TARGETING

Background

The Coastal Bays watershed in eastern Worcester County supports one of Maryland's most diverse ecosystems. Maryland's Coastal Bays consist of five bays and their corresponding watersheds, Assawoman, Isle of Wight, Newport, Sinepuxent, and Chincoteague, which have hydrologic exchange with the Atlantic Ocean through two inlets (Figure 1). These bays are enclosed by the coastal barriers, Fenwick and Assateague Islands, with ocean water entering the bays through the Ocean City inlet and the Chincoteague inlet in Virginia. The watershed for these bays encompasses 111,810 acres of land and 65,680 acres of open water within Maryland, in addition to smaller areas in Delaware and Virginia (USACE, 1998). According to the 2000 U.S. Census, the area immediately adjacent to Isle of Wight Bay and Assawoman Bay, including Ocean Pines and Fenwick Island (Ocean City), have the densest resident population (1,000-4999.9 people/mi$^2$) in the coastal bays (and the county). Berlin, while slightly lower density (200-999.9 people/mi$^2$), is also highly populated. Chincoteague Bay watershed is the least populated region in the coastal bays (<40 people/mi$^2$). Although this resident population is still fairly low overall, the county population is expected to double by the year 2020 (MCBP, 1999), with most of this increase being focused in the northern Coastal Bays region. These U.S. Census estimates do not take into account the high seasonal tourist population (roughly 12 million; MCBP, 1999).

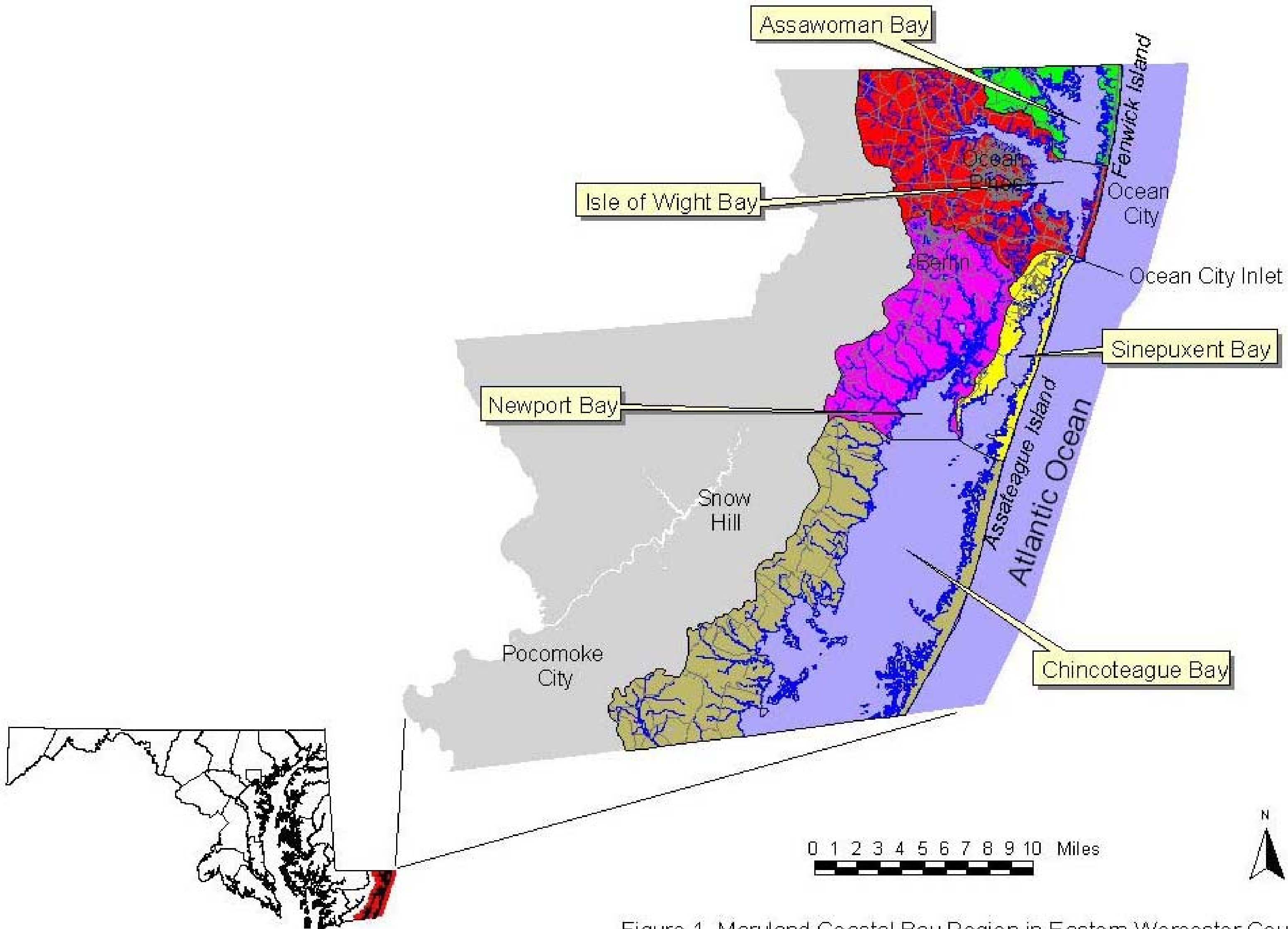


Figure 1. Maryland Coastal Bay Region in Eastern Worcester County.

**Wetlands and wetland loss**

Wetlands in the Coastal Bays

The natural physical condition of the Coastal Bays, including the low topographic relief (leading to sluggish drainage) and high water table, results in large amounts of wetlands (Figure 2). The U.S. Army Corp of Engineers defines wetlands as "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." The State of Maryland has a similar definition in its Nontidal Wetland Act and wetland regulations.

Tidal and nontidal wetlands

*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 geomorphically 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 geomorphically 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).

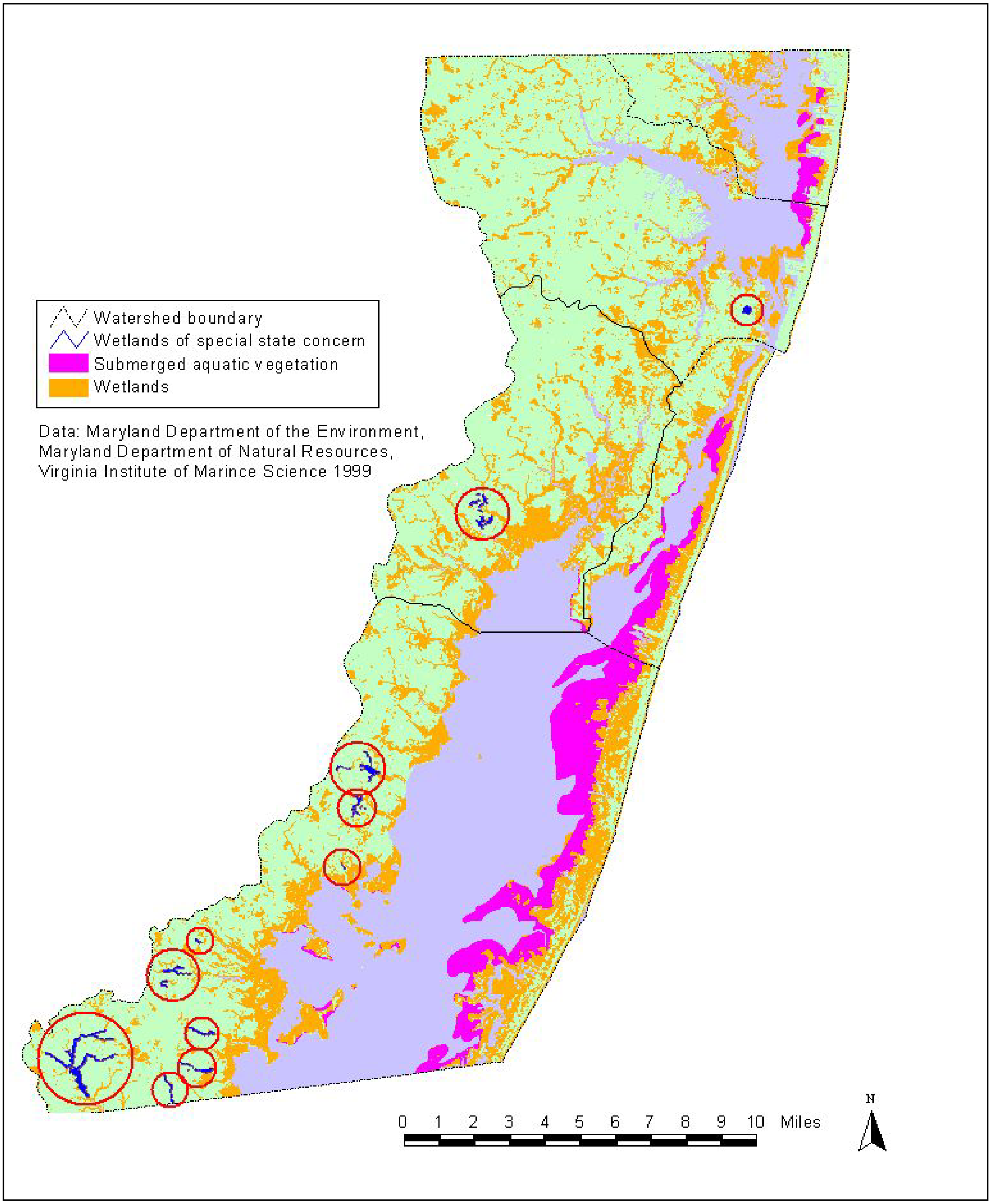


Figure 2. Wetlands and submerged aquatic vegetation in Maryland Coastal Bay region. Wetlands of special state concern are circled in red.

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.).

*Nontidal Wetlands*

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).

Wetland Classification

The Coastal Bays consist of several types of wetlands. A National Wetlands Inventory report from 2000 estimated that Coastal Bays watersheds had 525 acres marine wetlands (beach), 18,154 acres estuarine wetlands, and 17,757 acres palustrine wetlands (Tiner et al., 2000). The following wetland descriptions are based on Tiner and Burke (1995) with wetland classification being based on Cowardin et al. (1979) (Figure 3, Figure 4).

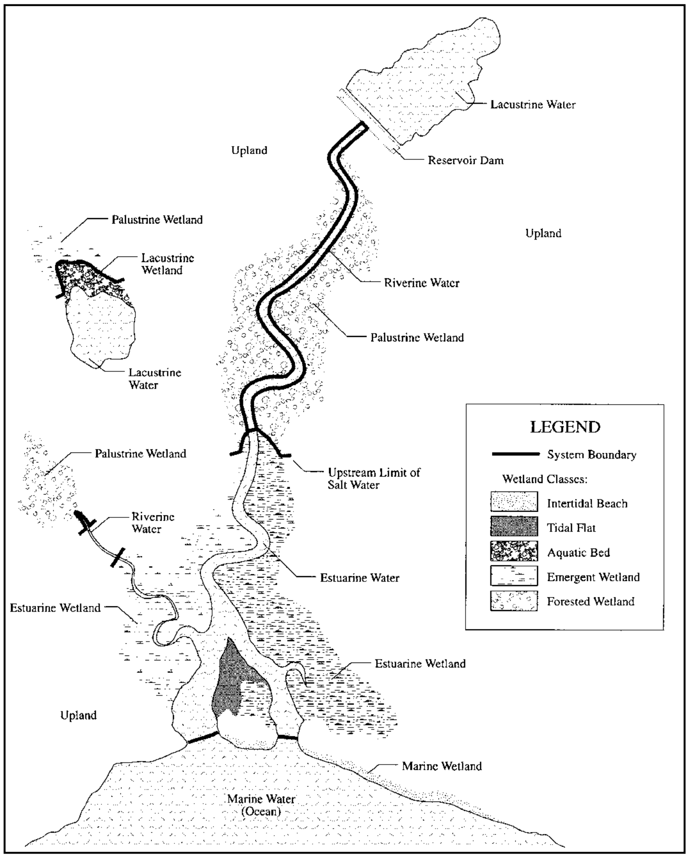


Figure 3. Wetland classes that may be present in a continuum of lacustrine, riverine, palustrine, estuarine, and marine environments of Maryland (Tiner and Burke, 1995).

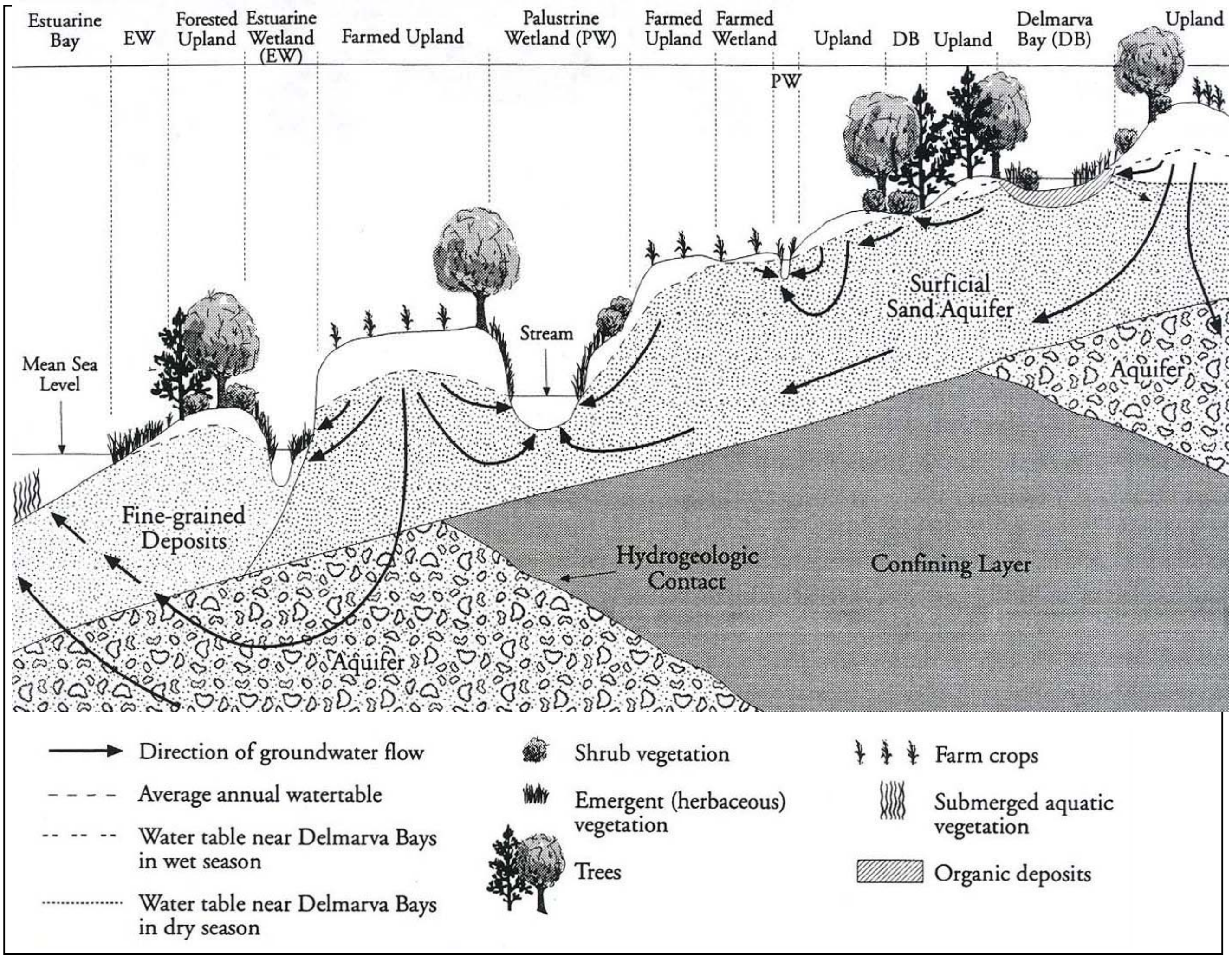


Figure 4. Groundwater flow in the Coastal Bays region. Vertical scale is exaggerated (Tiner and Burke, 1995; modified from Martha Hayes, U.S. Geological Survey).

*Marine wetlands*

Marine wetlands are all tidally influenced. This category encompasses ocean area above the continental shelf and the high-energy coastline, including sandy beaches along the Atlantic Ocean. These are most common on Assateague Island and have only sparse amounts of vegetation. Since these areas cannot support vegetation, therefore failing to meet the USACE definition of a wetland, it is controversial whether these areas should be included as wetlands.

*Estuarine wetlands*

Estuarine wetlands are all tidally influenced and contain salt or brackish water, with amounts of salinity and flooding heavily impacting wetland function. They occur in areas where ocean water is at least partially diluted with freshwater and extend upstream to the zone of freshwater. Subtidal wetlands are permanently inundated with tidal water while intertidal wetlands alternate between flooded and non-flooded conditions. Estuarine emergent subtidal wetlands occur along the west coast of Fenwick and Assateague Islands. These wetlands have the potential to provide valuable habitat for wildfowl (USACE, 1998). Estuarine intertidal emergent wetlands are common on the mainland shorelines. In the Assawoman Bay Watershed, there are extensive sections of emergent wetland. Other emergent wetlands are in the Isle of Wight Bay Watershed at the wider parts of Turville Creek and Herring Creek, and a few areas in the northern shorelines of St. Martins River. There are also extensive emergent wetlands along Trappe Creek, at Brockanorton Bay, Martin Bay, Johnson Bay, and on small islands within the Chincoteague Bay. Aquatic beds occur in shallow water areas and often support submerged aquatic vegetation. There are extensive SAV beds in Sinepuxent and Chincoteague Bays that are also classified as estuarine wetlands. NWI data is not too accurate for SAV identification. Instead, the best source for SAV information, including annual changes, is VIMS. VIMS has SAV data back to 1986.

*Palustrine wetlands*

Palustrine wetlands are tidal and non-tidal freshwater wetlands located on floodplains associated with streams and rivers, upland depressions, and in flats between drainage systems. The headwaters within the Coastal Bays contain relatively few wetlands, especially in Newport Bay watershed (near Berlin) and Isle of Wight Bay watershed, likely due to historic draining and filling of wetlands for agriculture, upland forest or urban development. In the Coastal Bays, forested wetlands are the most common palustrine type. Palustrine emergent and shrub wetlands are also present in small amounts. Based on Tiner et al. (2000), the majority (over three-quarters) of the palustrine wetland is not associated with a stream or river.

<u>Wetland Acreage</u>

*Based on GIS data*

Estimates of total wetland acreage in the Coastal Bays watershed (excluding deepwater habitat) based on different data sources have resulted in extremely different amounts. For this reason, we do not advocate the use of any one wetland estimate over the other, but simply report them as they are found. Therefore, acreage discrepancies found throughout this document are due to this fact. In estimating wetland acreage using existing GIS data, we eliminated deepwater habitats, a method employed by the USFWS in Tiner and Burke (1995) and Tiner et al. (2000). These deepwater habitats included:

- Marine: subtidal areas
- Estuarine: subtidal areas
- Riverine: unconsolidated bottom, rock bottom, open water (on older maps)
- Lacustrine: limnetic

Comparing the wetland amount should be done with extreme caution due to differences in methods employed by each survey. Extreme caution should be used when comparing wetland changes based on these surveys. GIS wetland acreage estimates are based on classification methods in Cowardin et al. (1979) (excluding deepwater habitats as defined above). For this report, we are focusing on all MDE regulated vegetated wetland types, with the exception of SAV wetlands (Table 1). We are not considering SAV wetlands or unvegetated wetlands for our prioritization efforts (Table 2).

Table 1. Estimates of regulated vegetated wetlands in the Coastal Bays watershed (excluding SAV wetlands) based on GIS data.

| Wetland Classification | GIS data source | | |
|---|---|---|---|
| | NWI | MDNR | Tiner et al. 2000 |
| Estuarine: emergent, scrub-shrub, forested | 16,763 | 16,893 | 17,093 |
| Palustrine: emergent, scrub-shrub, forested | 5,488 | 9,990 | 17,110* |
| Palustrine: farmed | N.A. | 443 | 47 |
| Total vegetated wetlands | 22,251 | 27,326 | 34,250* |

Table 2. Estimates of other wetlands in the Coastal Bays watershed (including SAV wetlands) based on GIS data.

| Wetland Classification | GIS data source | | |
|---|---|---|---|
| | NWI | MDNR | Tiner et al. 2000 |
| Marine | 718 | 370 | 525 |
| Estuarine: aquatic beds, unconsolidated shore, flat, beaches and bars, unconsolidated bottom | 1,086 | 6,404 | 1,086 |
| Palustrine: flat, open water, aquatic bed, unconsolidated bottom, unconsolidated shore | 369 | 555 | 615 |
| Total unvegetated wetlands | 2,173 | 7,329 | 2,226 |

NWI GIS data was based on digital ortho quads from 1981-1982 infrared photographs. MDNR GIS data was largely based on digital ortho quarter quads from 1988-1989 infrared photographs. Since the MDNR data was done at a more detailed scale (quarter quads versus quads), this method should result in more wetlands identified, which is the case. Tiner et al. (2000) GIS data was based on the MDNR GIS wetlands data, 1998 black and white photography, VIMS SAV data, and digitized hydric soils data. Due to the nature of the data, it is NOT valid to compare wetland change over time between the three different studies. *In the 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. Additional differences in wetland acreage (e.g. unconsolidated shoreline) may be due to the when the photos were taken (e.g. during which part of the tidal cycle) or various methods used. With this said, none of these GIS wetland layers are completely accurate, and should only be used as a rough estimate of wetland acreage and locations. Therefore, based on this GIS data, it is hard to make any accurate determinations about wetland gain or loss, only generalizations.

*Based on US Army Corp of Engineers*

According to US Army Corp of Engineers, there are approximately 16,600 acres of salt marsh along the Coastal Bays, with most being in Chincoteague Bay and only about 2,500 acres in the northern Coastal Bays. The USACE estimated the amount of nontidal wetlands, mostly forest and shrub wetland, to be 5,300 acres (USACE, 1998).

*Based on Coastal Wetlands of Maryland*

The Maryland Department of the Environment recommends use of *Coastal Wetlands of Maryland* (McCormick and Somes, 1982) as the most accurate source of information on tidal wetland acreage (Table 3). Tidal wetland acreage for major watersheds, including the Coastal Bays, were mapped (scale 1 inch = 200 feet) and calculated in the mid 1970's from aerial photography. Despite the age of the document and maps, they are considered to offer the most accurate information due to the scale of resulting maps and the extensive field verification (between 1976 and 1977). The actual limit of tidally-influenced wetlands is believed to have changed considerably, however. Some areas that were partially filled and not mapped in the 1970's have now become revegetated and would be considered as tidal wetlands (Dawson, pers. comm.).

Table 3. Tidal wetlands in the Coastal Bays watershed based on vegetation type (McCormick and Somes, 1982). *Total vegetated coastal marsh does not include open water, mudflat, sandbar/beach, or SAVs.

| Wetland type | Vegetation type | Acreage |
|---|---|---|
| Shrub Swamp *(fresh)* | Red maple/Ash | 29 |
| Wooded Swamp *(fresh except Loblolly pine which is often brackish)* | Bald cypress | 2 |
| | Red maple/Ash | 35 |
| | Loblolly pine | 4 |
| Fresh Marsh | Smartweed/Rice cutgrass | 4 |
| Brackish High Marsh | Meadow cordgrass/ Spikegrass | 18 |
| | Marshelder/Groundselbush | 50 |
| | Cattail | 46 |
| | Rosemallow | 2 |
| | Switchgrass | 23 |
| | Threesquare | 348 |
| | 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 |
| Open Water Category | Ponds | 638* |
| Mud Flats and Sandbars/Beaches | Mudflat | 136* |
| | Sandbar/Beach | 503* |
| SAVs | | 1,586* |
| Total Vegetated Coastal Marsh (Tidal) | | 14,362 |

Wetland Acreage By Watershed

Based on the MDNR wetland GIS data (as discussed previously), wetland acreage by watershed is as follows:

- Assawoman Bay: 2,746 wetland acres (including 20 acres farmed palustrine wetlands).
- Isle of Wight Bay: 5,648 wetland acres (including 193 acres farmed palustrine wetlands) in watershed.
- Newport Bay: 6,546 wetland acres (including 120 acres farmed palustrine wetlands) and 422 meters additional linear wetlands.
- Sinepuxent Bay: 4,023 wetland acres (including 23 acres farmed palustrine wetlands).
- Chincoteague Bay: 15,530 wetland acres (including 87 acres farmed palustrine wetlands) and 6,212 meters additional linear wetlands in watershed.
- Atlantic Ocean: 162 wetland acres.

Wetland Hydrology

The source of water to the wetland is important in determining the functions the wetland may provide (Figure 5). In some systems, the majority of water in a wetland enters through surface runoff. In these cases, it may be desirable to have a wetland with high clay content and/or high organic matter to bind water contaminants, acting as a filter for water quality. Other wetlands may receive most water from groundwater. In cases where this groundwater is rising up from the ground, sandy soils with high organic matter may allow high levels of denitrification (the change of nitrogen to a gas phase which is then released to the atmosphere).

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.

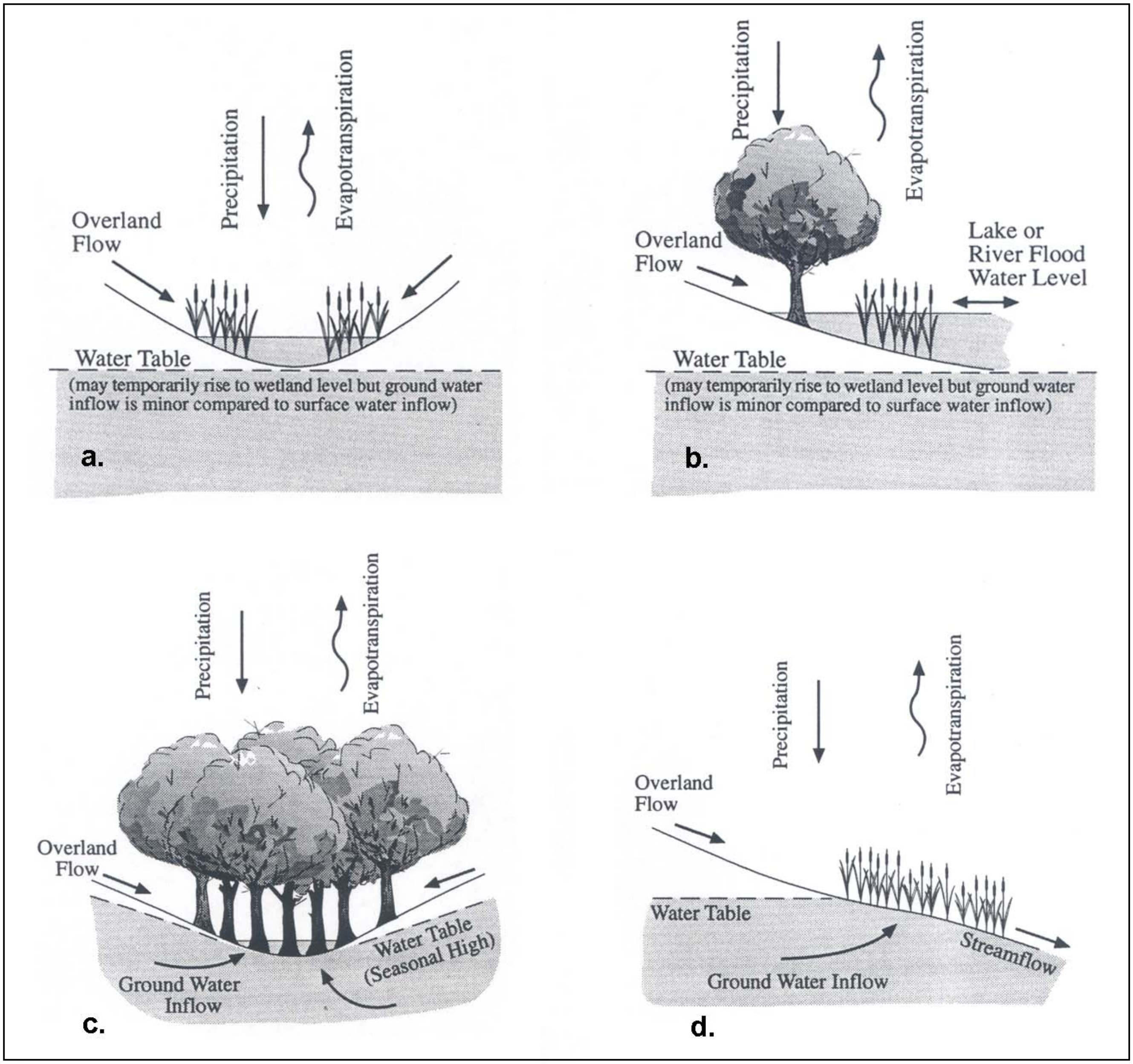


Figure 5. Hydrology of nontidal wetlands: a. depressional wetland, fed by surface water; b. floodplain wetland, fed by surface water; c. depressional wetland, fed by surface and ground water; d. sloping wetland, fed by surface and ground water (Tiner and Burke, 1995; as modified from Novitski, 1982).

Wetland Functional Assessment Methods

*Background*

We looked at existing wetland functional assessments to determine possible feasibility of using an existing functional assessment method in this project and to get ideas as to what indicators we should use in our evaluation. It may be desirable to evaluate future wetland restoration success using one or a combination of these functional assessment methods. The following information is summarized from Fugro-McClelland (East), Inc. (1993). Wetland assessments have been developed and used in various forms since the 1960's, after enactment of State wetland statutes in Connecticut and Massachusetts, and more frequently since 1972 after passage of the federal Clean Water Act. Methods typically involve a quantitative or qualitative evaluation of indicators believed to predict whether or not a wetland has the opportunity to perform a certain function. Other factors have also influenced assessment methods. For example, in recent years there has been more interest in predicting not only which functions a wetland may perform, but also attempting to determine the extent to which the functions are performed in comparison with similar wetlands. Some assessment methods consider the characteristics a wetland has for performing a certain valued function, in addition to other conditions that provide the wetland with the opportunity to perform the function. For instance, a wetland downgradient from a pollutant source has a higher opportunity to perform water quality improvement function. The most recent work in wetland assessment seeks to not only evaluate wetland function, but to determine the "health" or condition of a wetland. The assessment method under development to consider wetland condition and function is called the hydrogeomorphic (HGM) method.

The HGM approach is based on three factors that affect how wetlands function: position in the landscape (geomorphic setting), water source (hydrology), and the flow and fluctuation of the water once the water is in the wetland. Wetlands are initially classified based on the three factors. The method then defines functions performed by each class of wetland. The range of function is determined by evaluating numerous wetlands within the class, including wetlands that exhibit various levels of degradation, from severely impacted to nearly pristine in condition.

While there are numerous types of wetland assessments, the indicators used to predict function or determine condition are often quite similar. Most assessments consider factors such as presence of endangered species, inlet or outlets for surface water, flooding or ponding characteristics, vegetation type, size, adjacent land use, connection to another water body, other fish/wildlife habitats. Indicators used to assess the wetland condition and degradation includes: hydrological modification such as ditching, presence of exotic or invasive species, vegetation removal, fragmentation, excess nutrients or sediment, and lack of wildlife. Functions commonly assessed include water quality improvement through nutrient/sediment removal, flood attenuation, fish/wildlife habitat, groundwater discharge and recharge, and societal values.

*Specific functional assessments*

Tiner et al. (2000) classified wetlands in the Coastal Bays region using a classification scheme that bridged the NWI classification to the HGM classification. This method is described in the document entitled *Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors* (Tiner, 2003a). In Tiner et al. (2000), as a base map, they used the wetlands identified in the National Wetland Inventory (NWI). They modified this NWI map by photointerpretating 1998 1:40,000 black and white aerial photography and incorporating state digital wetland maps (from 1989 photography), digital submerged aquatic vegetation data, and Natural Resource Conservation Service digital hydric soil data. Additionally, investigators conducted a limited amount of field surveying.

These wetlands were classified into HGM types based on landscape position, landform, and water flow direction of the wetlands, determined by comparing the wetland maps with topographic maps and aerial photos. Wetlands in the Coastal Bays watershed were classified into five groups depending on their landscape positions, or their relationship to an adjacent waterbody: marine, estuarine, lotic (adjacent to freshwater streams and rivers), lentic (associated with lakes), and terrene (isolated or headwater). The majority of non-tidal wetlands were classified as terrene. These wetland types were further subdivided based on where they occur within these classifications and their water flow path.

Tiner et al. (2000) then assessed the potential ability of each wetland classification to provide a given function in the process called "Watershed-based Preliminary Assessment of Wetland Function". This assignment of function based on wetland type is described in the document entitled *Correlating Enhanced National Wetlands Inventory Data with Wetland Functions for Watershed Assessments: A Rationale for Northeastern U.S. Wetlands* (Tiner 2003b). The evaluated functions included: surface water detention, streamflow maintenance, nutrient transformation, sediment and particulate retention, coastal storm surge detention and shoreline stabilization, inland shoreline stabilization, fish and shellfish habitat, waterfowl and waterbird habitat, other wildlife habitat, and conservation of biodiversity. 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. This analysis resulted in different types and amounts of potential wetland function between the Coastal Bays watersheds (Table 4). More intensive fieldwork may produce different results, since some HGM types are difficult to distinguish from one another. In addition, some functions rely on characteristics only seen in the field, such as micro-topography.

Table 4. Wetlands having moderate to high potential to provide a given function within each Coastal Bays watershed. The 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).

| Watershed | Functions | | | | | Fish/ shellfish/ waterfowl habitat in aquatic beds (acres) |
|---|---|---|---|---|---|---|
| | Nutrient cycling (%) | Sediment deposition (%) | Surface water detention (%) | Coastal storm detention/ shore stabilization (%) | Fish/ shellfish/ waterfowl habitat (%) | |
| Assawoman | 79 | 81 | 7 | 81 | 73 | 462 |
| Isle of Wight | 33 | 35 | 57 | 30 | 22 | 219 |
| Newport | 55 | 55 | 45 | 56 | 44 | 84 |
| Sinepuxent | 67 | 76 | 11 | 74 | 69 | 1,910 |
| Chincoteague | 67 | 72 | 29 | 65 | 56 | 5,947 |

The State of Maryland Nontidal Wetlands Protection Act of 1989 lists several important functions wetlands may provide:

- Ground water discharge
- Flood flow attenuation
- Sediment/toxic retention
- Aquatic diversity/abundance
- Production export

- Sediment stabilization
- Nutrient removal/transformation
- Wildlife diversity/abundance

Fugro East, Inc developed a document called *A Method for the Assessment of Wetland Function* for MDE to assess these nontidal wetland functions; it includes looking at many measurable indicators of function (Fugro East, Inc., 1995). Within this model were a method for field assessment and a method for desktop assessment using GIS. The level of effort required to obtain values for each of these measurable indicators varies significantly. Each of the indicators results is a score. For instance, for the sediment stabilization function, one of the indicators is: "What is the frequency of overbank flooding?". If you rate frequency of flooding as: does not flood, score=0; low frequency of flooding, score=1; high frequency of flooding, score=2. Each function has several indicators, with each being assigned a score. At the end, these scores are added up and this number is divided by the total number possible, to get the functional capacity index. A partial list of wetland variables used in the assessment model and their associated indicators are as follows:

- Hydrogeomorphic class
- Landscape variables
    - size of wetland
    - location relative to other wetlands
    - watershed land use
    - regional scarcity of wetland type
    - wetland significance
    - topographic position
    - proportion of wetland edge bordering sediment source
- Hydrologic variables
    - water level fluctuation
    - water regime
    - adjacent to water body
    - surface water connection
    - overbank flooding
    - seeps/springs

    - surficial geologic deposit
    - wetland land use
    - topographic gradient of wetland
    - inlet/outlet properties (e.g., outlet restriction)
    - ratio of wetland area to watershed area
    - contribution from overland flow
    - ditching
- Soil variables
    - Soil type (i.e., organic matter content and texture)
- Vegetation variables
    - Dominant wetland vegetation
    - Dead plant material (e.g., standing or fallen tree trunks)
    - Vegetation characteristics (e.g., vegetation layers, percent cover, distribution)
    - Interspersion of open water and vegetation (e.g., proportion and distribution)
    - Wetland edge complexity
    - Stream sinuosity
    - Adjacent to fish habitat
    - Rare, threatened, endangered species
    - Adjacent to upland habitat
    - Connection to wildlife corridor

At this time, this method is not well utilized at MDE. When MDE reviews applications for wetland impact, wetland functions (based on a list of possible functions) are estimated based on best professional judgment, rather than on these indicators. This list of possible functions was based loosely on functions defined in different functional assessment methods (this one included). In the past, Montgomery County used an assessment method based on the Fugro East method. Since the Fugro East assessment method was designed for use with HGM, when HGM classifications are better documented for the area, we will reevaluate our limited use of the Fugro East method.

Maryland State Highway Administration (SHA) also has indicators used to assess wetland function. For the Rt. 113 project, partially located in the Coastal Bays watershed, they conducted functional assessments of the wetlands to be impacted by the project, using the USACE *Highway Methodology*

*Workbook* (USACE, 1995). This publication suggests indicators of wetland functions for tidal and nontidal wetlands, with examples of wetland functions/values not included in the MDE model being as follows: Recreation, Educational/Scientific Value, and Visual Quality.

In order to evaluate the usefulness of these methods to this project, we attempted to replicate results from the SHA Rt. 113 wetland impact study using only available GIS data, with the following conclusions. Some considerations/qualifiers (indicators) used in the SHA assessment based on the USACE *Highway Methodology Workbook Supplement* were impossible to estimate accurately without more detailed data or a field visit (e.g., evidence of fish, wetland edge is intermittently aerobic, no indicators of erosive forces are present, diffuse water flows are present in the wetland, indicators of erosion or siltation are present). Another finding was that some of the considerations/qualifiers used in the SHA method were vague, allowing a lot of room for personal judgment. Additionally, the determination of which functions were the principal functions (i.e. the most important/dominant functions this wetland provides) was based on personal judgment, and could be biased. These results are not especially surprising since the USACE *Highway Methodology Workbook Supplement* acknowledges that the considerations/qualifiers are flexible and based on best professional judgment. Keeping these limitations in mind, the majority of the considerations/qualifiers that we were able to estimate based on GIS data, had similar results. This suggests that functions can be estimated from GIS data, at least on a preliminary basis. The functions that we were best able to evaluate with our GIS data included flood flow alteration, fish and shellfish habitat, sediment/toxicant retention, and nutrient removal.

Next we determined the wetland functions for the Rt. 113 wetland impact study sites using the MDE methods versus using the SHA method. Some of the MDE desktop method indicators were not easily attainable from available GIS data (e.g., inlet/outlet characteristics, vegetation density and richness, etc.) other than rough estimates from aerial photos. Many of the wetland function results were the same as for the SHA study. Conflicts generally arose when determining if the function was a principal one or just present to a lesser degree. The MDE method results in a functional capacity index, which makes it hard to estimate if it is a principal function. The MDE method was less biased since the indicators were clearly described. For instance, descriptions for each indicator were detailed and even quantitative where appropriate. It may be desirable to consider indicators from both methods when evaluating wetland function potential.

SHA also used the method described in the *Highway Methodology Workbook* to determine the mitigation plan for Route 113. In order to satisfy requirements of replacing wetlands lost due to the highway construction, SHA and their consultant used infrared photography to look for wet sites, mainly in agricultural land, that were adjacent to the destroyed wetland or in the same watershed. Of these sites, they looked for ones that could potentially provide the same functions as the destroyed wetlands. In evaluating wetland function, SHA considered landscape position, location in the watershed, adjacent land-use, connection with other habitat, and sediment and nutrient sources (Jellick et al., 2002). They estimated what the functions of the site would be if it was a wetland. The amount of excavation required to create a wetland was also considered in site selection. Landowners were contacted to see who was interested in participating, and this ended up being a huge factor in site selection (Coastal Resources, Inc., 1999).

In the current study, we are loosely using these functional assessments to understand what general conditions (indicators) are desirable in order to have maximum function in restored and existing wetlands. For example, to maximize water quality function, one indicator is having a higher percent wetland edge bordering upland sediment source. In the future, it is possible that a more detailed investigation would include the stricter use of one of these functional assessment methods.

<u>Wetland Loss</u>

The most extensive wetland loss has occurred in Isle of Wight, Newport Bay, and Chincoteague Bay watersheds (MDNR and MDE, 2000). The following information is based on a 1998 report of wetland loss conducted by the Corp of Engineers (USACE, 1998; Spaur et. al., 2001). There has been a 10% loss of salt marsh area since 1900, with losses concentrated in the northern Coastal Bays [northern Coastal Bays (i.e., Isle of Wight and Assawoman Bays) had a loss of 37% salt marsh, or 1,530 acres, while the Southern Coastal Bays (i.e., Newport, Sinepuxent, and Chincoteague 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 Fenwick and Assateague.

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 wetlands not directly converted (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. USACE recommends restoring and creating forested wetland to improve water quality in the St. Martin River, Turville/Herring Creek, and Newport Bay subwatersheds. While historically forested wetlands were common on the interstream divide and depressional landscapes, it is recommended that restoration for water quality be at locations of maximum pollution interception. They locations along the landscape will often be different than where they were historically found (Spaur et al., 2001). They also recommend restoring salt marsh in the northern bays wherever suitable sites exist, but restoring salt marsh in the southern bays only where it previously existed (Spaur et al., 2001). MDE tracks wetland losses and gains in the region (Table 5).

Sea level rise is also contributing to losses in wetland area. As sea-level rises, marsh can encroach upon drowned mainland and stream valleys. It is now believed that landward marsh migration would not be able to maintain pace with losses due to sea-level rise due to steeper slopes that are now being encountered along the mainland (Hennessee and Stott, 1999). However, since the area is rapidly developing, this landward migration of wetlands is not possible. 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). Shoreline erosion is higher in the northern coastal bays. 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.

Table 5. Wetland gains and losses 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. Since this is based on the date of approval of authorization for impact, rather than the date the impact or mitigation actually occurred, not all mitigation or impacts have actually been completed by 12/31/2003. “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. “Voluntary gains” includes wetland restored/creation through other programs: NRCS Conservation Reserve Enhancement Program (CREP), NRCS Wetlands Reserve Program (WRP), USFWS, MDNR, 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) | Coastal Bays watershed | | | | | | Total change |
|---|---|---|---|---|---|---|---|---|
| | | AB | IOW | SB | NB | CB | Unkn. | |
| Nontidal 1991-2003 | Permanent impacts (regulatory) | -0.7 | -67.6 | -4.5 | -5.6 | -2.0 | 0 | -80.5 |
| | Permittee mitigation | 0 | 46.9 | 3.5 | 3.5 | 0 | 0 | 53.8 |
| | Programmatic mitigation (MDE) | 0 | 5.0 | 3.0 | 0.5 | 11.4 | 0 | 19.9 |
| | Other Gains | 0 | 1.2 | 0.1 | 0.8 | 3.9 | 0 | 6.0 |
| | Net change (regulatory) | -0.7 | -14.6 | 2.1 | -0.9 | 13.3 | 0 | -0.8 |
| Tidal 1996-2003 | Permanent impacts (regulatory) | -<0.1 | -0.3 | -0.2 | -0.2 | 0 | 0 | -0.8 |
| | Mitigation | 0 | 0.5 | 0.1 | 0 | 0 | 0 | 0.5 |
| | Net change (regulatory) | -<0.1 | 0.1 | -0.1 | -0.2 | 0 | 0 | -0.2 |
| Nontidal / Tidal 1998-2004* | Voluntary gains | 92.2 | 143.3 | 39.1 | 213.6 | 565.0 | 823.4 | 1876.6 |
| Total | | 91.7 | 128.8 | 41.1 | 212.6 | 578.3 | 823.4 | 1874.7 |

**Existing management plan goals**

In selecting possible sites for wetland restoration, creation and preservation, we tried to consider the goals from other interested parties. These main groups are Worcester County Government, Maryland Coastal Bays Program, and Maryland Department of Natural Resources. After reviewing some of these recommendations, discussing the issues with professionals in the field, and summarizing relevant literature, a suggested targeting plan was developed. It is our goal to address local concern, provide wetlands that have the highest amount of functional potential, and integrate these sites with other projects.

Comprehensive Development Plan: Worcester County

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, including Ocean City Harbor, Bishopville Prong, Herring Creek, St. Martin River, Manklin Creek, Turville Creek, and Trappe Creek. 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.

<u>Comprehensive Conservation and Management Plan for Maryland's Coastal Bays</u>

*The Comprehensive Conservation and Management Plan for Maryland's Coastal Bays* (MCBP, 1999) 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.

<u>Isle of Wight Bay Watershed Restoration Action Strategy</u>

The *Isle of Wight Bay Watershed Restoration Action Strategy* (Worcester County, 2002) makes several suggestions related to restoration and management of the Isle of Wight Bay watershed as summarized below.

- The land is classified into three types: Development Areas, Transition Areas, and Resource Use and Conservation Areas. The intent is for new development to be focused in the Development Areas, lower intensity development to be focused in the Transition Areas, and to limit development in the Resource Use and Conservation Areas.
- A habitat protection area with a 100-foot buffer of native woody vegetation should be established along the tidal water bodies and wetlands.
- Forest should be protected by reducing forest lost to development, requiring mitigation for losses, and preserving forest for wildlife corridors.
- Avoid impacts to any land surrounding the habitat of species considered threatened, endangered, or in need of conservation.
- Incorporate a 100-foot buffer around colonial waterbird nesting sites.
- Protect and create wildlife and plant corridors between important habitats.
- Install soft stabilization for shoreline erosion.
- Require 25-foot vegetated buffer between agriculture and a waterway or require a nutrient management plan.

- Protect natural areas.
- Redesign the ditches to allow establishment of natural vegetation and higher sinuosity.
- Create natural vegetation buffers of different width around perennial streams. This buffer should include floodplains, steep slopes, wetlands, and important habitats.
- Construct wetlands for wastewater treatment or additional treatment of septic systems.

<u>Maryland Coastal and Estuarine Land Conservation Plan DRAFT</u>

This Maryland Department of Natural Resources draft document (MDNR, 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/ESAs, 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.

<u>USACE</u>

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.

**Existing targeting efforts**

MDE has combined some of the past Coastal Bays targeting efforts, general and specific targeting recommendations from other documents, and our own priorities to develop the wetland targeting plan for the region. We hope to locate areas that may provide the highest amount of wetland function. This plan attempts to find general areas for wetland restoration and preservation based mainly on available desktop data and past studies. This plan may be used to direct interested parties to areas that may provide sites for potentially high-functioning restored wetlands or especially valuable wetlands in need of protection.

There are a few wetland targeting efforts that do exist for this region. They vary in the area they are evaluating and in their methods, but include: Tiner et al. (2000), Isle of Wight WRAS, Newport/Sinepuxent WRAS, USACE (for St. Martin's River), and SHA mitigation for Rt. 113.

Tiner, Starr, Bergquist, and Sword (2000)

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.

WRAS for Isle of Wight, Newport, and Sinepuxent Bays - sites identified for restoration

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. MDNR 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 MDNR water quality and macroinvertebrate community data (Primrose, 1999).
- Stream Corridor Assessment data (Czwartacki and Yetman, 2002).

Although the county planned to use property owner interest to choose final sites from the five proposed areas, and acknowledged that this may be a limiting factor, the initial selection process did not take landowner interest into account. Additionally, they focused on agricultural areas, excluding forest and developed areas from restoration consideration. For the Newport/Sinepuxent WRAS, they did include citizens' recommendations of additional restoration sites.

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 Rt. 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.

After the Isle of Wight WRAS was completed and potential areas were located, property owners were contacted to assess interest. Unfortunately, there was no owner interested in any of the five proposed areas. Instead, the county found interested property owners in the Ocean Pines area. Since this will be a concern with any restoration effort, we have to remember this prioritization is meant to be a long-term planning tool. The Newport Bay and Sinepuxent Bay WRAS are still in progress and should be completed in early fall. The Chincoteague Bay WRAS should be completed in 2005.

<u>USACE St. Martin's River Aquatic Ecosystem Restoration</u>

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 in the Corp's Continuing Authorities Program have resulted in a postponement.

Great Cypress Swamp Aquatic Ecosystem Restoration Project in Delaware

While this project is located in Delaware, it is still 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.

SHA Wetland Mitigation for Route 113

SHA used the method described in the *Highway Methodology Workbook* to determine the mitigation plan for Route 113. This procedure is discussed in detail in the Background Wetlands section within this document.

As noted, 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.

MDNR's Green Infrastructure Assessment

MDNR established a green infrastructure network that included hubs and corridors. These areas should be the focus of protection (MDNR, 2004 Draft) and restoration in order to preserve an important ecological network through the state. It is desirable to convert open land areas and disturbed areas within Green Infrastructure hubs and corridors to natural vegetation where possible (i.e., convert agriculture or barren land to natural vegetation). Additionally, some areas of Green Infrastructure should be considered high priority areas for preservation, especially areas of high ecological ranking and high development risk (as determined in the *Green Infrastructure Assessment*). The following descriptions are based on GIS data of protected lands (2002), MDNR wetlands (interpreted from 1988-1995 photos), NWI wetlands (interpreted from 1981-1982 photos), and Green Infrastructure Assessment data (2000-2003). Most of the hubs contain spots of agriculture in or around them that can be converted to natural vegetation. Nearly all hubs contain some portion of wetlands, many of these unprotected. There is relatively little Green Infrastructure located in the Isle of Wight Bay watershed, in comparison to the other watersheds. Also, development pressure is higher in the northern bays, Sinepuxent Bay, and northern Newport Bay. Protection of the areas with high development risk is especially important. There is a hub in western Isle of Wight watershed (in the headwaters) that is connected by a corridor to another hub running from Assawoman Bay watershed (around Greys Creek) to the mouth of St. Martin's River (including Isle of Wight Island). There is another hub in southern

Isle of Wight watershed (around Herring Creek) that connects with the hubs in the southern bay watersheds. In the southern Coastal Bays area, the Green Infrastructure is quite extensive, covering over half of the area. There is a long hub covering the majority of Assateague Island and hubs or corridors lining most of the Newport and Chincoteague Bay mainland shoreline. Only a small portion of the land designated as Green Infrastructure is currently protected, with largest areas including Assateague Island, several significantly-sized properties in Newport Bay, and near E.A. Vaughn Wildlife Management Area. Restoring and protecting adjacent systems may also enhance the wildlife benefits. Gaps in the Green Infrastructure are mainly agriculture land, with a few barren land cover areas in northern Chincoteague Bay watershed. The *Green Infrastructure Assessment* includes useful data on some of these Green Infrastructure gaps, including evaluation of the ecological benefit that wetland restoration projects within these gaps might provide.

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.

**Additional targeting considerations**

In addition to the existing targeting and restoration programs, there are many general recommendations and data that should be considered in this current targeting effort:

Water Quality

All five Coastal Bays watersheds are on the 303(d) List for low dissolved oxygen, high fecal coliform, and nutrients (although the only water body on the 303(d) List for nutrients in Chincoteague Bay was Big Millpond). The 1998 *Maryland Clean Water Action Plan* classified all five Coastal Bays watersheds as Category 1, watersheds not meeting clean water and other natural resource goals and therefore needing restoration. In addition to having the failed indicator of being on the 303d List, these watersheds had other failed indicators as follows (MDNR and MDE, 2000):

- *Assawoman Bay*: high nutrients, poor SAV abundance, high percentage impervious surface (11.6%), high percentage unforested stream buffer (40%)
- *Isle of Wight Bay*: poor SAV abundance, poor Non-Tidal Benthic IBI, and high historic wetland loss (16,129 acres)
- *Newport Bay*: high nutrient concentration, poor SAV abundance, poor Non-Tidal Benthic IBI, and high historic wetland loss (17,025 acres)
- *Sinepuxent Bay*: high percent unforested stream buffer (45%)
- *Chincoteague Bay*: high historic wetland loss (28,820 acres).

Assawoman Bay, Isle of Wight Bay, and Newport Bay watersheds were classified as Category 1 "Priority", watersheds being most in need of restoration since they failed to meet at least half of the restoration goals. Additionally, Newport Bay and Chincoteague Bay watersheds were classified as Category 3, a pristine or sensitive watershed that needs protection due to containing the select indicators as follows: Newport Bay – contains a migratory fish spawning area and a high number of wetland-dependent species; Chincoteague Bay contains a migratory fish spawning area, imperiled aquatic species, and a high number of wetland-dependent species. Chincoteague Bay was also a "selected" Category 3, a watershed that should be ranked one of the highest for protection.

Water quality data generally found northern Coastal Bays and Newport Bay watersheds to have worse conditions than Chincoteague Bay and Sinepuxent Bay watersheds (Boynton et al., 1993). According to the *Draft Aquatic Ecosystem Health 2004* report, nitrogen was the worst in the upper tributaries (Greys Creek, Bishopville Prong, Shingle Landing Prong, Turville Creek, Trappe Creek, Ayres Creek, Newport Creek and Marshall Creek), St. Martin River, northern Assawoman Bay and Herring Creek. St. Martin River and upper Newport Bay had highest chlorophyll, especially Bishopsville Prong and Trappe Creek. Areas with poor water quality should be the focus of wetland restoration/mitigation efforts. Based on TMDL results for the completed waterways, 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; a 13% reduction in phosphorus for Turville and Herring Creeks; a 45% reduction in nitrogen for Ayer Creek, Newport Bay, and Newport Creek; and a 69% reduction in phosphorus in Big Millpond (in Chincoteague Bay watershed).

The largest pollutant sources for nitrogen and phosphorus were non-point sources, mainly agricultural runoff (MDE, 2001). Developed areas can also contribute high amount of nutrients per area (Jellick et al., 2002), but agriculture results in much higher total nutrient loads in the Coastal Bays due to the high amount of agricultural land use. Sediment loads to the bays are mainly from row crops, shoreline erosion, and a smaller amount from development (Wells et al., 2002).

Stream benthic scores (benthic IBI) from MBSS and Stream Waders for the Coastal Bays were mainly poor and very poor, so were not utilized extensively when choosing sites in need of restoration. The stream corridor assessment for Isle of Wight Bay watershed indicated that the most common problem was stream channel alteration. This problem was most common in the headwaters, especially in the northern watershed. Inadequate stream buffers were also a problem, followed by minor stream erosion in the southern part of the watershed, construction erosion, trash, and sewage discharge. Minor fish migration barriers were encountered at some sites, mainly in the southern part of the watershed.

The most impacted benthic communities in St. Martin watershed were Carey's Branch and Church Creek (Primrose, 1999). A MDNR study also found high nutrient concentrations at three stations: a tributary to St. Martin at St. Martin Neck Road, Buntings Branch at Delaware Rt. 54 in Selbyville, and Church Creek at Rt. 113 (Primrose, 2002). The area with the highest total dissolved nitrogen load (79.5 mg/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. Of the communities sampled in Newport, Sinepuxent, and Chincoteague Bays during the

2003 nutrient synoptic survey, highest nitrate/nitrite concentrations and yields tended to be in Newport Bay watershed (Primrose, 2003). Orthophosphate concentrations were high or excessive in sites from all three watersheds, but yields were only excessive at three sites, two in Newport Bay watershed (Kitts Branch at Flower St., Kitts Branch at Rt. 346) and one in Chincoteague Bay watershed (an unnamed tributary to Robins Creek at Taylor Road). Nitrate/nitrite yields were also excessive at these three sites. Benthic populations were ranked as poor or very poor and fish populations were rated as fair or poor. These low ratings 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.

The highest volume of total macroalgae per station was found at Isle of Wight Bay and the highest abundance of "nutrient responsive algae" was in Isle of Wight Bay and Southern Chincoteague Bay (Goshorn et al., 2001). Pfiesteria was found in Turville Creek (MDNR, 1999) and high densities of Aureococcus were reported in Newport Bay, Public Landing, Tingles Island, and Green Run Bay (Tarnowski and Bussell, 2002). Areas with high macroalgae levels may have water quality impairment and should be targeted for possible wetland restoration/mitigation.

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

The *Maryland Coastal Bays Aquatic Sensitive Areas Initiative* (2004) was created to identify, describe, and map sensitive aquatic resources (both important habitat and species). This report found some of the highest ranked areas to be along the bayside of the barrier islands, especially Assateague Island. Additional smaller sections, with relatively high rankings, were in the main tidal tributaries, spots along the mainland coastline, and around bay islands. Restoration and protection for wildlife and habitat should focus in these areas or upstream of these areas to improve local water quality.

<u>Soils</u>

Many of the Coastal Bays wetlands were drained historically for agriculture. In order to have the most cost-effective wetland projects, it is ideal to restore sites where little effort is required to obtain the wetland by restoring the hydrology. Major excavation is expensive and can be minimized in an area where the majority of land has an elevation near the water table. Therefore, in the Coastal Bays region, we were able to select only sites with hydric soils and include the majority of the watershed.

A summary of discussions with scientists from NRCS, USFWS, Coastal Resources, Inc., Virginia Tech, and University of Maryland, in addition to interpreting indicators used in the documents Highway Methodology Workbook Supplement and MDE's Method for the Assessment of Wetland Function, is as follows. High organic matter in soils results in high nutrient and contaminant retention and is highly beneficial to wetland systems. Unfortunately, in created wetlands it takes many years before there are significant increases in organic matter. Supplementing a created wetland with organic matter is possible. But to increase organic matter levels to those found in natural wetlands or in high organic soils is difficult. For these reasons, ideal potential wetland sites will already have high organic matter content. Soils classified as histosols and soils having a histic epipedon have very high organic matter that developed over many years of wetland conditions. Histosols that are not presently wetlands (most of these soils are currently wetlands) would make ideal sites. Other soils having high organic matter include those with an umbric epipedon. Pocomoke soils, desirable for wetlands partly because of their high organic matter content, have been divided within Maryland into three different soils, all having umbric epipedons (Brewer, pers. comm.). These are Pone (which does not exist in Worcester County), Berryland, and Mullica. Berryland also has a spodic horizon, a layer of high aluminum. It is possible this soil may absorb higher rates of aluminum and other metals, which are linked with degradation of fish in low pH waters (pH $<5$), and so may be important in areas of low pH (Rizzo, pers. comm.). In selecting ideal wetland sites, soils having an umbric epipedon are desirable. Enhancement of existing wetlands would also have the benefit of already containing a high amount of organic matter.

Soil texture is important in holding water. Soils that are sandy or coarse textured may drain quickly and become droughty, not providing hydrologic conditions suitable for a wetland. However, the issue of soil texture is not a clear-cut one. Even if the surface layer is coarse textured, if there is a subsurface layer of fine textured sediment, water will still be retained in the system. Additionally, coarse textured soils with a water table very close to the surface may also contain hydrology to support a wetland system. High levels of organic matter also hold water in the system. For this reason, in soils with very high levels of organic matter, soil texture may not be as important. As mentioned, high clay content in soils may increase nutrient (especially phosphorus) and contaminant retention. This may not be a factor when there is a high amount of organic matter since organic matter will also hold the nutrients and pollutants. This factor may get complicated as coarser-textured materials may get water from the groundwater and allow high denitrification, while soils with high clay may receive water mainly from runoff. Additionally, sandy soils may have a buried clay layer limiting water movement and absorbing pollutants. Nitrogen removal through denitrification (loss of nitrogen to the atmosphere) is higher in soils with high organic matter and a fluctuating water table near the soil surface.

Flooding frequency is important because the soils that flood frequently also have higher rates of denitrification and a higher chance of nutrient removal. The flood frequency was estimated for the soils based on the description in the soil survey. Location within the landscape was also noted, as it will lead to different wetland functions. For instance, soils located within the floodplain will provide different functions than those located in depressions. Erodibility is important when selecting sites because wetlands adjacent to highly erodible land (especially row crops) have the potential to provide more water quality improvements. While it may be easiest to restore wetlands on soils classified as very poorly drained, it should be noted that soils classified as poorly drained are more likely to have been drained for agriculture (e.g. Elkton, Othello, Fallsington, etc.). For instance, in the wetland mitigation for U.S. 113, they did not have the opportunity to restore wetlands on soils classified as very poorly drained (Jellick, pers. comm.). However, it may be possible to find soils classified as very poorly drained in artificially drained forest. Forested areas are often overlooked in restoration plans. These sites also make excellent wetlands, as seen in artificially drained forested sites converted to forested wetland through the NRSC program (Nichols, pers. comm.). Most forested areas are artificially drained or are indirectly drained by nearby drains. For this reason, these areas should also be considered.

Streams

Headwater streams are mainly ditched or otherwise physically altered, especially in the headwaters of the northern Coastal Bays watershed. There is a lack of riparian buffers for a large portion of streams, especially in the watersheds of Assawoman Bay, Sinepuxent Bay, and Isle of Wight Bay. These areas are suitable for restoration. The headwater streams may have higher nutrient retention capacity. Streams adjacent to agriculture (especially row crops) and developed land generally receive higher nutrient and sediment runoff than streams adjacent to naturally vegetated areas. Locations where livestock have direct access to the streams are high pollution locations (this situation is rare in the Coastal Bays).

Public Drainage Associations and other ditches

Many of the Coastal Bays wetlands are ditched. Removing these ditches would improve wetland function. Wetland restoration and mitigation may be possible along PDA ditches. However, it is important that any wetland restoration/creation along the PDAs does not alter upstream agricultural drainage. To restore the hydrology, the wetland drains can be plugged (on-line) or the wetland can be built adjacent to the ditch (off-line) using a low-level berm (Nichols, pers. comm.). The ideal sites would be those created by plugging the drain. This may be possible at the top of the artificial drainage system or where these wetlands will not negatively impact upstream agriculture. Unfortunately, in most cases, there is either a perceived or real threat that the upstream drainage will be reduced by restoring an on-line wetland. In these instances, building small berms around the wetland and keeping them off-line (connected through the ditches by an outlet rather than having the wetland encompass the ditch) may prevent the wetland from altering upstream drainage of agricultural land. This second approach is generally more expensive and does not provide as large of a watershed for the wetland. Water entering the wetland is primarily from stream/ditch overflow during high flow periods and from groundwater. These systems may be flooded frequently but for short durations or they may be flooded for long periods. SHA designed an off-line system for the Rt. 113 project to improve water quality while not impacting upstream ditches. This included diverting high flow into a basin next to the stream. While this system does provide some function, likely it is not as desirable as an in-stream system that receives low-flow as well.

Roadside Drainage Ditches

In the 2004 document entitled *Management of Roadside Drainage in Worcester County for Water Quality: A Pictorial Guide*, Worcester County Department of Comprehensive Planning recommends designing roadside drainage to improve water quality, provide habitat, and be aesthetically pleasing. Some examples that could incorporate these functions while still providing adequate drainage and road safety include wetland ditches, sediment traps, and meandering drainageways. Deep ditches or steep slopes should be avoided since they may drop the surrounding water table and/or increase erosion. Poorly designed or failing roadside ditches could be upgraded to improve function.

Mosquito ditches

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). 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.

Prime farmland

Some things in conflict with wetland restoration and mitigation are soils designated by NRCS as prime farmland. With farmland rapidly being converted to development in many areas, it is desirable to preserve highly productive land as agriculture. Prime farmland when drained is also important land, especially when currently in farmland. For these reasons, when targeting for wetland restoration sites, we eliminated sites having prime farmland or prime farmland when drained (currently in farmland).

Wellhead Protection Areas

It is undesirable to excavate soil to build a wetland in wellhead protection areas, especially when the public water is drawn from the unconfined aquifer (MDE, 2004). Soil layers located above the water table retain some contaminants before they reach the water table. Since excavating reduces the depth of soil to the water table, this may reduce the filtering capacity of the soil. Wetlands may improve well water quality when they are in areas previously acting as pollutant sources (i.e. creating wetlands in the place of row crops), and when they act as discharge areas, pulling the water from the ground into the wetland. Although the wellhead protection areas have not been delineated for all community wells, the well locations are known. Community wells are located in the northern Coastal Bays, in the areas of the largest development. Caution should be used when selecting sites in these immediate areas.

Shoreline stabilization

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). In areas with higher erosion rates, it may be necessary to use hard structures, like a low profile stone revetment structure, which is basically stone stabilization that protects the toe of the slope while not exceeding the marsh elevation. Each site should be assessed individually.

Forested land

It is more desirable for us to restore agricultural fields to wetlands than to restore forest to wetlands. This is because farmland generally contributes a higher nutrient and pollutant load than forest. Forest, even pine forest, does provide habitat and water quality functions. Additionally, in many wetland restorations that take place in forest, berm construction may remove several acres of forest, resulting in a loss in forest cover. With this being said, wetland restorations taking place in forest land often make beautiful wetlands, so should not be excluded. We considered converting recently cleared forest and artificially-drained pine forests back to forested wetland. Although the forest industry in the region is an important entity, pine forest stands provide much less habitat than hardwood or mixed stands (Wilson, 2001). For this same reason, it is undesirable to convert upland hardwood forest to forested wetland, since this area already provides good habitat. Wetland forest that is ideal for preservation includes large parcels of high quality forest.

Property ownership

Small lots are undesirable for targeting because the property owner may not be interested or the prices might be too high to purchase easements because they do not have much land. Smaller sites are more common around areas of higher development and may be zoned as residential or commercial, which also may influence the owner interest. Additionally, the wetland site would be small and unconnected with other wetlands. Since it is desirable to have contiguous sections of wetland and other wildlife habitat, we are selecting large lots where large wetlands can be created or wetlands near other wetlands or desirable habitat (e.g., forest). Owners of large lots may feel that putting several acres into an easement or converting it to wetland may not make a large impact on their total lot value and usefulness. Additionally, these lots may be less expensive, especially if the lot cannot be extensively subdivided (e.g., zoned Resource Conservation). Since a major limitation in selecting a site is interest by the property owner, we will focus on areas with zoning that significantly limits subdivision potential (e.g., zoned agriculture, conservation, or estate). We will also include public land. Government-owned land was targeted because owners may be more open to this type of program. Other considerations include churches that own large amounts of land.

Rural Legacy

The area designated as Rural Legacy includes an area adjacent to Chincoteague Bay, from the Virginia line to Brockanorton Bay. Although large portions of this land are already protected by the state (including some Chesapeake Forest Land), Maryland Environmental Trust Easements, county, and agricultural easements, further protection and restoration should be focused in this area. In January 2002, there were 2,700 acres of land protected through Rural Legacy easements (MDNR, 2002b).

Critical Area

The portion of the Coastal Bays designated as the Critical Area may also be good locations for preservation and restoration.

Greenways

The Assateague Island National Seashore is a protected greenway roughly connected with the greenway along Sinepuxent Bay and Chincoteague Bay shore. The Sinepuxent Bay water trails are located off Assateague Island and traverse through marsh. Some of these greenways are not currently well protected, but should be protected. The Isle of Wight greenway on the Isle of Wight Island provides opportunities for restoration of marshland and extension of this greenway in the northern salt marsh region. The proposed Snow Hill Rail Trail, located in Southern Chincoteague Bay watershed, is mostly unprotected.

Ecologically Significant Areas (ESAs)

These areas are determined by MDNR to contain rare, threatened, or endangered species or rare/exemplary natural communities. It is important to protect these areas (MDNR, 2004 Draft). All of the NTWSSCs are included within the ESAs. Many of these ESAs are included within the Green Infrastructure network (with the exception of some smaller fragmented ecologically important areas).

Wetland proximity

In order to achieve a contiguous protected habitat area, rather than many fragmented wetlands, it is desirable to locate the site adjacent to other wetlands, forests, or other habitat. It is important to note that some isolated wetlands may be part of the metapopulation, isolated populations connected through emigration or immigration of propagules or individuals, and may be important for the overall maintenance of species diversity.

Historic Wetland Loss

As mentioned previously, wetland losses, both salt and fresh, were highest in the northern Coastal Bays watershed. Losses of forested palustrine wetlands, due to drainage or conversion may be 90%, with highest losses occurring in St. Martin River, Isle of Wight Bay, Manklin Creek, and Newport Bay subwatersheds (USACE, 1998). Additionally, there have been more recent wetland losses around some of the other waterways (e.g. Herring Creek and Turville Creek). A larger proportion of restoration/mitigation effort should be focused in the areas with high wetland loss. A high amount of forested palustrine wetlands should be created since they suffered such high losses. Additionally, high losses of salt marsh occurred on Fenwick Island, Ocean Pines, and bayside of Assateague Island. Since Fenwick Island and Ocean Pines are highly developed, wetland restoration opportunities in these areas will be limited.

Wetland type

What type of wetland should be restored? There is some debate on this subject. While some recommend restoring wetlands to their previous condition, this is often not a realistic option. As mentioned, there are many factors to consider. We need to design wetlands to be compatible with surrounding land use, the desires of the landowner (e.g. landowners may request certain wetland functions such as an open water element), and watershed needs (e.g. one watershed may need water quality improvements above other wetland functions). Wetlands can support certain types of recreation, including fishing, hunting, biking, hiking, bird watching, and limited boating (e.g., canoeing and kayaking).

Wetlands of special interest

For wetland habitat function, top priority should be to preserve wetlands known to provide exceptional habitat. It is difficult, if not impossible, to recreate some of these rare habitats. Wetland preservation and enhancement may include the nontidal wetlands of special state concern (NTWSSC) and other wetlands containing important habitat or threatened, rare or endangered species. Enhancement projects are very site-specific and may include removing invasive species or suppressing woody succession. All bogs and sea-level fens should be protected from nutrient additions (communication with Chris Spaur, 2004). These projects should be based on the MDNR Heritage Program NTWSSC surveys and discussions with that group. If wetland restoration or mitigation occurs adjacent to these areas, MDNR Heritage Program should be contacted so they can study the associated impacts to the NTWSSC.

MDNR Natural Heritage Program surveyed the NTWSSC sites in 2002 and 2003, compiling the results in the document *Nontidal Wetlands of Special State Concern of Five Central Maryland Counties & Coastal Bay Area of Worcester County, Maryland*. Specific site recommendations that resulted from this study are summarized below. Also summarized below is protection information based largely on MDNR GIS data with supplemental Worcester County GIS data. For a complete site listing and description of the wetlands of special state concern refer to the Background section of this document.

- *Isle of Wight Bay*
    - West Ocean City Pond - 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. This area is unprotected.
- *Newport Bay*
    - Ironshire Swamp – Since MDNR added this site to Porter Neck Bog, it is described under that name.
    - Porter Neck Bog - 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.
- *Chincoteague Bay*
    - Hancock Creek Swamp - The main threat is logging in the wetland, the buffer, and the surrounding forested slopes. The majority of this area is not protected.
    - Little Mill Run – 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.
    - PawPaw Creek – 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.
    - Pikes Creek – includes Pikes Creek and Stockton Powerlines

        - Pikes Creek - Logging should be avoided in the wetland and buffer. This area is partially protected.
        - Stockton Powerlines - This site is located in the headwaters of Chincoteague Bay, so contributes to the Bay's water quality (MDNR, 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.
    - Powell Creek - Logging should be avoided in the wetland and buffer. The surrounding slopes and upland area should also be protected. This area is unprotected.
    - Riley Swamp - Logging should be avoided in the wetland and buffer. Invasive plant species, especially near Greenback Road, should be manually controlled. This area is unprotected.
    - Scarboro Creek Woods - Logging within the wetland and buffer should be avoided. The surrounding forest should also be maintained. The majority of this area is protected.
    - Scotts Landing Pond - 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.
    - Tanhouse Creek - 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.

Threats to the additional wetland areas of potential importance within the Coastal Bays watershed as identified by the Maryland Natural Heritage Program (MDNR, 2004) are as follows:

- *Newport Bay*
    - Icehouse Branch. Avoid logging in the surrounding forest. Protect wetland buffers.
    - Massey Branch. 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. 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.
- *Chincoteague Bay*
  - Pikes Creek Woods. This site will be surveyed by Natural Heritage Program soon.
  - Spence Pond. The main threat is alteration of the hydrology.
  - Truitt Landing. Overall protection of the sea-level fen and slope are top priority. Logging should be avoided in the NTWSSC, 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. Threats include impacts to the water quality from agricultural runoff and development.

Additional non-tidal wetlands of significant, as identified in USACE (1998):

- Church Branch. This cypress swamp is one of the largest in the coastal bays watershed. It needs protection from logging and impacts of development.
- Great Cypress Swamp. This swamp is on the Maryland/Delaware Line, including within St. Martin's River. While much of it has been drained, including large portions within the St. Martin's River watershed, there is good potential for restoration and reconnection with some of the remaining cypress swamp. The Delaware Wildlands Trust owns some of the swamp located in the Pocomoke River watershed and in Delaware.

Tidal Coastal Bays wetlands identified by the Emergency Wetlands Resources Act of 1986 as being especially important to waterfowl include: Big Bay Marshes, Mills Island, and Tizzard Island (USACE, 1998).

Other potential sites

There are known areas where restoration or protection would be beneficial. These include the following:

- *The marshes on the northern side of the Isle of Wight Island*. These marshes are currently eroding (USACE, 1998). This island is owned by MDNR and is used for recreation.

- *Dead-end canals*. As suggested by the Comprehensive Conservation and Management Plan for Maryland's Coastal Bays, to improve the water flushing of the dead-end canals, they 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.
- *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).
- *Chesapeake Forests land*. Located in the western portion of Chincoteague Bay watershed, these areas provide opportunities for wetland restoration and creation (MDNR, 2003b).

**GIS data sources**

Soils

We utilized the 2000 USDA NRCS Soil Survey data for Worcester County (scale 1:24,000). In addition to being the most recent, designations of hydric soils are also more accurate than those in the MDP Natural Soils Groups. This data allowed us to select for or against the following attributes: hydric soil, drainage, prime farmland (including prime farmland when drained or irrigated), highly erodible soils, soil texture, soil organic matter, flood frequency, permeability, epipedons, histosols, or soil name.

Other

- Area background
    - Aerial Photos 1998-2000
    - Infrared Photography 1989
    - QUADS 1971-1986 (USGS)
    - ADC Map
- Green Infrastructure (MDNR 2000-2003)
    - Hubs, naturally vegetated corridors, agriculture, developed, or barren in potential corridors
    - Ecological rankings
    - Development risk
    - Gaps

- Protected lands (federal, state, county, private conservation properties, Maryland Environmental Trust easements, agricultural easements, Natural Heritage Areas – MDNR; additional sites – WO CO; partial list of WRP, CRP, and CREP - NRCS)
- Rural Legacy designation and priority preservation areas (as designated through the Rural Legacy Program - MDNR)
- Interior forest (including general forest quality – MDNR)
- Land use (MDP 2002)
- Shoreline change (MGS)
- Sensitive Species Project Review Areas and Ecologically Significant Areas within the Coastal Bays (MDNR)
- Property ownership and lot designations (MDP 2003)
- Zoning designations (Worcester County)
- Wetlands
    - Wetlands categorized using Cowardin classification (MDNR, NWI) and HGM type (Tiner et al., 2000)
    - Wetlands of Special State Concern (MDNR)
    - Other wetlands of special interest (proposed NTWSSC - MDNR)
    - Submerged aquatic vegetation (VIMS/MDNR)
- Streams
    - Streams and ditches (MDNR and Tiner, 2000)
    - MBSS (MDNR)
    - Isle of Wight Bay watershed SCA (MDNR)
    - Newport Bay/Sinepuxent Bay watersheds SCA (MDNR)
- Floodplain
    - 100-year floodplain (FEMA)
    - Properties with multiple flood damage (MDE)
- Water quality
    - Water samples from MDE, MDNR, MDNR volunteer data, NPS
    - Point sources of discharge for municipal and industrial (MDE)
- Drinking water
    - Well locations (including areas of high reported nitrates - MDE)

- Designated Wellhead Protection Areas (MDE)

**Summary of restoration targeting information - existing recommendations**

General Sites

- Stream corridors (MCBP, 1999; Fugro East, Inc., 1995; USACE, 1995; Worcester County, 1997)
    - Headwater streams (Worcester County, 2002)
    - Adjacent to pollutant source (Fugro East, Inc., 1995; USACE, 1995)
    - Establish more natural ditches through natural vegetation and sinuosity (Worcester County, 2002)
- Adjacent to a lake (Fugro East, Inc., 1995; USACE, 1995)
- 100-foot buffer around tidal waters and wetlands (Worcester County, 2002)
- 100-year floodplains (Worcester County, 1997, 2002)
- Shoreline stabilization (MCBP, 1999; Worcester County, 2002)
- Sources of pollutants
    - Agriculture (especially row crops) (Boynton et al., 1993; MCBP, 1999; Fugro East, Inc., 1995; MDE 2001; Worcester County, 2002)
        - Install riparian areas and wetlands on agricultural land (MCBP, 1999)
        - Target areas where livestock have direct access to streams
    - Highly erodible land (Fugro East, Inc., 1995)
    - Urban land (Jellick et al., 2002)
- Rural Legacy Area (Worcester County, 1997)
- Green Infrastructure (Weber, 2003)
    - Gaps within high-ranking hubs and corridors based on ecological ranking and development risk.
    - Areas within or adjacent to the hub and corridor network that will increase connectivity and interior condition (e.g., reducing edge habitat).
- Chesapeake Forest Land (MDNR, 2003b)
- Other forest (Spaur et al., 2001)
- Critical Area (Fugro East, Inc., 1995)
- Residential buffers (MCBP, 1999)

- In areas of high historic wetland losses, targeting types lost (i.e. forested wetlands) (MCBP, 1999; USACE, 1998)
- Wastewater treatment, sediment retention, stormwater management, and wildlife habitat (MCBP, 1999; Worcester County, 2002)
- Recreation
    - Where water-based recreation is not a threat to the system (MCBP, 1999)
    - Connect development and recreation (MCBP, 1999)
    - Maintain recreational areas (Worcester County, 1989)
- Habitat
    - Habitat for fish and shellfish (MCBP, 1999)
    - Bird habitat (MCBP, 1999)
    - Corridors between important habitats (Worcester County, 2002)
    - Types of regional significance (e.g. bald cypress swamps, Atlantic white cedar swamps, Delmarva Bay wetlands, sea-level fens) (Spaur et al., 2001)
- Soils
    - Soils – hydric (Worcester County, 2002)
    - High organic matter (discussions with several scientists, Fugro East, Inc., 1995; USACE, 1995)
        - Histosols (Fugro East, Inc., 1995)
        - Containing histic or umbric epipedons (discussions with Brewer, Rizzo, Jellick, Rabenhorst)
    - High clay content (may not be as important as organic matter) (Shanks, 2001; Worcester County, 2002; USACE, 1995)
    - Flood frequency high (Shanks, 2001; Fugro East, Inc., 1995)

<u>Specific Sites</u>

- Northern Coastal Bays watershed (high wetland losses forested palustrine wetlands) (USACE, 1998; Worcester County, 1997)
- Northern Coastal Bays watershed (salt marsh) (USACE, 1998, Spaur et al., 2001).
- Isle of Wight Bay (Boynton et al., 1993; MDNR and MDE, 2000; Worcester County, 1989; USACE, 1998)

- Assawoman Bay (Boynton et al., 1993; Chaillou et al., 1996; MDNR and MDE, 2000; Worcester County, 1989)
- Newport Bay watersheds (Boynton et al., 1993; MDNR and MDE, 2000; USACE, 1998)
- 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, 2001)
    - 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 Rt. 54 in Selbyville
    - Station 7. Careys Branch at Rt. 113
    - Station 8. Tributary to Birch Branch at Murray Road
    - Station 11. Tributary to Perkins Creek at Jarvis Road
    - Station 13. Birch Branch at Rt. 113
    - Station 15. Church Creek at Rt. 113
    - Station 17. Birch Branch at Campbelltown Road
    - Station 22. Church Creek at Careys Road
- 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 Rt. 346
    - Station 18. Kitts Branch at railroad tracks near Rt. 50
    - Station 21. Tributary to Sinepuxent Bay at Eagles Nest Road
    - Station 29. Tributary to Trappe Creek at Rt. 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.
- 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)
- Trappe Creek (Chaillou et al., 1996; MDE, 2002a; Worcester County, 1989)
- Herring Creek (MDE, 2001; Worcester County, 1989)
- Ayer Creek (MDE, 2002a)
- Newport Bay (Chaillou et al., 1996; MDE, 2002a)
- Newport Creek (MDE, 2002a)
- Big Millpond (in Chincoteague Bay watershed) (MDE, 2002b)
- 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 Rt. 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, Ocean Pines, and bayside of Assateague Island (high salt marsh loss) (USACE, 1998)
- The marshes on the northern side of the Isle of Wight Island (USACE, 1998)
- Dead-end canals (MCBP, 1999; Chaillou et al., 1996)
- Chesapeake Forests land – western portion of Chincoteague Bay watershed (MDNR, 2003b)
- Great Cypress Swamp – northwestern edge of Isle of Wight watershed (MDNR Natural Heritage Program, USACE, 1998, Spaur et al., 2001)

Excluded Areas

- Public Drainage Associations – do not alter upstream drainage or maintenance. Exceptions (locations within the PDAs where restoration/mitigation may be possible) include in the upper areas. Off-line sites will not significantly disturb hydrology of the PDAs, so are options for restoration/mitigation.
- Prime farmland (Worcester County, 1989)
    - Prime farmland without alteration

    - Prime farmland when drained, currently in agriculture
- Wellhead Protection Areas (MDE Water Supply Program) – restoration/enhancement should be okay, as long as there is no excavation.
    - Do not excavate area acting as a filter
    - Community wells are all located in the northern Coastal Bays watershed
- Forested land containing high quality hardwood forest habitat

Most sources recommended restoration of the northern watersheds and Newport Bay watershed, mainly because of the poor water quality in these areas and the high amount of historic wetland loss. Within this northern area, there were several sources recommending restoration in St. Martins River watershed. Several sources also recommended Bishopville Prong and Birch Branch. Some literature sources and personal contacts suggested trying to improve water quality in the dead-end canals, if possible. Additionally, there were many recommendations to restore other waterways.

**MDE restoration analysis and final recommendations**

In Maryland Coastal Bays watershed, we will consider all wetland restoration and preservation projects having interested landowners. The below prioritization effort is intended to target locations where we should actively seek restoration or preservation opportunities, and recommend the list for other entities as well. Due to the conditions of this region, with little effort wetlands can be restored in almost any area having hydric soil. Our intent is to predict the areas where restored wetlands would provide the most function. For information on the GIS methods used, please refer to Appendix B.

<u>Priority 1 restoration sites</u>

*Selecting sites*

1) **Hydric soils**: In the Coastal Bays watershed, we were able to select only sites with hydric soils and include the majority of the watershed.
2) **Rank hydric soils**: We ranked soil names based on readily obtainable attributes from the 2000 NRCS soil survey. Most wetland restoration projects occurring on hydric soils in the Coastal Bays watershed are successful in creating wetlands, regardless of the soil organic matter or texture. However, wetland functioning may be higher on certain soil types. After discussions with many soil scientists (including Gary Jellick, Al Rizzo, Jim Brewer, John

Galbraith, and Marty Rabenhorst), we came up with a soil ranking (Table 6). Location within the landscape was noted, as it will lead to different wetland functions (e.g., soils located within the floodplain will provide different functions than those located in depressions). Soils with a landform = "Estuarine Tidal Marsh" may become acidic when drained. These soils are very poorly drained and many have high organic matter or a histic epipedon. High organic matter in soils results in high nutrient and contaminant retention and is highly beneficial to wetland systems. In general, these soils have not been converted from wetlands, but there are some exceptions. These soils would be ranked top for preservation and restoration. Additional soils with histic epipedons (but not having a landform of estuarine tidal marsh) are also ranked top priority for restoration and preservation. Soils that are very poorly drained with umbric epipedons (also high in organic matter) are ranked next priority. These soils (very poorly drained) were historically very wet, so wetland hydrology may be easier to restore than soils classified as poorly drained. Soils that are poorly drained and have a high amount of organic matter or fine textures are ranked next. The worst ranked are poorly drained soils with low organic matter and coarse texture. Coarse-textured soils may drain too quickly to establish adequate wetland hydrology and may have lower nutrient and contaminant retention. This may not be as large of a factor when there is a high amount of organic matter. While it is often easiest to restore wetlands on soils classified as very poorly drained, it should be noted that soils classified as poorly drained are more likely to have been drained for agriculture (e.g. Elkton, Othello, Fallsington, etc.). However, it may be possible to find soils classified as very poorly drained in artificially drained forest (Jellick). For the general site prioritization, we only ranked the soils "very poorly drained" and "poorly drained" because we did not want to eliminate other soils at this level. However, a GIS data layer was created that does rank the NRCS soil data into more fine-tuned ranking as found in the table. This may be useful when comparing between specific on-the-ground sites.

3) **Exclude prime farmland when drained on agriculture from targeting effort**: We excluded prime farmland when drained on agricultural land.
4) **Within Green Infrastructure network**: We looked for areas of very poorly drained hydric soils, without prime farmland when drained on agriculture, within the GI network.
5) **Exclude areas currently in forest**: For priority 1 sites, we excluded forested land. NRCS projects within the Coastal Bays watershed that do convert drained forest to wetlands have

resulted in beautiful wetlands with diverse ecology. Therefore, we do consider restoring forest (especially pine forest) to wetland in priority 2.

6) **Exclude areas currently in wetlands**: We excluded areas classified as MDNR and NWI wetlands. However, this method excluded some other sites, which we added later.
7) **Include zoning with restrictions on development lot size and include protected land**. For the analysis of priority 1, we wanted to consider only areas within county zoning classifications of Resource Conservation, Agriculture, or Estate. Therefore, we excluded areas zoned other than these three, with the exception of protected land (owned by the county, state, federal, private conservation, and Maryland Environmental Trust).
8) **Exclude MDE-designated wellhead protection areas.** We excluded areas within designated wellhead protection areas.

The above eight criteria resulted in a map highlighting several areas**.** All of these areas may be desirable restoration sites, but some are relatively small. While these sites are good locations, this map may be missing some sites and not considering other factors. Therefore, we analyzed the data considering additional factors.

9) **Look for additional sites on orthophoto based on the below criteria.** We basically tried to find areas with the highest concentration of these desirable elements:
   - **Adjacent to or within Green Infrastructure network**: We visually assessed the proximity to GI network, favoring areas that would contribute to the GI network if restored.
   - **Adjacent to streams with no forest/wetland buffer (with pollutant source)**: We looked for inadequately buffered streams having an adjacent pollutant source (agriculture, barren, or developed land use). We selected portions of the 150-foot stream buffer having urban, agriculture, or barren land use on hydric soil. This method was employed in the WRAS characterization for IOW. Many Coastal Bays wetland systems are discharge wetlands, with the water coming up from the water table. Additionally, most precipitation falling to this area infiltrates rather than running off the soil, so wetlands not directly along the stream may also benefit water quality. Wetlands having deep-rooted vegetation (e.g. trees) may be the most effective at removing nutrients from

the groundwater. In many cases, wetlands created next to the streams will need to be built off-line to address actual or perceived reduction in upstream drainage.

- **Adjacent to wetlands or other natural systems**: To assess the surrounding natural systems, we looked at adjacent streams and wetlands.
- **Pollution source**: We looked for areas that were a pollution source themselves or were downstream of a pollution source. These were also included in the selection of inadequate stream buffers on agricultural land (see above).
- **MDNR farmed wetlands**. Wetlands that are currently being farmed may be good options for wetland enhancement. It is also likely that these areas are not extremely productive as farmland since they are so wet. We looked for areas with a high concentration of farmed wetlands.

10) **Consider actual property lot size**: Although we already excluded from consideration certain zoning classifications that would suggest smaller property size (e.g., zoned residential), we wanted to further evaluate the dominant property size of the selected areas. We looked at the property ownership of the desirable sites that we had highlighted. All of the highlighted sites are at least partially on moderate to large sized lots. The site with some of the smallest lots is in Sinepuxent Bay watershed.
11) **In areas of poor water quality**: Water quality data was used to divide the priority 1 sites into two groups, ones in areas of poor water quality and ones in areas of better water quality. Areas with better water quality may not be as desirable for overall Coastal Bays watershed restoration, but for restoration where it is desirable to restore within the same 8-digit watershed as the impact. For instance, most recommendations suggest the Northern Coastal Bays and Newport are most in need of restoration, but if wetland restoration is required in Chincoteague or Sinepuxent Bays, there are still some priority 1 sites from which to chose.

We used summary data from State of the Bays Report and TMDL recommendations. Essentially all areas were on the 303(d) List, so that itself was not a good way to prioritize areas. For the headwater areas, sites with the worst nutrient concentrations during the MDNR synoptic survey were used. These coincided with the other recommendations, but were helpful in selecting specific areas within the headwaters.

All of the above criteria resulted in maps of priority 1 restoration sites (Figure 6: Isle of Wight, Assawoman, Newport, Sinepuxent Bays and Figure 7: Chincoteague Bay).

Table 6. Soil characteristics and ranking for the hydric soils within Maryland Coastal Bays watershed. Characteristics are based on the 2000 Worcester County Soil Survey (USDA, 2000).

| Map Symbol | Soil Name | Family or higher taxonomic class | Drainage | Epipedon | OM | Texture | Landform | Acid when drained | Rank |
|---|---|---|---|---|---|---|---|---|---|
| As | Askecksy | Siliceous, mesic Typic Psammaquents | pd | ochric | 2 | 1 | FL/DEP | N | 4 |
| Bh | Berryland | Sandy, siliceous, mesic Typic Haplaquods | vpd | Umbric (spodic horizon) | 4 | 1 | FL/DEP | N | 2 |
| Br | Broadkill | Fine-silty, mixed, nonacid, mesic Typic Sulfaquents | vpd | ochric | 4 | 3 | TM | Y | 1 |
| BX | Boxiron (40%); Broadkill (40%) | Boxiron: Fine-silty, mixed, nonacid, Histic Typic Sulfaquents; Broadkill: Fine-silty, mixed, nonacid, mesic Typic Sulfaquents | vpd | histic | 5 | organic | TM | Y | 1 |
| Ch | Chicone | Coarse-silty, mixed, acid, mesic Thapto-Histic Fluvaquents | vpd | buried histic | 4 | 2 | FP | N | 2 |
| Ek | Elkton | Fine-silty, mixed, mesic Typic Endoaquults | pd | ochric | 2 | 3 | FL/DEP | N | 3 |
| Em | Elkton | Fine-silty, mixed, mesic Typic Endoaquults | pd | ochric | 2 | 3 | FL/DEP | N | 3 |
| Fa | Fallsington | Fine-loamy, mixed, mesic Typic Endoaquults | pd | ochric | 2 | 3 | FL/DEP | N | 3 |
| Hu | Hurlock | Coarse-loamy, siliceous, mesic Typic Endoaquults | pd | ochric | 2 | 2 | FL/DEP | N | 4 |
| In | Indiantown | Coarse-loamy, siliceous, acid, mesic Cumulic Humaquepts | vpd | umbric | 3 | 2 | FP | N | 2 |
| Ke | Kentuck | Fine-silty, mixed, mesic Typic Umbraquults | vpd | umbric | 4 | 3 | FL/DEP | N | 2 |

Table 6 (continued)

| Map Symbol | Soil Name | Family or higher taxonomic class | Drainage | Epipedon | OM | Texture | Landform | Acid when drained | Rank |
|---|---|---|---|---|---|---|---|---|---|
| Ma | Manahawkin | Sandy or sandy-skeletal, siliceous, dysic, mesic Terric Medisaprists | vpd | histic | 5 | organic | S/FP | N | 1 |
| MC | Mannington (50%); Nanticoke (45%) | Mannington: Fine-silty, mixed, nonacid, mesic Typic Hydraquents; Nanticoke: Fine-silty, mixed, nonacid, mesic Typic Hydraquents | vpd | buried histic | 3 | 3 | MF | N | 2 |
| Mu | Mullica (55%); Berryland (30%) | Mullica: Coarse-loamy, siliceous, acid, mesic Typic Humaquepts; Berryland: Sandy, siliceous, mesic Typic Haplaquods | vpd | umbric | 4 | 2 | FL/DEP | N | 2 |
| Ot | Othello | Fine-silty, mixed, mesic Typic Endoquults | pd | ochric | 2 | 3 | FL/DEP | N | 3 |
| Pk | Puckum | Dysic, mesic Typic Medisaprists | vpd | histic | 5 | organic | S/FP | N | 1 |
| Pu | Purnell | Sandy, mixed, mesic Histic Sulfaquents | vpd | histic | 5 | organic | TM | Y | 1 |
| Su | Sunken | Fine-silty, mixed, mesic Typic Endoaqualfs | vpd | ochric | 4 | 3 | TM | Y | 1 |
| Tk | Transquaking | Euic, mesic Typic Sulfihemists | vpd | histic | 5 | organic | TM | Y | 1 |
| TP | Transquaking (55%); Mispillion (35%) | Transquaking: Euic, mesic Typic Sulfihemists; Mispillion: Loamy, mixed, euic, mesic Terric Sulfihemists | vpd | histic | 5 | organic | TM | Y | 1 |
| Zk | Zekiah | Coarse-loamy, siliceous, acid, mesic Typic Fluvaquents | pd | ochric | 4 | 2 | FP | N | 3 |

Drainage: pd=poorly drained, vpd=very poorly drained. Organic matter represents undrained organic matter. Higher numbers indicate higher organic matter. Drained OM is generally lower. Soil texture: 1=sandy; 2=coarse-silty/coarse loamy; 3=fine-loamy/fine-silty; organic=histic. Landform: FL/DEP=Lowland flat and depressions, TM=Estuarine tidal marshes, FP=Flood plains, S/FP=Swamps and floodplains, MF= Mud flat. Ranking: Higher numbers indicate more desirable soils for wetland restoration.

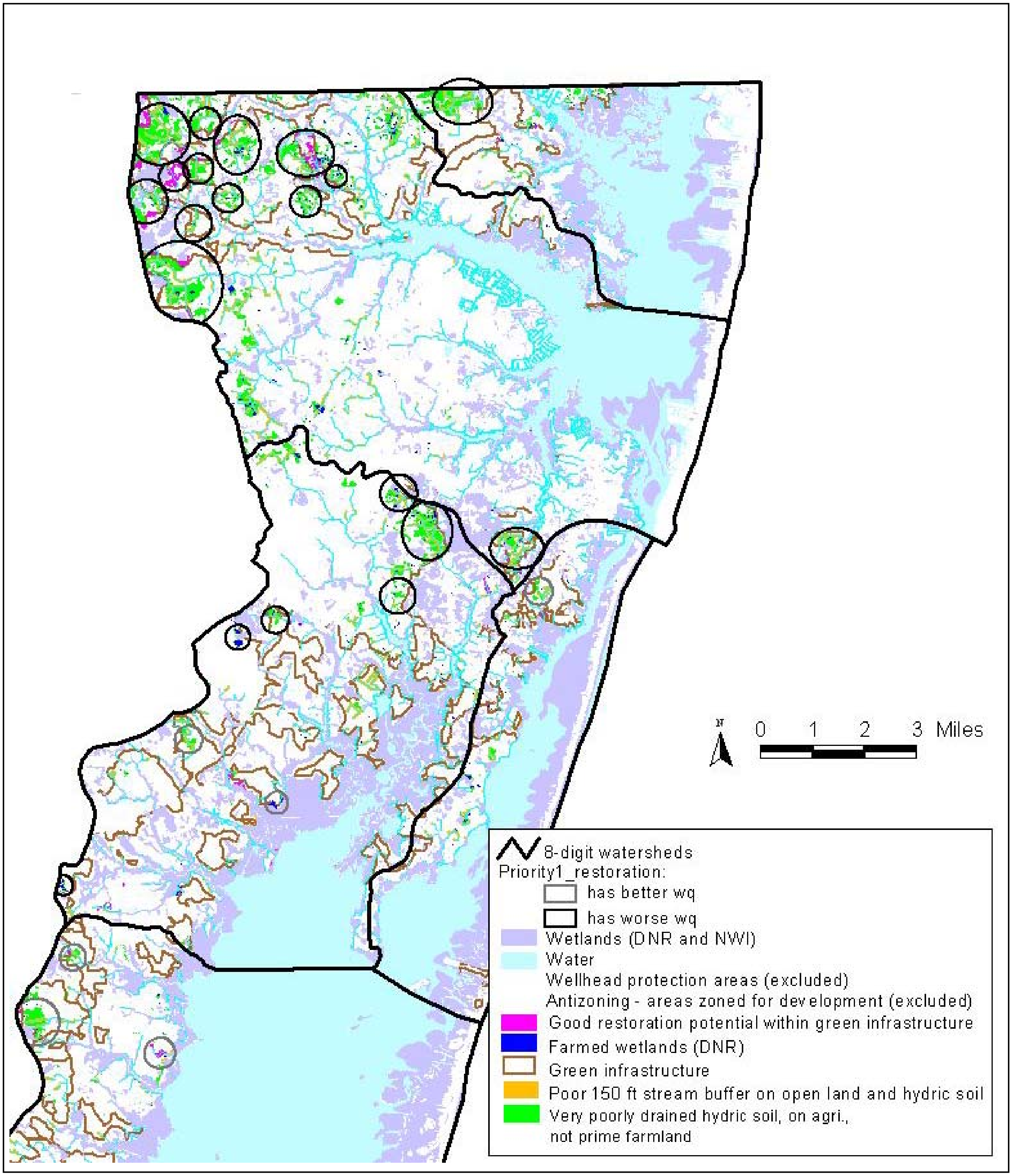


Figure 6. Priority 1 wetland restoration sites for four northern Coastal Bays watersheds.

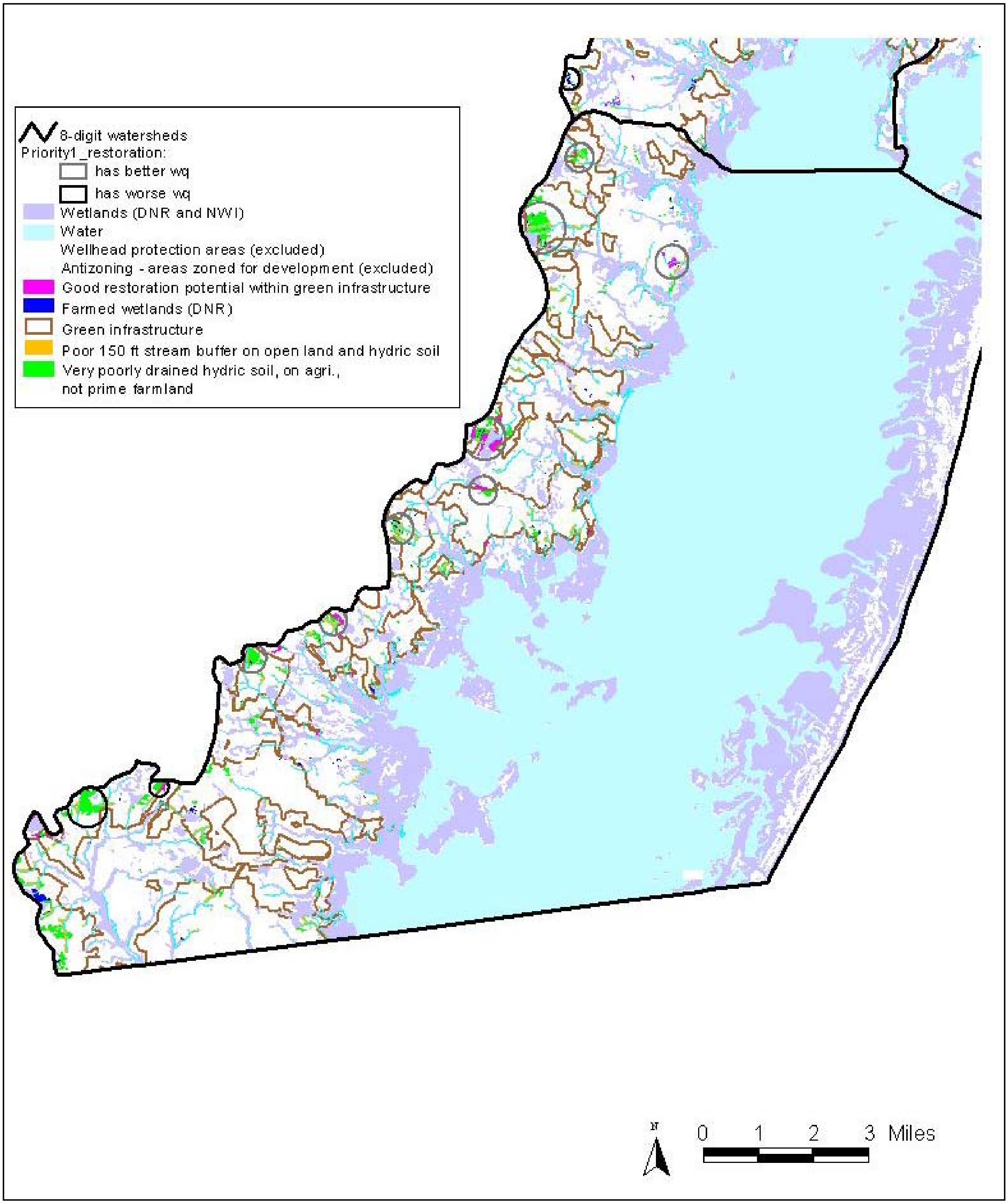


Figure 7. Priority 1 wetlands restoration sites for Chincoteague Bay watershed.

*How this compares to the WRAS (IOW) potential restoration sites.*

We compared our priority 1 results with the Isle of Wight WRAS results. Our results highlighted most of the sites they chose. Exceptions were Birch #2 (south of Peerless Road) since it is dominated by prime farmland which we excluded, and Bishopsville #1 since it was not within or adjacent to Green Infrastructure. Bishopsville #1 is a site that we ranked as priority 2. This site is in Bishopsville watershed (an area having poor water quality), it has large areas of very poorly drained soils currently in agriculture (including several MDNR classified farmed wetlands), and there are many streams and ditches without a buffer. This is a site that sticks out as being an exception to the rules of priority 1. From this comparison, we determined that our methods are finding similar results as the WRAS method, but we are finding more sites. Even mimicking the methods employed for the IOW WRAS, we found slightly different results due to the different data sources employed (e.g. we used different stream and soil layers and an additional wetland layer).

Priority 2 restoration sites

Basically, in determining priority 2 sites, we considered many of the same principals as for priority 1, but were less restrictive.

- **Include both poorly and very poorly drained soils.**
- **Still exclude prime farmland and wellhead protection areas.**
- **Include artificially drained forest when it is on very poorly drained hydric soil in or adjacent to Green Infrastructure.** Restoring artificially drained forest to wetland may provide less water quality improvement than converting marginal cropland to wetland (partly because agriculture land use is a much higher pollutant source), but forested wetlands can provide more water quality function than forested upland. Additionally, upland forested areas often provide more habitat than farmland, so it may be less desirable to convert forest to wetland than to convert farmland to wetland. However, when wetland hydrology is restored to these drained forests, they often become beautiful ecologically diverse wetlands. This type of restoration has the benefit of providing immediate forest cover in the wetland (versus wetlands built on agricultural land that may take a few decades to develop forest cover). We selected soils ranked very poorly drained, within the GI network, currently forest but not wetland.

The above criteria resulted in maps of priority 2 restoration sites (Figure 8: Isle of Wight, Assawoman, Newport, Sinepuxent Bays and Figure 9: Chincoteague Bay).

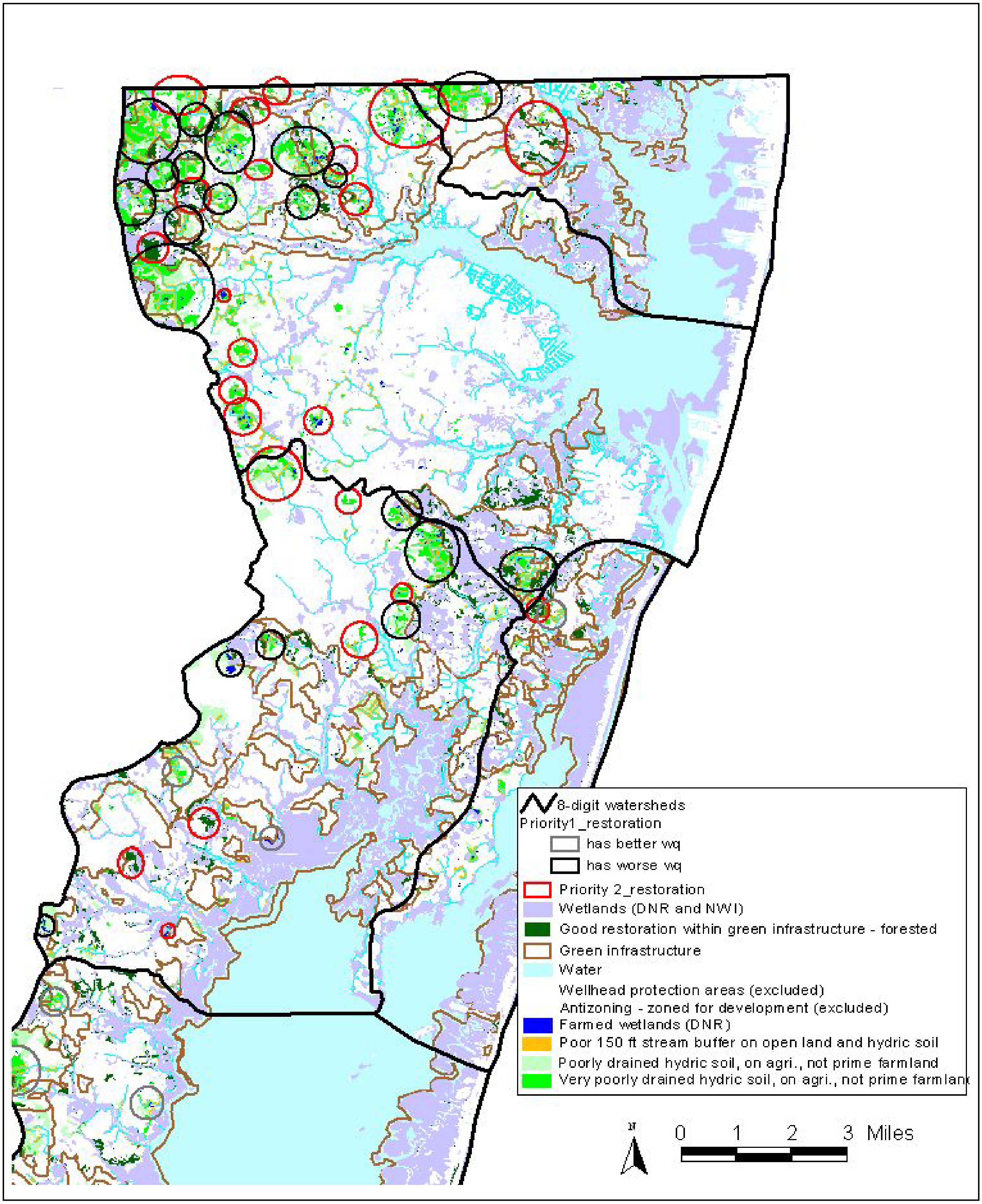


Figure 8. Priority 1 and 2 wetland restoration sites for four northern Coastal Bays watersheds

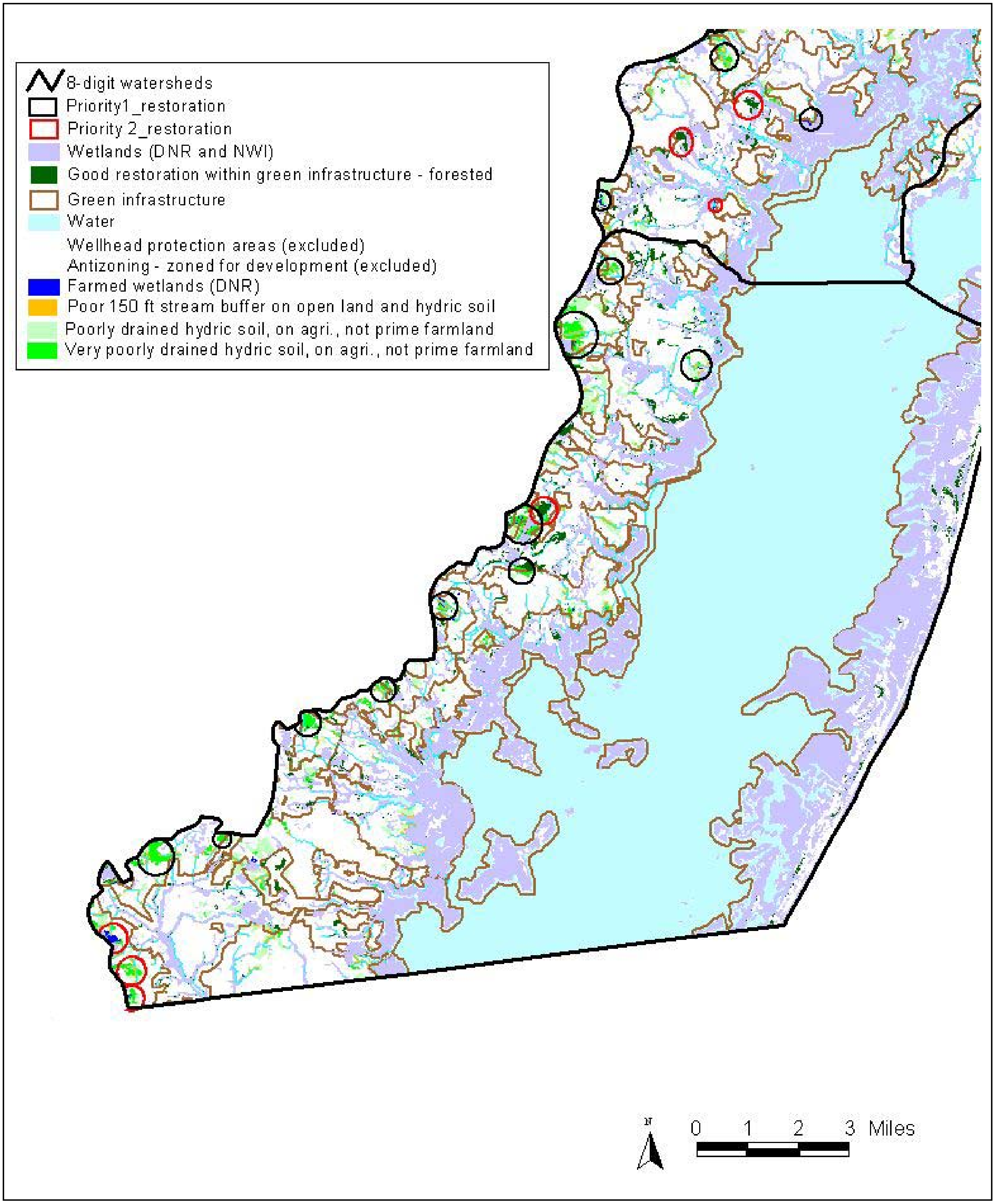


Figure 9. Priority 1 and 2 wetland restoration sites for Chincoteague Bay watershed.

Protected land

Protected land was targeted because owners may be more open to the idea of restoration on their property. We looked for areas that are protected (private conservation, Maryland Environmental Trust easements, federal, state, county land, Chesapeake Forest land) on hydric soil, and not currently designated as wetlands. We did not include agricultural easements, CREPs, or WRPs.

This resulted in a map showing restoration opportunities on currently protected land (Figure 10: Isle of Wight, Assawoman, Newport, Sinepuxent Bays and Figure 11: Chincoteague Bay).

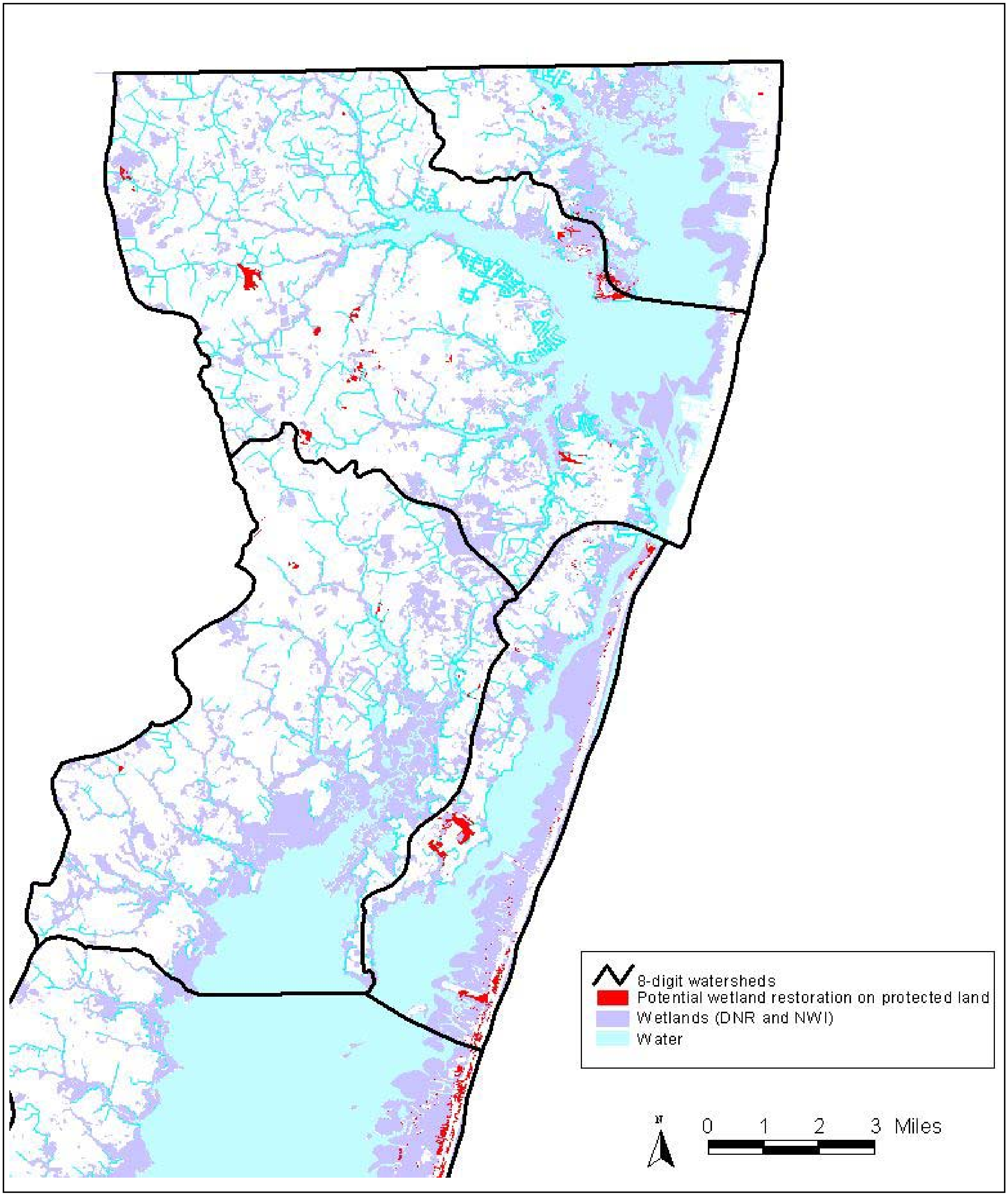


Figure 10. Potential wetland restoration sites for protected land within the four northern Coastal Bays watersheds.

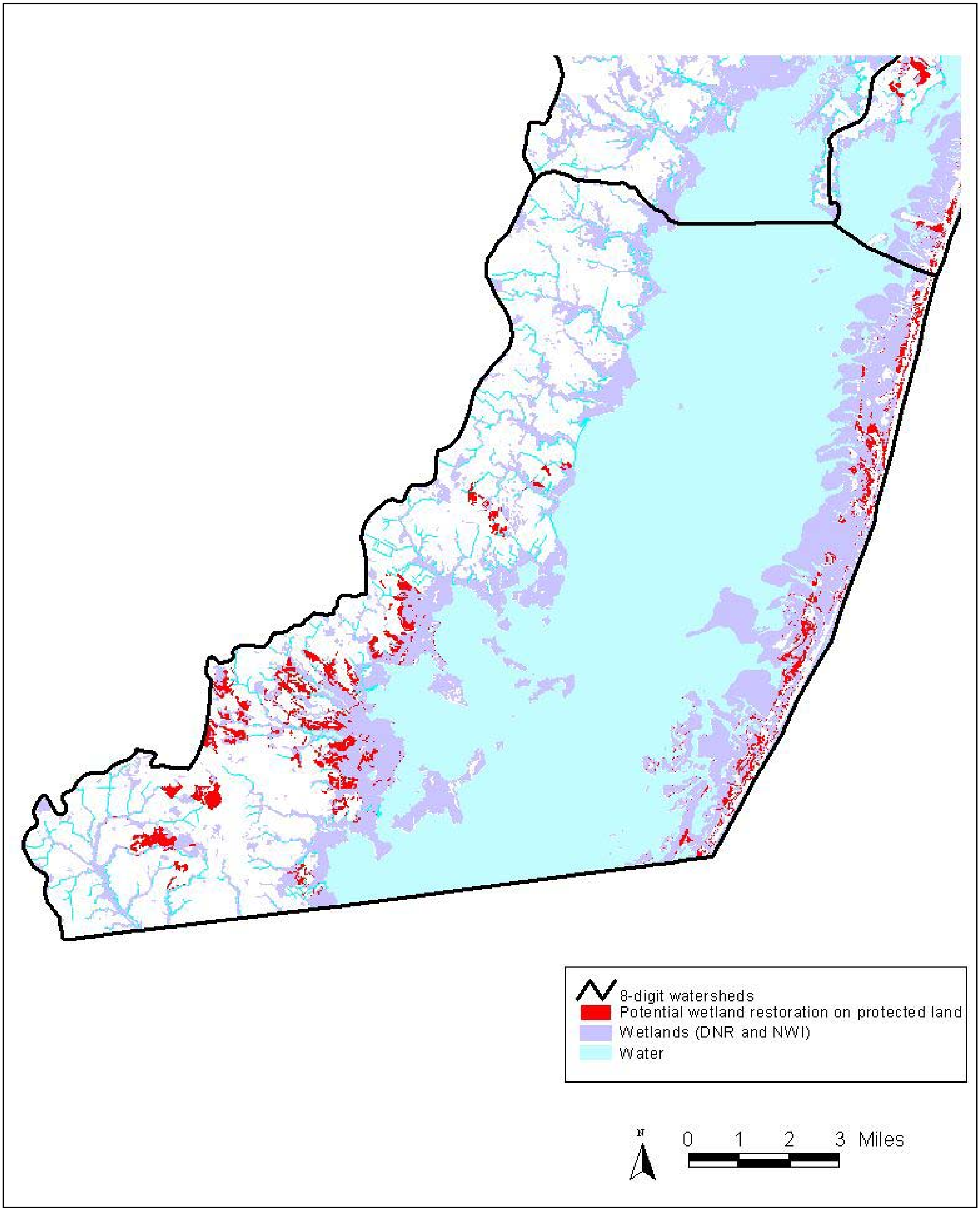

Figure 11. Potential wetland restoration sites for protected land within Chincoteague Bay watershed.

Previous recommendations for restoration sites

- **Stream "problem" sites as identified through the SCA (IOW, Newport, Sinepuxent) having**:
  - Stream erosion. We selected sites with moderate to severe stream erosion (severity 1 to 3).
  - Inadequate buffers. We selected buffers ranked very severe (severity 1 and 2)
  - Fish barriers. We excluded debris barriers because we felt many of these may be temporary or may be removed by methods easier than restoration. Of the remaining barriers, only one is severe – Bishopsville Dam (which is planned for removal). The remaining blockages had a low severity (severity 4 and 5). Therefore, identified fish barriers are only a minor variable inhibiting aquatic ecosystem, when compared to other issues.
- **Tiner.** Sites identified for restoration during the Tiner et al. (2000) study should be considered as enhancement options, especially ditched estuarine and palustrine wetlands, tidally restricted wetlands, and farmed wetlands. As discussed in the background section of the report, palustrine forested wetlands may be overestimated in the Tiner wetlands layer.
- **Additional recommendations.** In order to address all of the specific site recommendations within the targeting section, ones that were not directly addressed in the previous section are listed below.
  - Isle of Wight, Assawoman, and Newport Bays (these bays also have some of the worst water quality so were generally the target of restoration).
  - Marshes on the northern side of Isle of Wight Island.
  - Dead-end canals (this would likely be an out-of-kind structure).
  - Ocean City Harbor.
  - Manklin Creek, Fenwick Island, and Ocean Pines.
  - Great Cypress Swamp

These additional previous recommendations for restoration are also shown on a map (Figure 12).

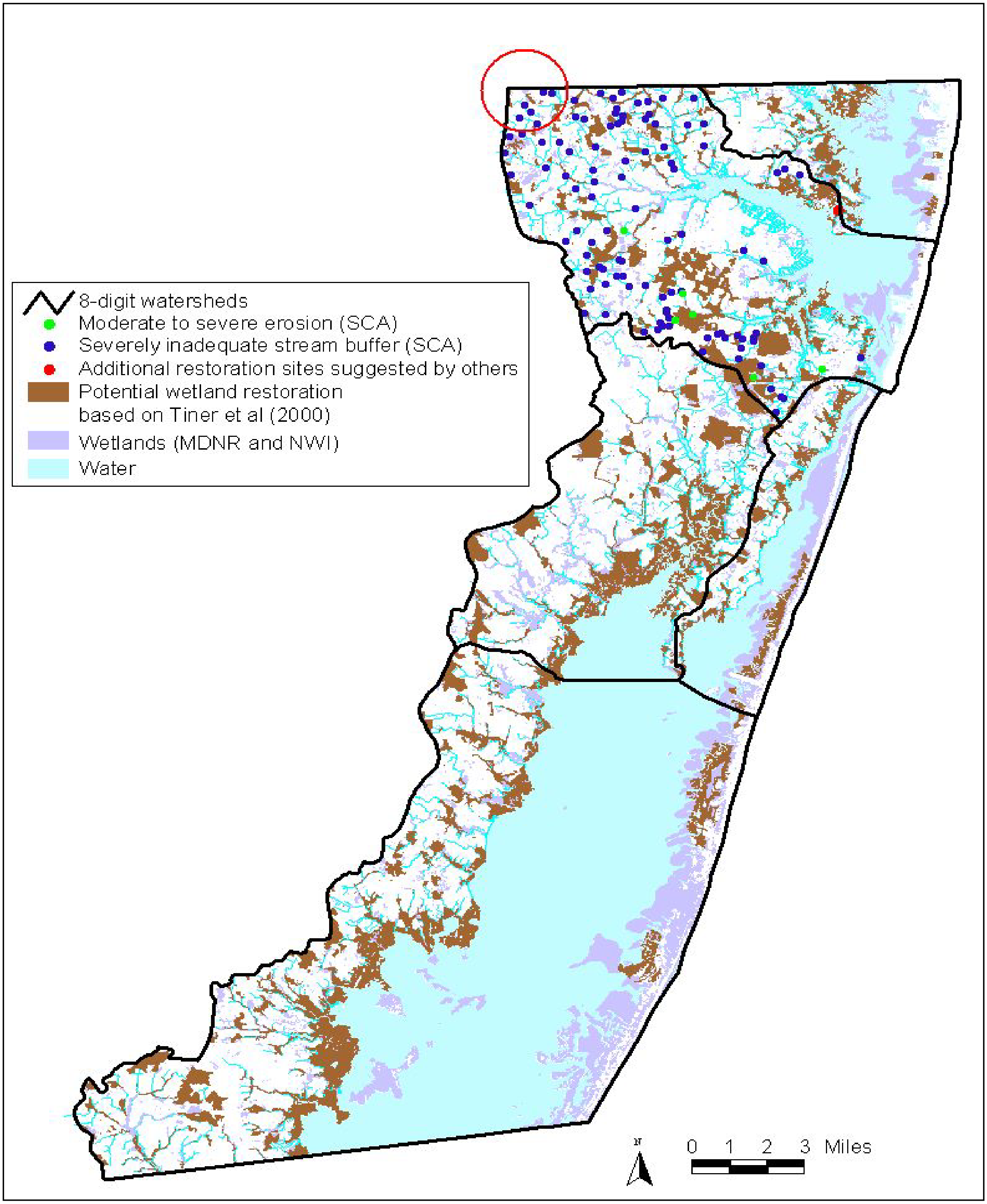


Figure 12. Additional wetland restoration sites within the Coastal Bays watershed.

**Summary of protection targeting information - existing recommendations**

General Sites

- Aquatic systems
    - Coastal Resources (Worcester County, 1989)
    - Wetlands (MCBP, 1999; Worcester County, 1997, 2002)
    - Drainageways (Worcester County, 1989)
    - 100-ft buffer around tidal waterbodies and wetlands (Worcester County, 2002)
    - Stream corridors and their buffers (MCBP, 1999; Worcester County, 1997)
    - Natural shoreline and surrounding areas (MCBP, 1999)
- Areas of high erosion (Worcester County, 1989)
- Bays, beaches, bluffs (MCBP, 1999; Worcester County, 1989)
- Floodplains (Worcester County, 1989, 1997, 2002)
- Forests
    - Forests in general (Worcester County, 1989)
    - Forests adjacent to streams and wetlands (MCBP, 1999)
    - Large parcels of hardwood/mixed forest (MCBP, 1999)
- Recreational
    - Areas of high recreational value (Worcester County, 1989)
    - Greenways between development and recreation (MCBP, 1999)
    - Sensitive areas from detrimental impacts of water-recreation (MCBP, 1999)
- Rural Legacy Area (Worcester County, 1997)
- Green Infrastructure (MDNR, 2004 Draft)
    - Hubs with high ecological ranking and high development risk
    - Corridors connecting hubs of high ecological ranking
- Non-fragmented systems (USACE, 1995)
- Histosols (Fugro East, Inc., 1995; USACE, 1995)
- Important habitat
    - Habitats of threatened and endangered species (MCBP, 1999; Fugro East, Inc., 1995; Worcester County, 1997, 2002)
    - Ecologically Significant Areas (MDNR, 2004 Draft)
    - Horseshoe crab habitat (MCBP, 1999)

- Migration and breeding habitat of neotropical songbirds (MCBP, 1999)
- 100-foot buffer around colonial waterbird nesting sites (Worcester County, 2002)
- Corridors between significant habitat (Worcester County, 2002)
- Connected to other wildlife habitat (USACE, 1995)
- Bird habitat (MCBP, 1999)

<u>Specific Sites</u>

- Newport Bay and Chincoteague Bay watersheds (MDNR & MDE, 2000)
- Skimmer Island (USACE, 1998)
- West Ocean City Pond (MDNR, 1987)
- Ironshire Swamp (MDNR, 1987)
- Porter Neck Bog (MDNR, 1987)
- Hancock Creek Swamp (MDNR, 1987)
- Little Mill Run (MDNR, 1987)
- PawPaw Creek (MDNR, 1987)
- Pikes Creek (MDNR, 1987)
- Powell Creek (MDNR, 1987)
- Riley Swamp (MDNR, 1987)
- Scotts Landing Pond (MDNR, 1987)
- Tanhouse Creek (MDNR, 1987)
- Sinepuxent Bay water trail (MDNR, 2000)
- Snow Hill Rail Trail (MDNR, 2000)
- Church Creek cypress swamp (Spaur, 2004)
- Other cypress swamp sites when identified (Spaur, 2004)

Because Chincoteague Bay generally has the best water quality within the Coastal Bays, and is currently the least developed, it is desirable to protect this area. Recommendations of which waterways to protect were mixed, with no one area being recommended the most.

**MDE protection analysis and final recommendations**

<u>Priority 1 protection sites</u>

- **Nontidal Wetlands of Special State Concern (NTWSSC) or proposed Nontidal Wetlands of Special State Concern** (MDNR, 2004). Since all NTWSSC and proposed NTWSSC either have unique flora or fauna, or provide unique habitat, we ranked all NTWSSC and proposed NTWSSC as priority 1 for protection. We looked for NTWSSC or proposed NTWSSC that were not already protected. Within this priority 1 layer, we ranked these sites further. We wanted to protect wetlands that were surrounded by protected natural land, either currently or planned, since a large contiguous natural system is desirable for habitat function. For this reason, sites were ranked based on Green Infrastructure (GI), ecological ranking, Rural Legacy (RL), surrounding land use (LU), and surrounding protected land.
    - Isle of Wight
        - *West Ocean City Pond*. This site is outside of the GI and RL and is surrounded by residential LU.
    - Newport Bay
        - *Porter Neck Bog* (Ironshire Swamp, as listing in COMAR, is now included under this name). This site is within the GI but outside of RL. It is mostly surrounded by forest and some agriculture.
        - *Icehouse Branch*. This proposed NTWSSC is within the GI but outside of RL. It is mostly surrounded by forest and some agriculture.
        - *Massey Branch*. This proposed NTWSSC is within the GI but outside of RL. It is mostly surrounded by forest and some agriculture.
        - *St. Lawrence Neck*. This proposed NTWSSC is within the GI but outside of RL. It is mostly surrounded by forest and some agriculture.
    - Chincoteague Bay
        - *Waterworks Creek*. This proposed NTWSSC is within GI but outside of RL. It is surrounded by mixed forest and wetlands.
        - *Spencer Pond*. This proposed NTWSSC is within GI but outside of RL. It is surrounded by mixed forest.
        - *PawPaw Creek*. This NTWSSC is within GI but outside of RL. It is surrounded by mostly pine forest.
        - *Tanhouse Creek*. This NTWSSC is within GI. Although it is outside of the RL, it is very close. Some nearby RL land is protected. It is surrounded by mixed forest and some agriculture.

- *Scotts Landing Pond* – This NTWSSC is within GI but outside of RL (surrounded by it). It is surrounded by pine forest and wetland.
- *Truitt Landing*. This proposed NTWSSC is protected by a MET.
- *Scarboro Creek Woods*. This site is within GI and RL. It is partially protected by E.A Vaughn WMA and is surrounded by mixed forest and agriculture.
- *Pikes Creek Woods*. This proposed NTWSSC is not within GI, but is adjacent to it. It is within RL. The ecological ranking was not as high as the other sites. This site is next to a lot of protected land (E.A. Vaughn WMA, MDNR-owned Chesapeake Forest land, and a MET). This site is largely surrounded by agriculture.
- *Pikes Creek*. Over half of this site is protected by Chesapeake Forest land and the other portion is adjacent to E.A. Vaughn WMA and a MET. This site is within GI and RL, and is surrounded by pine forest and agriculture.
- *Stockton Powerlines*. The majority of the site is protected by MDNR-owned Chesapeake Forest land. This site is within GI and RL, and is surrounded by mixed forest and agriculture.
- *Riley Creek Swamp*. This site is within GI and RL, and is surrounded by mainly agriculture (and a thin strip of mixed forest).
- *Hancock Creek Swamp*. This site is within GI and RL, and is surrounded by forest. It is partially protected and has some protected land around it.
- *Powell Creek*. This site is within RL but outside of GI. It is surrounded by agriculture and was given a relatively low ecological ranking.
- *Little Mill Run*. A small amount of this site (in the NE) is protected by MDNR-owned Chesapeake Forest land. This site is within GI, but the GI is mainly agriculture. It is outside of RL. It is mostly surrounded by agriculture, with thin strips of forest.

Although all of the above sites should be ranked priority 1, some of the most desirable NTWSSC and proposed NTWSSC sites for protection include Tanhouse Creek, Scotts Landing Pond, and sites within both designated Green Infrastructure network and Rural Legacy. The sites Pikes Creek, Pikes Creek Woods, Scarboro Creek Woods, and Stockton Powerlines are close together and are near large areas of protected land. If these areas were all protected, it would create a large protected area, which is desirable. NTWSSC sites with lowest preservation priority include West Ocean City Pond, Powell Creek and Little Mill Run.

**Additional sites were added to priority 1 based on the following:**

- Within or adjacent to designated Rural Legacy area and other protected land.
- Wetlands within MDNR-designated Ecologically Significant Areas (ESA).
- Within or adjacent to Green Infrastructure or corridor. Consider ecological ranking and development risk. Look for remaining wetlands in high ecological ranking area.
- Adjacent to waterways or other natural systems (i.e. wetlands, hardwood forests).
- Areas identified by the Emergency Wetlands Resources Act of 1986
- Church Branch Cypress Swamp

Most of the priority 1 protection sites fall within Newport Bay and Chincoteague Bay, areas identified by Unified Watershed Assessment as being high priority for preservation (Figure 13). Only one site is within Isle of Wight (West Ocean City Pond) and none are within Sinepuxent or Assawoman.

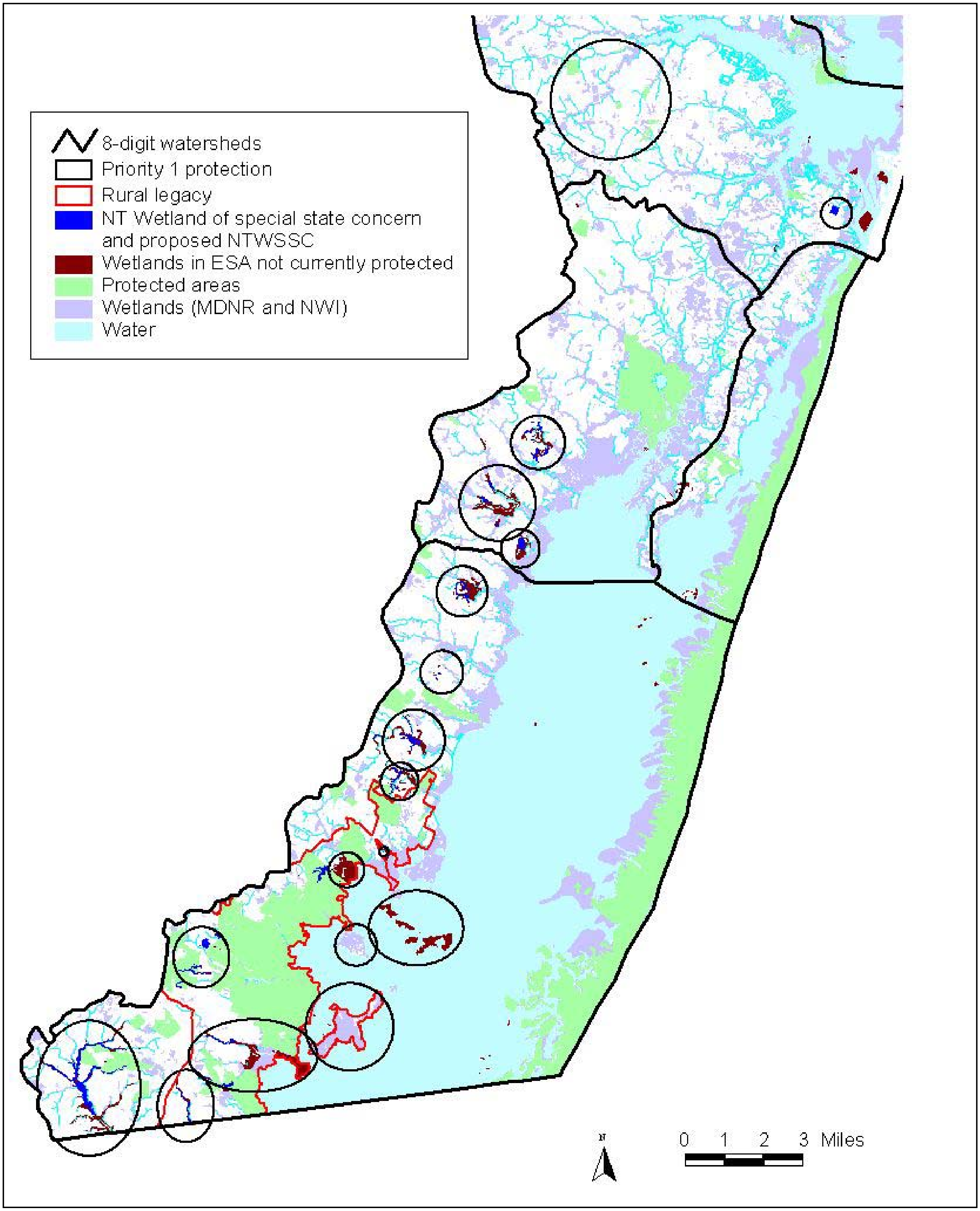


Figure 13. Priority 1 wetland preservation sites within the Coastal Bays watershed.

**Priority 2 protection sites**: priority 2 uses many of the same factors as priority 1, but is not as strict. For instance, if some of the criteria were met, the site would be considered (e.g. Priority 2 sites within Isle of Wight watershed are not within or adjacent to RL or protected land, but are within the GI network and are the largest wetland systems in that watershed).

- **Within or adjacent to Rural Legacy.**
- **Adjacent to protected land.**
- **Wetlands within MDNR-designated Ecologically Significant Areas (ESA)**. We selected wetlands that were not yet protected that intersected (xtools) with the ESA layer.
- **Areas identified as being important in the Aquatic Sensitive Species Report**.
- **Within or adjacent to Green Infrastructure or corridor**. Consider ecological ranking and development risk. Look for remaining wetlands in high ecological ranking area. We also considered ecological ranking, which was closely related to Green Infrastructure. All priority two sites are in areas of high ecological ranking. This layer may be more useful in comparing areas outside of the Green Infrastructure network.
- **Adjacent to waterways or other natural systems** (i.e. wetlands, hardwood forests).
- **Large wetland systems.**
- **Tiner wetland functional assessment.** We added two sites that Tiner classified as being important for biodiversity since they were large wetland complexes. These areas do not have many MDNR or NWI wetlands identified on them. Therefore, further site investigation will determine if these sites are actually wetlands.
- **Headwater wetlands.** Existing headwater wetlands with high estimated function for maintaining water quality should also be protected. These may largely include headwater wetlands in Isle of Wight and the northern half of Newport Bay.
- **Once priority 1 restoration areas are restored, they should be protected.** There are currently few extensive wetland areas within Isle of Wight watershed, but many priority 1 restoration areas are located there. Once these sites are restored, if they are considered important in maintaining water quality or providing a natural vegetation network, these areas should be protected.

Priority 2 protection sites are shown on the maps (Figure 14: Isle of Wight, Assawoman, Newport, Sinepuxent and Figure 15: Chincoteague Bays.

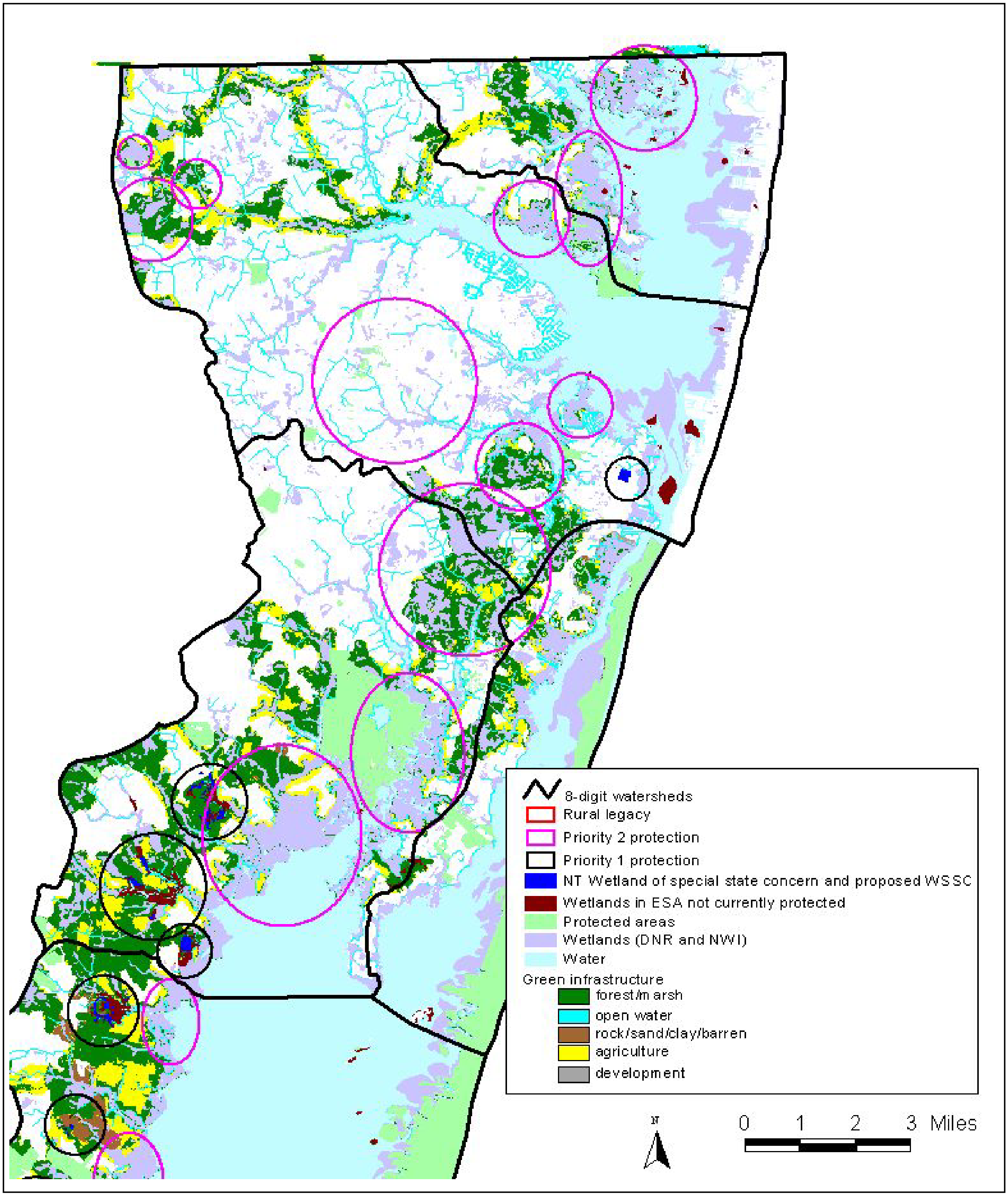


Figure 14. Priority 1 and 2 wetland preservation sites with the four northern Coastal Bays watersheds.

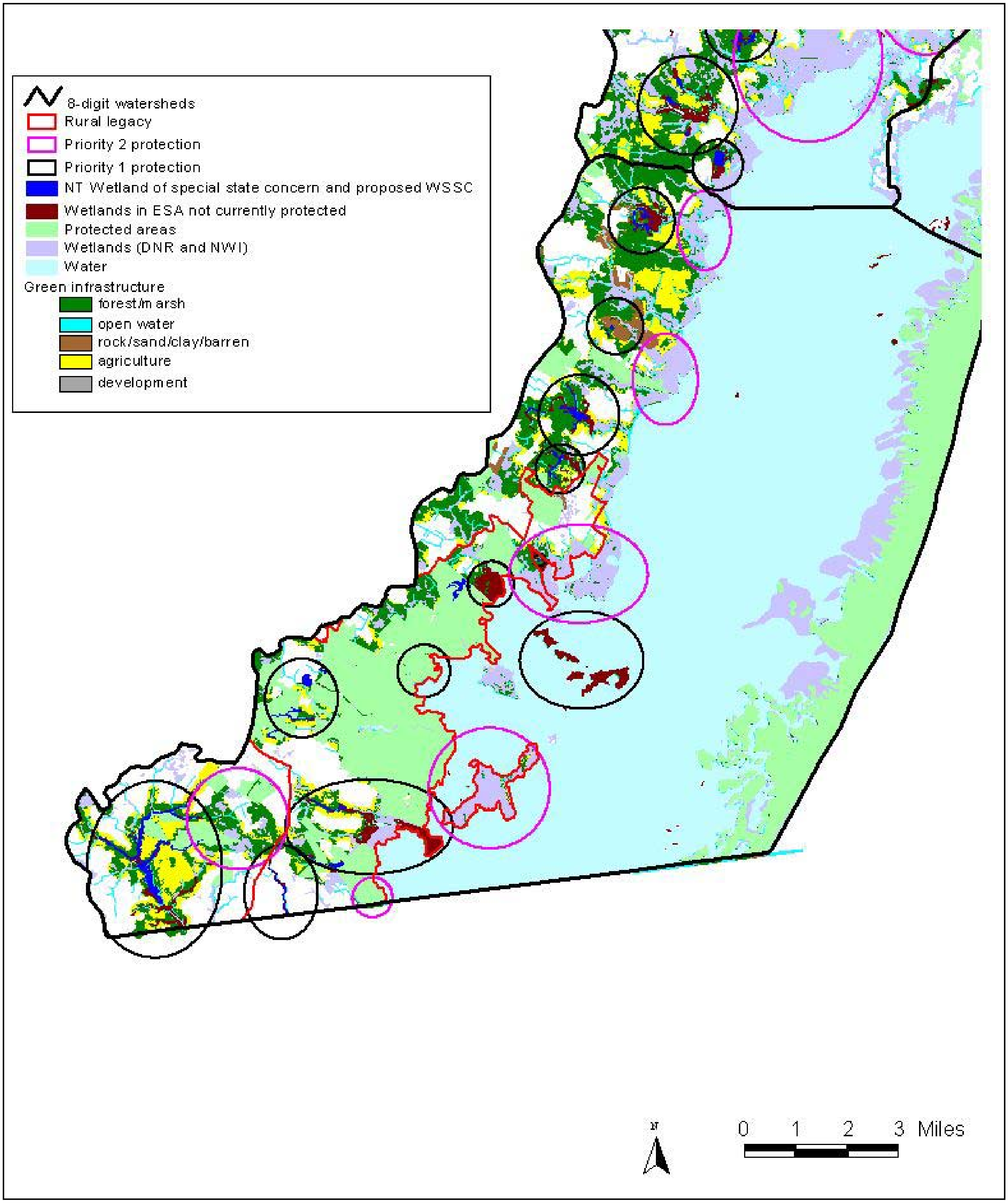


Figure 15. Priority 1 and 2 wetland preservation sites within Chincoteague Bay watershed.

## Mitigation

Compensatory mitigation is the replacement of wetlands lost through regulated activities. Mitigation is a state and federal requirement of permittees, with a goal of achieving a no-net-loss of wetland acreage and function. Mitigation usually results in a requirement to create new wetlands or restore former wetlands to compensate for losses of wetland acreage and function. On some occasions, enhancement of existing wetlands is accepted as mitigation. Enhancement of existing wetlands is generally less preferable than restoration or creation, since there is no increase in wetland acreage. Enhancement of wetlands does improve wetland function, condition, and value. Other less common types of mitigation are preservation, which is the long-term protection of an existing wetland, without an increase in acreage or function. Another type of mitigation evaluated for this project is "out-of-kind" mitigation, an activity that does not directly create, restore or enhance a wetland, but improves other aquatic resources or establishes an environmental benefit or function that a wetland may provide. Examples are riparian buffers, stream restoration, or water quality improvement projects.

The State holds permittees responsible for conducting mitigation for wetland losses greater than 5,000 square feet in size. MDE assumes responsibility for mitigation of the cumulative remaining smaller wetland losses, and funds its projects from fees accepted from permittees in lieu of permittee-conducted mitigation. Due to the prevalence of losses from development of many small lots in areas such as Ocean Pines, MDE's greatest mitigation debt is in the Coastal Bays watershed.

Despite the extensive amount of suitable area for wetland creation and restoration, MDE has not been successful in compensating for all authorized losses. This section of the report presents tasks to facilitate wetland mitigation in the Coastal Bays while considering the findings of the targeted information for restoration and preservation.

MDE's lack of progress in adequately compensating for losses is attributed to:

1) Lack of public land with suitable, available area. Public land, such as parks, is often used by MDE across the State for mitigation due to compatibility of wetlands with other management plans for the site. Access to public land does not require acquisition of land or an easement, which are costly and time consuming processes.

2) Lack of staff. The lack of public land means that mitigation must be accomplished on private land. This requires an additional effort of outreach that staff has been unable to accommodate. Active outreach is a principal reason that voluntary restoration through agricultural cost share programs has been successful.
3) Land costs. Landowners will need incentives beyond gaining wetland benefits in order to undertake wetland projects and restrict the use of an area located on potentially buildable land. Fair compensation for use of land is necessary, however, land costs are increasing throughout the Coastal Bays.
4) Logistical difficulties. State land acquisitions of easements or fee simple purchases are extremely time consuming and require involvement and support of multiple agencies.

In order to overcome these challenges, MDE will:

a) Form more partnerships. MDE will work with Worcester County, Natural Resources Conservation Service, and the Corps of Engineers to contact landowners. Preliminary discussions have begun.
b) Focus on larger parcels, so there is room to allow establishment of a wetland without sacrificing development opportunities. Sites in estate or rural conservation zoning will be targeted.
c) Support mitigation requirements that are a combination of restoration, enhancement, preservation, or out-of-kind projects. At a minimum, there will be 1:1 mitigation requirement in the form of restoration or creation. Other forms of mitigation such as enhancement, preservation, or out-of-kind projects will be considered for the remaining balance of any mitigation requirements.