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Background

In 2004, MDE completed a project for the 6-digit Coastal Bays watershed, which covers the eastern portion of Worcester County. Since this current document is meant to be a consolidated project covering the entire State, we wanted to include relevant information from that 2004 Coastal Bays document. To save time, we inserted large portions of the Coastal Bays document into this one. A lot of research has been done in the Coastal Bays watershed, so there is often more information on that area than for the Pocomoke watershed portion of Worcester County. While this document does include much information about the Coastal Bays, for more detailed information, the audience is encouraged to read the 2004 Coastal Bays document (MDE, 2004a).

This region's economy is largely agriculture (poultry, crops, and some hogs) and tourism (especially around Ocean City) (USACE, 1998). Ecotourism is becoming increasingly popular (Wilson, 2002).

Of the Worcester County land use, over half is forest (53%), a third agriculture (33%), and smaller amount of development (7%), wetland (6%) and barren land (1%) (based on MDP 2002 land use GIS data). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR.

The Coastal Bays watershed in the eastern portion of the County supports one of Maryland's most diverse ecosystems. Maryland's Coastal Bays include five bays and their corresponding watersheds: Assawoman, Isle of Wight, Newport, Sinepuxent, and Chincoteague. These bays are enclosed by the barrier islands, Fenwick and Assateague, with ocean water entering the bays through two inlets: the Ocean City inlet and the Chincoteague inlet in Virginia. The Maryland portion of these watersheds contain 111,810 acres of land and 65,680 acres of open water. There are addition smaller amounts in Delaware and Virginia (USACE, 1998).

Unconfined wells in the region have some contamination from nitrate and volatile organic compounds (from leaking underground fuel tanks and gas stations). Wellhead protection areas around the wells are currently being designated by MDE, and should be used for future land use management. Wellhead protection areas are being delineated for the Coastal Bays region, and have been completed for Ocean Pines, Berlin, and Briddle. Reported contaminants to the wells are not a serious problem at this time, but do include iron, nitrogen, volatile organic compounds (VOCs), and some salt-water intrusion.

There are two State-designated 6-digit watersheds and nine 8-digit watersheds: Coastal Area (021301) includes Assawoman Bay (02130102), Isle of Wight Bay (02130103), Sinepuxent Bay (02130104), Newport Bay (02130105) and Chincoteague Bay (02130106); Pocomoke River (021302) includes Lower Pocomoke River (02130202), Upper Pocomoke River (02130203), Dividing Creek (02130204) and Nassawango Creek (02130205).

Streams

The following information is based on the Maryland Tributary Strategies 2004 document entitled *Maryland's Lower Eastern Shore*: Maryland's Lower Eastern Shore basin includes areas in Wicomico, Caroline, Somerset, Worcester, and Dorchester Counties and the waterways Pocomoke, Wicomico, Nanticoke and Big Annemessex Rivers, Fishing Bay, Pocomoke and Tangier Sounds. Land cover is 61% forest/wetlands and 32%

agriculture. About 60% of the houses are on septic. Point sources are not a major source of pollution. In 2002, sources of nitrogen, phosphorus, and sediments were from agriculture (60%, 58%, 70% respectively). Based on water quality sampling, nitrogen was good or fair in the southern portion and poor in Wicomico and Nanticoke Rivers. Phosphorus was good or fair throughout. Total suspended solids (TSS) was poor in the majority of the area, with only three sampling having fair or good TSS (South Tangier Sound, Big Annemessex River, and Pocomoke River). All areas were below the SAV restoration goal. Benthic communities were generally good, with the best communities located in Nanticoke and Wicomico Rivers. Degraded communities were likely impacted by high sedimentation. This document describes the success of implementing BMPs like this:

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

The 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* described Coastal Bay streams as follows:

> The streams in the Coastal Bays are mainly shallow and slow moving, with headwater streams often having been ditched. Based on 1901 USGS quad maps (Maptech, Inc., 2003) and Tiner et al., (2000), the majority of streams in the watershed have been physically altered, especially in the headwaters of the northern Coastal Bays watershed. Estimates from Tiner et al. (2000) suggest there are 448.7 miles of ditches, 166.2 miles of channelized streams, and 19.9 miles of natural streams. Public Drainage Associations (PDAs) manage and maintain artificial drainage systems for agriculture using landowner tax money. These PDAs manage 71.8 stream miles in the Coastal Bays, within the watersheds of Isle of Wight Bay and Newport Bay. The majority of these drainage systems are sprayed with herbicide and mowed on a regular basis to maintain water flow. A frequently encountered environmental concern is the lack of riparian buffers for a large portion of the stream miles. According to 1994 Maryland Department of Planning data, this problem is most common in the watersheds of Assawoman Bay, Sinepuxent Bay, and Isle of Wight Bay. Stream erosion is only a minor concern due to the flat topography and slow stream velocities.

Wetlands

<u>Wetland classifications</u>

According to Tiner and Burke (1995), in 1981-1982 there were 59,486 acres of wetlands (9.9% of the State's total). The wetland types were Estuarine (18,954 acres), Palustrine (39,603 acres), and Riverine (198 acres). Comparisons of this 1981-1982 wetland acreage with historic wetland acreage (based on hydric soils) represents a 68%, or 127,264 acre, loss (MDE, 2002a). This is the highest loss of wetland acreage in the State.

A 1994 report from the U.S. Fish and Wildlife Service (Tiner and Foulis) estimated wetland trends in part of Worcester and surrounding Counties for the period from 1982 to 1988-89. The study area was the U.S. Geological Survey quadrangles for Princess Anne (Somerset), Salisbury (Somerset and Wicomico Counties) Wango (Wicomico and Worcester Counties) Delmar (Wicomico) and Pittsville (Wicomico County). There were over 187 acres of vegetated wetlands, primarily palustrine forested wetlands, that were converted to upland. Conversion to agricultural land and ditching were the primary causes. There were over 2700 acres of wetlands were converted to another wetland type, with most changes due to silvicultural practices to establish plantations for Loblolly pine (*Pinus taeda).* Other changes resulted from forested wetland timber harvest, with the succeeding wetland types being scrub-shrub or emergent wetlands. The water regime was also altered in some wetlands.

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

- Marine wetlands (excluding deepwater habitat) are along the intertidal beaches of the Atlantic Ocean.
- Estuarine wetlands can be salt or brackish tidal wetlands. Vegetation is largely dependent upon salinity and hydrology, with plant diversity increasing with decreased salinity and decreased flooding. They can be classified into five groups:
    - Estuarine intertidal flats are mud or sand shores that are exposed twice a day (at low tide) or less. These areas have sparse macrophytic vegetation.
    - Estuarine emergent wetlands have vegetation composition that is strongly influenced by salinity level and duration/frequency of inundation.
        - Salt marshes are closest to the ocean and occur in the Coastal Bays of Maryland. There are two general types of salt marshes, regularly flooded low marsh (often dominated by smooth cordgrass-tall form) and irregularly flooded high marsh (often dominated by salt hay grass, salt grass, and smooth cordgrass – short form). Plant diversity is generally low.
        - Brackish marshes are the most common type of Maryland Estuarine wetland, found along the Chesapeake Bay and tidal rivers. Low brackish marsh is often dominated by smooth cordgrass-tall form and water hemp while the high brackish marsh is often dominated by salt hay grass, salt grass, black needlerush, smooth cordgrass-short form, Olney three-square, switchgrass, common three-square, big cordgrass, common reed, salt marsh bulrush, seaside goldenrod, rose mallow, and narrow-leaved cattail.

        - Oligohaline marshes are only slightly saline and are located in the upper tidal rivers. Low oligohaline marshes are often dominated by arrow arum, pickerelweed, spatterdock, wild rice, soft-stemmed bulrush, narrow-leaved cattail, water hemp, and common three-square while high oligohaline marshes are often dominated by big cordgrass, common reed, narrow-leaved cattail, wild rice, broad-leaved cattail, and sweet flag.
    - Estuarine scrub-shrub swamps are often dominated by high-tide bush and groundsel bush.
    - Estuarine forested swamps are often dominated by loblolly pine. Due to sea level rise bringing in more salinity, some of these systems are being converted into salt marshes.
    - Estuarine Aquatic beds generally contain submerged aquatic vegetation, including eelgrass and widgeongrass in high salinity areas and widgeongrass and other species in lower salinity areas.
- Palustrine wetlands can be classified into four major groups depending on the dominant vegetation type: forested, scrub-shrub, emergent, and aquatic. These wetlands were described for the Maryland Coastal Plain Province.
    - Palustrine forested wetlands are the dominant palustrine wetland type on the Coastal Plain and are located in floodplains, depressions, and drainage divides. They can be classified into four main groups:
        - Tidally flooded wetlands are freshwater wetlands that are tidally influenced. Common tree species may include red maple, green ash, black willow and black gum.
        - Semipermanently flooded wetlands are nontidal wetlands that are flooded for much of the growing season. These are uncommon in Maryland. Some examples, dominated by bald cypress, are along Battle Creek and the Pocomoke River. Higher elevations may be dominated by red maple, black gum, sweet bay, swamp black gum, fringe tree, ironwood, and swamp cottonwood.
        - Seasonally flooded wetlands are nontidal wetlands that are flooded for generally longer than two weeks during the growing season. Some of the more common tree dominants include red maple, sweet gum, pin oak, willow oak, loblolly pine, or swamp chestnut oak. There is often a thick shrub understory. Atlantic white cedar swamps may have been located historically in Worcester County (Lower Pocomoke River) (Dill et al., 1987). Few Atlantic white cedar swamps remain in Maryland since most have been converted to hardwood swamp.
        - Temporarily flooded wetlands are nontidal wetlands that are flooded the least of the four types, about a week. Seasonally saturated wetlands, wetlands having a high water table during the cooler months, are also included in this category. Some of these areas are managed for loblolly pine harvesting. Other tree dominants include red maple, sweet gum, black gum, willow oak,

water oak, basket oak, swamp white oak, southern red oak, sycamore, black willow, American holly, sweet bay.

- Scrub-Shrub wetlands are less common than forested wetlands on the Coastal Plain. They are often dominated by buttonbush (in the wetter systems), silky dogwood, arrowwood, alder and tree saplings.
- Emergent wetlands are very diverse in the Coastal Plain region due to the occurrence of both tidal and nontidal wetlands. They can be categorized into several different types:
    - Tidal fresh marshes occur along the large coastal waterways, between the brackish marshes and tidal freshwater swamps. It is speculated that in addition to tidal flooding, temporary periods of salt water in these areas may discourage woody succession. These freshwater wetlands are often more diverse than wetlands with higher salinity levels. Vegetative dominance changes seasonally. There is often a distinct vegetative zonation pattern based on elevation. Some common dominance types according to McCormick and Somes (1982) are arrowheads, big cordgrass, bulrushes, bur-marigold, cattails, common reed, giant ragweed, golden club, pickerelweed/arrow arum, purple loosestrife, reed canary grass, rose mallow, and smartweed/rice cutgrass
    - Interdunal wet swales have a very high water table, allowing hydrophytic plants to grow adjacent to dunes having xeric plant species. These sites are often dominated by common three-square, salt hay grass, and rabbit-foot grass.
    - Semipermanently flooded marshes are often dominated by cattail, spatterdock, arrow arum, water willow, and bur-reeds.
    - Seasonally flooded marshes include isolated depressional wetlands called "potholes" or "Delmarva Bays" (mostly in Caroline, Kent, and Queen Anne's)
    - Temporarily flooded wet meadows include areas recently timber harvested that will soon revert back to woody vegetation.
- Aquatic beds include small ponds with vegetation on the bottom and/or surface. These are the wettest of the Palustrine types.

- Riverine wetlands are found within the channel and include nonpersistent vegetation.
- Lacustrine wetlands are associated with deepwater habitat (e.g. freshwater lakes, deep ponds, and reservoirs). They can be classified into lacustrine aquatic beds (wetlands are located in the shallow water) and lacustrine emergent wetlands (wetlands are located along the shoreline).

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

Tidal wetland acreage was also estimated in *The Coastal Wetlands of Maryland* (Table 1). Worcester County had 21,289 acres of vegetated tidally-influenced wetlands (excluding SAV), mainly wooded swamp and saline high and low marsh. There was also a fair amount of brackish and tidal fresh marsh, and a smaller amount of shrub swamp.

Due to the higher stress associated with higher salinity levels, saline marsh often has very low species richness and species diversity, lower than brackish or fresh marsh. Saline marsh may also have quite distinct plant zonation patterns. Wooded swamp vegetation is often found in the upper tidal reaches and may form a continuum with nontidal swamp. Tidal forest swamp may contain abundant hummocks and often has smaller trees than found in nontidal forest swamp.

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

Major Vegetation Type	Vegetation Type	Acreage
Shrub Swamp *(Fresh)*	Swamp rose	0
	Smooth alder/Black willow	0
	Red maple/Ash	41
Swamp forest *(fresh except pine, which is often brackish)*	Bald cypress	3,595
	Red maple/Ash	2,400
	Loblolly pine	4
Fresh marsh	Smartweed/Rice cutgrass	407
	Spatterdock	143
	Pickerelweed/Arrow arum	38
	Sweetflag	0
	Cattail	103
	Rosemallow	80
	Wildrice	3
	Bulrush	0
	Big cordgrass	177
	Common reed	0
Brackish High Marsh	Meadow cordgrass/Spikegrass	18
	Marshelder/Groundselbush	55
	Needlerush	0
	Cattail	46
	Rosemallow	2
	Switchgrass	28
	Threesquare	348
	Big cordgrass	0
	Common reed	26
Brackish Low Marsh	Smooth cordgrass	26
Saline High Marsh	Meadow cordgrass/Spikegrass	2,304
	Marshelder/Groundselbush	1,780
	Needlerush	121
Saline Low Marsh	Smooth cordgrass, tall growth form	95
	Smooth cordgrass, short growth form	9,449
Submerged Aquatic Vegetation	Submerged aquatic plants	1,590

The following is from the 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays*:

Tidal Wetlands

Sipple (1999) presents a description of the tidal marshes and their formation in the Coastal Bays. Tidal wetland marshes in the Coastal Bays differ geomorphologically from tidal wetlands in Chesapeake Bay. Coastal Bays wetlands were formed as the rate of sediment accretion surpassed that of sea level rise, and where tidal and storm derived sediments were deposited behind barrier islands. In contrast, tidal marshes in Chesapeake Bay were formed by more recent deposits of sediment in stream channels and estuarine meanders or sea level inundation of uplands. The tidal marshes also differ geomorphologically within the Coastal Bays, between the wetlands adjacent to the mainland, and those wetlands on the west side of the barrier islands. The wetlands on the barrier islands have alternating layers of sand and peat, caused by the movement of the islands to "roll back and over" the back barrier environments (Sipple, 1999). Since neither flood-tidal inlet deposits nor overwash deposits occur anymore around the Fenwick barrier, marsh on the bayside of the barrier is no longer being created (Spaur, 2004). Historically, sediments would also accumulate in shallow lagoons behind the islands, allowing invasion of cordgrass (Sipple, 1999). However, according to (Spaur, 2004), the low tidal range in the Maryland portion of the coastal bays does not allow enough sediment accumulation for marsh development (although some have formed this way in Virginia). These marshes on the bay-side of the barriers are still eroding though (Spaur, 2004). On the mainland, the marshes are eroding on their eastern fronts, particularly from storms that occur during low tides (Sipple, 1999). The wetlands here are on deeper sediments, and are generally higher and older marshes. Only parts of these wetlands are flooded by daily tides, by an elaborate dendritic structure of tidal guts. On the upland side of the mainland tidal marshes, the wetland vegetation is encroaching due to sea level rise (Sipple, 1999).

Tiner and Burke (1995) describes the Coastal Bays tidal wetlands as gradually grading into tidal fresh marshes, then to palustrine forested wetlands, or areas that end abruptly at the upland. Spaur (2004) suggests that since there is only a small amount of freshwater marsh (as shown in McCormick and Somes, 1982), there is often a distinct break between brackish tidal wetland and nontidal wetland. Depressions within the high marsh are known as "salt pans," where salt water collects after high tides. Evaporation of water subsequently results in salt accumulation in the soil, which can be so extreme that at times no plant life survives. At other times, vegetation may be abundant. This pan may revert to a freshwater system after heavy rains.

Based on Coastal Wetlands of Maryland, the majority of tidal wetlands were classified as saline high marsh or saline low marshes (McCormick and Somes, 1982). These areas typically have low plant species diversity due largely to the high salinity levels, except at the high marsh to the upland border where effects of salinity are diminished. Saline high marshes are dominated by Meadow cordgrass (Spartina patens) and/or Spikegrass (Distichlis spicata), Marshelder/Groundselbush (Iva frutescens/Baccharis hamifolia) and Needlerush (Juncus roemerianus). Saline low marshes are dominated by Smooth cordgrass (Spartina alterniflora) in its tall or short growth forms. These tidal wetlands have the highest salinities of any tidal wetlands in Maryland.

There has been some encroachment from *Phragmites* in the Coastal Bays tidal wetlands, but it has not been extensive (Dawson, pers. comm.).

<u>Nontidal Wetlands</u>

The Maryland State Highway Administration (1998) compiled a recent list of wetland vegetation from fieldwork within the US 113 study corridor. Most nontidal wetlands in the Coastal Bays watershed are forested, and primarily associated with floodplains along stream channels. Other wetlands were found on broad upland flats and depressions with poor drainage. Most of the wetlands on the flats were in the northern Coastal Bays watersheds, and have been altered by logging and farming activities. The water table in many areas has been lowered by extensive ditching. The Worcester Soil Conservation District has restored the hydrology in numerous ditched forested wetlands (mainly in Southern Coastal Bays) with support from the USDA Wetlands Reserve Program.

Dominant tree species include Red maple (*Acer rubrum),* Sweetgum *(Liquidambar styraciflua),* and Black gum *(Nyssa sylvatica).* Other common trees in the canopy include Green ash *(Fraxinus pennsylvanica),* Loblolly pine *(Pinus taeda)* and Willow oak *(Quercus phellos)*. Common understory shrubs included Spicebush *(Lindera benzoin),* Arrowwood *(Viburnum dentatum),* American holly *(Ilex opaca),* Sweet pepperbush *(Clethra alnifolia)*, and Sweetbay *(Magnolia virginia).* A State-designated rare species, Seaside alder, *(Alnus maritima)* is found in at least one wetland.

Limited areas of bald cypress swamp still occur in the Coastal Bays watershed, including Church Branch cypress swamp (USACE, 1998) and others (Dennis, 1986). It is speculated that cypress swamp was historically located in the Maryland Coastal Bays watershed portion, adjacent to the Great Cypress Swamp on the Maryland/Delaware border. Based on presence of Atlantic white cedar in other similar coastal lagoon systems, it is highly likely that this species was historically located in the Coastal Bays watershed (Spaur et al., 2001).

The formation and maintenance of the Ocean City Inlet resulted in higher salinity inside the bays and the conversion of some fresh water and low-salinity forested tidal wetlands to salt marsh. The estuaries affect over half the wetlands in this region, from salt and brackish wetlands to tidal freshwater wetlands (Tiner et al., 2000). Most tidal areas are brackish and include salt marshes, brackish marshes, and scrub-shrub wetlands.

Specific wetland functional assessments for the Coastal Bays watershed

Tiner et al. (2000) identified Coastal Bay wetlands using the wetlands identified in the National Wetland Inventory (NWI), 1998 1:40,000 black and white aerial photography, State digital wetland maps (1989 photography), digital submerged aquatic vegetation data, and Natural Resource Conservation Service digital hydric soil data. They also conducted some field verification.

In this Tiner et al. (2000) document, they acknowledge that palustrine forested wetlands may be overestimated due to difficultly in distinguishing between forests that are currently wetlands and ones that were drained but still have hydric soils.

Tiner et al. (2000) classified these Coastal Bay wetlands into five HGM types based on landscape position, or their relationship to an adjacent waterbody: marine, estuarine, lotic (adjacent to freshwater streams and rivers), lenthic (associated with lakes), and terrene (isolated or headwater). The majority of non-tidal wetlands were classified as terrene. These wetland types were subdivided based on landform and water flow path.

The ability of each wetland classification to perform a particular function was estimated in the process “Watershed-based Preliminary Assessment of Wetland Function” (Tiner et al. (2000). This process is described in the document entitled *Correlating Enhanced National Wetlands Inventory Data with Wetland Functions for Watershed Assessments: A Rationale for Northeastern U.S. Wetlands* (Tiner 2003b). Evaluated functions include: surface water detention, streamflow maintenance, nutrient transformation, sediment and particulate retention, coastal storm surge detention and shoreline stabilization, inland shoreline stabilization, fish and shellfish habitat, waterfowl and waterbird habitat, other wildlife habitat, and conservation of biodiversity. This analysis found that each Coastal Bays watershed provided different functions (results shown in individual watershed sections). This assessment did not factor in wetland disturbance, actual ecosystem health, or difference between two wetlands of similar classification.

The 1984 document entitled *Uncommon Wetlands in the Coastal Plain of Maryland* (Sipple and Klocker, 1984) lists the 14,435-acre Pocomoke Swamp as being an uncommon wetland type. This wetland contains cypress swamp, shrub swamp, and marsh and is important due to its large size, unusual vegetation type, rare plants, and high overall diversity.

General Wetland Functions

Stormwater and Flood Control

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

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

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

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

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

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

Groundwater Recharge and Discharge

Functions

Wetlands facilitate the flow of water between the ground water system and surface water system. Wetlands periodically perform different functions, depending on the gradient of the groundwater table and the topography of the land surface. The relationship of the groundwater table and the land surface dictates which function - groundwater recharge or discharge - a wetland performs.

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

Values

Ground water discharge helps maintain a wetland's water balance and water chemistry. This wetland function is also critical to the formation of hydric soils and the maintenance of ecosystem habitats in different types of wetlands.

Ground water recharge is the primary mechanism for aquifer replenishment which ensures future sources of groundwater for commercial and residential use.

Modification of Water Quality

Water Quality Improvement

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

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

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

Nutrient Cycling: Addition, Removal and Transformation

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

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

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

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

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

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

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

Toxics Retention

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

Sediment Reduction

Wetlands along rivers, streams and coastal areas are important for removing sediment from surface and tidal waters. During large flood events, rivers frequently overtop their banks and water flows through adjacent floodplains and wetlands. Flood waters carry large volumes of suspended sediment, mostly fine sand, silt and clay. Because floodplains and wetlands provide resistance to flow - from dense vegetation, microtopography, and woody debris - the flow of water is slowed and sediment is deposited and stored in these areas. Similarly, coastal marshes and estuaries retain sediment brought in by tides and residual suspended sediment from rivers.

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

Wildlife Habitat/Biodiversity

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

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

<u>General Restoration Considerations</u>

Hydric soils suggest where wetlands are currently or were historically. Since the majority of the County is hydric soil, most areas that are not currently wetlands still have hydric soils (based on NRCS SSURGO GIS data and NWI/DNR wetlands). These soils are classified as “poorly drained” and “very poorly drained.” Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

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

As would be expected, there is a high amount of prior converted wetland now in agricultural use. Public Drainage Association ditches and artificial drainage are important for the local economy, since the soil is generally too wet to farm without drainage. Wetland restoration/mitigation is possible along PDA ditches, but it should not alter upstream agricultural drainage. To restore the hydrology, the wetland drains can be plugged (on-line) or the wetland can be built adjacent to the ditch (off-line) using a low-level berm around the wetland (Nichols, pers. comm.). Off-line wetlands are connected through the ditches by an outlet rather than having the wetland encompass the ditch. Since on-line wetlands have a larger watershed, and therefore the potential to provide higher water quality function, ideal sites would be on-line. On-line wetlands are also generally less expensive to be built. Plugging drains (on-line) may be desirable at the top of the artificial drainage system or where these wetlands will not negatively impact upstream agriculture. In instances where there is a perceived or real threat that upstream drainage will be reduced by on-line wetland restoration, off-line wetlands can be built. Water entering the wetland is primarily from stream/ditch overflow during high flow periods and from groundwater.

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

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

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

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.

Wetlands in the Coastal Bays Watershed

The Comprehensive Conservation and Management Plan (CCMP) notes that approximately 1,500 acres of tidal wetlands and 25,000 acres of non-tidal wetlands have been lost in the Coastal Bays watershed since the 1930's (MCBP, 1999). Bulkheads installed for stabilization led to some loss of tidal wetlands. These wetland losses also resulted in habitat loss and reduction in nutrient and sediment filtration.

There is concern that mitigation to replace wetlands that are being lost within the Coastal Bays watershed has been inadequate. To address this issue, a study was completed in 2004 evaluating current wetland management within the Coastal Bays watershed (Stribling, 2004). Since the Coastal Bays watershed is a priority for wetland restoration and preservation, MDE completed the document *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* in 2004.

Sensitive Resources

Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays
This Maryland Department of the Environment document (MDE, 2004a) summarizes relevant existing literature and management plans for the coastal bays watershed and makes additional recommendations for types and locations of wetland restoration, preservation, and mitigation in the watershed based on the background information and a GIS analysis. Large portions of this Coastal Bays document is included within this current document. This document summarized existing management plan goals as follows:

> *Comprehensive Plan*
> The Comprehensive Development Plan for Worcester County (Worcester County, 1989) discusses the importance of preserving agricultural land, coastal resources, and forest. It also recommends reducing pollution to the bays from point and non-point sources. In this plan, the region is divided into three categories: Coastal, Upland, and Agriculture. "Coastal" is within 250 feet of tidal waters or tidal wetlands, "uplands" is upland area not being used for agriculture, and "agriculture" is upland area where agriculture is present. The distinction between uplands without agriculture and uplands with agriculture is important since preserving agriculture, even at the expense of other natural resources, is a goal of the County. Using these three categories, the plan outlines protection objectives for each. The protection goal for coastal wetlands is to protect 100% of the tidal wetlands and 50% of the non-tidal wetlands. The protection goal for non-tidal wetlands is to protect 100% in uplands and 30% in agriculture. For the buffer, the goal is to protect 100% in coastal areas, 50% in uplands and 25% in agriculture. Protecting and restoring forested land in the coastal areas and drainageways, and protecting areas of high erosion hazard, bays, beaches, bluffs, and floodplains is also important. The plan suggests maintaining areas of high recreational value. Areas zoned as "Rural Estate" have limited subdivision potential. Therefore, these "Rural Estate" areas may be good locations to target restoration, mitigation, or preservation.
>
> A supplement to this plan was established in 1997. This included the requirement of the 1992 Planning Act to address strategies to protect sensitive areas. These sensitive areas and the protection plans are as follows:
>
> - *Habitats of threatened and endangered species*. Protect these areas and discourage development nearby.
> - *Stream corridors*. Protect sensitive stream sections and their associated buffers. The Soil Conservation District is encouraging grassed buffers

along small agricultural ditches and 10-foot herbaceous plants and shrubs along larger agricultural ditches.

- *Steep slopes, over 15%*. These slopes comprise only 0.3% of the County. Forested areas on steep slopes should be protected.
- *100-year floodplains*. These areas are often highly developed, especially in the coastal area. Protect forest within the 100-year floodplain. Discourage development in the 100-year floodplain, and instead encourage open areas, including recreational and natural areas.
- *Wetlands, Forests, and Coastal Bays*. Protect, restore, and create wetlands. Protect forest, including within the Rural Legacy areas. Restore or create forests, especially in the northern Coastal Bays.

The Comprehensive Conservation and Management Plan for Maryland's Coastal Bays (MCBP, 1999).
This document provides guidelines to preserving and restoring the valuable resources in the Coastal Bays. Many goals were outlined in this document including for water quality, fish, wildlife, recreation, navigation, and community and economic development. Goals relating to the present wetland prioritization project are summarized below:

- Decrease nutrient, sediment and chemical inputs from developed land, agriculture, stormwater runoff, and point sources.
- Increase fish and shellfish, enhance forest habitat and wetlands, protect threatened and endangered species, and control invasive species.
- Enhance water recreation and access.
- Educate the public.

Suggested actions to achieve these goals include:

- To reduce nutrients from stormwater runoff (Goal WQ #2)
  - Increase residential buffers to reduce runoff from lawns.
  - Preserve wetlands and their buffers in riparian areas to decrease stormwater nutrient runoff.
  - Build new/retrofit storm water management facilities, which may include the use of wetland treatment.
- Reduce nutrients from agriculture (Goal WQ #4)
  - Encourage adoption of nutrient management strategies
  - Investigate new agricultural ditch management for water quality improvements (currently being used in Delaware).
- Reduce sediment inputs (Goal WQ #6)
  - Encourage soft protection of shoreline along eroding shores.
  - Establish shoreline buffers of wetlands, riparian buffers, and shore grasses to protect the shoreline, focusing on property owners experiencing severe erosion.
  - Restore shoreline marshes.
  - Encourage stream restoration to reduce shoreline erosion.
  - Reduce development in shoreline areas that are highly erodible.
- Increase fish and shellfish (Goal FW #1)

- Protect bay beaches and other horseshoe crab habitat.
- Improve habitat for fish and shellfish.
- Retrofit drainage into dead-end canals and interconnect canals with 8 ft. diameter pipes.
- Promote and protect natural shoreline and adjacent areas.

- Improve forest habitat (Goal FW #2)
  - Protect migration and breeding habitat of neotropical songbirds.
  - Protect large tracts of hardwood/mixed forest and forests adjacent to streams and wetlands.
  - Mitigate forest loss in areas where forest was impacted.
  - Encourage habitat development in agricultural land by creating buffers and grasslands.
  - Restore riparian areas and wetlands on agricultural land.
- Protect and restore wetlands (Goal FW #3)
  - Focus wetland restoration/creation in areas of high historic losses and target types and functions lost.
  - Preserve wetlands.
  - Create wetlands to provide wastewater treatment, sediment retention, stormwater management, and wildlife habitat.
  - Protect, enhance, and restore bird habitat.
  - Educate and poll landowners to determine possible mitigation/restoration locations.
- Protect threatened/endangered species (Goal FW #4)
  - Protect habitat of threatened and endangered species and adjacent habitats.
  - Create and restore potential habitat for threatened and endangered species if feasible.
- Reduce negative impacts from recreational activities (Goal RN #3)
  - Protect sensitive areas from negative impacts of water-based recreation.
  - Create sensitive habitat in areas where disturbance by water-based recreation is not a threat.
- Improve water recreation and water access (Goal RN #5)
  - Encourage passive recreation and access in the floodplains and near Chincoteague Bay, E.A. Vaughn Wildlife Management Area, and other protected sites.
  - Develop greenways between developments and recreation areas.

Maryland Coastal and Estuarine Land Conservation Plan DRAFT
This Maryland Department of Natural Resources draft document (DNR, 2004 Draft) discusses land preservation at a general scale for the coastal zone Counties (16 out of the 23 Counties). In this plan, they suggest focusing preservation efforts on areas within the State-designated Green Infrastructure network or Ecologically Significant Areas. Qualifying properties would then be "evaluated on their relationships to the GI/Ecologically Significant Areas, the ecologic or ESA importance of the

property, as well as other factors relevant to habitat, water quality, and safeguarding environmental research." The final step in reviewing potential properties would be to assess management options and how the site relates to other plans.

NRCS wetland restoration
This document would not be complete if it did not mention the local wetland restoration efforts conducted by the NRCS. The following information is based on discussions with Bruce Nichols from NRCS. This restoration is not a targeting effort but is instead based on opportunity. Generally, after an interested landowner contacts NRCS, NRCS looks at maps, aerial photos, and conducts site visits to determine for which program they qualify (e.g. CREP, CRP, WRP). NRCS is generally looking for characteristics that indicate if the site can easily become a wetland. This includes a broad interpretation of the conditions present. The soil must be such that it will provide hydrology necessary to establish a wetland (e.g., fine-textured sediment present at least in the subsoil or very high water table). They do a mixture of restoration techniques, including plugging ditches and excavating to create a berm. Sites are chosen on hydric soils (with a few exceptions), since they are so extensive in the area. Many successful projects have been completed through this program on agricultural fields and drained forest. Some projects have even resulted in habitat for uncommon species. They allow and even encourage responsible timber harvesting within restored wetlands because by making the wetlands economically important, the program will be more successful. This economic importance of wetlands may also be possible through certain types of aquaculture. Estimated acreage of wetland restoration completed through this program and other programs (both voluntary and programmatic) is included in the background (Wetlands section). The majority of wetland restoration through this program is located in Chincoteague Bay watershed.

Other Relevant Programs

Green Infrastructure and Greenways
Green Infrastructure network covers much of this County, with the largest hubs being located along the Pocomoke River State Forest and along Assateague Island. Areas within the GI network that are currently unprotected should be protected. There are small areas designated as vegetated Green Infrastructure corridors. There are also small sections of Green Infrastructure considered to be "gaps," currently in development, agriculture, or barren land, within these corridors. It is desirable to restore these areas back to natural vegetation, as they can provide a wildlife corridor, a protective buffer, and may be especially important along the waterways. For more detailed information, refer to section on the individual watershed.

Ecologically Significant Areas

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

Natural Heritage Areas

There are State-designated Natural Heritage Areas (NHA) located in watersheds Sinepuxent Bay, Lower Pocomoke River, and Nassawango Creek. 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.

Priority Funding Areas

While there are Priority Funding Areas throughout the County, most are located in the northern portion of the County (e.g. Berlin, Ocean Pines, Ocean City, the East side of Herring Creek, along Rte. 113). Some of the other PFAs include Pocomoke City and Snow Hill.

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.

Rural Legacy

Designated rural legacy land is located in the southern portion of the County. For detailed information about the program, refer to the individual watershed sections (Chincoteague Bay and Lower Pocomoke River watersheds).

Agricultural Easements

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

Watershed Information

Assawoman Bay (02130102)

Background

Based on MDP 2002 GIS land use data, the Assawoman Bay watershed has 5,876 acres of open water and 6,849 acres of land. The land acres are divided as follows: urban 1,930 acres (28%), agriculture 1,607 acres (23%), forest 1,713 acres (25%), wetlands 1,467 acres (21%) and barren land 131 acres (2%). 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.

Some of the Maryland portion of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data). In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas are classified as “prime farmland when drained.” While it may not be desirable to exclude all soils classified as “prime farmland when drained” from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

The streams are mainly shallow and slow moving, with headwater streams often having been ditched. A frequently encountered environmental concern is the lack of riparian buffers for a large portion of stream miles. According to 1994 Maryland Department of Planning data, within the Coastal Bay watershed, this problem is most common in the watersheds of Assawoman Bay, Sinepuxent Bay, and Isle of Wight Bay.

The largest mapped wetlands (based on DNR and NWI GIS data) are located along the major waterways and around the Bay itself. Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
    - Emergent: 1,435 acres
    - Scrub shrub: 23 acres
    - Forested: 9 acres
    - Unconsolidated shore: 939 acres
- Marine unconsolidated shore: 21 acres
- Palustrine
    - Emergent: 10 acre
    - Scrub shrub: 1 acre
    - Forested: 249 acres
    - Unconsolidated bottom: 41 acres

  - Farmed: 20 acres
- Total: 2,747 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains (Table 2).

The 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* discusses wetland gains/losses, water quality, and restoration in the Coastal Bays watershed. Some of the following paragraphs are from that document. Gains and losses for Assawoman Bay watershed (Table 2), as tracked by MDE. "Permanent impacts" includes permanent wetland losses that required a MDE permit. "Permittee mitigation" includes compensatory mitigation of wetland restoration or creation completed by the permittee, as required under their wetland impact permit. "Programmatic mitigation" includes compensatory mitigation of wetland restoration/creation completed by MDE using compensation fund money (permitees pay into the compensation fund for mitigation requirements rather than performing mitigation themselves). "Other gains" includes other wetland restoration/creation that required a permit. 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 nontidal wetlands (Walbeck, 2005). "Voluntary gains" includes wetland restored/creation through other programs: NRCS Conservation Reserve Enhancement Program (CREP), NRCS Wetlands Reserve Program (WRP), USFWS, DNR, and Ducks Unlimited. Tidal wetlands data includes SAV, open water, mudflat, and vegetated wetlands. *2004 voluntary restoration records are incomplete (Clearwater, 2005).

Nontidal/ Tidal	Action (gain/loss)	02130104
Nontidal 1991-2004	Permanent impacts (regulatory)	-0.8
	Permittee mitigation	0
	Programmatic mitigation (MDE)	0
	Other Gains	0
	Net change (regulatory)	-0.8
Tidal 1996-2003	Permanent impacts (regulatory)	-<0.1
	Mitigation	0
	Net change (regulatory)	-<0.1
Nontidal/ Tidal 1998-2004*	Voluntary gains	92.2
Total		91.4

The following information is based on a 1998 report of wetland loss conducted by the U.S. Army Corp of Engineers (USACE, 1998). There has been a 10% loss of salt marsh area since 1900, with losses concentrated in the northern Coastal Bays (northern Coastal

Bays had a loss of 37% salt marsh, or 1,530 acres, while the Southern Coastal Bays had a loss of 228 acres). The northern bays, excluding Fenwick Island, had 580 acres of salt marsh loss, concentrated in Ocean Pines and Ocean City north of the inlet. Fenwick Island had 950 acres of salt marsh loss. A large portion of the once extensive zone of emergent salt marsh along the bayside of Fenwick Island is gone. In addition to direct wetland losses, coastal engineering and maintenance of the ocean city inlet may have prevented the natural formation of wetlands in some areas such as the bay side of Assateague Island.

The 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* summarized wetland loss in the Coastal Bays. Loss of forested wetland in the Coastal Bays due to conversion (e.g. filling) to agriculture and development was estimated at 44% or 24,768 acres total (21,000 acres converted to agriculture and 3,700 acres to development) (USACE, 1998). Once again, these losses were worse in the north than the south (52% or 13,562 acres and 37% or 11,205 acres, respectively). Most of the remaining wetlands (26,300 acres) have been hydrologically modified by artificial drainage to create forested uplands (e.g. timber plantations), agriculture, and urban area, so are no longer wetlands. Sea level rise is also contributing to losses in wetland area (USACE, 1998). Structural shoreline stabilization practices, such as bulkheads and riprap, prevent encroachment from sea level rise that would have resulted in new tidal wetlands. Some threats to wetland function include jet skis, boating, and feral horses (Conley, 2004). Construction of long piers across the tidal marsh destroys wetland habitat under the pier, accelerates erosion, fragments the marsh system (degrading bird habitat), and allows invasion by non-native species (Ayella, 2004). In an attempt to reduce mosquitoes, ditches have been created in many of the tidal wetlands. Although the success of these efforts in reducing mosquitoes is questionable, these ditches clearly impact the natural wetland system.

Tiner et al. (2000) estimated wetland function within the Coastal Bays watershed (Table 3). This assessment method did not take into account disturbance to the wetland, actual ecosystem health (e.g., water quality of adjacent waters), or difference between two wetlands of similar type.

Table 3. Wetlands within Assawoman Bay watershed having moderate to high potential to provide a given function. The total acreage of wetlands and percentage of wetlands providing the given function excludes ponds, deepwater habitats, and aquatic beds. Aquatic beds provide a habitat function for fish, shellfish, and waterfowl are also listed (Tiner et al., 2000).

Functions					Fish/ shellfish/ waterfowl habitat in aquatic beds (acres)	Total (acres)
Nutrient cycling (%)	Sediment deposition (%)	Surface water detention (%)	Coastal storm detention/ shore stabilization (%)	Fish/ shellfish/ waterfowl habitat (%)		
79	81	7	81	73	462	2,042

Code of Maryland Regulations

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

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 nutrients concentrations, poor SAV abundance, high percent impervious surface (12%), and high percent unforested stream buffer (40%). Wetland loss was estimated to be 3,531 acres. Indicators for Category 3 include high wetland-dependent species.

According to the *2002 Maryland Section 305(b) Water Quality Report* Assawoman Bay failed to fully support all designated uses due to low oxygen. It is also on the 2004 Impaired Surface Water 303(d) List for being impaired by nutrients (causing low seasonal DO <5mg/L). Although some background information was included in the Northern Coastal Bays TMDL, no TMDL was actually completed for Assawoman Bay.

Assawoman Bay total nitrogen loads are from agriculture (38%), direct groundwater discharge (7%), direct atmospheric deposition (37%), urban (11%), and forest/herbaceous (7%). Assawoman Bay total phosphorus loads are from agriculture (56%), direct atmospheric deposition (25%), urban (13%), and forest/herbaceous (6%) (MDE, 2001).

A Draft Water Quality Analysis was completed for fecal coliform in Assawoman Bay. This study found that designated uses related to fecal coliform were being met.

Water quality data was collected from MDE in 1998, DNR in 1998, and MCBP in 1997-1999. Greys Creek is the main tributary to Assawoman Bay. Most sites in this watershed had chlorophyll a levels exceeding the SAV habitat requirement of 15ug/l. Highest chlorophyll a levels were measured in shoreline areas receiving less flushing. The station at Ocean City, 79th street, had a chlorophyll a level of 98ug/l in 1998. Ocean City stations generally had high DIN. Assawoman Bay had DO levels above 5.0mg/l at the surface but below 5.0mg/l at the bottom. Greys Creek had DO values below 5.0mg/l.

The DNR/MCBP STAC2004 draft report Stated that Greys Creek is severely nutrient enriched and Northern Assawoman Bay is also highly enriched.

Stream Waders monitored two sites from this watershed in 2001, resulting in a family index of biotic integrity (IBI) of very poor.

Areas of SAV are currently located on the bay side of Fenwick Island.

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. There are extensive areas of hydric soil throughout the watershed that are not mapped wetland (based on NRCS SSURGO GIS data and NWI/DNR wetlands). There is a large area of "very poorly drained" hydric soil in the northwestern-most portion of the watershed. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

A Green Infrastructure hub is located along Greys Creek, and a GI corridor connects this hub with neighboring watersheds. This GI network is unprotected except a small amount protected by Isle of Wight WMA. Since some of the GI corridor is not currently in natural vegetation, it may be desirable to restore this area back to natural vegetation.

In the document entitled *Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report*, Tiner et al., (2000) proposed wetland restoration sites in the Coastal Bays watershed totaling 25,365 acres. These sites were classified into two categories: former wetlands (Type 1) and existing impaired wetlands (Type 2). They were scattered throughout the watershed. Type 1 sites included filled wetlands (without any buildings on them), farmed wetlands, and those converted to deepwater. He did not include any additional sites with hydric soils. The Type 2 sites were classified as wetlands in the Tiner study. These included impounded, excavated, ditched, tidally restricted, and shallow pond wetlands. The majority of wetlands were classified as Type 2. Potential wetland function was not evaluated.

Dead-end canals were built along the coast to allow residents water-access to the bays. Some dead-end canals are located on Fenwick Island and along Greys Creek. These canals have poor water circulation, since they are often surrounded by land on three sides, are deeper than surrounding bay waters, and have a high input of organic detritus and residential chemical runoff. For these reasons, dead-end canals often have poor water quality and provide poor habitat. These areas may be good locations for some type of water quality/habitat improvement project.

Many of the Coastal Bays tidal wetlands are ditched in an effort to reduce mosquitoes. During ditch maintenance, the ditches are dredged with the sediment being thrown to the sides (on the marsh surface). It is questionable whether these ditches actually reduce mosquito numbers. Since this ditching alters the natural wetland system (e.g., altering accessibility of fish and possibly reducing wetland nutrient/pollutant filtration), the wetlands may benefit from mosquito ditch removal. Restoration of hydrology in these extensive ditched tidal wetlands is currently being considered by the Coastal Wetlands Initiative (CWI), a partnership that includes the Maryland Departments of Natural Resources, Environment, and Agriculture, and the U.S. Fish and Wildlife Service. Goals are to protect and restore upland and saltmarsh habitat in the Maryland Coastal Bays. Most restoration activities will involve modifying mosquito ditches to restore hydrological conditions that will enable SAV and fish to recolonize areas of the saltmarsh where they were historically found. A grant has been received through the North American Wetland Conservation Act (NAWCA) funds to enhance 400 acres of saltmarsh at E.A. Vaughn WMA by partially blocking mosquito ditches.

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

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.
    - Forested palustrine wetlands (USACE, 1998; Worcester County, 1997)
    - Salt marsh (USACE, 1998, Spaur et al., 2001).
    - Fenwick Island (high salt marsh loss) (USACE, 1998)
    - Dead-end canals (MCBP, 1999; Chaillou et al., 1996)
    - Remove mosquito ditching.
    - Restore "gaps" within the Green Infrastructure network to natural vegetation.
    - Restoration areas identified within Tiner, et al. 2000 study.
    - Restore additional sites based on recommendations from SCA and WRAS.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
- Protect areas within the Green Infrastructure network.
- Protect the DNR-designated Ecologically Significant Areas.
    - o There are several areas along the Bay that contain species or natural communities of concern to DNR, but with no official status.
    - o There are also several areas along Fenwick Island that contain State-listed species.

Isle of Wight Bay (02130103)

Background

Based on MDP 2002 GIS land use data, the Isle of Wight Bay watershed has 7,516 acres of open water and 33,568 acres of land. The land acres are divided as follows: urban 8,089 acres (24%), agriculture 12,423 acres (37%), forest 11,738 acres (35%), wetlands 1,172 acres (3%) and barren land 146 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.

Some of the Maryland portion of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data), with large areas located around Shingle Landing Prong, Bishopsville Prong, and Manklin Creek. In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas along some of the waterways are classified as "prime farmland when drained." There are large areas in the headwaters of Shingle Landing Prong and

Bishopsville Prong (in the northwestern-most portion of this watershed) and in the headwaters of Turville and Herring Creeks. While it may not be desirable to exclude all soils classified as "prime farmland when drained" from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

Main waterbodies in Isle of Wight watershed are Shingle Landing Prong and Bishopsville Prong (draining into St. Martins River), Herring Creek, Turville Creek, and Manklin Creek. St. Martin's River contributes the largest amount of fresh water to the bay. This watershed has low topographic relief, high water table, poor surface drainage, and sandy soils (MDE, 2001). The streams are mainly shallow and slow moving, with headwater streams often having been ditched. Public Drainage Associations (PDAs) manage and maintain artificial drainage systems for agriculture using landowner tax money. These PDAs manage 71.8 stream miles in the Coastal Bays, within the watersheds of Isle of Wight Bay and Newport Bay. The majority of these drainage systems are sprayed with herbicide and mowed on a regular basis to maintain water flow. A frequently encountered environmental concern is the lack of riparian buffers for a large portion of the stream miles. According to 1994 Maryland Department of Planning data, within the Coastal Bays watershed, this problem is most common in the watersheds of Assawoman Bay, Sinepuxent Bay, and Isle of Wight Bay.

Mapped wetlands (based on DNR and NWI GIS data) are mainly located along waterways, but there are some large wetlands located in the interstream divides and depressions not directly associated with waterways, especially in the headwater areas. Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
  - Aquatic bed: 5 acres
  - Emergent: 1,316 acres
  - Scrub shrub: 31 acres
  - Forested: 16 acres
  - Unconsolidated shore: 824 acres
- Marine unconsolidated shore: 14 acres
- Palustrine
  - Emergent: 124 acre
  - Scrub shrub: 57 acre
  - Forested: 2,857 acres
  - Unconsolidated bottom: 211 acres
  - Farmed: 193 acres
- Total: 5,648 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains (Table 4).

The 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* discusses wetland gains/losses, water quality, and restoration in the Coastal Bays watershed. Some of the following paragraphs are from that document. Wetland gains and losses for this watershed, as tracked by MDE (Table 4). “Permanent impacts” includes permanent wetland losses that required a MDE permit. “Permittee mitigation” includes compensatory mitigation of wetland restoration or creation completed by the permittee, as required under their wetland impact permit. “Programmatic mitigation” includes compensatory mitigation of wetland restoration/creation completed by MDE using compensation fund money (permitees pay into the compensation fund for mitigation requirements rather than performing mitigation themselves). “Other gains” includes other wetland restoration/creation that required a permit. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a loss in nontidal regulated wetlands (Walbeck, 2005). “Voluntary gains” includes wetland restored/creation through other programs: NRCS Conservation Reserve Enhancement Program (CREP), NRCS Wetlands Reserve Program (WRP), USFWS, DNR, and Ducks Unlimited. Tidal wetlands data includes SAV, open water, mudflat, and vegetated wetlands. *2004 voluntary restoration records are incomplete.

Nontidal/ Tidal	Action (gain/loss)	02130103
Nontidal 1991-2004	Permanent impacts (regulatory)	-71.3
	Permittee mitigation	48.0
	Programmatic mitigation (MDE)	5.0
	Other Gains	1.2
	Net change (regulatory)	-17.2
Tidal 1996-2003	Permanent impacts (regulatory)	-0.3
	Mitigation	0.5
	Net change (regulatory)	0.1
Nontidal/ Tidal 1998-2004*	Voluntary gains	143.3
Total		126.2

The following information is based on a 1998 report of wetland loss conducted by the Corp of Engineers (USACE, 1998). There has been a 10% loss of salt marsh area since 1900, with losses concentrated in the northern Coastal Bays (northern Coastal Bays had a loss of 37% salt marsh, or 1530 acres, while the Southern Coastal Bays had a loss of 228 acres). The northern bays, excluding Fenwick Island, had 580 acres of salt marsh loss, concentrated in Ocean Pines and Ocean City north of the inlet. Fenwick Island had 950 acres of salt marsh loss. A large portion of the once extensive zone of emergent salt marsh along the bayside of Fenwick Island is gone. In addition to direct wetland losses, coastal engineering and maintenance of the ocean city inlet may have prevented the natural formation of wetlands in some areas such as the bay side of Assateague Island.

Loss of forested wetland in the Coastal Bays due to conversion (e.g. filling) to agriculture and development was estimated at 44% or 24,768 acres total (21,000 acres converted to agriculture and 3,700 acres to development) (USACE, 1998). Once again, these losses were worse in the north than the south (52% or 13,562 acres and 37% or 11,205 acres, respectively). Most of the remaining wetlands (26,300 acres) have been hydrologically modified by artificial drainage to create forested uplands (e.g. timber plantations), agriculture, and urban area, so are no longer wetlands. For this reason, loss of non-tidal forested wetlands may be as high as 90%. Highest amounts of forested wetland loss occurred in the St. Martin River, Isle of Wight Bay, Manklin Creek, and Newport Bay subwatersheds.

Sea level rise is also contributing to losses in wetland area. The once continuous salt marshes on the north of Isle of Wight Bay Island are now fragmented due to development, sea level rise and erosion (USACE, 1998). Structural shoreline stabilization practices, such as bulkheads and riprap, prevent encroachment from sea level rise that would have resulted in new tidal wetlands. Some threats to wetland function include jet skis, boating, and feral horses (Conley, 2004). Construction of long piers across the tidal marsh destroys wetland habitat under the pier, accelerates erosion, fragments the marsh system (degrading bird habitat), and allows invasion by non-native species (Ayella, 2004). In an attempt to reduce mosquitoes, ditches have been created in many of the tidal wetlands. Although the success of these efforts in reducing mosquitoes is questionable, these ditches clearly impact the natural wetland system.

Tiner et al. (2000) estimated wetland function within the Coastal Bays watershed (Table 5). This assessment method did not take into account disturbance to the wetland, actual ecosystem health (e.g., water quality of adjacent waters), or difference between two wetlands of similar type.

Table 5. Wetlands within Isle of Wight watershed having moderate to high potential to provide a given function within each Coastal Bays watershed. The total acreage of wetlands and percentage of wetlands providing the given function excludes ponds, deepwater habitats, and aquatic beds. Aquatic beds provide a habitat function for fish, shellfish, and waterfowl are also listed (Tiner et al., 2000).

Functions					Fish/ shellfish/ waterfowl habitat in aquatic beds (acres)	Total (acres)
Nutrient cycling (%)	Sediment deposition (%)	Surface water detention (%)	Coastal storm detention/ shore stabilization (%)	Fish/ shellfish/ waterfowl habitat (%)		
33	35	57	30	22	219	6,698

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a “designated use” in the Code of Maryland Regulations 26.08.02.08. Waterways not specifically

designated within COMAR are classified Use I, water contact recreation and protection of aquatic life. The designations are as follows:

- All estuarine portions except those listed below: Use II, shellfish harvesting.
- Bishopsville Prong and tributaries, Shingles Landing Prong (above St. Martins River at Piney Island), Herring Creek (above Rte. 50), and Ocean City Harbor (above west OC Harbor): Use I, water contact recreation and protection of 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 nutrient concentrations, poor SAV abundance, poor non-tidal benthic index of biotic integrity (BIBI), and high historic wetland loss (16,129 acres).

The *2002 Maryland Section 305(b) Water Quality Report* Stated that Isle of Wight Bay failed to fully support all designated uses due to low oxygen and bacteria from industrial discharge, non-point sources, natural sources, and low tidal flushing. The nontidal wadeable tributaries to St. Martins River, Herring Creek, Turville Creek, and Manklin Creek failed to support all designated uses in some portions (5.8 miles) due to poor biological community and had inconclusive results in other portions (17.6 miles). Some tributaries to St. Martin River and Turville Creek had low oxygen and high chlorophyll (DNR, 2000). Bishopville Pond (60.2 acres) also failed to support all designated uses due to high nutrients and low oxygen from non-point sources, upstream sources, high sediment oxygen demand (SOD), and natural sources.

Surface water bodies that are on the 2004 Impaired Surface Water 303(d) List and either are in need of a TMDL or have a completed TMDL but are still impaired, are as follows:

- *Isle of Wight watershed* (tidal): nutrients (causing low seasonal DO <5mg/L and high pH)
- *Herring Creek/Turville Creek* (021301030687): fecal coliform
- *Crippen Branch* (021301030690): poor biological community
- *Church Branch* (021301030691): poor biological community
- A TMDL was approved for nutrients at St. Martin River, Shingle Landing Prong, Bishopville Prong, Herring Creek, and Turville Creek. A TMDL will be conducted for the remaining tributaries later.

A TMDL was completed in 2001 for nitrogen and phosphorus in St. Martins River, Shingle Landing Prong, Bishopsville Prong, Herring Creek, and Turville Creek, summarized as follows. These waterways have excessive nutrients, high chlorophyll a, and low dissolved oxygen. St. Martin's River has two major point source discharges: There are two major point sources releasing nitrogen and phosphorus within the St. Martin River Watershed: Ocean Pines Service Area Waste Water Treatment Plant

(WWTP), discharging into the St. Martin River, and the Perdue Farms processing plant, discharging into an unnamed tributary of Church Branch (a tributary of Shingle Landing Prong). Other less significant point sources include: the Ocean City WWTP discharging into the Atlantic Ocean, Showell Farms discharging to Birch Branch (a tributary to Shingle Landing Prong) and the Perdue Hatchery on Bishopville Prong.
Isle of Wight Bay total nitrogen loads are from agriculture (52%), point sources (9%), direct groundwater discharge (3%), direct atmospheric deposition (17%), urban (11%), and forest/herbaceous (8%). Isle of Wight Bay total phosphorus loads are from agriculture (66%), point sources (5%), direct atmospheric deposition (10%), urban (13%), and forest/herbaceous (6%). Herring Creek total nitrogen loads are from agriculture (29%), direct groundwater discharge (3%), direct atmospheric deposition (16%), urban (23%), and forest/herbaceous (29%). Herring Creek total phosphorus loads are from agriculture (38%), direct atmospheric deposition (10%), urban (29%), and forest/herbaceous (23%). Turville Creek total nitrogen loads are from agriculture (61%), direct groundwater discharge (1%), direct atmospheric deposition (4%), urban (17%), and forest/herbaceous (17%). Turville Creek total phosphorus loads are from agriculture (68%), direct atmospheric deposition (2%), urban (18%), and forest/herbaceous (12%). St. Martin River total nitrogen loads are from agriculture (66%), point sources (13%), direct groundwater discharge (1%), direct atmospheric deposition (6%), urban (7%), and forest/herbaceous (7%). St. Martin River total phosphorus loads are from agriculture (77%), point sources (7%), direct atmospheric deposition (3%), urban (8%), and forest/herbaceous (5%). Shingle Landing Prong total nitrogen loads are from agriculture (66%), point sources (22%), urban (5%), and forest/herbaceous (7%). Shingle Landing Prong total phosphorus loads are from agriculture (86%), point sources (3%), urban (6%), and forest/herbaceous (5%). Bishopsville Prong total nitrogen loads are from agriculture (82%), urban (9%), and forest/herbaceous (9%). Bishopsville Prong total phosphorus loads are from agriculture (85%), urban (9%), and forest/herbaceous (6%). MDE is requiring the following pollutant reductions: a 31% reduction in nitrogen and a 19% reduction in phosphorus for St. Martin River, Shingles Landing Prong and Bishopville Prong; and a 13% reduction in phosphorus for Turville and Herring Creeks.

Stream Waders monitored 18 sites in 2001, reporting family IBI ratings of very poor (17 out of 18 sites) to poor (1 site). The one site monitored in the 1997 MBSS found benthic IBI of fair. The 2001 MBSS surveyed 4 sites, finding poor to fair values for fish IBI and very poor to poor values for benthic IBI. The DNR Landscape and Watershed Analysis Division monitored 19 sites in the St. Martin's River, finding most impacted communities on Carey's Branch and Church Creek (Primrose, 1999). Dead-end canals had lower macroinvertebrate abundance and biomass relative to open Coastal Bays (USACE, 1998).

DNR conducted a stream corridor assessment for this watershed in 2001. From this assessment, it was noted that the most common problem was stream channel alteration, as 69% of the stream channels had been converted, mainly into agricultural ditches. This problem was most common in the headwaters, especially in the northern watershed. Inadequate stream buffer (<50ft) was the next most common problem encountered (64%). Other less-frequently encountered issues included stream erosion in the southern part of the watershed, construction erosion, trash, and sewage discharge. Minor fish migration barriers were encountered at 32 sites, mainly in the southern part of the watershed. These consisted of sites inhibiting fish passage due to shallow water or a drop in water (e.g., a culvert of fixed elevation with an outfall into a stream with an eroded bottom). The one reported dam was above Bishopville Road and is scheduled for removal. Poor benthic populations were likely due to poor habitat from ditching and flow of storm water. Subwatersheds with sites having poor physical conditions, poor benthic communities, or excessive nutrients should be targeted for restoration.

A study conducted by DNR in 1998 and 1999 looked at frequency and abundance of macroalgae species in the Coastal Bays (Goshorn et al., 2001). Of the 25 genera found, the top most abundant were *Agardhiella* and *Gracilaria*. The highest volume of total macroalgae per station was found at Isle of Wight Bay in both years. The abundance of "nutrient responsive algae," algae species assumed to benefit from nutrient enrichment (*Enteromorpha* spp., *Ulva lactuca*, *Cladophora vagabunda*, *Gracilaria tikvahiae*, *Chaetomorpha* spp., and *Agardhiella* spp.), was highest in Isle of Wight Bay and southern Chincoteague Bay. *Pfiesteria* was confirmed in Turville Creek (DNR, 1999). *Aureococcus*, an algae that causes brown tides, was reported at high densities in Newport Bay, Public Landing, Tingles Island, Green Run Bay, and at lower densities in all other bays and major tributaries except Sinepuxent Bay (Tarnowski and Bussell, 2002). Areas with high amounts of flushing with ocean water, near the Ocean City inlet, have better water quality (USACE, 1998).

Water quality data from MDE in 1998, DNR in 1998, and MCBP in 1997-1999 are summarized below. The DNR nutrient synoptic survey (part of the WRAS) conducted in 1999 and 2001 (Isle of Wight and St. Martin River) is also included. Median annual data (based on years 2001-2003) based on DNR and ASIS data and trends based on ASIS data as reported in the document *Draft Aquatic Ecosystem Health 2004, Maryland Coastal Bays Monitoring Report*, including nitrogen and phosphorus levels is also summarized below.

The majority of freshwater entering Isle of Wight Bay is from the St. Martin River. Major tributaries to the St. Martin River include Bishopville Prong and Shingle Landing Prong. Other tributaries to the Isle of Wight Bay include Manklin Creek, Turville Creek, and Herring Creek. St. Martin's watershed had the highest pollutant load and unit per area load within Isle of Wight watershed (USACE, 1998), including high nutrient loads and high fecal coliform (Shanks, 2001). During the low flow periods, the open bays had a fairly low level of chlorophyll a (10-20ug/l) and surface DO levels were at or above 5.0mg/l but bottom water DO levels were reported to be below 5.0mg/l. In the St. Martin River, chlorophyll a levels were higher, with average low flow values for each year ranging between 15ug/l and 50ug/l. Some higher values were reported along the shorelines. According to TMDL results, this river had low DO values where the upstream tributaries enter the river and where the river enters the Isle of Wight Bay, due to higher deposition at these locations. In Shingles Landing Prong and Bishopville Prong, chlorophyll a values were very high. Chlorophyll a generally exceeded 50ug/l with values occasionally exceeding 250ug/l in Bishopville Prong (just below the dam). Based on data used in the northern Coastal Bays TMDL, Bishopville Prong had several very low DO concentrations, with lowest individual readings found just below the dam and in the dam. According to TMDL results, there was high DIN and high DIP in Bishopville Prong and north of the MD/DE line. Although values in Shingles Landing Prong were above 5.0mg/l during the day, TMDL results suggest values drop below 5.0mg/l in the early morning hours. Shingles Landing Prong also had some high individual readings of dissolved inorganic phosphorus (DIP; ortho-phosphate) and dissolved inorganic nitrogen (DIN) in low flow months. For both Shingles Landing Prong and Bishopville Prong, MDE is requiring a 31% reduction in non-point source nitrogen based on the TMDL. Turville Creek and Herring Creek had chlorophyll a above 15ug/l and DO values <5mg/l during low flow conditions. Some stations in Turville Creek had high DIN during low flow conditions and Herring Creek had high DIN and high DIP during low flow months. Manklin Creek had some DO values below 5.0mg/l in low flow months and chlorophyll a values above 15ug/l. Results from a DNR study in 1999 for the St. Martins Watershed found high nutrient concentrations at three stations: a tributary to St. Martin at St. Martin Neck Road, Buntings Branch at Delaware Rte. 54 in Selbyville, and Church Creek at Rte. 113 (Primrose, 2002). The area with the highest total dissolved nitrogen load (79.5mg/L) was on Buntings Branch at Delaware Route 54 in Selbyville. Other areas of high nutrients were at Birch Branch at Route 113, Birch Branch at Campbelltown Road, and a tributary to Birch Branch at Murray Road.

A summary of water quality status and trends data as Stated in DNR/MCBP STAC2004 draft report is as follows. Upper tributaries (Bishopville Prong, Shingle Landing Prong, and Turville Creek) are severely nutrient enriched. St. Martin River and Herring Creek are also highly enriched. Open Isle of Wight Bay have lowest total nitrogen. Phosphorus enrichment appears to be more widespread with few sites meeting SAV threshold for TP. The SAV chlorophyll threshold was met in Isle of Wight Bay; while the St. Martin River failed. STAC chlorophyll threshold show hypereutrophic conditions are present in Bishopsville Prong. Daytime measurements show that DO falls below 5 mg/l during the summer months throughout the St. Martin River, as well as Manklin Creek, Herring Creek, and Turville Creek.

There are two major point sources releasing nitrogen and phosphorus within the St. Martin River Watershed: Ocean Pines Service Area Waste Water Treatment Plant (WWTP), discharging into the St. Martin River, and the Perdue Farms processing plant, discharging into an unnamed tributary of Church Branch (a tributary of Shingle Landing Prong) (MDE, 2001). Other less significant point sources include: the Ocean City WWTP discharging into the Atlantic Ocean, Showell Farms discharging to Birch Branch (a tributary to Shingle Landing Prong) and the Perdue Hatchery on Bishopville Prong.

SAV is currently located on the bay side of the barrier islands, with the exception of southern Fenwick Island.

According to MDE, restricted shellfish harvesting areas are in the St. Martin River, Turville Creek, Herring Creek, and Ocean City (Ocean side near route 90).

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. There are extensive areas of hydric soils that are not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands), especially in the headwaters. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

There are three main Green Infrastructure (GI) hubs in this watershed: one around Isle of Wight and north of St. Martins River, one around Longridge Swamp, and around and south of Herring Creek. There are also some GI corridors, mostly located in the northern portion of the watershed. Little of the GI network is protected, with the exception of Isle of Wight WMA. There are also some small METs located outside of the GI network. Some of the GI corridors may be good sites for restoration to natural vegetation.

There is one State-designated Nontidal Wetlands of Special State Concern within this watershed. *West Ocean City Pond* is a large, shallow freshwater pond/wetland that contains a State-Endangered plant species (DNR, 2003a). An older study found an additional State-Endangered plant species and two uncommon plant species (DNR, 1991). The site is important for migrating and wintering waterfowl and resident waterfowl. Forested buffers around the lake should be maintained. In the future, the water willows growing in the shallow southern section of the pond may need to be controlled; otherwise, they may eventually replace native vegetation or alter the pond hydrology (DNR, 2003a). This area is unprotected.

In the document entitled Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report, Tiner et al., (2000) proposed wetland restoration sites in the Coastal Bays watershed totaling 25,365 acres. These sites were classified into two categories: former wetlands (Type 1) and existing impaired wetlands (Type 2). They were scattered throughout the watershed. Type 1 sites included filled wetlands (without any buildings on them), farmed wetlands, and those converted to deepwater. He did not include any additional sites with hydric soils. The Type 2 sites were classified as wetlands in the Tiner study. These included impounded, excavated, ditched, tidally restricted, and shallow pond wetlands. The majority of wetlands were classified as Type 2. Potential wetland function was not evaluated.

A Watershed Restoration Action Strategy was completed for Isle of Wight watershed in 2001. When determining potential restoration sites within the WRAS, Worcester County looked for sites within the general areas designated by the Watershed Characterization. These included:

- *Hydric soils*. Digitized soil data was based on the Natural Soil Groups Classification developed by Maryland Department of Planning. "Hydric soil" status may have been difficult to establish due to vague groupings used in the Natural Soil Groups and changes in "hydric soil" definition since the groupings were made.
- *Wetness of soil*. DNR estimated nutrient retention of soil assuming higher wetness of soil equates to higher nutrient retention.

- *Adjacent land use*. Select hydric soils between a stream and cropland.
- *Proximity to wetlands*. Select hydric soils within 300 feet of a wetland.
- *The DNR water quality and macroinvertebrate community data* (Primrose, 1999).
- *Stream Corridor Assessment data* (Czwartacki and Yetman, 2002).

For the Isle of Wight, there were five identified potential restoration areas. All areas had stream sites with channel alteration, very poor buffers, and lateral ditching. Bishopville #1 is located north of St. Martins Neck Road between Route 367 and Mumford Road and drains into Bishopville Prong (above Shell Mill Road). Within this section, there were also stream sites with minor erosion. Bishopville #2 is west of Bishopville Prong, between Jarvis Road and Hammond Road. These streams drain into Slab Bridge Prong and Perkins Creek before entering Bishopville Prong. Carey #1 is in the headwaters of Carey Branch and includes a high density of agricultural ditches. Birch #1 is on Birch Branch, west of Rte. 113 and south of Carey #1. Birch #2 is south of Peerless Road and drains into Birch Branch and Middle Branch. USACE is considering projects in some of these areas.

The USACE looked in greater detail at some areas identified in the Isle of Wight WRAS, within the St. Martin River watershed. They identified areas for: potential shoreline stabilization, riparian restoration, improved water quality, wetland restoration, oyster reef construction, and removal of fish blockages. Although the USACE did intend to implement projects based on this analysis, funding issues have resulted in postponement.

SHA used the method described in the *Highway Methodology Workbook* to determine the mitigation sites for Route 113. This wetland mitigation plan was only for selecting sites to satisfy current wetland mitigation requirements. It was not meant as a long-tem plan for wetland restoration/mitigation. Additionally, they focused only on areas near the impacted sites.

The USACE (1998) and Spaur et al. (2001) targeted the northern coastal bays for salt marsh restoration due to the high amount of historic loss and because the natural process of marsh creation is no longer possible in that region. Since the natural process of marsh creation is still operational in the southern bays, salt marsh restoration in that region should only be located on historic salt marsh sites. For water quality improvement, they recommended that nontidal wetland restoration be focused in St. Martin's River, Turville/Herring Creek, and Newport Bay. Unfortunately, in order to achieve the possible water quality improvement, restored wetlands may not be located in the same landscape setting as where they were historically.

The Great Cypress Swamp Aquatic Ecosystem Restoration Project in Delaware is within the vicinity of the Coastal Bays and is very relevant to that area. This restoration may include several thousands of acres. This study is also on hold due to inadequate funding from the Corp's Continuing Authorities Program.

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.

- High wetland losses forested palustrine wetlands (USACE, 1998; Worcester County, 1997)
- Salt marsh (USACE, 1998, Spaur et al., 2001).
- St. Martins River (Chaillou et al., 1996; MDE, 2001; USACE, 1998; Worcester County, 1989)
- High nutrient concentrations based on nutrient synoptic survey for Isle of Wight (Primrose, 1999, 2002)
    - Station 1. Tributary to St. Martin at St. Martin Neck Road
    - Station 2. Tributary to St. Martin at St. Martin Neck Road
    - Station 4. Bunting Branch at Delaware Rte. 54 in Selbyville
    - Station 7. Careys Branch at Rte. 113
    - Station 8. Tributary to Birch Branch at Murray Road
    - Station 11. Tributary to Perkins Creek at Jarvis Road
    - Station 13. Birch Branch at Rte. 113
    - Station 15. Church Creek at Rte. 113
    - Station 17. Birch Branch at Campbelltown Road
    - Station 22. Church Creek at Careys Road
- Shingles Landing Prong (MDE, 2001)
- Bishopville Prong (MDE, 2001; Worcester County, 1989)
- Bishopville #1 is north of St. Martins Neck Road between Route 367 and Mumford Road, draining into Bishopville Prong above Shell Mill Road. (Worcester County, 2002)
- Bishopville #2 is west of Bishopville Prong, between Jarvis Road and Hammond Road. Draining into Slab Bridge Prong and Perkins Creek before entering Bishopville Prong. (Worcester County, 2002)
- Turville Creek (MDE, 2001; Worcester County, 1989)
- Herring Creek (MDE, 2001; Worcester County, 1989)
- Ocean City Harbor (Worcester County, 1989)
- Carey #1 is located in the headwaters of Carey Branch (Worcester County, 2002)
- Birch #1 is on Birch Branch, west of Rte. 113 and south of Carey #1. (Worcester County, 2002)
- Birch #2 is south of Peerless Road and drains into Birch Branch and Middle Branch. (Worcester County, 2002)
- Manklin Creek (high wetland losses) (USACE, 1998; Worcester County, 1989)
- Fenwick Island and Ocean Pines (high salt marsh loss) (USACE, 1998)
- Great Cypress Swamp – northwestern edge of Isle of Wight watershed (DNR Natural Heritage Program, USACE, 1998, Spaur et al., 2001)
- The marshes on the northern side of the Isle of Wight Island. These marshes are currently eroding (USACE, 1998). This island is owned by DNR and is used for recreation.
- Dead-end canals. Dead-end canals were built along the coast to allow residents water-access to the bays. Many of these dead-end canals are located in Ocean Pines (at the mouth of the St. Martins River) and Ocean

City). These canals have poor water circulation, since they are often surrounded by land on three sides, are deeper than surrounding bay waters, and have a high input of organic detritus and residential chemical runoff. For these reasons, dead-end canals often have poor water quality and provide poor habitat. To improve the water flushing, the dead-end canals can be connected by pipes. Other restoration opportunities within the dead-end canals will be considered, but due to possible resistance from existing property owners, restoration of the canals may be difficult. Although this may not be directly related to wetlands, it may improve local water quality (MCBP, 1999).

- Skimmer Island (north of the Route 50 bridge). Bay islands are important for colonial waterbird nesting. Skimmer Island is an important rookery, shorebird-feeding site, and horseshoe crab-spawning site and is currently unprotected (USACE, 1998).
- Shoreline stabilization using marsh vegetation. Where possible, shoreline stabilization efforts should employ marsh vegetation. This may be especially feasible in smaller waterways (e.g. Turville Creek, Herring Creek, Bishopsville Prong).
- Preserve areas of high recreational value, including Ocean City Harbor, Bishopville Prong, Herring Creek, St. Martin River, Manklin Creek, and Turville Creek (Worcester County, 1989).
- Restore “gaps” in the Green Infrastructure network to natural vegetation.
- Restore/create wetlands designed to remove nitrogen and phosphorus from the St. Martin River, Bishopsville Prong, Shingle Landing Prong, Herring Creek, or Turville Creek (MDE, 2001).
- Restore additional sites recommended in SCA and WRAS.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
- Protect areas within the Green Infrastructure network.
- Protect wetlands that function to remove nitrogen and phosphorus from the St. Martin River, Bishopsville Prong, Shingle Landing Prong, Herring Creek, or Turville Creek (MDE, 2001).
- Protect the DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain Federally-listed species, State-listed species, or areas of concern to DNR, but with no official status.
- Protect WSSC and buffers.

<u>Sinepuxent Bay (02130104)</u>

Background

Based on MDP 2002 GIS land use data, the Sinepuxent Bay watershed has 5,951 acres of open water and 7,506 acres of land. The land acres are divided as follows: urban 1,661 acres (22%), agriculture 851 acres (11%), forest 2,333 acres (31%), wetlands 1,755 acres (23%) and barren land 905 acres (12%). 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.

Some of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data). In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas are classified as "prime farmland when drained." While it may not be desirable to exclude all soils classified as "prime farmland when drained" from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

The streams are mainly shallow and slow moving, with headwater streams often having been ditched. A frequently encountered environmental concern is the lack of riparian buffers for a large portion of the stream miles. According to 1994 Maryland Department of Planning data, this problem is most common in the watersheds of Assawoman Bay, Sinepuxent Bay, and Isle of Wight Bay.

North Sinepuxent Bay is a designated Natural Heritage Area within this watershed. To get this designation, an area must contain threatened or endangered species and be the best Statewide examples.

Mapped wetlands (based on DNR and NWI GIS data) are mainly located along the bay, however, smaller wetlands are scattered throughout the watershed. Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
  - Emergent: 1,711 acres
  - Scrub shrub: 106 acres
  - Forested: 13 acres
  - Unconsolidated shore: 1,523 acres
- Marine unconsolidated shore: 101 acres
- Palustrine
  - Emergent: 66 acre
  - Scrub shrub: 35 acre
  - Forested: 429 acres
  - Unconsolidated bottom: 19 acres
  - Farmed: 23 acres
- Total: 4,028 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains (Table 6).

The 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* discusses wetland gains/losses, water quality, and restoration in the Coastal Bays watershed. Some of the following paragraphs are from that document. Wetland gains and losses for this watershed, as tracked by MDE (Table 6). "Permanent impacts" includes permanent wetland losses that required a MDE permit.

"Permittee mitigation" includes compensatory mitigation of wetland restoration or creation completed by the permittee, as required under their wetland impact permit. "Programmatic mitigation" includes compensatory mitigation of wetland restoration/creation completed by MDE using compensation fund money (permitees pay into the compensation fund for mitigation requirements rather than performing mitigation themselves). "Other gains" includes other wetland restoration/creation that required a permit. 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 nontidal wetlands (Walbeck, 2005). "Voluntary gains" includes wetland restored/creation through other programs: NRCS Conservation Reserve Enhancement Program (CREP), NRCS Wetlands Reserve Program (WRP), USFWS, DNR, and Ducks Unlimited. Tidal wetlands data includes SAV, open water, mudflat, and vegetated wetlands (Clearwater, 2005). *2004 voluntary restoration records are incomplete.

Nontidal/ Tidal	Action (gain/loss)	02130104
Nontidal 1991-2004	Permanent impacts (regulatory)	-4.7
	Permittee mitigation	3.5
	Programmatic mitigation (MDE)	3.0
	Other Gains	0.1
	Net change (regulatory)	1.9
Tidal 1996-2003	Permanent impacts (regulatory)	-0.2
	Mitigation	0.1
	Net change (regulatory)	-0.1
Nontidal/ Tidal 1998-2004*	Voluntary gains	39.1
Total		37.1

The following information is based on a 1998 report of wetland loss conducted by the Corp of Engineers (USACE, 1998). There has been a 10% loss of salt marsh area since 1900, with losses concentrated in the northern Coastal Bays (northern Coastal Bays had a loss of 37% salt marsh, or 1530 acres, while the Southern Coastal Bays had a loss of 228 acres). In addition to direct wetland losses, coastal engineering and maintenance of the ocean city inlet may have prevented the natural formation of wetlands in some areas such as the bay side of Assateague Island. Loss of forested wetland in the Coastal Bays due to conversion (e.g. filling) to agriculture and development was estimated at 44% or 24,768 acres total (21,000 acres converted to agriculture and 3,700 acres to development) (USACE, 1998). Once again, these losses were worse in the north than the south (52% or 13,562 acres and 37% or 11,205 acres, respectively). Most of the remaining wetlands (26,300 acres) have been hydrologically modified by artificial drainage to create forested uplands (e.g. timber plantations), agriculture, and urban area, so are no longer wetlands. Sea level rise is also contributing to losses in wetland area (USACE, 1998). Structural shoreline stabilization practices, such as bulkheads and riprap, prevent encroachment from sea level rise that would have resulted in new tidal wetlands. Some threats to wetland function include jet skis, boating, and feral horses (Conley, 2004). Construction of long piers across the tidal marsh destroys wetland habitat under the pier, accelerates erosion, fragments the marsh system (degrading bird habitat), and allows invasion by non-native species (Ayella, 2004). In an attempt to reduce mosquitoes, ditches have been created in many of the tidal wetlands. Although the success of these efforts in reducing mosquitoes is questionable, these ditches clearly impact the natural wetland system.

Tiner et al. (2000) estimated wetland function within the Coastal Bays watershed (Table 7). This assessment method did not take into account disturbance to the wetland, actual ecosystem health (e.g., water quality of adjacent waters), or difference between two wetlands of similar type.

Table 7. Wetlands within the Sinepuxent Bay watershed having moderate to high potential to provide a given function within each Coastal Bays watershed. The total acreage of wetlands and percentage of wetlands providing the given function excludes ponds, deepwater habitats, and aquatic beds. Aquatic beds provide a habitat function for fish, shellfish, and waterfowl are also listed (Tiner et al., 2000).

Functions					Fish/ shellfish/ waterfowl habitat in aquatic beds (acres)	Total (acres)
Nutrient cycling (%)	Sediment deposition (%)	Surface water detention (%)	Coastal storm detention/ shore stabilization (%)	Fish/ shellfish/ waterfowl habitat (%)		
67	76	11	74	69	1,910	2,769

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a “designated use” in the Code of Maryland Regulations 26.08.02.08. Waterways not specifically designated within COMAR are classified Use I, water contact recreation and protection of aquatic life. All estuarine portions are designated: Use II, shellfish harvesting.

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. Failing indicators include high percent unforested stream buffer (45%).

Based on the *2002 Maryland Section 305(b) Water Quality Report* Sinepuxent Bay had low levels of dissolved oxygen, but results were inconclusive (8.8 miles) as to weather this waterway fully supported all designated uses. Sinepuxent Bay is on the 2004 Impaired Surface Water 303(d) List for being impaired by nutrients (causing low seasonal DO <5mg/L)

A Draft Water Quality Analysis was completed for fecal coliform in Sinepuxent Bay. This study found that designated uses related to fecal coliform were being met.

Of the sites sampled in the 2003 nutrient synoptic survey (Primrose, 2003), two had high or excessive orthophosphate concentrations (unnamed tributary to Sinepuxent Bay at Rte. 611 and at Eagles Nest Road, respectively). Nitrate/nitrite levels and orthophosphate yields were baseline. Chlorophyll a levels were below 15ug/l and dissolved oxygen levels were generally at or above 5mg/l even during low flow periods (some DNR samples in the Coastal Bays had low dissolved oxygen readings at depth). DIN and DIP values were moderately high in some years.

The DNR/MCBP STAC2004 draft report Stated that Sinepuxent Bay has some of the lowest total nitrogen levels and that the SAV chlorophyll threshold was met in Sinepuxent Bay.

There is a point source discharge from Assateague Island National Seashore Visitor Center.

The majority of the SAV is currently located on the bay side of the barrier islands (with the exception northern Assateague Island around the Ocean City inlet).

Family IBI was found to be very poor for the three stations surveyed by the Stream Waders in 2001. DNR conducted a stream corridor assessment for this watershed in 2003. Data will be available shortly.

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. There are many hydric soils that are not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands) throughout the watershed. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

During the 2003 Stream Corridor Assessment (Patterson and Yetman, 2004), over 130 stream miles were surveyed and 211 potential environmental problems were identified. Problems included channel alteration (72 sites), inadequate stream buffer (70 sites), pipe outfall (19 sites), fish barriers (17 sites), stream bank erosion (14 sites), unusual conditions (12 sites), trash dumping (6 sites), and exposed pipe (1 site).

In the document entitled *Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report*, Tiner et al., (2000) proposed wetland restoration sites in the Coastal Bays watershed totaling 25,365 acres. These sites were classified into two categories: former wetlands (Type 1) and existing impaired wetlands (Type 2). They were scattered throughout the watershed. Type 1 sites included filled wetlands (without any buildings on them), farmed wetlands, and those converted to deepwater. He did not include any additional sites with hydric soils. The Type 2 sites were classified as wetlands in the Tiner study. These included impounded, excavated, ditched, tidally restricted, and shallow pond wetlands. The majority of wetlands were classified as Type 2. Potential wetland function was not evaluated.

Green Infrastructure is located along Assateague Island and the northern portion of the mainland. Assateague Island is protected by Assateague Island National Seashore and Assateague Island State Park. Additional protected land, outside of the GI network, includes County-owned property, a MET, and a portion of Assateague Island State Park on the mainland side. Possible restoration projects may be to return the corridor "gaps" to natural vegetation. According to the Maryland Greenways Commission, there are two proposed or existing greenways within this watershed:

- *Assateague Island National Seashore*. This greenway runs along both Assateague Island and the mainland shoreline.
- *Sinepuxent Bay Water Trails*

Assateague Island is protected by federal and State governments and provides habitat and recreational opportunities for swimming, boating, fishing, and camping. The island provides habitat for several important species, including the piping plover species, a federally threatened species; the beach tiger beetle, a State endangered species (USACE, 1998); and Peregrine falcons. Restoration or protection would be beneficial at t*he northern end of Assateague Island*. There is a low amount of dune and salt marsh due to reduced sediment transport (USACE, 1998).

Restoration of hydrology in these extensive ditched tidal wetlands is currently being considered by the Coastal Wetlands Initiative (CWI), a partnership that includes the Maryland Departments of Natural Resources, Environment, and Agriculture, and the U.S. Fish and Wildlife Service. Goals are to protect and restore upland and saltmarsh habitat in the Maryland Coastal Bays. Most restoration activities will involve modifying mosquito ditches to restore hydrological conditions that will enable SAV and fish to recolonize areas of the saltmarsh where they were historically found. A grant has been received through the North American Wetland Conservation Act (NAWCA) funds to enhance 400 acres of saltmarsh at E.A. Vaughn WMA by partially blocking mosquito ditches. There are several reference communities of tidal wetlands on Assateague National Seashore (Harrison 2001). The community *Typha (latifolia, angustifolia)/Hibiscus moscheutus* (Cattail/Rose mallow) is found in slightly brackish (oligohaline) to brackish (mesohaline0 systems that are subject to daily tidal inundation. *Juncus roemerianus* (black needlerush) is found in brackish to salt (polyhaline) systems with daily tidal inundation and are generally found on sandy substrates. *Phragmites australis* (Common reed) may be found in waters from fresh to brackish salinity, and is often considered to be an invasive species in need of control.

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

When determining potential restoration sites within WRAS, Worcester County looked for sites within the general areas designated by the Watershed Characterization. These included:

- *Hydric soils*. Digitized soil data was based on the Natural Soil Groups Classification developed by Maryland Department of Planning. “Hydric soil” status may have been difficult to establish due to vague groupings used in the Natural Soil Groups and changes in “hydric soil” definition since the groupings were made.
- *Wetness of soil*. DNR estimated nutrient retention of soil assuming higher wetness of soil equates to higher nutrient retention.
- *Adjacent land use*. Select hydric soils between a stream and cropland.
- *Proximity to wetlands*. Select hydric soils within 300 feet of a wetland.
- *The DNR water quality and macroinvertebrate community data* (Primrose, 1999).
- *Stream Corridor Assessment data* (Czwartacki and Yetman, 2002).

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.
- High nutrient concentrations based on nutrient synoptic survey for Newport/Sinepuxent Bays - Station 21. Tributary to Sinepuxent Bay at Eagles Nest Road (Primrose, 2003).
    - Ocean City Harbor (Worcester County, 1989).
    - Bayside of Assateague Island (high salt marsh loss) (USACE, 1998).
    - Restore “gaps” in the Green Infrastructure network to natural vegetation.
    - Enhance ditched tidal marshes
    - Restore sites based on recommendations from SCA and WRAS.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
- Protect DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain Federally-listed species and State-listed species that are not completely protected.
- Protect areas within the Green Infrastructure network.
- Protect tidal wetland reference sites, while managing *Phragmites* as needed.

<u>Newport Bay (02130105)</u>

Background

Based on MDP 2002 GIS land use data, the Newport Bay watershed has 5,263 acres of open water and 27,228 acres of land. The land acres are divided as follows: urban 2,822 acres (10%), agriculture 9,514 acres (35%), forest 11,582 acres (43%), wetlands 3,246 acres (12%) and barren land 63 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.

Some of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data). In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas are classified as "prime farmland when drained." While it may not be desirable to exclude all soils classified as "prime farmland when drained" from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

Newport Bay consists of the main bay and several tributaries: Ayer Creek, Trappe Creek, Newport Creek, and Marshall Creek. Kits Branch drains into Trappe Creek. Newport Bay drains into Chincoteague Bay. This watershed has low topographic relief, sandy soils, high ground water, and poor surface drainage (MDE, 2002b). The streams are mainly shallow and slow moving, with headwater streams often having been ditched. Public Drainage Associations (PDAs) manage and maintain artificial drainage systems for agriculture using landowner tax money. These PDAs manage 71.8 stream miles in the Coastal Bays, within the watersheds of Isle of Wight Bay and Newport Bay. The majority of these drainage systems are sprayed with herbicide and mowed on a regular basis to maintain water flow. A frequently encountered environmental concern is the lack of riparian buffers.

Mapped wetlands (based on DNR and NWI GIS data) are mainly located along waterways and around the Bay. There are additional large wetlands located on interstream divides or depressions. Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
  - Emergent: 3,272 acres
  - Scrub shrub: 8 acres
  - Forested: 14 acres
  - Unconsolidated bottom: 6 acres
  - Unconsolidated shore: 37 acres
- Palustrine
  - Emergent: 57 acre
  - Scrub shrub: 96 acre
  - Forested: 2,793 acres
  - Unconsolidated bottom: 143 acres
  - Farmed: 120 acres
- Total: 6,546 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains (Table 8).

The 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* discusses wetland gains/losses, water quality, and restoration in the Coastal Bays watershed. Some of the following paragraphs are from that document. Wetland gains and losses for this watershed, as tracked by MDE (Table 8). "Permanent impacts" includes permanent wetland losses that required a MDE permit.

"Permittee mitigation" includes compensatory mitigation of wetland restoration or creation completed by the permittee, as required under their wetland impact permit. "Programmatic mitigation" includes compensatory mitigation of wetland restoration/creation completed by MDE using compensation fund money (permitees pay into the compensation fund for mitigation requirements rather than performing mitigation themselves). "Other gains" includes other wetland restoration/creation that required a permit. 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). "Voluntary gains" includes wetland restored/creation through other programs: NRCS Conservation Reserve Enhancement Program (CREP), NRCS Wetlands Reserve Program (WRP), USFWS, DNR, and Ducks Unlimited. Tidal wetlands data includes SAV, open water, mudflat, and vegetated wetlands (Clearwater, 2005). *2004 voluntary restoration records are incomplete.

Nontidal/ Tidal	Action (gain/loss)	02130 105
Nontidal 1991-2004	Permanent impacts (regulatory)	-5.9
	Permittee mitigation	3.5
	Programmatic mitigation (MDE)	0.5
	Other Gains	0.8
	Net change (regulatory)	-1.1
Tidal 1996-2003	Permanent impacts (regulatory)	-0.2
	Mitigation	0
	Net change (regulatory)	-0.2
Nontidal/ Tidal 1998-2004*	Voluntary gains	213.6
Total		212.3

Tiner et al. (2000) estimated wetland function within the Coastal Bays watershed (Table 9). This assessment method did not take into account disturbance to the wetland, actual ecosystem health (e.g., water quality of adjacent waters), or difference between two wetlands of similar type.

Table 9. Wetlands within Newport Bay watershed having moderate to high potential to provide a given function within each Coastal Bays watershed. The total acreage of wetlands and percentage of wetlands providing the given function excludes ponds, deepwater habitats, and aquatic beds. Aquatic beds provide a habitat function for fish, shellfish, and waterfowl are also listed (Tiner et al., 2000).

Functions					Fish/ shellfish/ waterfowl habitat in aquatic beds (acres)	Total (acres)
Nutrient cycling (%)	Sediment deposition (%)	Surface water detention (%)	Coastal storm detention/ shore stabilization (%)	Fish/ shellfish/ waterfowl habitat (%)		
55	55	45	56	44	84	7,850

The following information is based on a 1998 report of wetland loss conducted by the Corp of Engineers (USACE, 1998). There has been a 10% loss of salt marsh area since 1900, with losses concentrated in the northern Coastal Bays (northern Coastal Bays had a loss of 37% salt marsh, or 1530 acres, while the Southern Coastal Bays had a loss of 228 acres). The northern bays, excluding Fenwick Island, had 580 acres of salt marsh loss, concentrated in Ocean Pines and Ocean City north of the inlet. Fenwick Island had 950 acres of salt marsh loss. A large portion of the once extensive zone of emergent salt marsh along the bayside of Fenwick Island is gone. In addition to direct wetland losses, coastal engineering and maintenance of the ocean city inlet may have prevented the natural formation of wetlands in some areas such as the bay side of Assateague Island.

Loss of forested wetland in the Coastal Bays due to conversion (e.g. filling) to agriculture and development was estimated at 44% or 24,768 acres total (21,000 acres converted to agriculture and 3,700 acres to development) (USACE, 1998). Once again, these losses were worse in the north than the south (52% or 13,562 acres and 37% or 11,205 acres, respectively). Most of the remaining wetlands (26,300 acres) have been hydrologically modified by artificial drainage to create forested uplands (e.g. timber plantations), agriculture, and urban area, so are no longer wetlands. For this reason, loss of non-tidal forested wetlands may be as high as 90%. Highest amounts of forested wetland loss occurred in the St. Martin River, Isle of Wight Bay, Manklin Creek, and Newport Bay subwatersheds. Sea level rise is also contributing to losses in wetland area (USACE, 1998). Structural shoreline stabilization practices, such as bulkheads and riprap, prevent encroachment from sea level rise that would have resulted in new tidal wetlands. Some threats to wetland function include jet skis, boating, and feral horses (Conley, 2004). Construction of long piers across the tidal marsh destroys wetland habitat under the pier, accelerates erosion, fragments the marsh system (degrading bird habitat), and allows invasion by non-native species (Ayella, 2004). In an attempt to reduce mosquitoes, ditches have been created in many of the tidal wetlands. Although the success of these efforts in reducing mosquitoes is questionable, these ditches clearly impact the natural wetland system.

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

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. It is also classified as a Category 3, a pristine or sensitive watershed in need of protection. Failing indicators include high nutrient concentrations, poor SAV abundance, poor non-tidal benthic index of biotic integrity (BIBI), and high historic wetland loss (17,025 acres). Indicators for Category 3 include migratory fish spawning areas and high amount of wetland-dependent species.

The *2002 Maryland Section 305(b) Water Quality Report* Stated that Newport Bay tidal embayment and tidal creeks and rivers failed to support all designated uses due to low oxygen from non-point sources and eutrophication. The tidal embayment also had high macroalgae. A tributary to Newport Bay had elevated levels of turbidity (DNR, 2000). Nontidal wadeable tributaries had portions (2.9 miles) that failed to fully support all designated uses due to a poor biological community and portions (11.6 miles) that had inconclusive results.
Surface water bodies that are on the 2004 Impaired Surface Water 303(d) List and either are in need of a TMDL or have a completed TMDL but are still impaired, are as follows:

- *Kitts Branch subwatershed* (021301050685): poor biological community
- A TMDL was approved for Ayer Creek, Newport Creek, Newport Bay mainstem, and biochemical oxygen demand TMDL for Kitts Branch.

A TMDL was completed in 2002 for Ayer Creek, Newport Creek, Newport Bay, and Kitts Branch. Ayer Creek, Newport Bay, and Newport Creek are impaired by nutrients and have excessive algal blooms and low dissolved oxygen. Ayer Creek total nitrogen loads are from agriculture (73%), direct groundwater discharge (10%), direct atmospheric deposition (2%), urban (4%), and forest/herbaceous (11%). Ayer Creek total phosphorus is from agriculture (84%), urban (8%), and forest/herbaceous (8%). This subwatershed has no point source discharges. Newport Creek total nitrogen loads are from agriculture (60%), direct groundwater discharge (21%), direct atmospheric deposition (2%), urban (3%), and forest/herbaceous (14%). Newport Creek total phosphorus is from agriculture (79%), urban (9%), and forest/herbaceous (12%). This subwatershed has no point source discharges. Newport Bay total nitrogen loads are from agriculture (38%), point sources (30%), direct groundwater discharge (12%), direct atmospheric deposition (9%), urban (4%), and forest/herbaceous (7%). Newport Bay total phosphorus is from agriculture (67%), point sources (20%), urban (5%), and forest/herbaceous (8%). Kitts Branch has low dissolved oxygen. Kitts Branch contains a major point source discharge (Tyson Foods) and a minor point discharge (Kelly Foods). MDE set a TMDL for nitrogen in Ayer Creek, Newport Bay, and Newport Creek (a 45% reduction) and a TMDL for biochemical oxygen demand in Kitts Branch.

A Draft Water Quality Analysis was completed for fecal coliform in Newport Bay. This study found that designated uses related to fecal coliform were being met.

Water quality data from MDE in 1998, DNR in 1998, and MCBP in 1997-1999 are summarized below. The DNR nutrient synoptic surveys (part of the WRAS) conducted in 1999 and 2002 (Isle of Wight and St. Martin River) and 2003 (Newport, Sinepuxent, with a few stations in Chincoteague) are also included. There was a high concentration of sampling stations in the northern Coastal Bays (Figure 31). Median annual data (based on years 2001-2003) based on DNR and ASIS data and trends based on ASIS data as reported in the document *Draft Aquatic Ecosystem Health 2004, Maryland Coastal Bays Monitoring Report*, including nitrogen and phosphorus levels is also summarized below. The main tributaries of Newport Bay include Ayer Creek, Trappe Creek, Newport Creek, and Marshall Creek. Based on the 2003 nutrient synoptic survey, several locations had high or excessive nitrate/nitrite concentrations or yields, or had high orthophosphate concentrations (Primrose, 2003). These may be due to point sources, row crops, poultry manure stock-piling or application, and septic systems. Kitts Branch was influenced by high BOD levels from Tyson Food, Inc, and had extremely high DIN and DIP, and chlorophyll a levels above 15ug/l. Some site had excessive estimated nitrate/nitrite and orthophosphate yields, likely due to the point discharge (Kitts Branch at Flower St. and Kitts Branch at Rte. 346, Primrose, 2003) Trappe Creek had chlorophyll a levels exceeding 50ug/l. Ayer Creek had chlorophyll a levels above 50ug/l, high DIN, and high DIP. Newport Creek had chlorophyll a levels above 50ug/l and high DIN at the headwaters of Beaverdam Creek (a tributary to Newport Creek). Newport Bay has chlorophyll a levels above 15ug/l in low flow months. The headwaters of Marshall Creek had very high chlorophyll a levels, high DIN, and high DIP. Bottle Branch (at Harrison Road) had excessive orthophosphate yields likely due to the Berlin WWTP (Primrose, 2003). DO levels were below 5.0mg/l in all sampled areas of Newport Bay watershed, with DO < 2.5mg/l at Ayer Creek.

The DNR/MCBP STAC2004 draft report States that upper tributaries (Trappe Creek, Ayres Creek, Newport Creek and Marshall Creek) are severely enriched with nitrogen. Phosphorus enrichment appears to be widespread with few sites meeting SAV threshold for TP. The SAV chlorophyll threshold was not met in upper Newport Bay. STAC chlorophyll threshold show hypereutrophic conditions are present in Trappe Creek. Daytime measurements show that DO falls below 5 mg/l during the summer months in areas of Newport Bay.

The Stream Waders Program monitored 6 sites, finding family IBI values of very poor to poor. The one site monitored in the 1997 MBSS had benthic IBI rating of very poor. There were 2 sites monitored by the 2001 MBSS, finding that fish IBI was fair and benthic IBI was very poor to poor. The three sites monitored in the 2003 DNR Nutrient Synoptic Survey had benthic IBI of very poor. DNR conducted a stream corridor assessment for this watershed in 2003. Data will be available shortly.

Aureococcus, an algae that causes brown tides, was reported at high densities in Newport Bay (Tarnowski and Bussell, 2002).

There are two major point sources to this bay: Berlin WWTP that discharges in winter months to Bottle Branch, a tributary to Trappe Creek, and Tyson Food, Inc. that discharges into Kitts Branch, a tributary to Trappe Creek (MDE, 2002b). Other point sources include: Kelly Foods Corp, Newark WWTP, Ocean City Ice and Seafood, and Berlin Shopping Center (now closed).

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. There are many hydric soils that are not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands). These include along some of the waterways and in the headwaters. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

During the 2003 Stream Corridor Assessment (Patterson and Yetman, 2004), over 130 stream miles were surveyed and 211 potential environmental problems were identified. Problems included channel alteration (72 sites), inadequate stream buffer (70 sites), pipe outfall (19 sites), fish barriers (17 sites), stream bank erosion (14 sites), unusual conditions (12 sites), trash dumping (6 sites), and exposed pipe (1 site).

The main Green Infrastructure hubs are around Newport Bay and the headwaters of Ayer Creek, with only small corridors connecting the hubs. This GI network is unprotected. Restoration to natural vegetation may be desirable in areas of GI "gaps." According to the Maryland Greenways Commission, an existing greenway within this watershed is called Assateague Island National Seashore, running along both Assateague Island and the mainland shoreline.

Restoration of hydrology in these extensive ditched tidal wetlands is currently being considered by the Coastal Wetlands Initiative (CWI), a partnership that includes the Maryland Departments of Natural Resources, Environment, and Agriculture, and the U.S. Fish and Wildlife Service. Goals are to protect and restore upland and saltmarsh habitat in the Maryland Coastal Bays. Most restoration activities will involve modifying mosquito ditches to restore hydrological conditions that will enable SAV and fish to recolonize areas of the saltmarsh where they were historically found. A grant has been received through the North American Wetland Conservation Act (NAWCA) funds to enhance 400 acres of saltmarsh at E.A. Vaughn WMA by partially blocking mosquito ditches.

There are several reference communities of tidal wetlands on Assateague National Seashore (Harrison 2001). The community *Typha (latifolia, angustifolia)/Hibiscus moscheutus* (Cattail/Rose mallow) is found in slightly brackish (oligohaline) to brackish (mesohaline0 systems that are subject to daily tidal inundation. *Juncus roemerianus* (black needlerush) is found in brackish to salt (polyhaline) systems with daily tidal inundation and are generally found on sandy substrates. *Phragmites australis* (Common reed) may be found in waters from fresh to brackish salinity, and is often considered to be an invasive species in need of control.

There are two State-designated Nontidal Wetlands of Special State Concern within this watershed, as described below.

- *Ironshire Swamp*. Although this site is listed in COMAR under the name Ironshire Swamp, DNR Natural Heritage Program has combined it with the WSSC Porter Neck Bog, and it is now described under that name.
- *Porter Neck Bog*. This is a forested seepage wetland containing three RTE species and two State "Watch List" species. This site is located in the Porter Creek headwaters. The spring needs to be protected. Natural disturbance to maintain the open vegetative structure is necessary for the sensitive species. In the absence of this natural disturbance (the current condition), woody succession should be manually controlled. This area is not protected. (DNR, 2003a).

DNR Natural Heritage Program proposed additional wetland areas to be classified as WSSC. These sites have characteristics that qualify as Nontidal Wetlands of Special State Concern, but are not currently designated as such. The DNR 2003 document *Nontidal Wetlands of Special State Concern of Five Central Maryland Counties and Coastal Bay Area of Worcester County, Maryland* summarizes most of these sites:

- *Icehouse Branch*. This tidal creek has characteristics of the rare sea-level fen and contains five RTE plant species and one "Watch List" species. Avoid logging in the surrounding forest. Protect wetland buffers.
- *Massey Branch*. This is a brackish marsh with characteristics of a rare sea-level fen. There are three RTE plant species and two "Watch List" plant species, mostly located in this ecotone between the brackish marsh and forest. The surrounding watershed, including an adequate buffer, should be maintained to limit impacts from agricultural runoff and development, since these plant species generally require healthy water quality. The landowners should be contacted to encourage protection.
- *St. Lawrence Neck*. This site contains rare sea-level fen habitat, two RTE plant species, and one "Watch List" species. Additionally, there are areas of wet forest, salt marsh, and a seepage slope. Some areas are now tidally influenced due to ditches. Overall protection of the sea-level fen and slope are top priority. Logging should be avoided in the wetland, buffer, and upland forest to reduce impacts from erosion and runoff. One of the rare species benefits from mowing along Langmaid Road. Fire or manual removal of woody vegetation should be employed to control woody succession in the seepage areas.

SHA used the method described in the *Highway Methodology Workbook* to determine the mitigation plan for Route 113 for selecting sites to satisfy current wetland mitigation requirements. It was not meant as a long-tem plan for wetland restoration/mitigation. Additionally, they focused only on areas near the impacted sites.

When determining potential restoration sites within WRAS, Worcester County looked for sites within the general areas designated by the Watershed Characterization. These included:

- Hydric soils. Digitized soil data was based on the Natural Soil Groups Classification developed by Maryland Department of Planning. "Hydric soil"

status may have been difficult to establish due to vague groupings used in the Natural Soil Groups and changes in "hydric soil" definition since the groupings were made.
- Wetness of soil. DNR estimated nutrient retention of soil assuming higher wetness of soil equates to higher nutrient retention.
- Adjacent land use. Select hydric soils between a stream and cropland.
- Proximity to wetlands. Select hydric soils within 300 feet of a wetland.
- The DNR water quality and macroinvertebrate community data (Primrose, 1999).
- Stream Corridor Assessment data (Czwartacki and Yetman, 2002).

The Worcester County Comprehensive Plan suggests maintaining areas of high recreational value, including Trappe Creek.

Many of the Coastal Bays tidal wetlands are ditched in an effort to reduce mosquitoes. During ditch maintenance, the ditches are dredged with the sediment being thrown to the sides (on the marsh surface). It is unclear whether this ditching actually reduces mosquitoes. Since this ditching alters the natural wetland system (e.g., altering accessibility of fish and possibly reducing wetland nutrient/pollutant filtration), the wetlands may benefit from mosquito ditch removal. Restoration of hydrology in these extensive ditched tidal wetlands is currently being considered.

In the document entitled *Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report*, Tiner et al., (2000) proposed wetland restoration sites in the Coastal Bays watershed totaling 25,365 acres. These sites were classified into two categories: former wetlands (Type 1) and existing impaired wetlands (Type 2). They were scattered throughout the watershed. Type 1 sites included filled wetlands (without any buildings on them), farmed wetlands, and those converted to deepwater. He did not include any additional sites with hydric soils. The Type 2 sites were classified as wetlands in the Tiner study. These included impounded, excavated, ditched, tidally restricted, and shallow pond wetlands. The majority of wetlands were classified as Type 2. Potential wetland function was not evaluated.

When determining potential restoration sites within WRAS, Worcester County looked for sites within the general areas designated by the Watershed Characterization. These included:
- Hydric soils. Digitized soil data was based on the Natural Soil Groups Classification developed by Maryland Department of Planning. "Hydric soil" status may have been difficult to establish due to vague groupings used in the Natural Soil Groups and changes in "hydric soil" definition since the groupings were made.
- Wetness of soil. DNR estimated nutrient retention of soil assuming higher wetness of soil equates to higher nutrient retention.
- Adjacent land use. Select hydric soils between a stream and cropland.
- Proximity to wetlands. Select hydric soils within 300 feet of a wetland.
- The DNR water quality and macroinvertebrate community data (Primrose, 1999).

- Stream Corridor Assessment data (Czwartacki and Yetman, 2002).

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.
    - High nutrient concentrations based on nutrient synoptic survey for Newport/Sinepuxent Bays (Primrose, 2003)
        - Station 1. Tributary to Marshall Creek at Langmaid Road
        - Station 14. Bottle Branch at Harrison Road
        - Station 15. Kitts Branch at Flower Street
        - Station 17. Kitts Branch at Rte. 346
        - Station 18. Kitts Branch at railroad tracks near Rte. 50
        - Station 29. Tributary to Trappe Creek at Rte. 376
        - Station 30. Tributary to Kitts Branch at Seahawk Road
        - Station 31. Ayers Creek at Sinepuxent Road
        - Station 41. Poplartown Branch at Beaverdam Creek Road.
    - Trappe Creek (Chaillou et al., 1996; MDE, 2002b; Worcester County, 1989)
    - Ayer Creek (MDE, 2002b)
    - Newport Bay (Chaillou et al., 1996; MDE, 2002b)
    - Newport Creek (MDE, 2002b)
    - Restore "gaps" in the Green Infrastructure network to natural vegetation.
    - Restore/create wetlands designed to remove nitrogen from the waterways Ayers Creek, Newport Bay, and Newport Creek and BOD from Kitts Branch.
    - Enhance ditched tidal wetlands.
    - Restore sites based on recommendations from SCA and WRAS.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
    - Protect areas within the Green Infrastructure network.
    - Protect WSSC and buffers.
    - Protect the DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain Federally-listed species, State-listed species, or areas of concern to DNR, but with no official status.
    - Protect wetlands that function to remove nitrogen from the waterways Ayers Creek, Newport Bay, and Newport Creek and BOD from Kitts Branch.
    - Protect tidal wetland reference sites, while managing for *Phragmites* as needed.

<u>Chincoteague Bay (02130106)</u>

Background

Based on MDP 2002 GIS land use data, the Chincoteague Bay watershed has 46,379 acres of open water and 42,732 acres of land. The land acres are divided as follows: urban 678 acres (2%), agriculture 14,179 acres (33%), forest 17,129 acres (40%), wetlands 9,829 acres (23%) and barren land 916 acres (2%). 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 Worcester County-owned Big Millpond is located within this watershed, near Welbourne. It is on Swan Gut Creek and is fed by Little Mill Run, Marshall Ditch, and Payne Ditch (MDE, 2002c). The streams are mainly shallow and slow moving, with headwater streams often having been ditched. A frequently encountered environmental concern is the lack of riparian buffers.

Some of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data). In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas are classified as "prime farmland when drained." While it may not be desirable to exclude all soils classified as "prime farmland when drained" from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

The following information is based on the 2005 WRAS characterization (Shanks, 2005). Chincoteague Bay, at roughly 46,483 acres, is the largest waterbody in the Coastal Bays of Maryland. This bay is separated from the Atlantic Ocean by Assateague Island, a barrier island. Portions of Assateague Island, along with a portion of the mainland, drain into this bay. There are roughly 182 stream and ditch miles. About half of the streams/ditches adjacent to agricultural land are hydric soils.

In 2002, 80 species of fish were sampled in this watershed, largely dependent upon the estuarine system (e.g. croaker, summer flounder, weakfish, spot, striped bass, black sea bass). While oysters were once abundant in this region, due to predation, disease, and overharvesting, few remain. DNR is trying to reestablish bay scallops, and some have been reported in northern Chincoteague Bay during a 2003 Hard Clam Survey. While SAV coverage is much lower than historic levels, possibly due to disease in the 1930s, it has been increasing in recent years. While there is still more SAV acreage found along the eastern side of the bay (along Assateague Island), more recent SAV beds have formed in the western side of the bay (around Miller Island and Parker Bay, south side of Tizzard Island, north shore of Rowley Cove, and north shore of Brockanorton Bay). MBSS sampling in nontidal streams/ditches reported FIBI of the one sampled site was poor and BIBI of the two sampled sites were very poor (The Waterworks Creek tributary site) and poor (Powell Creek site). These findings suggest a poor habitat and/or poor water quality. Like all other impoundments in Maryland, there is a Statewide fish consumption advisory for fish due to methylmercury. The impoundment creating Big Millpond is a blockage to fish migration. There are many tracked sensitive species within this watershed, including 17 animal species and 43 plant species. There are also a large number of ecologically significant areas, 30, within the watershed. Based on a 2000 DNR Coastal Zone

Management Report, areas of low elevation on the mainland and barrier island may be affected by sea level rise. It is anticipated that DNR Coastal Zone Management Division and U.S. Geological Survey will develop a sea level rise inundation model for Worcester County shortly. Some types of harmful algae have been reported in Chincoteague Bay: Brown tide was found largely in the northern Chincoteague Bay, with lesser blooms around Taylors Landing and Pirate Islands. Pfiesteria and Chattonella have been reported around Marshall Creek and Massey Branch. (Shanks, 2005).

Coastal salt marshes are extremely productive (Sipple, 1999).

Mapped wetlands (based on DNR and NWI GIS data) are mainly located around the Bay and along the waterways, with additional significant wetlands in the interstream divides or in depressions. Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
    - Aquatic bed: 2 acres
    - Emergent: 8,720 acres
    - Scrub shrub: 203 acres
    - Forested: 18 acres
    - Unconsolidated bottom: 12 acres
    - Unconsolidated shore: 3,055 acres
- Marine unconsolidated shore: 77 acres
- Palustrine
    - Aquatic bed: 30 acres
    - Emergent: 259 acre
    - Scrub shrub: 158 acre
    - Forested: 2,798 acres
    - Unconsolidated bottom: 112 acres
    - Farmed: 87 acres
- Total: 15,532 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains (Table 10).

The 2004 document entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* discusses wetland gains/losses, water quality, and restoration in the Coastal Bays watershed. Some of the following paragraphs are from that document. Wetland gains and losses for this watershed, as tracked by MDE (Table 10). "Permanent impacts" includes permanent wetland losses that required a MDE permit. "Permittee mitigation" includes compensatory mitigation of wetland restoration or creation completed by the permittee, as required under their wetland impact permit. "Programmatic mitigation" includes compensatory mitigation of wetland restoration/creation completed by MDE using compensation fund money (permitees pay into the compensation fund for mitigation requirements rather than performing mitigation themselves). "Other gains" includes other wetland restoration/creation that required a permit. 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). "Voluntary gains" includes wetland restored/creation through other programs: NRCS Conservation Reserve Enhancement Program (CREP), NRCS Wetlands Reserve Program (WRP), USFWS, DNR, and Ducks Unlimited. Tidal wetlands data includes SAV, open water, mudflat, and vegetated wetlands (Clearwater, 2005). *2004 voluntary restoration records are incomplete.

Nontidal/ Tidal	Action (gain/loss)	02130106
Nontidal 1991-2004	Permanent impacts (regulatory)	-2.0
	Permittee mitigation	0
	Programmatic mitigation (MDE)	16.7
	Other Gains	3.9
	Net change (regulatory)	18.6
Tidal 1996-2003	Permanent impacts (regulatory)	0
	Mitigation	0
	Net change (regulatory)	0
Nontidal/ Tidal 1998-2004*	Voluntary gains	565.0
Total		546.4

The following information is based on a 1998 report of wetland loss conducted by the Corp of Engineers (USACE, 1998). There has been a 10% loss of salt marsh area since 1900, with losses concentrated in the northern Coastal Bays (northern Coastal Bays had a loss of 37% salt marsh, or 1530 acres, while the Southern Coastal Bays had a loss of 228 acres). The northern bays, excluding Fenwick Island, had 580 acres of salt marsh loss, concentrated in Ocean Pines and Ocean City north of the inlet. Fenwick Island had 950 acres of salt marsh loss. A large portion of the once extensive zone of emergent salt marsh along the bayside of Fenwick Island is gone. In addition to direct wetland losses, coastal engineering and maintenance of the Ocean City inlet may have prevented the natural formation of wetlands in some areas such as the bay side of Assateague Island.

Loss of forested wetland in the Coastal Bays due to conversion (e.g. filling) to agriculture and development was estimated at 44% or 24,768 acres total (21,000 acres converted to agriculture and 3,700 acres to development) (USACE, 1998). Once again, these losses were worse in the north than the south (52% or 13,562 acres and 37% or 11,205 acres, respectively). Most of the remaining wetlands (26,300 acres) have been hydrologically modified by artificial drainage to create forested uplands (e.g. timber plantations), agriculture, and urban area, so are no longer wetlands. For this reason, loss of non-tidal forested wetlands may be as high as 90%. Sea level rise is also contributing to losses in wetland area (USACE, 1998). Structural shoreline stabilization practices, such as bulkheads and riprap, prevent encroachment from sea level rise that would have resulted in new tidal wetlands. Some threats to wetland function include jet skis, boating, and feral horses (Conley, 2004). Construction of long piers across the tidal marsh destroys wetland habitat under the pier, accelerates erosion, fragments the marsh system (degrading bird habitat), and allows invasion by non-native species (Ayella, 2004). In an attempt to reduce mosquitoes, ditches have been created in many of the tidal wetlands. Although the success of these efforts in reducing mosquitoes is questionable, these ditches clearly impact the natural wetland system.

Tiner et al. (2000) estimated wetland function within the Coastal Bays watershed (Table 11). This assessment method did not take into account disturbance to the wetland, actual ecosystem health (e.g., water quality of adjacent waters), or difference between two wetlands of similar type.

Table 11. Wetlands within Chincoteague Bay having moderate to high potential to provide a given function within each Coastal Bays watershed. The total acreage of wetlands and percentage of wetlands providing the given function excludes ponds, deepwater habitats, and aquatic beds. Aquatic beds provide a habitat function for fish, shellfish, and waterfowl are also listed (Tiner et al., 2000).

Functions					Fish/ shellfish/ waterfowl habitat in aquatic beds (acres)	Total (acres)
Nutrient cycling (%)	Sediment deposition (%)	Surface water detention (%)	Coastal storm detention/ shore stabilization (%)	Fish/ shellfish/ waterfowl habitat (%)		
67	72	29	65	56	5,947	16,505

Code of Maryland Regulations
All Maryland stream segments are categorized by Sub-Basin and are given a “designated use” in the Code of Maryland Regulations 26.08.02.08. Waterways not specifically designated within COMAR are classified Use I, water contact recreation and protection of aquatic life. All estuarine portions are designated: Use II, shellfish harvesting.

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 high historic wetland loss (28,820 acres). Indicators for Category 3 include high imperiled aquatic species indicator, migratory fish spawning area, and high amounts of wetland-dependent species.

The *2002 Maryland Section 305(b) Water Quality Report* States that Chincoteague Bay failed to support all designated uses due to bacteria, low oxygen, and macroalgae from non-point sources, low tidal flushing, and natural sources. The nontidal wadeable tributaries had portions (1.4 miles) that did not support all uses due to a poor biological community, while the majority (11.1 miles) had inconclusive results. Big Mill Pond (60.2 acres), failed to fully support all designated uses due to nutrients, siltation, and low oxygen levels from non-point sources, natural sources, upstream sources, and sediment oxygen demand (SOD). Surface water bodies that are on the 2004 Impaired Surface Water 303(d) List and either are in need of a TMDL or have a completed TMDL but are still impaired, are as follows:

- *Chincoteague Bay* (tidal): nutrients (causing low seasonal DO <5mg/L)
- *Powel Creek* (021301060671 non-tidal): poor biological community
- *Waterworks/South Creek* (021301060680 non-tidal): poor biological community
- *Fifteen Mile Branch* (021301060680 non-tidal): poor biological community
- *Big Mill Pond*; TMDL was approved for nutrients.

A TMDL was completed for phosphorus and sediment in Big Millpond, summarized as follows. Excessive sedimentation, occasional algal blooms, and low dissolved oxygen are resulting in this waterway not supporting recreation uses. There are no point sources within the watershed of this impoundment. MDE is requiring the following pollutant reductions: 69% reduction in phosphorus in Big Millpond (in Chincoteague Bay watershed).

A Draft Water Quality Analysis was completed for fecal coliform in Chincoteague Bay. This study found that designated uses related to fecal coliform were being met.

Water quality data from MDE in 1998, DNR in 1998, ASIS (Assateague Island National Park Service) in 1998, and MCBP in 1997-1999 are summarized below. The DNR nutrient synoptic surveys (part of the WRAS) conducted in 2003 (Newport, Sinepuxent, with a few stations in Chincoteague) are also included. Median annual data (based on years 2001-2003) based on DNR and ASIS data and trends based on ASIS data as reported in the document *Draft Aquatic Ecosystem Health 2004, Maryland Coastal Bays Monitoring Report*, including nitrogen and phosphorus levels is also summarized below. Chincoteague Bay had low flow chlorophyll a levels at or near 15ug/l, with one station reaching roughly 23ug/l in 1998. Elevated levels of chlorophyll a, DIN, and DIP were roughly near the shoreline, but were generally not as high as in the northern Coastal Bays. Dissolved oxygen levels were consistently above 5mg/l. Big Millpond had excessive phosphorus and sediment loads. Polluted water from Newport Bay drains into Chincoteague Bay, reducing water quality (USACE, 1998).

The *DNR/MCBP STAC2004 draft report State*s southern Chincoteague Bay has some of the lowest total nitrogen. Phosphorus enrichment appears to be more widespread with few sites meeting SAV threshold for TP. The SAV chlorophyll threshold was met in Chincoteague Bays.
Daytime measurements show that DO falls below 5 mg/l during the summer months in areas of Chincoteague Bay near Figgs Landing and Green Run Bay.

Public Landing Harbor Marina discharges into this bay.

According to MDE, there is a small restricted shellfish harvesting area in Johnson Bay.

Chincoteague Bay is polyhaline, greater than 18ppt salinity, generally ranging between 23 and 36 ppt. Water quality is generally better than other Maryland Coastal Bays, like Newport and St. Martins. In the Chincoteague Bay open tidal waters, water quality is good/excellent south of Figgs Point and good/fair north of Figgs Point. Near-shore areas, Johnson Bay and Public Landing, was poorer than the open water sections. While DO levels are generally above 5.0mg/l, they sometimes drop lower in near-shore locations, including around Figgs Landing and Green Run Bay, during summer months. Chlorophyll a is generally low (below 15 ug/l), but were higher during summer months near Public Landing and Taylor Landing (between 15 and 50 ug/l). It is suggested that nitrogen is the limiting nutrient in this bay. Nitrogen concentrations were generally below 1.0 mg/l, with lowest levels in the southern bay. While phosphorus is generally below 0.1 mg/l, TP levels in Johnsons Bay and near Public Landing were higher than in the more open water areas. (with some moderate readings occasionally reported). Areas north of Public Landing have excessive nutrients. In nontidal portion, some streams have elevated nitrogen and elevated phosphorus. DO in Big Millpond can drop below 2 mg/l in summer months and chlorophyll a levels can be fairly high (between 20 and 20 mg/l) while upstream tributaries had much better water quality. Phosphorus was high in the pond and upstream tributaries. Total nitrogen was also high in the pond, Payne Ditch, and twice as high in Little Mill Run. While groundwater generally had nitrate levels less than 1 mg/l, some areas (including near Big Millpond and Lower Scarboro Creek) had elevated nitrates. (Shanks, 2005)

SAV is increasing in Chincoteague Bay, and as a result bay scallops have begun to appear (and some areas have been stocked by DNR). The majority of the SAV is currently located on the bay side of the barrier islands and in extensive beds within Chincoteague Bay (Figure 2). Small SAV beds have also spread out along the mainshore coastline in sandy bay-bottom sediments.

The Stream Waders Program monitored 20 sites from this watershed in 2001. Results found non-tidal family benthic index of biotic integrity ratings from very poor (15 out of 20 sites) to fair. The one station monitored in the 1997 MBSS found a benthic IBI of poor. There were three stations monitored in the 2001 MBSS. These sites had poor fish IBI and very poor to poor benthic IBI. The two sites monitored in the 2003 DNR Nutrient Synoptic Survey had benthic IBI of poor and very poor. DNR is currently conducting a stream corridor assessment for this watershed (in 2004). Data will be available in 2004/2005.

A study conducted by DNR in 1998 and 1999 looked at frequency and abundance of macroalgae species in the Coastal Bays (Goshorn et al., 2001). Of the 25 genera found, the top most abundant were *Agardhiella* and *Gracilaria*. The abundance of “nutrient responsive algae,” algae species assumed to benefit from nutrient enrichment (*Enteromorpha* spp., *Ulva lactuca*, *Cladophora vagabunda*, *Gracilaria tikvahiae*, *Chaetomorpha* spp., and *Agardhiella* spp.), was highest in Isle of Wight Bay and southern Chincoteague Bay.

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. There are many hydric soils that are not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands), located throughout the watershed. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

In 2004 a nutrient synoptic survey was completed for Chincoteague Bay watershed (Primrose, 2004). Of the 36 subwatersheds sampled, nitrate/nitrite concentrations were excessive in five, high in eight, and moderate in seven. Most of the excessive concentrations were associated with animal and row crop agriculture in the vicinity of Stockton and Greenbackville or with concentrated septic systems. Of the 34 subwatersheds sampled for orthophosphate, concentrations were excessive in eleven, high in eight, and moderate in eight. These elevated levels are scattered throughout the subwatersheds, but may be linked to water columns having fine suspended sediments loads with phosphorus-rich soils. These higher concentrations also appear in areas lacking forest cover. Since orthophosphate yields are generally low throughout the sampled subwatersheds, impact to Chincoteague Bay is likely minor. Overall, when compared to other Eastern Shore watersheds, this watershed has low nutrient concentrations., likely due to the high percentage of forest and wetland cover. Based on this survey, overall conclusions are that the lower areas in the watershed and the population areas have the highest nutrient levels. Septic systems and intense row crop agriculture are contributing nutrients to groundwater in areas with well-drained soils.

A stream corridor assessment was completed for Chincoteague Bay watershed in 2004 (Pellicano and Yetman, 2004). Of the 79 stream miles walked, there were 158 potential environmental problems. These problems included channel alteration (66 sites), inadequate stream buffer (63 sites), stream bank erosion (11 sites), fish barriers (6 sites), trash dumping (6 sites), unusual conditions (2 sites)pipe outfalls (2 sites) and exposed pipe (1 site). Most of the problems ranged from minor to moderate severity.

Green Infrastructure covers much of this watershed, including all of Assateague Island and large portions of the mainland shoreline. Protected land includes Assateague Island National Seashore, E.A., DNR-owned Chesapeake Forest land, and several large METs. There are still many unprotected GI hub areas that should be protected. It is desirable that GI corridor “gaps” be restored to natural vegetation. According to the Maryland Greenways Commission, there are three proposed or existing greenways within this watershed:

- *Snow Hill Rail Trail*
- *Assateague Island National Seashore*. This greenway runs along both Assateague Island and the mainland shoreline.
- *Sinepuxent Bay Water Trails*

The following information is based on the document *Rural Legacy FY 2003: Applications and State Agency Review*. The Coastal Bays Rural Legacy Area includes approximately 16,200 acres. This area is currently largely undeveloped (98%). This area was chosen in order to protect Chincoteague Bay waterfront, agriculture, forest, wetlands, water quality, and wildlife. It is also intended to create a greenbelt between E.A. Vaughn WMA, Pocomoke State Forest, and Assateague Island Seashore and encourage tourism and recreation. The goal is to protect 8,500 acres (52%). Currently, 5,800 acres (36%) of this land is protected through various methods. The sponsor is Worcester County. The report also includes a list of property owners who are interested in selling an easement and the priority of acquiring these easements. Since the Rural Legacy Program funds are not adequate enough to support all of these requests, other programs should consider preservation of these sites.

Many of the Coastal Bays tidal wetlands are ditched in an effort to reduce mosquitoes. During ditch maintenance, the ditches are dredged with the sediment being thrown to the sides (on the marsh surface). It is unclear whether this ditching actually reduces mosquitoes. Since this ditching alters the natural wetland system (e.g., altering accessibility of fish and possibly reducing wetland nutrient/pollutant filtration), the wetlands may benefit from mosquito ditch removal. Restoration of hydrology in these extensive ditched tidal wetlands is currently being considered by the Coastal Wetlands Initiative (CWI), a partnership that includes the Maryland Departments of Natural Resources, Environment, and Agriculture, and the U.S. Fish and Wildlife Service. Goals are to protect and restore upland and saltmarsh habitat in the Maryland Coastal Bays. Most restoration activities will involve modifying mosquito ditches to restore hydrological conditions that will enable SAV and fish to recolonize areas of the saltmarsh where they were historically found. A grant has been received through the North American Wetland Conservation Act (NAWCA) funds to enhance 400 acres of saltmarsh at E.A. Vaughn WMA by partially blocking mosquito ditches.

The following information is based on discussions with Bruce Nichols from NRCS. This restoration is not a targeting effort but is instead based on opportunity. They do a mixture of restoration techniques, including plugging ditches and excavating to create a berm. Sites are chosen on hydric soils (with a few exceptions), since they are so extensive in the area. Many successful projects have been completed through this program on agricultural fields and drained forest. Some projects have even resulted in habitat for uncommon species. They allow and even encourage responsible timber harvesting within restored wetlands because by making the wetlands economically important, the program will be more successful. The majority of wetland restoration through this program is located in Chincoteague Bay watershed.

In the document entitled *Watershed-based Wetland Characterization for Maryland's Nanticoke River and Coastal Bays Watersheds: A Preliminary Assessment Report*, Tiner et al., (2000) proposed wetland restoration sites in the Coastal Bays watershed totaling 25,365 acres. These sites were classified into two categories: former wetlands (Type 1) and existing impaired wetlands (Type 2). They were scattered throughout the watershed. Type 1 sites included filled wetlands (without any buildings on them), farmed wetlands, and those converted to deepwater. He did not include any additional sites with hydric soils. The Type 2 sites were classified as wetlands in the Tiner study. These included impounded, excavated, ditched, tidally restricted, and shallow pond wetlands. The majority of wetlands were classified as Type 2. Potential wetland function was not evaluated.

Assateague Island is protected by federal and State governments and provides habitat and recreational opportunities for swimming, boating, fishing, and camping. The island provides habitat for several important species, including the piping plover species, a federally threatened species; the beach tiger beetle, a State endangered species (USACE, 1998); and Peregrine falcons.

Three Coastal Bays wetlands were identified by the Emergency Wetlands Resources Act of 1986 as being especially important to waterfowl. These wetlands are all located in the Chincoteague Bay near Stockton and include: Big Bay Marshes, Mills Island, and Tizzard Island.

There are several reference communities of tidal wetlands on Assateague National Seashore (Harrison 2001). The community *Typha (latifolia, angustifolia)/Hibiscus moscheutus* (Cattail/Rose mallow) is found in slightly brackish (oligohaline) to brackish (mesohaline) systems that are subject to daily tidal inundation. *Juncus roemerianus* (black needlerush) is found in brackish to salt (polyhaline) systems with daily tidal inundation and are generally found on sandy substrates. *Phragmites australis* (Common reed) may be found in waters from fresh to brackish salinity, and is often considered to be an invasive species in need of control.

A tidal wetland reference community of *Iva frutescens/Spartina patens* (Marsh elder/salt meadow cordgrass) is found along Parker Bay at the E.A. Vaughn Wildlife Management Area. These communities are subject to daily or irregular flooding by brackish (mesohaline) water. Low species diversity is often common, and decreases with increasing salinity. Microtopography is variable, from nearly level to having hummocks and hollows (Harrison and Stango, 2003).

Wetlands at the E.A. Vaughn Wildlife Management Area have been treated to control *Phragmites* (DNR, 1998).

There are several State-designated Nontidal Wetlands of Special State Concern within this watershed, as described below.

- *Hancock Creek Swamp*. This site is located south of Stockton. It is a mature deciduous swamp surrounded by steep forested slopes. It contains a State-threatened species (also globally rare), a State-endangered plant species, and a State “Watch List” plant species. The main threat is logging in the wetland, the buffer, and the surrounding forested slopes. The majority of this area is not protected. (DNR, 2003a).
- *Little Mill Run*. This site is located along Little Mill Run, Marshal Ditch, Marshall Mill Run, Payne Ditch and Big Millpond. This is a diverse wetland complex of bottomland forest, seepage wetland, and aquatic habitat including open water at Big Millpond. It has some areas of steep slopes along Little Mill Run. This site contains three threatened or endangered plant species, a vulnerable threatened species, and a vulnerable species “In Need of Conservation.” Recently, canopy gaps created during

tornadoes have allowed oriental stilt grass to invade the site. Tornadoes have created canopy gaps allowing invasive vegetation (Oriental stilt-grass) to establish. Although herbicides are generally needed to control this grass, it is not recommended in this case since it would likely harm the sensitive species. Additionally, the floodplain and surrounding slopes should be protected and logging should be avoided in the wetland, buffer, and surrounding uplands. A small portion of this area is protected. (DNR, 2003a).

- *PawPaw Creek*. This wetland/stream complex is unusual for the lower coastal plain, having a relatively steep bluff and topography more similar to the Piedmont in one section (DNR, 1987). The lower section is low open forest. This site contains two threatened species (one which is globally rare), and a State "Watch List" plant species. – Main threats include trail development and mowing. While the sensitive species require some natural disturbance, direct disturbance would harm them. Japanese honeysuckle is present and should be monitored, but no action is recommended at this time. This area is not protected (DNR, 2003a).
- *Pikes Creek*. This site contains Pikes Creek and Stockton Powerlines, since they are a connected system.
    - *Pikes Creek*. One of the habitats at this site, mature bottomland hardwood forests are fairly rare for the region due to past draining and clearing. Although forest covered the majority of the site only a decade ago, many areas have been recently clear-cut. Plant species at this site are more common in the Piedmont than the Eastern Shore (DNR, 1991). This site contains a State-threatened species (DNR, 2003a). The surrounding habitats contain other threatened or endangered species (DNR, 2002a). The important plant species generally occur under the powerline right-or-way or in the recent clear-cut areas (DNR, 2002a). Logging should be avoided in the wetland and buffer. This area is partially protected (DNR, 2003a).
    - *Stockton Powerlines*. This is a bog-like wetland that was once fairly common to the region, but is now unusual (DNR, 1987). This site is located in the headwaters of Chincoteague Bay, so is important for the bay's water quality (DNR, 1991). It contains seven State-RTE species and two State "Watch List" species. This site is located in the headwaters of Chincoteague Bay, so contributes to the Bay's water quality (DNR, 1987). Fire or manual woody succession suppression is necessary to maintain the open habitat required of the sensitive species. Most of this area is protected. (DNR, 2003a).
- *Powell Creek*. This mature deciduous forested wetland (DNR, 1987) is located along Powell Creek and is surrounded by steep forested slopes. It has a State threatened (also considered to be globally rare) species and other uncommon plant species (DNR, 2003a). Forest interior birds are also present (DNR, 1987). Logging should be avoided in the wetland and buffer. The surrounding slopes and upland area should also be protected. This area is unprotected (DNR, 2003a).
- *Riley Creek Swamp*. This deciduous forested wetland contained a State-threatened (also considered globally rare) species during past surveys (although not found in this 2003 survey). It is possible that the invasion of weedy species caused by nearby

bridgework and fallen trees is to blame. Most of the swamp is in good condition. Logging should be avoided in the wetland and buffer. Invasive plant species, especially near Greenback Road, should be manually controlled. This area is unprotected. (DNR, 2003a).

- *Scarboro Creek Woods*. This area is a mature deciduous forest and swamp within the headwaters of Scarboro Creek (DNR, 1987). It contains a State-threatened (also considered globally rare) species and two State "Watch List" plant species. Logging within the wetland and buffer should be avoided. The surrounding forest should also be maintained. The majority of this area is protected (DNR, 2003a).
- *Scotts Landing Pond*. This 1-acre herbaceous Delmarva Bay, or seasonal depression wetland, is in good condition (DNR, 2003a). It is one of the few naturally occurring open freshwater wetlands in this region (DNR, 1987). It is more unusual because it is rarely dry (DNR, 1991). It contains two State "Watch List" plant species and provides good amphibians habitat. This pond is very susceptible to changes in hydrology. There is a ditch connecting this pond to a nearby marsh system. In a high water event, salt water could be transported up this ditch and into the pond, essentially destroying the current vegetative system. It is recommended this ditch be plugged. Additionally, any new nearby wells could reduce the water table and substantially alter the critical hydrology. Woody species may need to be manually removed in the future to control woody succession. Logging should be avoided in the buffer. This area is not protected (DNR, 2003a).
- *Tanhouse Creek*. This swamp forest is unusual for the lower coastal plain, having a relatively steep topography (DNR, 1987). There is a diverse sedge community present and two RTE species (one also considered globally rare). This wetland is surrounded by diverse forest. Logging in the wetland, buffer, and upland forest should be avoided. Oriental stilt-grass, entering the site from the logging road to the south, should be controlled through herbicidal spraying. This area is not protected (DNR, 2003a).

DNR Natural Heritage Program proposed additional wetland areas to be classified as WSSC. These sites have characteristics that qualify as Nontidal Wetlands of Special State Concern, but are not currently designated as such. The DNR 2003 document *Nontidal Wetlands of Special State Concern of Five Central Maryland Counties and Coastal Bay Area of Worcester County, Maryland* summarizes most of these sites:

- *Pikes Creek Woods*. This site will be surveyed by Natural Heritage Program soon. The main threat is alteration of the hydrology.
- *Spence Pond*. This site has three seasonal ponds containing one State-designated endangered plant species and two "Watch-List" plant species. It is surrounded by a pine plantation and has a logging road adjacent.
- *Truitt Landing*. This site contains a rare sea-level fen, two RTE species and two "Watch List" species. It also contains salt marsh and a seepage slope. Some areas are now tidally influenced due to the ditching. Overall protection of the sea-level fen and slope are top priority. Logging should be avoided in the WSSC, adjacent wetlands, buffer, and upland forest. Fire or manual removal of woody vegetation should be employed to control woody succession in the seepage areas.

- *Waterworks Creek*. This is a brackish marsh and mixed pine forest ecotone containing one rare plant species and one "Watch List" plant species. Threats include impacts to the water quality from agricultural runoff and development.

Specific recommendations for restoration:
- Restore wetlands and streams within the headwaters.
- *The northern end of Assateague Island*. There is a low amount of dune and salt marsh due to reduced sediment transport (USACE, 1998). DNR and the federal government own this island.
- Enhance tidal wetlands at E.A. Vaughn WMA by partially plugging ditches.
- *Chesapeake Forests land*. Located in the western portion of Chincoteague Bay watershed, these areas provide opportunities for wetland restoration and creation (DNR, 2003b).
  - *Bayside of Assateague Island* (high salt marsh loss) (USACE, 1998).
  - Restore "gaps" in the Green Infrastructure network to natural vegetation.
  - Restore/create wetlands designed to remove sediment and phosphorus from Big Millpond (MDE, 2002c)
  - Remove mosquito ditching where feasible.
  - Restore sites based on recommendations from the SCA and WRAS.

Specific recommendations for preservation:
- Protect wetlands and streams within the headwaters.
- Protect areas within the Green Infrastructure network.
- Protect WSSC and buffers.
- Protect Big Bay Marshes, Mills Island, and Tizzard Island.
- Protect the DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain Federally-listed species, State-listed species, or areas of concern to DNR, but with no official status.
- Protect wetlands that function to remove sediment and phosphorus from Big Millpond.
- Protect areas within the designated Rural Legacy Area.
- Protect tidal wetland reference sites (including around Mills Island), while managing for *Phragmites* as needed.

<u>Lower Pocomoke River (02130202)</u>

Background

The Worcester County portion of this watershed has roughly 79,933 land acres (based on MDP 2002 land use GIS data). Over half of the land use is forest (58%), followed by agriculture (36%), developed land (5%), and wetlands (1%). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR.

Some of the Worcester County portion of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data). While this is located throughout the watershed, large areas are west of the Pocomoke River. In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional some areas in the southeast portion of the watershed are classified as "prime farmland when drained." While it may not be desirable to exclude all soils classified as "prime farmland when drained" from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

The Pocomoke River was designated as a scenic river by the Maryland General Assembly. Lower Nassawango Creek, Mattaponi, and Hickory Point 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.
The Pocomoke River begins in the Great Cypress Swamp north of the MD-DE State line. In Maryland, it meanders southwest for 54 miles before draining into the Pocomoke Sound. Some of the northernmost Bald Cypress swamps and other wetlands border the river along its entire length. This river is the intersection for many northern and southern plants. The river generally has only a loosely defined bank and is often buffered by dense forest swamp. This river is home to the Delmarva Fox Squirrel, wood ducks, and other wildfowl. The lower Pocomoke is brackish up to Pocomoke City. This brackish area is a good shellfish, fish, and other aquatic life nursery and harvesting area. Above Pocomoke City, there is great fishing and hunting. The river is tidal between the Pocomoke Sound to above Whiton's Crossing (roughly 41 miles). The high amount of recreation occurring on the River may become a threat to the resource. (MDP, 1981)

The Pocomoke River below Pocomoke City is still fairly pristine in appearance, while above Porter's Crossing, much of the surrounding swamp has been channelized and ditched (Sipple, 1999).

Mapped wetlands (based on DNR and NWI GIS data) are mainly located along the Pocomoke River and tributaries. However, additional wetlands are located in the interstream divides and in depressions. Estimates of wetland acreage for the entire Maryland portion of the watershed, based on DNR mapped wetlands, are as follows:

- Estuarine
    - Emergent: 1,621 acres
    - Scrub shrub: 55 acres
    - Unconsolidated shore: <1 acres
- Palustrine
    - Emergent: 800 acres
    - Scrub shrub: 911 acres
    - Forested: 17,459 acres
    - Unconsolidated bottom: 304 acres
    - Farmed: 178 acres

- Riverine emergent: 7 acres
- Total: 21,337 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. (Table 12).

(Table 12). Wetland gains and losses for this watershed, as tracked by MDE. Based on data for the time period of January 1, 1991 through December 31, 2004, for the entire Maryland portion of the watershed, there has been a gain in wetlands (Walbeck, 2005).

Basin code	Permanent Impacts	Permittee Mitigation	Programmatic Gains	Other Gains	Net Change
02130202	-5.61	4.77	21.30	0.41	20.87

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. Stream segments not specifically listed in COMAR are designated Use I, recreation contact and protection of aquatic life. All estuarine portions (except Fair Island Canal and Pocomoke River above the MD/VA line) are designated Use II, shellfish harvesting.

Water Quality

The 1998 Clean Water Action Plan classified this watershed as "Priority" Category 1, a watershed not meeting clean water and other natural resources goals and therefore needing restoration. Since it is a "Priority" Category 1 watershed, this watershed was selected as being one of the most in need of restoration within the next two years since it failed to meet at least half of the goals. It is also classified as a "Selected" Category 3, a pristine or sensitive watershed most in need of protection. Failing indicators include high nitrogen and phosphorus loads, poor SAV abundance, low SAV habitat index, low benthic IBI, high amount of historic wetland loss (71,922 acres), high soil erodibility (0.31), and being on the 303(d) List for water quality impairment. Indicators of Category 3 include a high imperiled aquatic species indicator, containing four migratory fish spawning areas, a high percent of the watershed being forested (56%), and State-designated Wildlands (3,912 acres).

According to the *2002 Maryland Section 305(b) Water Quality Report*, the Lower Pocomoke River and tidal tributaries (from the mouth to Snow Hill) fail to fully support all designated uses due to low oxygen and elevated levels of bacteria from sources of municipal discharges, agriculture, non-point, natural, eutrophication, and blackwater. The 2002 305(b) also reports that some of the nontidal wadeable streams (i.e. Jones Ditch sub-watershed [2000]) do not fully support all designated uses due to the poor biological community from low oxygen and siltation.

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

- *Lower Pocomoke River* (tidal); fecal coliform, nutrients, sediments.
- *Jones Ditch* (021302020632 non-tidal in Worcester County); sedimentation.
- *Kelly Mill Branch* (021302020633 non-tidal in Worcester County); poor biological community.
- *Corkers Creek* (021302020633 non-tidal in Worcester County); poor biological community.
- *Wagnam Creek* (021302020628 non-tidal in Worcester County); poor biological community.
- *Wagnam Creek Unnamed Tributary* (021302020628 non-tidal in Worcester County); poor biological community.
- *Wagnam Swamp Branch* (021302020628 non-tidal in Worcester County); poor biological community.
- *Rehobeth Branch* (021302020625 non-tidal in Somerset County); poor biological community.
- *Poorhouse Branch* (021302020639 non-tidal in Worcester County); poor biological community.
- *Puncheon Landing Branch* (021302020627 non-tidal in Somerset County); poor biological community.

MBSS sampling found FIBI of good (only one site sampled) and BIBI of poor and very poor.

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. Most of the soils that are not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands) are hydric soils, which is a lot of land. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

Green Infrastructure is spread throughout the watershed, with the largest hub around Pocomoke River State Forest and the Pocomoke River. Some of this land is protected by Pocomoke River State Forest, DNR-owned Chesapeake Forest land, and TNC-owned Nassawango Creek Preserve. There are some additional protected lands, outside of the GI network, that are County-owned. There are still many unprotected GI hub areas that should be protected. It is desirable that GI corridor “gaps” be restored to natural vegetation. According to the Maryland Greenways Commission, there are three proposed or existing greenways within this watershed:

- *Snow Hill Rail Trail*
- *Pocomoke River Regional Greenway*
- *Bogiron Water Trail*. This existing water trail runs along the Pocomoke River and Nassawango Creek.

A partnership of the Department of Natural Resources, U.S. Fish and Wildlife Service (FWS), and the Nature Conservancy established a goal to protect and restore riparian habitat on the mainstem and tributaries of the Pocomoke River in Wicomico, Worcester, and Somerset Counties. In March 2006 Maryland submitted a North American Wetland

Conservation Act (NAWCA) Grant Proposal to FWS to purchase conservation easements from three willing landowners on properties with a total of 1187.5 acres of riparian forest, forested wetlands, and farmland. Approximately 655 acres of forested wetland will be enhanced by breaching a berm to allow improved access of the river to its floodplain (Murphy, 2006, Personal communication).

As part of an ongoing project to classify the vegetative communities in Maryland, DNR created the document entitled *Herbaceous Tidal Wetland Communities of Maryland's Eastern Shore.* In this document, they characterized 14 community types, with some being found in this County. A reference site, the best example of a particular community type, *Eleocharis (fallax,rostellata)* tidal herbaceous vegetation is located in Cypress Swamp (on the east side of Pocomoke River). This community type has a preliminary designation of SR. This site is within the DNR-owned Hickory Point Natural Heritage Area.

Hickory Point also supports the tidal wetland shrub community of *Morella cerifera-Rosa palsatris/Thelypteris palustris* (Wax Myrtle-Swamp Rose/Royal fern). The community is subject to regular tidal flooding by slightly brackish (oligohaline) waters. There is typically microtopography with hummocks and hollows (Harriosn and Stango, 2003).

Two forested tidal wetland reference communities are also found at Hickory Point. One community is *Taxodium distichum/Nyssa biflora/Bignonia capreolata* (Bald Cypress/Swamp Blackgum/Cross-vine), and is daily or irregularly flooded predominantly by fresh water. There is pronounced microtopography of hummocks and hollows (Harrison et al., 2004). This community is also found on the Pocomoke River in Pocomoke State Forest. The other Hickory Point community is *T. distichum/Carex hyalinolepsis* (Bald cypress/Shoreline sedge). These communities are relatively small, with daily to irregular flooding by fresh water, though there may be seasonal inputs of higher salinity water. There are moderate hummocks and hollows Harrison et al., 2004).

The following information is based on the document *Rural Legacy FY 2003: Applications and State Agency Review*. The Coastal Bays Rural Legacy Area includes approximately 16,200 acres. This area is currently largely undeveloped (98%). This area was chosen in order to protect Chincoteague Bay waterfront, agriculture, forest, wetlands, water quality, and wildlife. It is also intended to create a greenbelt between E.A. Vaughn WMA, Pocomoke State Forest, and Assateague Island Seashore and encourage tourism and recreation. The goal is to protect 8,500 acres (52%). Currently, 5,800 acres (36%) of this land is protected through various methods. The sponsor is Worcester County. The report also includes a list of property owners who are interested in selling an easement and the priority of acquiring these easements. Since the Rural Legacy Program funds are not adequate enough to support all of these requests, other programs should consider preservation of these sites.

There are several State-designated Nontidal Wetlands of Special State Concern (WSSC) within the Worcester County portion of this watershed.

- *Campground Branch*. This relatively undisturbed mature bottomland hardwood forest contains two State Endangered plant species and an uncommon tree. Because this is "old forest," the site also provides habitat for specialized birds and insects (DNR, 1991). This site is along the upstream portion of Campground Branch and is currently unprotected. DNR proposed that this site be removed from the designated WSSC list.
- *Hickory Point Cypress Swamp NHA*. This large wetland is adjacent to the Pocomoke River and is mostly protected by Pocomoke State Forest.
- *Lower Nassawango Creek NHA*. This large wetland is along the Nassawango Creek and Pocomoke River. Large portions of it, including the entire stretch along the Pocomoke River, are protected by the Nature Conservancy. Some portions (within Nassawango Creek watershed) remain unprotected.
- *Mattaponi NHA (also called Blades Sandpits)*. This large wetland is along the Pocomoke River and is mostly protected by Pocomoke State Forest.
- *Oak Hall Road Powerline*. This site contains two rare or uncommon species, including a healthy population of a State Endangered plant and an uncommon sedge. Historically, fire and beaver activity created canopy openings in the wetlands, critical for the survival of many different wetland plant species. As humans have suppressed these natural disturbances, these habitats (and plants that require them) have become rare. Powerline right-of-way maintenance recreates these unique habitats (DNR, 1991). This site is just outside of the Pocomoke River State Forest and is not currently protected.
- *Pocomoke Sand Ridge*. This wetland is adjacent to the Pocomoke River and is currently unprotected.
- *Poorhouse Branch*. This large wetland is at the confluence of the Pocomoke River and Poorhouse Branch (in the watersheds Lower and Upper Pocomoke River). It is only partially protected by the Pocomoke River State Forest.
- Potential WSSC. There are several potential WSSC.
    - This site is located in the headwaters of Acquango Branch and is protected by Chesapeake Forest Land.
    - This site is located in the headwaters of Hardship Branch and is partially protected by Chesapeake Forest Land.
    - This site is located in the headwaters of Pattys Branch and is currently unprotected.
    - This site is located in the headwaters of Corbin and Drexell Branchs and is currently unprotected.
    - This site is adjacent to the Pocomoke River and is protected by the Pocomoke River State Forest.
    - This site is on the border of Virginia and is currently unprotected.

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.
- Restore "gaps" in the Green Infrastructure network to natural vegetation.
- Restore riparian habitat of the Pocomoke River mainstem and tributaries.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
- Protect areas within the Green Infrastructure network, especially along the Pocomoke River and in the large GI hubs.
- Protect WSSC and buffers.
- Protect additional DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain State-listed species or areas of concern to DNR, but with no official status.
- Protect designated Rural Legacy Area.
- Protect any remaining Bald Cypress swamps along the Pocomoke River.
- Protect the mainstem of the Pocomoke River and tributaries.
- Protect tidal wetland reference communities.

Upper Pocomoke River (02130203)

Background

The Worcester County portion of this watershed has roughly 51,300 land acres (based on MDP 2002 land use GIS data). Over half of the land use is forest (58%), followed by agriculture (39%) and developed land (3%). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR.

Some of the Worcester County portion of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data). Main concentrations are located just outside of the Pocomoke River marshes. In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas in the far western and northern portions of the watershed are classified as “prime farmland when drained.” While it may not be desirable to exclude all soils classified as “prime farmland when drained” from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

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

The Pocomoke River was designated as a scenic river by the Maryland General Assembly.
Much of the swamp in the upper Pocomoke River has been channelized and ditched (Sipple, 1999).

The largest mapped wetlands (based on DNR and NWI GIS data) are along the Pocomoke River and tributaries. Smaller wetlands are scattered throughout. Estimates of wetland acreage for the entire Maryland portion of the watershed, based on DNR mapped wetlands, are as follows:

- Palustrine
  - Emergent: 63 acres
  - Scrub shrub: 779 acres
  - Forested: 17,310 acres
  - Unconsolidated bottom: 150 acres
  - Farmed: 431 acres
- Total: 19,309 acres

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. (Table 13).

(Table 13). Wetland gains and losses for this watershed, as tracked by MDE. Based on data for the time period of January 1, 1991 through December 31, 2004, for the entire Maryland portion of the watershed, there has been a gain in wetlands (Walbeck, 2005).

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

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

Water Quality

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

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

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

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

MBSS sampling found FIBI of good to very poor and BIBI ranging from fair to very poor. Some very poor sites were located along Timmonstown Branch, Fivemile Branch, Libertytown Branch, and some of the far northern tributaries of the Pocomoke.

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. Most of the soil that is not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands) is classified as hydric soil. Therefore, there is a lot. Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

Green Infrastructure covers much of this watershed, including along Pocomoke River, Old Mill Branch, Ninepin Branch, and Colbourne Branch. Only small portions of the GI hubs are protected by DNR-owned Chesapeake Forest land, Pocomoke River Corr. NHCP, small MET holdings, and small County-owned properties. There are still many unprotected GI hub areas that should be protected. It is desirable that GI corridor "gaps" be restored to natural vegetation. According to the Maryland Greenways Commission, a proposed greenway within this watershed is called Pocomoke River Regional Greenway.

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

There are three Nontidal Wetland of Special State Concern (WSSC) and a few potential WSSC within this watershed.

- *Burbage Crossing Swamp*. This site is along the Pocomoke River, just south of the Pocomoke Oxbow WSSC and confluence with Adkins Race. This is an old, diverse cypress swamp within the Pocomoke River floodplain. It also contains old Red Oaks. Due to the mature State of this forest, it provides habitat for special species including two State Endangered and one uncommon plant species. Some of the functions of this swamp include maintaining water quality, aesthetic quality, and habitat for the designated scenic Pocomoke River (DNR, 1991). This site is unprotected. DNR proposed that this site be removed from the designated WSSC list.
- *Delaware Wildlands*. While the majority of this wetland is within Worcester County, a portion is also within northeastern Wicomico. This 500-acre wooded wetland contains three animal species "In Need of Conservation," including a bird that requires forest interior dwelling habitat, an insect, and an amphibian. It also contains a State rare shrub (DNR, 1991). Only a small portion of this site is protected by Chesapeake Forest land, the remainder is unprotected.
- *Pocomoke Oxbow*. This site is a ¼ mile meander along the Pocomoke River, just upstream of the confluence with Adkins Race. Since it is isolated from the Pocomoke River by channelization in the 1940's, its only connection to the river is during periodic flooding in the winter and spring. This oxbow serves as a pond, providing habitat for amphibians and other animals. There is an old diverse hardwood forest adjacent to the oxbow that provides habitat for specialized animals and interior dwelling birds. The floodplain forest east of the oxbow contains two State Endangered species. There is also an interesting ferric rock outcrop east of the oxbow (DNR, 1991). This site is unprotected.

- *Poorhouse Branch*. This site is located at the confluence of the Pocomoke River and Poorhouse Branch. It is only partially protected by the Pocomoke River State Forest.
- *Potential WSSC*.
    - This large wetland is located along the Pocomoke River, near the confluences of Duncun Ditch and Tilghman Race (some is within Wicomico County). It is only partially protected by the Pocomoke River State Forest.
    - This site is in the headwaters of Colbourne Branch (also within Nassawango Creek watershed) and is partially protected by Chesapeake Forest.
    - This site is near the intersection of Voting House Road and Forest Lane and is unprotected.

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.
- Restore “gaps” in the Green Infrastructure network to natural vegetation, especially along the Pocomoke River.
- Restore the riparian habitat of the Pocomoke River mainstem and tributaries.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
- Protect areas within the Green Infrastructure network that are not protected, especially along the Pocomoke River.
- Protect WSSC and buffers.
- Protect the DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain Federally-listed species, State-listed species, or areas of concern to DNR, but with no official status.
- Protect any remaining Bald cypress swamp along the Pocomoke River.
- Protect the mainstem and tributaries of the Pocomoke River.

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

Background

The Worcester County portion of this watershed has approximately 26,529 land acres (based on MDP 2002 land use GIS data). The majority of land use is forest (80%), followed by agriculture (18%), development (1%) and wetlands (1%). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR.

Some of the Worcester County portion of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data), located mostly in the southern portion. In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas in the northern portion of the watershed are classified as "prime farmland when drained." While it may not be desirable to exclude all soils classified as "prime farmland when drained" from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

There are large areas of mapped wetlands (based on DNR and NWI GIS data) along Dividing Creek and other waterways. There are many additional large wetlands that are located in interstream divides and in depressions. Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

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

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. (Table 14).

(Table 14). Wetland gains and losses for this watershed, as tracked by MDE. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight loss in wetlands (Walbeck, 2005).

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

Code of Maryland Regulations

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

Water Quality

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

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

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

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

MBSS sampling found FIBI and BIBI of good to very poor, with very poor sites located on Pusey Branch and Miller Branch.

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. Most of the soil that is not mapped wetlands (based on NRCS SSURGO GIS data and NWI/DNR wetlands) is classified as hydric soil. Therefore, the majority of the watershed is hydric soil, with the northern half of the watershed containing more “very poorly drained” soils while the southern half is more “poorly drained.” Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

Green Infrastructure hub covers the majority of this watershed, with protected land being Pocomoke River State Forest, DNR-owned Chesapeake Forest land, County-owned properties, and small MET holdings. There are still many unprotected GI hub areas that should be protected. It is desirable that GI corridor “gaps” be restored to natural vegetation.

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

A forested tidal wetland reference community is found on Dividing Creek. The community is *Taxodium distichum/Nyssa biflora/Bignonia capreolata* (Bald Cypress/Swamp Blackgum/Cross-vine), and is daily or irregularly flooded predominantly by fresh water. There is pronounced microtopography of hummocks and hollows (Harrison et al., 2004).

This watershed has three State-designated Nontidal Wetlands of Special State Concern (WSSC) and two potential WSSC, as described below.

- *Dividing Creek Ponds*. This site contains two hydrologically-different Delmarva bays. The 3-acre bay contains four State-Endangered plant species and two uncommon plant species. The second smaller bay contains an additional rare species. Delmarva bays are seasonal ground water-fed ponds that are dry in the summer and wet in the winter/spring. These ponds were once common on the Eastern Shore, but have been largely destroyed due to drainage and filling for agriculture and development. These bays provide unique habitat and therefore often contain rare species. These bays are surrounded by mature pine forest containing habitat for interior dwelling bird species. Due to the seasonal changes in these ponds, further surveys conducted during different times of the year may reveal additional rare species. This site provides a good opportunity for ecological research (DNR, 1991). This site is mostly protected by Pocomoke River State Forest.
- *Furnace Road Powerlines*. This site contains boggy emergent wetlands and upland meadows containing 16 rare species, including four State-Endangered species. These rare species require open habitat to thrive. This type of open habitat was historically caused by fires and flooding, and was once much more common. Suppression of these natural disturbances has made these habitat types fairly uncommon. Powerline maintenance is now the main source of this habitat (DNR, 1991). This site is mostly protected by Pocomoke River State Forest.
- *Spearin Road Powerlines*. This site contains an open emergent wetland with six rare and uncommon species. These rare species require open habitat to thrive. This type of open habitat was historically caused by fires and flooding, and was once much more common. Suppression of these natural disturbances has made these habitat types fairly uncommon. Powerline maintenance is now the main source of this habitat. The adjacent upland meadow contains a State-Endangered wildflower. Further surveying may reveal additional RTE species (DNR, 1991). This site is partially in Nassawango Creek watershed and is protected by DNR-owned Chesapeake Forest Land.
- *Potential WSSC*
    - This site is along the intersection of Saint Lukes Road and Cardinal Lane and is not protected.
    - This site is east of the intersection of Corner House Road and Sand Road. It is protected by DNR-owned Chesapeake Forest Land.

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.
- Restore “gaps” in the Green Infrastructure network to natural vegetation.
- Restore riparian habitat in the Pocomoke River tributaries.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
- Protect areas within the Green Infrastructure network.
- Protect the small remaining portions of unprotected WSSC and buffers.

- Protect the DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain Federally-listed species, State-listed species, or areas of concern to DNR, but with no official status.
- Protect tidal wetland reference communities.
- Protect riparian habitat in Pocomoke River tributaries.

Nassawango Creek (02130205)

Background

The Worcester County portion of this watershed has roughly 25,786 land acres (based on MDP 2002 land use GIS data).The majority of the land use is forest (71%), followed by agriculture (26%), and developed land (2%). Note that wetland acreage estimates based on this land use data may be grossly underestimated. Better wetland estimates, as discussed elsewhere in this document, are based on GIS data from DNR.

Some of this watershed is classified as prime farmland (based on NRCS SSURGO GIS data), with main concentrations in the lower half of the watershed. In order to preserve agriculture in the County, wetland restoration/creation should attempt to avoid areas classified as prime farmland. Additional areas, mostly in the upper half of the watershed, are classified as "prime farmland when drained." While it may not be desirable to exclude all soils classified as "prime farmland when drained" from consideration, these additional areas should be lower priority for wetland restoration/creation than soils not classified as prime farmland.

Lower Nassawango Creek is a designated Natural Heritage Area within this watershed. To get this designation, an area must contain threatened or endangered species and be the best Statewide examples.

Mapped wetlands (based on DNR and NWI GIS data) are located along Nassawango Creek and tributaries. There are also large wetlands in the northern half of the watershed, in the headwaters, that are not as closely associated with the waterways. Estimates of wetland acreage for the entire watershed, based on DNR mapped wetlands, are as follows:

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

MDE tracks all regulated nontidal wetland activity in Maryland, including regulated wetland impacts and gains. (Table 15).

(Table 15). Wetland gains and losses for this watershed, as tracked by MDE. Based on data for the time period of January 1, 1991 through December 31, 2004, for this watershed, there has been a slight loss in wetlands (Walbeck, 2005).

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

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

Water Quality

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

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

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

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

MBSS sampling found FIBI of fair and BIBI of fair and very poor, with very poor sites located along Millville Creek.

Restoration/Preservation

Hydric soils suggest where wetlands are currently or were historically. There are many hydric soils that are not mapped wetlands (based on NRCS SSURGO GIS data and

NWI/DNR wetlands), especially in the northern portion of this watershed. These are classified as "poorly drained" and "very poorly drained." Hydric soils that are not currently wetlands may be good potential sites for wetland restoration.

Green Infrastructure covers the majority of this watershed, with the exception of the southeast portion of the watershed. Protected land is DNR-owned Chesapeake Forest land, Pocomoke River State Forest, and The Nature Conservancy Nassawango Creek Preserve. There are still many unprotected GI hub areas that should be protected. It is desirable that GI corridor "gaps" be restored to natural vegetation. According to the Maryland Greenways Commission, an existing greenway within this watershed is called Nassawango Creek Preserve.

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

A forested tidal wetland reference community are also found on Nassawango Creek. The community is *Taxodium distichum/Nyssa biflora/Bignonia capreolata* (Bald Cypress/Swamp Blackgum/Cross-vine), and is daily or irregularly flooded predominantly by fresh water. There is pronounced microtopography of hummocks and hollows (Harrison et al. 2004). Nassawango Creek also supports a tidal shrub wetland reference community of *Alnus maritimus/Acorus calamus* (Seaside alder/Sweetflag). The community type is flooded daily by tidal freshwater and typically contains microtopography of hummocks and hollows (Harrison and Stango, 2003).

There are several State-designated Nontidal Wetland of Special State Concern (WSSC) in this watershed, as described below.

- *Colbourne Powerline*. This site contains three rare or uncommon plant species, including two State-Endangered. These rare species require open habitat to thrive. This type of open habitat was historically caused by fires and flooding, and was once much more common. Suppression of these natural disturbances has made these habitat types fairly uncommon. Powerline maintenance is now the main source of this habitat (DNR, 1991). This site is unprotected.
- *Longridge Powerline*. This site contains bog-like wetlands with five rare plant species. These rare species require open habitat to thrive. This type of open habitat was historically caused by fires and flooding, and was once much more common. Suppression of these natural disturbances has made these habitat types fairly uncommon. Powerline maintenance is now the main source of this habitat (DNR, 1991). This site is unprotected.

- *Lower Sturges Creek Bog*. This site is along Mt. Olive Church Road, just south of Bear Swamp. This site contains a wide variety of habitat, with some examples being seasonal ponds, wet meadows, sphagnum seeps, swamp forest, and bogs. There are 16 rare or uncommon plant species, including eight State endangered and one State threatened plant species. The diverse habitat found at this site also encourages species recolonization and interesting wildlife (DNR, 1991). This site is currently unprotected.
- *Mt. Olive Church Pond (DNR name: Mount Olive Church Wetlands)*. This site contains a sphagnum bog with healthy populations of four rare or uncommon plant species, including three State-Endangered. Sphagnum bogs are uncommon in Maryland, especially on the Lower Coastal Plain. Due to the unique acidic conditions of bogs, they provide unusual habitat for unusual plant species (DNR, 1991). This site is protected by DNR-owned Chesapeake Forest Land.
- *Nassawango Creek (DNR calls a small portion on the border of Wicomico County Bear Swamp; an upstream portion is also referred to as Lawes Ditch by MDE)*. This is a large WSSC following Nassawango Creek and portions of the Pocomoke River (in Lower Pocomoke River watershed), Furnace Branch, Mount Olive Branch, Millville Creek, and continuing into Wicomico County. This is one of Maryland's most pristine waterways and is bordered by bald cypress swamps and diverse upland forest. Large portions are protected by TNC, DNR-owned Chesapeake Forest Land, and Pocomoke River State Forest. Some portions are still unprotected.
- *Spearin Road Powerlines*. This site contains an open emergent wetland with six rare and uncommon species. These rare species require open habitat to thrive. This type of open habitat was historically caused by fires and flooding, and was once much more common. Suppression of these natural disturbances has made these habitat types fairly uncommon. Powerline maintenance is now the main source of this habitat. The adjacent upland meadow contains a State-Endangered wildflower. Further surveying may reveal additional RTE species (DNR, 1991). This site is partially in Dividing Creek watershed and is protected by DNR-owned Chesapeake Forest Land.
- *Potential WSSC*.
    - This site is just east of Lower Sturges Creek WSSC and is currently unprotected.
    - This site is north of Mt. Olive Church Pond WSSC and is currently unprotected. It is partially protected by Chesapeake Forest Land.
    - This site is on the border of Dividing Creek and Upper Pocomoke watersheds, north of Lawes Road. It is partially protected by Chesapeake Forest Land.
    - This site is near the intersection of Forest Land Road and Disharoon Road. It is unprotected.
    - This site is around Scotty Road, on the border of Lower Pocomoke River and Nassawango Creek watersheds. It is unprotected.

Specific recommendations for restoration:

- Restore wetlands and streams within the headwaters.

- Restore "gaps" in the Green Infrastructure network to natural vegetation.
- Restore riparian habitat in Pocomoke River tributaries.

Specific recommendations for preservation:

- Protect wetlands and streams within the headwaters.
- Protect areas within the Green Infrastructure network.
- Protect WSSC and buffers.
- Protect the DNR-designated Ecologically Significant Areas. Within this watershed, there are areas that contain State-listed species or areas of concern to DNR, but with no official status.
- Protect tidal wetland reference sites.
- Protect riparian habitat in Pocomoke River tributary.