek Basin	0	80	<1	20
West River Basin	57	16	<1	27
Parish Creek Basin	0	40	1	59

The West River had overall good benthic condition with failing sites only moderately degraded. Patterns of degradation could not be linked to low dissolved oxygen (Basin Summary Team and CBP, 2004a).

The West River has had very little SAV mapped since 1984 (www.vims.edu/bio /sav/). There were approximately 10 acres in 1994 and 1998, well below the Tier I goal of 116 acres. The beds mapped in 1998 were located near Curtis Point. There has only been one spot ground-truthed in this river, Johns Creek in 1995, finding only widgeon grass. Data from the water quality monitoring site located near Councillors Point indicates that the SAV habitat requirements are met only for phosphorous and nitrogen concentrations. Suspended solids and algae levels are borderline, and the river fails for light attenuation and percent light at leaf (Basin Summary Team and CBP, 2004a).

In the West River, total nitrogen and total phosphorus concentrations are fair and dissolved inorganic nitrogen and dissolved inorganic phosphorus concentrations are good. Total phosphorus concentration is improving (decreasing). The ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus is relatively low throughout the year, indicating that continued reductions in phosphorus concentrations in addition to reductions in nitrogen might further reduce phytoplankton growth and bring the system into better balance (Basin Summary Team and CBP, 2004a).

Between 1998 and 2000, researchers at the Smithsonian Environmental Research Center (SERC) collected water quality data from seven stations in the Rhode River. Dissolved

inorganic nitrogen measurements from the Rhode River reflect a similar pattern to that observed in the Magothy River. Dissolved inorganic nitrogen concentrations are high upriver, lower in the middle portions of the river, and then increase again near the mouth of the river. Upriver concentrations are likely high due to proximity to sources. Concentrations near the mouth may be higher due to nearby wastewater treatment plants or the influence of the Susquehanna River. Half of the sampling sites in the Rhode River were severely degraded with low biomass and a high percentage of pollution-tolerant organisms. Benthic condition in the Rhode River could not be linked to low dissolved oxygen (Basin Summary Team and CBP, 2004a).

For the Rhode River, SAV has not been reported since 1978 by the aerial survey (www.vims.edu/bio/sav/), and this coverage represents the Tier I goal of 15 acres. Citizen ground-truthing has found four species of SAV, horned pondweed, widgeon grass, milfoil and an unidentified species, scattered throughout the river. Data from the water quality monitoring site located near High Island indicates that the SAV habitat requirements are borderline for suspended solids, phosphorous and algae concentrations. Nitrogen levels pass, and the river fails for light attenuation and percent light at leaf (Basin Summary Team and CBP, 2004a).

In the Rhode River, total nitrogen, total phosphorus and dissolved inorganic phosphorus concentrations are fair and dissolved inorganic nitrogen concentration is good. Dissolved inorganic nitrogen and total phosphorus concentrations are improving (decreasing). The ratio of dissolved inorganic nitrogen to dissolved inorganic phosphorus is relatively low in all seasons, indicating that continued reductions in nitrogen would further limit algal production. Continued reductions in phosphorus would help bring the system into better balance (Basin Summary Team and CBP, 2004a).

The Maryland Biological Stream Survey sampled four sites during 2000-2002 and three sites during the 1995-1997 sampling periods. Sites sampled in 1995-1997 were unnamed tributaries to Muddy Creek, Mill Swamp Branch, and Smith Creek. No fish were observed. Sites sampled in 2000-2002 were an unnamed tributary to Johns Creek, Mill Swamp Branch, Williamson Branch, and Bluejay Branch (DNR, 1995-1997; 2000-2002).

Restoration/Preservation

The West River Improvement Association has established an oyster sanctuary, monitors water quality, and educates residents about oyster farming (Anne Arundel County DPW, 2004).

A Green Infrastructure hub surrounds Smithsonian Institute and County-owned Deep Pond/Beverley Beach area. The Smithsonian Green Infrastructure hub connects with surrounding watersheds through Green Infrastructure corridors. Some of the Green Infrastructure network has gaps in natural vegetation. These gaps may be desirable areas for restoration to natural vegetation. While these hubs are mostly protected, the corridors are unprotected (DNR, 2000-2003).

The designated Rural Legacy area within Anne Arundel County is 17,890 acres and is sponsored by Anne Arundel County government. It is located within the watersheds West River, Patuxent River Upper, and Patuxent River Middle and connects with a Rural Legacy area in Prince George's County. This Rural Legacy area (within Anne Arundel County) extends from the confluence of the Rhode River and West River to the Patuxent River. There are currently 7,096 acres of protected land within the Rural Legacy area, including large areas of permanently protected land (1,900 acres) at the Smithsonian Environmental Research Center (SERC) on the Rhode River, plus another adjacent 100 acres in protective easements held by SERC. The goals of protecting these areas are to protect the watershed, protect forested riparian corridors, wetlands, and other habitat corridors, and preserve agricultural and forested land (DNR, 2003a).

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

Specific Restoration Recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect currently unprotected Rural Legacy Area, starting with properties ranked as high priority.
- Protect headwater stream/wetland complexes and a buffer area.

<u>West Chesapeake Bay (02131005)</u>

Background

Based on MDP 2002 GIS land use data, the Anne Arundel portion of the West Chesapeake Bay watershed has 953 acres of open water and 14,420 acres of land. The land acres are divided as follows: urban 2,929 acres (20%), agriculture 3,460 acres (24%), forest 7,621 acres (53%), wetlands 399 acres (3%) and barren land 12 acres (<1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

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

- Estuarine
    - Emergent: 1,237 acres
    - Scrub shrub: 5 acres
    - Unconsolidated shore: 170 acres
- Palustrine
    - Aquatic bed: 5 acres
    - Emergent: 320 acres

  - Scrub shrub: 92 acres
  - Forested: 3,393 acres
  - Unconsolidated bottom: 153 acres
  - Unconsolidated shore: 16 acres
  - Farmed: 1 acre
- Total: 5,392 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 gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131005	-7.19	12.37	1.30	0	6.48

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.

- Use I: water contact recreation and aquatic life; all portions except those described below.
- Use II: All Anne Arundel estuarine portions of tributaries except:
  - Rockhold Creek and tributaries above Mason Beach Road
  - Tracys Creek above Rte. 256

Water Quality

The 1998 Clean Water Action Plan classified this watershed as Category 1, a watershed not meeting clean water and other natural resource goals and therefore needing restoration. It is also classified as a Category 3, a pristine or sensitive watershed in need of protection. Failing indicators include poor non-tidal benthic index of biotic integrity (BIBI) and fish index of biotic integrity, high population density, and high soil erodibility (0.30). Wetland loss was estimated to be 12,960 acres. Indicators for Category 3 include high percent headwater streams within Interior Forest (47%) and high percent of watershed being forested.

The 2002 305(b) report found that tidal tributaries along the western shore of the Bay fail to support all uses due to bacteria from nonpoint sources, failing septics, natural sources (poor tidal flushing). A portion of the sampled nontidal, wadeable tributaries also failed to support all designated uses due to a poor biological community and siltation from habitat alteration and changes in hydrology (DNR, 2002b).

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:

- *West Chesapeake Bay* (tidal); nutrients, sediments
- *Herring Bay* (tidal in Anne Arundel County); fecal coliform.
- *Tracy Creek* (tidal in Anne Arundel County); fecal coliform.
- *Rockhold Creek* (tidal in Anne Arundel County); fecal coliform.
- *Parker Creek* (021310050976 non-tidal in Calvert County); sediment.
- *Parker Creek Unnamed Tributary* (021310050976 non-tidal in Calvert County); sediment.
- *Plum Point Creek* (021310050977 non-tidal in Calvert County); poor biological community.
- *Plum Point Creek Unnamed Tributary* (021310050977 non-tidal in Calvert County); poor biological community.
- *Fishing Creek* (021310050978 non-tidal in Calvert County); poor biological community.
- *Fishing Creek Unnamed Tributary* (021310050978 non-tidal in Calvert County); poor biological community.

A Draft TMDL was completed in 2005 for fecal coliform in the restricted shellfish harvesting areas of Tracy and Rockhold Creeks. These relatively narrow creeks drain about 106 acres. Sources of fecal coliform in these areas is as follows: wildlife (72%), domestic animals (21%), livestock (7%), and human (1%).

Restoration/Preservation

Main Green Infrastructure hubs within the Anne Arundel portion of this watershed are located along Tracys Creek, Deep Creek/Deep Cove, and around Fairhaven (DNR, 2000-2003). Green Infrastructure corridors connect these hubs with other watersheds. Some of the connecting Green Infrastructure corridors contain gaps in natural vegetation. These gaps may be desirable areas for restoration to natural vegetation. These areas are unprotected, except for a County-owned property Deep Creek northeast of Deep Creek.

There are no designated Nontidal Wetlands of Special State Concern within the Anne Arundel County portion of this watershed.

Specific Restoration Recommendations:

- Restore “gaps” in designated Green Infrastructure hub to natural vegetation.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected.
- Protect currently unprotected Rural Legacy Area, starting with properties ranked as high priority.
- Protect headwater stream/wetland complexes and a buffer area.

Patuxent River Lower (02131101)

Based on MDP 2002 GIS land use data, the Anne Arundel portion of the Patuxent River lower watershed has no open water and 3,328 acres of land. The land acres are divided as follows: urban 500 acres (15%), agriculture 1,447 acres (43%), and forest 1,380 acres (41%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

The Anne Arundel County portion of this watershed is small. The Patuxent River was designated as a scenic river by the Maryland General Assembly. The following is a summary from a document entitled *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997). The Patuxent River Commission supports, coordinates, and implements programs, policies, and projects of the Patuxent River. Among the managements plans proposed for the Patuxent River include:

- Establish "a primary management area" delineating the area along the river and its tributaries to identify and manage land from which pollution is most likely to be transported into the river.
    - Prince George's County has established the Patuxent River Management Area, with criteria for stream and wetland buffers within Patuxent watershed.
    - Montgomery County has adopted a master plan for Patuxent River, with guidelines for the protection of steep slopes, wetlands, reservoirs, and other sensitive areas in the Patuxent River watershed.
- Implement a comprehensive watershed management approach to control all sources of pollution and resource degradation.
- Continue restoration, improvement, and protection of the habitat functions of aquatic and terrestrial living resources. These include:
    - Riparian forest: to stabilize stream banks.
    - Stream quality: to improve spawning ranges.
    - Wetlands: protection and restoration.
    - Forest land: to enhance contiguous tracts of forest.
    - Submerged aquatic vegetation and tidal marsh.
    - Concentrate new development in and around existing developed areas and population centers while protecting the rural and agricultural landscape.
    - Enhance the environmental quality and community design in new and existing communities.
    - Develop a sense of stewardship for the Patuxent River and its watershed through increased public education and participation programs.
    - Fund and meet the above plans.

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

- Estuarine
  - Emergent: 4,372 acres
  - Scrub shrub: 89 acres
  - Forested: 10 acres
  - Unconsolidated shore: 125 acres
- Palustrine
  - Aquatic bed: 73 acres
  - Emergent: 605 acres
  - Scrub shrub: 1,040 acres
  - Forested: 7,619 acres
  - Unconsolidated bottom: 687 acres
  - Unconsolidated shore: 7 acres
  - Farmed: 79 acres
- Total: 14,707 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 (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131101	-11.56	9.98	0	0.15	-1.43

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. Waters in Anne Arundel portion of Patuxent River Lower are designated as Use I: water contact recreation and 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 resource 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 low SAV abundance and habitat index, poor tidal and non-tidal benthic index of biological integrity (BIBI), poor non-tidal instream habitat index, and high amount historic wetland loss (42,599 acres). Indicators for Category 3 include high imperiled aquatic species indicator, migratory fish spawning area, high number of wetland-dependent species, high amount of headwater streams in Interior Forest, and high percent of the watershed being forested.

According to the 2002 305(b) report, a portion of the nontidal mainstem and tributaries fail to support all designated uses due to pesticides, nutrients, low oxygen, and bacteria

due to nonpoint sources, failing septics, natural sources (poor tidal flushing), eutrophication, and other sources. The nontidal, wadeable tributaries do support all designated uses. Lake Lariat does not support all designated uses due to Hg in fish from atmospheric deposition and other sources (DNR, 2002b).

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:

- *Patuxent River lower* (tidal); fecal coliform, poor biological community, sediments, nutrients, chlorpyrifos (in water).
- *Mill Creek* (tidal); fecal coliform.
- *Mill Creek* (021311010884 tidal in Calvert County); fecal coliform.
- *Solomons Island Harbor* (021311010873 tidal in Calvert County); fecal coliform.
- *Harper and Parson Creeks* (021311010871 tidal in St. Mary's County); fecal coliform.
- *Goose Creek* (021311010871 tidal); fecal coliform.
- *Indian Creek* (021311010887 tidal in St. Mary's/Charles County); fecal coliform.
- *Town Creek* (021311010872 tidal in St. Mary's County); fecal coliform.
- *St. Thomas Creek* (021311010877 tidal in St. Mary's County); fecal coliform.
- *Island Creek* (021311010878 tidal in Calvert County); fecal coliform.
- *Washington Creek* (021311010884 tidal in St. Mary's County); fecal coliform.
- *Persimmons Creek* (021311010884 tidal in St. Mary's County); fecal coliform.
- *Battle Creek* (021311010879 tidal in Calvert County); fecal coliform.
- *Buzzard Island Creek* (021311010882 tidal); fecal coliform.
- *Buzzard Island Creek* (021311010882 non-tidal in Calvert County); poor biological community.
- *Summerville Creek Unnamed Tributary* (021311010894 non-tidal in Prince Georges County); poor biological community.
- *Fowler's Mill Branch* (021311010902 non-tidal in Calvert County); poor biological community.
- *Cuckold Creek* (021311010874 non-tidal in St. Mary's County); fecal coliform, poor biological community.
- *Swanson Creek* (021311010890 non-tidal in Prince Georges County); poor biological community.
- *Patuxent River Unnamed Tributary* (021311010895 non-tidal in Calvert County); poor biological community.
- *Cocktown Creek Unnamed Tributary* (021311010896 non-tidal in Calvert County); poor biological community.
- *Chew Creek* (021311010899 non-tidal in Calvert County); poor biological community.
- *Hall Creek* (021311010902 non-tidal in Anne Arundel County); poor biological community.

Multiple subbasins within this watershed are impaired by a April 7, 2000 PEPCO oil spill. Impaired areas include Swanson, Washington, Trent Hall, Persimmon, Indian, and

Cremona Creeks, and Golden Beach. A TMDL is not required for these contaminants since other controls will results in water quality designation attainment.

Restoration/Preservation

Within the small Anne Arundel County portion of this watershed, there are some small Green Infrastructure corridors, all unprotected (DNR, 2000-2003). According to a 2000 Maryland Greenways Commission document, a proposed greenway is the Chesapeake Beach Rail Trail.

There are no Nontidal Wetlands of Special State Concern within the Anne Arundel portion of this watershed.

Specific Restoration Recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.
- Recommendations based on the *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997):
    - Riparian forest: stabilize stream banks.
    - Stream quality: improve spawning ranges.
    - Wetlands and submerged aquatic vegetation: protect and restore.
    - Forest land: enhance contiguous tracts of forest.
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Recommendations based on the *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997):
    - Wetlands and submerged aquatic vegetation: protect.
    - Forest land: enhance contiguous tracts of forest.
    - Protect headwater stream/wetland complexes and a buffer area.

<u>Patuxent River Middle (02131102)</u>

Background

The entire Patuxent River Middle watershed covers 66,478 acres (DNR & MDE, 2000) and is located in Anne Arundel, Prince George's, and Calvert Counties. Our 8-digit watershed calculations are based on the most recent DNR watershed delineations, having different borders for this watershed than the previous version. Based on MDP 2002 GIS land use data, the Anne Arundel portion of the Patuxent River middle watershed has 531 acres of open water and 26,437 acres of land. The land acres are divided as follows: urban 3,659 acres (14%), agriculture 11,372 acres (43%), forest 10,643 acres (40%), wetlands 660 acres (2%) and barren land 103 acres (<1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

Fresh tidal marsh are located along meandering portions along the Patuxent River. It likely took hundreds or thousands of years to create these wetlands. The tidal portion extends from Queen Anne's Bridge in Anne Arundel County to the discharge into the Chesapeake Bay, roughly forty-five miles. The freshwater tidal marsh section runs from Ferry Landing (in Calvert) to Waysons Corner (in Anne Arundel). Between Ferry Point and Cocktown Creek, there is a transition zone with fresh and brackish. South of Cocktown Creek is brackish marsh. It is believed that the Patuxent River was historically wider and deeper, but due to agricultural sedimentation in the 18th and 19th centuries, this open water converted into low marsh and eventually high marsh. It is also believed that common reed has been spreading along the Patuxent River, near Mataponi Creek, due to the heavy sedimentation occurring there. The common reed in the freshwater tidal marshes has replaced the once prevalent stands of wildrice. As of the early 1980s, wildrice was still abundant around Ferry Point and between a mile below MD Rte. 4 and the southern end of Jug Bay (Sipple, 1999).

The Patuxent River was designated as a scenic river by the Maryland General Assembly. The following is a summary from a document entitled *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997). The Patuxent River Commission supports, coordinates, and implements programs, policies, and projects of the Patuxent River. Among the managements plans proposed for the Patuxent River include:

- Establish "a primary management area" delineating the area along the river and its tributaries to identify and manage land from which pollution is most likely to be transported into the river.
    - Prince George's County has established the Patuxent River Management Area, with criteria for stream and wetland buffers within Patuxent watershed.
    - Montgomery County has adopted a master plan for Patuxent River, with guidelines for the protection of steep slopes, wetlands, reservoirs, and other sensitive areas in the Patuxent River watershed.
- Implement a comprehensive watershed management approach to control all sources of pollution and resource degradation.
- Continue restoration, improvement, and protection of the habitat functions of aquatic and terrestrial living resources. These include:
    - Riparian forest: to stabilize stream banks.
    - Stream quality: to improve spawning ranges.
    - Wetlands: protection and restoration.
    - Forest land: to enhance contiguous tracts of forest.
    - Submerged aquatic vegetation and tidal marsh.
    - Concentrate new development in and around existing developed areas and population centers while protecting the rural and agricultural landscape.
    - Enhance the environmental quality and community design in new and existing communities.

- Develop a sense of stewardship for the Patuxent River and its watershed through increased public education and participation programs.
- Fund and meet the above plans.

Extensive forests, wetlands, and streams are found in the Jug Bay Wetlands Sanctuary in Anne Arundel County and managed by the County, and the State lands of the Patuxent River Park, Patuxent Natural Resources Management Areas, and Merkle Wildlife Sanctuary in Prince George's County. The State lands are collectively known as the Patuxent Watershed Park. The Merkle Wildlife Sanctuary is particularly noted as a wintering area for Canada geese.
The Department of Natural Resources (DNR, www.dnr.state.md.us.baylinks/11.html) describes Jug Bay like this:

> As a body of water, Jug Bay is something of an anomaly, appearing to be an appendage on a bend in the river. Jug Bay's 350 acres are very shallow—only about a foot deep beyond the river channel. The valley through which the Patuxent flows here is actually no wider than the valley immediately upstream or downstream, but it has spread out over its floodplain, a marsh nestled between low river terraces. These sandy, gravelly terraces rise 20 to 50 feet above the present river level here, remnants of an earlier flood plain formed before the last North American ice age. As huge ice sheets extended out of Canada southward as far as Pennsylvania and New Jersey, the sea level dropped roughly 350 feet below today's level. In response, the Patuxent River gradually cut down through its flood plain to reach the sea. Parts of that old, higher flood plain were left behind in the form of the terraces we see today. With the retreat of the continental ice sheets, the sea rose to its present level, and the river switched from downcutting to meandering, flooding the level lands beyond its channel to leave us with the present landscape.

Upper Patuxent Marshes is a designated Natural Heritage Area. To get this designation, an area must contain threatened or endangered species and be the best Statewide examples.

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*. In this document, they categorize nine shrubland tidal wetland communities, including some in Anne Arundel County. One of the reference sites, the best example of a particular community type, is the *Salix nigra* tidal wetland on the Upper Patuxent River (south of Mill Creek and north of Jug Bay). This site is owned by The Nature Conservancy.

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

- Estuarine
    - Emergent: 1,225 acres

  - Scrub shrub: 13 acres
  - Unconsolidated shore: 17 acres
- Palustrine
  - Aquatic bed: 12 acres
  - Emergent: 343 acres
  - Scrub shrub: 347 acres
  - Forested: 2,400 acres
  - Unconsolidated bottom: 274 acres
  - Unconsolidated shore: 18 acre
  - Farmed: 10 acres
- Total: 4,658 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 gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131102	-3.11	3.77	9.00	0	9.66

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. For the Anne Arundel County portion they are as follows:

- Use I: water contact recreation and aquatic life; all portions except those described below.
- Use II: All estuarine portions of tributaries except Patuxent River and tributaries above Ferry Landing

Water Quality

The 1998 Clean Water Action Plan classified the watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resource 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 pristine or sensitive watershed in need of protection. Failed indicators supporting this designation are high modeled nitrogen and phosphorus loading rates, poor SAV abundance and SAV habitat index, poor non-tidal benthic and instream habitat indices, high population density, high soil erodibility, and being on the 303d list. Indicators for Category 3 include high imperiled aquatic species indicator, presence of migratory fish spawning area, and a high number of wetland-dependent species.

The 2002 305(b) report indicates that 0.1 square miles of the tidal mainstem and tidal tributaries meets designated uses. An additional 1.1 square miles of tidal mainstem and

tributaries failed to meet all designated uses due to pesticides, low oxygen, and bacteria from natural conditions and unknown sources. In nontidal, wadeable tributaries, 44.8 miles of waters were found to meet all designated uses. Results were inconclusive for an additional 66.5 miles of nontidal, wadeable tributaries (DNR, 2002b). The 2000 305(b) report noted bank stability as a site-specific habitat issue that might affect the aquatic community (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:

- *Patuxent River middle* (tidal); nutrients, sediments, chlorpyrifos (in water and sediment).
- *Swan Point Creek* (021311020908 non-tidal in Prince Georges County); poor biological community.
- *Swan Point Creek Unnamed Tributary* (021311020908 non-tidal); poor biological community.
- *District Branch* (021311020917 non-tidal in Prince Georges County); poor biological community.
- *Ferry Branch* (021311020915 non-tidal in Anne Arundel County); poor biological community.
- *Patuxent River Unnamed Tributary* (021311020915 non-tidal); poor biological community.
- *Patuxent River Unnamed Tributary* (021311020914 non-tidal in Anne Arundel County); poor biological community.
- *Pindell Branch* (021311020908 non-tidal); poor biological community.
- *Cabin Branch* (021311020906 non-tidal in Anne Arundel County); poor biological community.
- *Deep Creek* (021311020908 non-tidal in Anne Arundel County); poor biological community.
- *Lyons Creek* (021311020910 non-tidal in Anne Arundel/Calvert Counties); poor biological community.

Multiple subbasins within this watershed are impaired by a April 7, 2000 PEPCO oil spill. Impaired areas include Craney Creek and Buena Vista. A TMDL is not required for these contaminants since other controls will results in water quality designation attainment.

The Maryland Biological Stream Survey sampled 13 sites in Anne Arundel County in 2000-2002, and seven sites in Anne Arundel, Prince George's, and Calvert County in 1995-1997. Index scores for fish and benthic communities were generally poor or fair, with marginal or sub-optimal instream habitat scores. Only two sites, Lyons Creek in Calvert County and an unnamed tributary to Mataponi Creek in Prince George's County, received scores in the "good" range for fish and benthic communities. Other sampled streams included Deep Creek, Mataponi Creek, Charles Branch an a tributary, Ferry Branch, tributaries to the Patuxent River, Pindell Branch, Cabin Branch, Swan Point Creek, and Southwest Branch. Common fish species included Blacknose dace, Rosyside

dace, Eastern mudminnow, Tesselated darter, American eel, Bluegill, Least Brook lamprey, and Pumpkinseed (DNR, 1995-1997; 2000-2002).

During 1985-2002, the Patuxent River watershed showed water quality improvements by reductions in total nitrogen and total phosphorus concentrations at most sample points in the mainstem of the river. During the same period, abundance of algae increased at four of twelve sample points while the remainder of sites showed no trend. The total suspended solids increased at one site during 1985-2002 (Jackson Landing), while at thirteen other sites there was no trend or a decrease in total suspended solids. Changes to water clarity showed no trend or a decline during the same period at ten sample sites (Basin Summary Team and CBP, 2004c).

Restoration/Preservation

Within the Anne Arundel portion of this watershed, the most significant Green Infrastructure hubs are located along the Patuxent River, Rock Branch, and Lyons Creek. There are some Green Infrastructure corridors connecting these hubs with each other and with other watersheds (DNR, 2000-2003). Some the Green Infrastructure network has gaps in natural vegetation. These gaps may be desirable sites for restoration to natural vegetation. This Green Infrastructure network is largely unprotected, except areas of Jug Bay and Patuxent River Park. These waterfront Green Infrastructure areas should be high priority for protection. According to a 2000 Maryland Greenways Commission document, existing or proposed greenways include Chesapeake Beach Rail Trail and Patuxent Regional Greenway.

The watershed contains the highly significant Jug Bay wetland complex. The area has received numerous designations due to its wetland and habitat resources. A portion of the Jug Bay Wetlands Sanctuary in Anne Arundel County and Patuxent River Park in Prince George's County have been part of the Chesapeake Bay National Estuarine Research Reserve (CBNERR) since 1990. There are plans to seek designation of the entire Sanctuary as part of the CBNERR in Maryland. The Jug Bay Wetlands Sanctuary was also named a Nationally Important Bird Area by the American Bird Conservancy and the National Audubon Society (Anne Arundel County, 2004). The North Carolina Turtle Reserve also declared the Jug Bay Wetlands Sanctuary an official Turtle Sanctuary in 2000 (Anne Arundel County, 2004).

Jug Bay Wetlands Sanctuary also contains several rare, threatened, and endangered plants. These may include the smooth tick trefoil, downy bushclover, downy milk pea, rynchosia, and turtlehead (Jugbay Wetlands Sanctuary, www.jugbay.org). The Jug Bay Important Bird Area provides breeding habitat for wading birds, migration habitat for shorebirds, and wintering habitat for waterfowl (Audubon IBAP, www.audubon.org/bird/iba).

Jug Bay and adjacent extensive upstream and downstream wetlands were also designated as an Area of Critical State Concern in 1981 (MDP, 1981). Jug Bay includes tidal wetlands, non-tidal wetlands and a buffer area. This area contains some of the largest

freshwater marshes in Maryland, and provides habitat for abundant plants and animals. This area is also the farthest good upriver area for anadromous fish spawning. Extensive research continues to be done in this wetland, since it represents a relatively undisturbed site. However, as with many wetlands in the region, research is revealing that Canada goose grazing is negatively impacting the vegetative community. Jug Bay, upstream and downstream wetlands are also designated as the Upper Patuxent Marshes Natural Heritage Area, both as a Nontidal Wetlands of Special State Concern and a Natural Heritage Area. This area contains some of the largest freshwater marshes in Maryland (Anne Arundel County, 2004). Some of this WSSC is not currently protected. The area is also part of Green Infrastructure as the Patuxent Regional Greenway, an ecological greenway through parts of Howard, Montgomery, Anne Arundel, Calvert, Charles, Prince George's, and St. Mary's Counties (MD Greenways Commission, 2000).

Sipple (1999) described the presence of the invasive plant purple loosestrife in freshwater tidal wetlands of Mataponi Creek and Lyon's Creek in the 1980's. Mataponi Creek flows in part through the Merkle Wildlife Sanctuary south of Jug Bay. Sipple also reported the presence of the extirpated southern naiad (*Najas gracillima*), previously thought to be endangered extirpated, along Lyon's Creek and the threatened shoreline sedge (*Carex hyalinolepis*) along Lyon's Creek and Mataponi Creek. The current status of the southern naiad is unknown. *Phragmites* and wildrice were identified as dominant plants in many areas of the freshwater tidal marsh (Sipple, 1999), but there is concern that *Phragmites* is spreading.

Hundreds of acres of *Phragmites* in tidal wetlands have been treated with herbicides on the Prince George's County portion of Jug Bay, with hopes of increasing the wildrice stands. Eradication of *Phragmites* in the Anne Arundel County Jug Bay Wetlands Sanctuary has been prohibited, due to the benefits provided (Anne Arundel County DRP, 2004). The Maryland Department of the Environment established a nontidal wetland mitigation site on the Merkle Wildlife Sanctuary. An extensive wetland creation project for highway mitigation was also done on the river. The site is now known as Wooton's Landing Park.

The designated Rural Legacy area within Anne Arundel County is 17,890 acres and is sponsored by Anne Arundel County government. It is located within the watersheds West River, Patuxent River Upper, and Patuxent River Middle and connects with a Rural Legacy area in Prince George's County. This Rural Legacy area (within Anne Arundel County) extends from the confluence of the Rhode River and West River to the Patuxent River. There are currently 7,096 acres of protected land within the Rural Legacy area, including large areas of permanently protected land (1900 acres) at the Smithsonian Environmental Research Center (SERC) on the Rhode River, plus another adjacent 100 acres in protective easements held by SERC. The goals of protecting this areas is to protect the watershed, protect forested riparian corridors, wetlands, and other habitat corridors, and preserve agricultural and forested land (DNR, 2003a).

Specific Restoration Recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.

- Management within Jug Bay Wetlands Sanctuary:
    - Control resident Canada geese to protect and restore wild rice stands
    - Manage for environmental research and education, passive recreation
    - Restore hundreds of acres of wild rice in tidal wetlands (Anne Arundel County DRP, 2004)
    - Establish 300 foot buffers of natural vegetation around streams and nontidal wetlands (Anne Arundel County DRP, 2004)
- Recommendations based on the *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997):
        - Riparian forest: stabilize stream banks.
        - Stream quality: improve spawning ranges.
        - Wetlands and submerged aquatic vegetation: protect and restore.
        - Forest land: enhance contiguous tracts of forest.
    - Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect WSSC and buffers.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected.
- Protect unprotected Rural Legacy Area, starting with properties ranked as high priority.
- Recommendations based on the *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997):
        - Wetlands and submerged aquatic vegetation: protect and restore.
        - Forest land: enhance contiguous tracts of forest.
- Protect tidal wetlands used as reference sites in DNR's wetland vegetative community survey (all within Upper Patuxent Marshes WSSC).
- Protect headwater stream/wetland complexes and a buffer area.

<u>Patuxent River Upper (02131104)</u>

Background

The Patuxent River upper watershed extends from the southwestern tip of Howard County and much of the boundary between eastern Prince George's County and western Anne Arundel County. The watershed contains the mainstem of the Patuxent River. The headwaters of the watershed are a transition area between the Piedmont and Coastal Plain provinces, with portions of underlying rock, gravels, and other unconsolidated sediments. Significant sediment deposition typically occurs in streams in the Piedmont-Coastal Plain transition area (Prestegaard et al., 2000), as the topography flattens and stream flows decrease in velocity. Stream channels and floodplains are also wider in the Coastal Plain than in the upstream Piedmont region. The southern end of the watershed is just north of the tidal limit of the Patuxent River at Queen Anne Bridge Road.

Most of the nutrients in the Upper Patuxent River flow downstream to the lower Patuxent, causing problems there. There are three major wastewater treatment plants within this watershed. Most hydric soils are along the streams and floodplains. Wetlands mostly occur along the waterways (DNR, 2002a).

Based on MDP 2002 GIS land use data, the Anne Arundel County portion of the Patuxent River upper watershed has 9 acres of open water and 22,446 acres of land. The land acres are divided as follows: urban 4,118 acres (18%), agriculture 6,540 acres (29%), forest 11,786 acres (53%), and barren land 1 acres (<1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

Fresh tidal marsh are located along meandering portions along the Patuxent River. It likely took hundreds or thousands of years to create these wetlands. The tidal portion extends from Queen Anne's Bridge in Anne Arundel County to the discharge into the Chesapeake Bay, roughly forty-five miles. The freshwater tidal marsh section runs from Ferry Landing (in Calvert) to Waysons Corner (in Anne Arundel). Between Ferry Point and Cocktown Creek, there is a transition zone with fresh and brackish. South of Cocktown Creek is brackish marsh. It is believed that the Patuxent River was historically wider and deeper, but due to agricultural sedimentation in the 18th and 19th centuries, this open water converted into low marsh and eventually high marsh. It is also believed that common reed has been spreading along the Patuxent River, near Mataponi Creek, due to the heavy sedimentation occurring there. The common reed in the freshwater tidal marshes has replaced the once prevalent stands of wildrice. As of the early 1980s, wildrice was still abundant around Ferry Point and between a mile below MD Rte. 4 and the southern end of Jug Bay (Sipple, 1999).

The Patuxent River was designated as a scenic river by the Maryland General Assembly. The following is a summary from a document entitled *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997). The Patuxent River Commission supports, coordinates, and implements programs, policies, and projects of the Patuxent River. Among the managements plans proposed for the Patuxent River include:

- Establish "a primary management area" delineating the area along the river and its tributaries to identify and manage land from which pollution is most likely to be transported into the river.
    - Prince George's County has established the Patuxent River Management Area, with criteria for stream and wetland buffers within Patuxent watershed.
    - Montgomery County has adopted a master plan for Patuxent River, with guidelines for the protection of steep slopes, wetlands, reservoirs, and other sensitive areas in the Patuxent River watershed.
- Implement a comprehensive watershed management approach to control all sources of pollution and resource degradation.
- Continue restoration, improvement, and protection of the habitat functions of aquatic and terrestrial living resources. These include:

  - Riparian forest: to stabilize stream banks.
  - Stream quality: to improve spawning ranges.
  - Wetlands: protection and restoration.
  - Forest land: to enhance contiguous tracts of forest.
  - Submerged aquatic vegetation and tidal marsh.
- Concentrate new development in and around existing developed areas and population centers while protecting the rural and agricultural landscape.
- Enhance the environmental quality and community design in new and existing communities.
- Develop a sense of stewardship for the Patuxent River and its watershed through increased public education and participation programs.
- Fund and meet the above plans.

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

- Lacustrine unconsolidated bottom: 1 acre
- Palustrine
  - Aquatic bed: 8 acres
  - Emergent: 217 acres
  - Scrub shrub: 200 acres
  - Forested: 4122 acres
  - Unconsolidated bottom: 426 acres
  - Unconsolidated shore: 11 acres
  - Farmed: 45 acres
- Total: 5,030 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 gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131104	-3.57	12.06	0	0.05	8.54

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. For the Anne Arundel County portion they are as follows:

- Use I: water contact recreation and aquatic life; all portions except those described below.
- Use II: shellfish harvesting; All estuarine portions of tributaries except Patuxent River and tributaries above Ferry Landing

Water Quality

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resource 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 nutrient concentrations, poor non-tidal benthic index of biotic integrity (BIBI), poor non-tidal instream habitat index, high percent impervious surface (16%), high population density, and high soil erodibility (0.30). Wetland loss was estimated to be 10,106 acres. Indicators for Category 3 includes a high imperiled aquatic species indicator.

The 2002 305(b) report States that the mainstem river to Rocky Gorge Dam in Howard County meets all designated uses for 23.5 miles. In wadeable tributaries, 23.4 miles met all designated uses while results for 71.7 miles were inconclusive (DNR, 2002b).

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:

- *Patuxent River* (non-tidal); nutrients, sediments
- *Patuxent River Unnamed Tributary* (021311050940 non-tidal in Howard County); poor biological community.
- *Patuxent River Unnamed Tributary* (021311050940 non-tidal in Prince Georges County); poor biological community.
- *Stockett's Run* (021311050930 non-tidal in Anne Arundel County); poor biological community.
- *Honey Branch* (021311050931 non-tidal in Prince Georges County); poor biological community.
- *Horsepen Branch* (021311050937 non-tidal in Prince Georges County); poor biological community.
- *Cash Lake* (impoundment in Prince Georges County); Methylmercury (in fish tissue).

MBSS sampling rated fish communities as very poor to good and benthic communities from very poor to fair. Most of the fish species found are tolerant species, but a few are intolerant. Sites with the lowest scores were in streams with urbanization and poor stream buffers. The lower portion of this river still supports Herring and Shad. Some of the fish species found included American eel, Blacknose dace, Green sunfish, Least Brook Lamprey, Tesselated darter, Rosyside dace, Swallowtail Shiner, and White sucker. The Upper Patuxent River historically provided spawning habitat for Herring, Shad, White perch, and Yellow perch. There is potential to restore these habitats. DNR stocks trout for recreational fishing in Laurel Lake and on the Patuxent River just downstream of H.T. Duckett Dam (DNR, 2002a).

The following information is summarized from the nutrient synoptic survey. Nutrient concentrations and yields were low compared to other State watersheds. Orthophosphate

concentrations were highest in Anne Arundel County, but this was possibly due to high amounts of rain prior to sampling. Most sites within Stocketts Run watershed had excessive concentrations. Orthophosphate yields were generally low. Macroinvertebrate communities rated fair to very poor, with habitat assessment rated as suboptimal. Stream banks erosion and sedimentation within the stream likely led to these low rankings.

Restoration/Preservation

During the Stream Corridor Assessment for the Anne Arundel County portion of this watershed, 50 stream miles were surveyed. From those streams surveyed, they found a total of 166 problems. There was a high amount of erosion (41 sites). While the erosion extended over long distances, most was rated as minor to moderate, with the exception of two sites rated very severe. Another reported problem was poor vegetated buffers (28 sites). Most sites were rates as minor to moderate in severity, with land use being small recently-planted trees or pasture. Other problems included pipe outfalls (21 sites), fish migration barriers (17 sites), channel alteration (12 sites), and addition identified problems.

The WRAS strategy for the Anne Arundel portion of the watershed discusses subwatershed characterization and possible restoration activities. Many of the specific improvement activities include improving stormwater management, reducing sediment load by stabilizing stream banks, implementing BMPs, improving stream buffers, and improving fish passages. Specific wetland-related improvements include:

- Conducting wetland restoration on two hydric soil locations within Cox Branch watershed.
- Possible large-scale restoration on US Military property within Unnamed Tributary to Patuxent (UPS3).
- Possible wetland restoration on agricultural hydric soils in Unnamed Tributary to Patuxent (UPS6).

Main Green Infrastructure hubs are located along Patuxent River, the large expanse of Patuxent Wildlife Research Center, Stocketts Run (DNR, 2000-2003). Some areas of the Green Infrastructure network have gaps in natural vegetation. These gaps may be desirable sites for restoration to natural vegetation. Protected areas include Patuxent Wildlife Research Center, Globe Communications WMA, Patuxent River NRMA, and several County-owned properties. The remaining unprotected waterfront Green Infrastructure hubs should be high priority for preservation. According to a 2000 Maryland Greenways Commission document, existing or proposed greenways include Patuxent Regional Greenway and Washington, Baltimore and Annapolis Trail.

The designated Rural Legacy area within Anne Arundel County is 17,890 acres and is sponsored by Anne Arundel County government. It is located within the watersheds West River, Patuxent River Upper, and Patuxent River Middle and connects with a Rural Legacy area in Prince George's County. This Rural Legacy area (within Anne Arundel County) extends from the confluence of the Rhode River and West River to the Patuxent River. There are currently 7,096 acres of protected land within the Rural Legacy area,

including large areas of permanently protected land (1,900 acres) at the Smithsonian Environmental Research Center (SERC) on the Rhode River, plus another adjacent 100 acres in protective easements held by SERC. The goals of protecting these areas are to protect the watershed, protect forested riparian corridors, wetlands, and other habitat corridors, and preserve agricultural and forested land (DNR, 2003a).

There are two designated Nontidal Wetlands of Special State Concern (WSSC) and one potential WSSC located within the Anne Arundel County portion of this watershed.

- *Patuxent Maple Swamp*. This bottomland forest includes two rare plant species and a rare animal. In addition to providing important habitat, this site provide flood storage. Main threats include changes in hydrology, specifically changes in the essential regular flooding cycles, forest clearing, upstream development, invasion by non-native plant species, and reduced water quality entering the site (McCarthy et al., 1988). This site is only partially protected by Patuxent River Watershed Park.
- *Patuxent Wildlife Research Center*. This large site contains over 3,000 acres of mostly contiguous forest, including a large section of mature forest. It connects with extensive adjacent forests to create one of the largest forest regions within the Washington-Baltimore region. This site contains at least one rare plant species, forest interior dwelling species, and excellent educational/research opportunities. Threats include fragmentation from development or road expansion, forest clearing, changes in water quality or hydrology, and the large deer population (McCarthy et al., 1988). This area is protected by federal land.
- *Potential WSSC*. There is one potential WSSC located within the US Air Force Transmitter Center.

Specific Restoration Recommendations:

- Restore "gaps" in designated Green Infrastructure hub to natural vegetation.
- Implement recommendations based on the *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997):
    - Riparian forest: stabilize stream banks.
    - Stream quality: improve spawning ranges.
    - Wetlands and submerged aquatic vegetation: protect and restore.
    - Forest land: enhance contiguous tracts of forest.
- Implement recommendations based on the Stream Corridor Assessment for the Anne Arundel County portion of this watershed: erosion, poor vegetated buffers, fish migration barriers.
- Recommendations based on the WRAS strategy for the Anne Arundel portion of the watershed: improving stormwater management, reducing sediment load by stabilizing stream banks, implementing BMPs, improving stream buffers, and improving fish passages. Specific wetland-related improvements include:
    - Conducting wetland restoration on two hydric soil locations within Cox Branch watershed.
    - Possible large-scale restoration on US Military property within Unnamed Tributary to Patuxent (UPS3).

    - Possible wetland restoration on agricultural hydric soils in Unnamed Tributary to Patuxent (UPS6).
- Restore wetlands and streams within the headwaters.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along waterways.
- Protect WSSC and buffers.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands that are not already protected.
- Protect unprotected Rural Legacy Area, starting with properties ranked as high priority.
- Implement recommendations based on the *Patuxent River Policy plan: An update for 1984 to 1997* (DNR, 1997):
    - Wetlands and submerged aquatic vegetation: protect and restore.
    - Forest land: enhance contiguous tracts of forest.
- Protect headwater stream/wetland complexes and a buffer area.

<u>Little Patuxent River (02131105)</u>

Background

The Little Patuxent River watershed encompasses over 66,200 acres in Howard and Anne Arundel Counties. Based on MDP 2002 GIS land use data, the Anne Arundel County portion of the Little Patuxent River watershed has 101 acres of open water and 28,120 acres of land. The land acres are divided as follows: urban 11,165 acres (40%), agriculture 2,487 acres (9%), forest 14,214 acres (51%), wetlands 7 acres (<1%) and barren land 247 acres (1%). Since estimates of wetland acreage based on this MDP data are often underestimated, DNR wetland estimates, as presented later in this document, should be used instead.

Channel morphology changes near the boundary of the Piedmont/Coastal Plain physiographic regions. Significant sediment deposition normally occurs in the transition area downstream of the boundary as the material, which had been carried by the higher velocity flows from the Piedmont, settles out since it can no longer be transported by the slower flows of the flatter Coastal Plain province.

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

- Lacustrine unconsolidated bottom: 54 acres
- Palustrine
    - Aquatic bed: 12 acres
    - Emergent: 202 acres
    - Scrub shrub: 158 acres
    - Forested: 2,648 acres
    - Unconsolidated bottom: 345 acres

  - Unconsolidated shore: 13 acres
  - Farmed: 4 acres
- Riverine unconsolidated shore: 3 acres
- Total: 3,439 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 gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts (acres)	Permittee Mitigation (acres)	Programmatic Gains (acres)	Other Gains (acres)	Net Change (acres)
02131105	-23.33	35.52	2.75	0.71	15.65

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. For the Anne Arundel County portion they are as follows:

- Use I: water contact recreation and aquatic life; all portions except those described below.
- Use I-P: water contact recreation and aquatic life, public water supply; Little Patuxent River and all tributaries above Old Forge Bridge (1 mi. south of MD Route 198)

Water Quality

According to the 2002 305(b) report, approximately 93 miles on nontidal, wadeable tributaries failed to support all designated uses, though results for nearly 30 miles of tributaries was inconclusive. Sewerage systems, urban runoff, habitat alteration, hydromodification, and channelization were sources of the pollution to the biological community. Centennial Lake in Howard County also failed to support all uses from nutrients and siltation from nonpoint, upstream, and natural sources (DNR, 2002b).

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resource 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 pristine or sensitive watershed in need of protection. Failing indicators include high phosphorus and nitrogen loadings, poor non-tidal benthic index of biotic integrity (BIBI), poor non-tidal fish index of biotic integrity, poor non-tidal instream habitat index, high percent impervious surface (26%), high population density, high percent unforested stream buffer (40%), and high soil erodibility (0.29). Wetland loss was estimated to be 10,022 acres. Indicators for Category 3 include high imperiled aquatic species indicator and the presence of a drinking water intake.

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:

- *Little Patuxent River* (non-tidal); cadmium, nutrients, sediments.
- *Little Patuxent River* (021311050946 non-tidal in Anne Arundel County); poor biological community.
- *Little Patuxent River* (021311050948 non-tidal); poor biological community.
- *Little Patuxent River* (021311050954 non-tidal in Howard County); poor biological community.
- *Little Patuxent River* (021311050957 non-tidal in Howard County); poor biological community.
- *Unnamed Tributary to Little Patuxent River* (021311050946 non-tidal in Anne Arundel County); poor biological community.
- *Unnamed Tributary to Little Patuxent River* (021311050948 non-tidal); poor biological community.
- *Unnamed Tributary to Little Patuxent River* (021311050954 non-tidal in Howard County); poor biological community.
- *Unnamed Tributary to Little Patuxent River* (021311050957 non-tidal in Howard County); poor biological community.
- *Franklin Branch* (021311050949 non-tidal to Anne Arundel County); sediment.
- *Midway Branch* (021311050949 non-tidal to Anne Arundel County); sediment.
- *Dorsey Branch* (021311050952 non-tidal to Anne Arundel County); poor biological community.
- *Dorsey Branch to Little Patuxent River* (021311050952 non-tidal to Howard County); poor biological community.
- *Unnamed Tributary* to *Plumtree Branch* (021311050956 non-tidal to Howard County); poor biological community.
- *Towsers Branch* (021311050947 non-tidal in Anne Arundel County); poor biological community.

The Little Patuxent River is part of the headwaters for the Patuxent River Basin. Nutrients in the Little Patuxent River system are mostly generated within the watershed and related issues like eutrophication of local lakes may be addressed by local action to control nutrient loads (A minority of the total load is from atmospheric deposition). However, most nutrients in the Little Patuxent River are transported downstream to the Patuxent River estuary before the water flow slows down enough for water quality problems to arise. For example, excessive algae growth in the Patuxent estuary during warm months is caused by high nutrient loads that arise from upstream nutrient sources including the Little Patuxent River.

Fish species and their relative abundance are reflective of the habitat in each section. Fish communities and physical habitat received fair to very poor rankings in Howard County sampling sites in 1997. Scores in Dorsey Run in Anne Arundel County were rated as good in this same sample period. Fish in general were scarce due, most likely, to poor habitat for most species. The species that were common or abundant tend to adapt well to sandy, low gradient streams. Northern hogsuckers and longnose dace are both adapted to

rocky riffle habitat. Both species are found in low abundance because there are few sections like that in the three sites sampled. Longnose dace and hogsuckers could be more common in the fall-line section at Savage where the habitat is suitable for them. Based on observations by DNR Fisheries Service personnel, the main problems affecting fisheries in this watershed are related to urbanization and its associated impacts. Uncontrolled runoff from old developments and excessive runoff from sites that need retrofitting are two problems that generate erosion, destabilize streambanks, and thermally pollute the river. In 2000-2002 MBSS sampling results for five stations in the Anne Arundel County portion of the watershed, all sites received poor scores for the benthic IBI. Three scores for the fish IBI were good, one site received a ranking of fair.

The Little Patuxent River is stocked at Savage Mill Park for a very popular recreational trout fishery. A tributary in Anne Arundel County was identified as a reference stream in 1997 MBSS sampling. In comparison to the more than 1,000 small (12-digit) watersheds identified by DNR in Maryland, several of the 12-digit subwatersheds in Howard County's Little Patuxent watershed ranked as either high (Dorsey Run) or moderately high (Hammond Branch) and the remainder ranked as neutral. The 1999 Stream Corridor Assessment survey identified 66 blockages to fish passage in Howard County.

Restoration/Preservation

Within the Anne Arundel portion of this watershed, there is a large Green Infrastructure hub in the southwest. Some of the Green Infrastructure network contains gaps in natural vegetation (DNR, 2000-2003). These gaps may be desirable areas for restoration to natural vegetation. This area is partially protected by Fort Meade, US Naval Academy Dairy Farm, Odenton Park, Patuxent River Park, and other County-owned properties. There is still a large portion of Green Infrastructure hub between the Little Patuxent River and the Patuxent River that is unprotected. According to a 2000 Maryland Greenways Commission document, existing or proposed greenways include the South Shore Trail and the Washington Baltimore and Annapolis Trail.

The Little Patuxent River WRAS for the Howard County portion identified some of the following concerns and interests (Shanks, 2001):

- Fragmented forest / habitat characterizes the majority of the Little Patuxent watershed. Fragmentation tends to reduce habitat value for some wildlife, limits species diversity, reduces resilience to stresses like disease, etc.
- Most stream segments have stresses related to urban or agricultural land use affecting water quality and aquatic habitat.
- Several small stream headwater areas have local watersheds dominated by forest. These areas may have relatively high quality stream habitat if other stresses such as significant concentrated stormwater flows or intensive human activities are not present.
- Forested headwater stream areas may present opportunities to enhance or expand relatively high quality water and habitat to downstream areas.

There are three Nontidal Wetlands of Special State Concern (WSSC) and a potential WSSC in the Anne Arundel County portion of the watershed:

- *Little Patuxent Oxbow* is in an old meander of the Little Patuxent River and contains a diverse wetland complex of forested wetland, emergent marsh, open water, and seepage areas. A floating mat of vegetation exists over part of the open water portion. Three rare plants, designated as State endangered, threatened, and uncommon, are found in the wetland. They are a parasitic plant, a wildflower, and an insectivorous plant (DNR, 1991). This site is mostly protected by Oxbow Natural Area. This is the largest natural impoundment in the State (Sipple, 1999).
- *Ft. George G. Meade (DNR name: Little Patuxent River)*, consisting of old bottomland and swamp in the floodplains of the Patuxent and Little Patuxent Rivers, is part of one of the largest tracts of forest in central Maryland. All but one of the known forest interior birds known to occur in Maryland are found at this site. As of 1991, the site had not been inventoried for rare plants and animals, but many were found in similar habitats. Historic records also list a rare snake, fish, and insect. The wetlands and upland forest are credited with filtering sediment and other pollutants from surface waters (DNR, 1991). The majority of this site is within Patuxent Wildlife Research Refuge. However, a small portion of the Nontidal Wetland of Special State Concern is located on the Tipton Airport.
- *The Patuxent Community Ponds* consists of two ponds connected by a narrow drainage. The smaller pond was reported as being mowed to its edges in a 1991 report, but the larger pond was surrounded by shrub swamp, forested wetlands, and a diverse herbaceous community. A State rare plant was found at the larger pond (DNR, 1991). DNR has proposed that this site be deleted from the list of WSSC. This site is County parkland.
- There is also a potential WSSC located near the Little Patuxent River, by the Capitol Raceway. It is mostly protected by Patuxent River Park.

A programmatic wetland mitigation site, Little Patuxent Ridge, is located in the watershed in Howard County.

Specific Restoration Recommendations:

- Restore “gaps” in designated Green Infrastructure hub to natural vegetation.
- Remove fish blockages
- Implement recommendations based on the Little Patuxent River WRAS for the Howard County portion:
    - Fragmented forest.
    - Forested headwater stream areas may present opportunities to enhance or expand relatively high quality water and habitat to downstream areas.

Specific Preservation Recommendations:

- Protect portions of Green Infrastructure that are not currently protected, especially along the Little Patuxent River and the large Green Infrastructure hub.
- Protect WSSC and expanded buffers.
- Protect additional DNR-designated Ecologically Significant Areas containing wetlands.

- Protect streams with rare fish and mussels.
- Protect headwater stream/wetland complexes and a buffer area.