A User's Guide to Watershed Planning in Maryland

December 2005

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Foreword

This manual was developed by the Center for Watershed Protection in cooperation with the Maryland Department of Natural Resources and Maryland Department of the Environment. Funding for this project was provided by the United States Environmental Protection Agency, under contract number 14.05.980.EPA.056.

The preparation of the manual was greatly influenced by two sets of interviews conducted in late 2004 and early 2005. The first round included interviews with more than 15 state and federal agency program managers to identify current and anticipated state and federal watershed planning requirements and resources. The second round of interviews focused on county and city staff involved in local watershed planning to define the current watershed planning practice in Maryland, and determine local technical needs and desired integration. Those interviewed were invited to review the draft guide as well.

The Center for Watershed Protection project team included:

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About This Guide

A User's Guide to Watershed Planning in Maryland presents a common watershed planning framework for Maryland communities, assembles planning resources into one place, integrates regulatory drivers, and presents the methods necessary for completing a local? watershed plan. Local government staff are the primary audience for this guide. Other groups writing watershed plans in Maryland such as watershed organizations are also encouraged to utilize this framework.

This guide took more than a year to complete and represents the compilation of information gathered from 25 interviews with state agency program managers and local government staff. It also incorporates a review of more than 47 local watershed planning surveys; a review of existing watershed management planning guides; and research on Maryland GIS mapping, monitoring, modeling, and financial resources available to watershed planners.

The guide starts by introducing a basic eight-step framework for developing watershed plans followed by 27 principles of an effective watershed plan. The remainder of the guide is dedicated to describing the methods used to complete the steps and meet the principles. The methods are organized into four broad categories: desktop analysis, field assessment, stakeholder involvement, and management methods.

For first time watershed planning efforts or small local governments that lack the resources and expertise to complete an extensive watershed plan should not be intimidated by the number of methods presented within the User's Guide as many of them are optional. Selecting the methods necessary to complete a watershed plan will largely depend on the amount of funding available and purpose of the plan. Guidance on the minimum methods needed to complete a watershed plan is provided in Chapter 1. Small local governments should also consider utilizing a consultant to complete the plan or completing the plan in several phases.

> These call outs are provided throughout the Users Guide to emphasize key points during the watershed planning process.

The format of the guide is primarily web-based with the intent that it will be a living document that is periodically updated and revisited as methods continue to be tested and refined. With this in mind, User's Guide downloadable tools are provided in lieu of appendices and are referenced throughout the guide. This approach keeps the guide slim and readable and easy to update, and users will have easy access to the User's Guide tools they need to complete their plan.

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List of Acronyms and Abbreviations

AWMS:	Animal Waste Management System
B-IBI:	Benthic Index of Biological Integrity
BMP:	Best Management Practice
C2K:	Chesapeake 2000 Bay Agreement
CBP:	Chesapeake Bay Program
CCMP:	(Coastal Bays) Comprehensive Conservation Management Plan
COMAR:	Code of Maryland Regulations
CWP:	Center for Watershed Protection
DPI:	Discharge Prevention Investigation
EMC:	Event Mean Concentration
EPA:	Environmental Protection Agency
ESC:	Erosion and Sediment Control
FCP:	Forest Conservation Plan
FEMA:	Federal Emergency Management Agency
F-IBI:	Fish Index of Biological Integrity
FIC:	Future Impervious Cover
FIDS:	Forest Interior Dwelling Species
FSD:	Forest Stand Delineation
GIS:	Geographic Information System
IC:	Impervious Cover
ICC:	Impervious Cover Coefficient
ICM:	Impervious Cover Model
IDA:	Intensely Developed Areas
IDDE:	Illicit Discharge Detection and Elimination
LDA:	Limited Development Areas
MBSS:	Maryland Biological Stream Survey
MD DNR:	Maryland Department of Natural Resources
MDA:	Maryland Department of Agriculture
MDE:	Maryland Department of the Environment
MDP:	Maryland Department of Planning
MOA:	Municipal Operations Analysis
MOU:	Memorandum of Understanding
MOS:	Margin of Safety
MS4:	Municipal Separate Storm Sewer System
NCA:	Needs and Capabilities Assessment
NPDES:	National Pollutant Discharge Elimination System
NPS:	Nonpoint Source
PCB:	Polychlorinated Biphenyls
PFA:	Priority Funding Area

RBP:	Rapid Bioassessment Protocol
RCA:	Resource Conservation Areas
RRI:	Retrofit Reconnaissance Inventory
RSAT:	Rapid Stream Assessment Technique
RTE:	Rare, Threatened and Endangered (Species)
SAV:	Submerged Aquatic Vegetation
SCA:	Stream Corridor Assessment
SRI:	Stream Repair Inventory
SSPRA:	Sensitive Species Project Review Area
STORET:	STORage and RETrival
SVAP:	Stream Visual Assessment Protocol
SWA:	Source Water Assessment
TDR:	Transfer of Development Rights
TMDL:	Total Maximum Daily Load
URSA:	Urban Reforestation Site Assessment
USA:	Unified Stream Assessment
USDA:	United States Department of Agriculture
USGS:	United States Geological Survey
USSR:	Unified Subwatershed and Site Reconnaissance
WTM:	Watershed Treatment Model
YOY:	Young of the Year

Chapter 1: Basic Concepts of Local Watershed Planning

While watershed planning is not new to Maryland, it has historically been conducted by a variety of local, state and private organizations over a range of scales and has featured an array of methods and techniques. The main intent of this guide is to provide a common planning framework for Maryland jurisdictions. Additionally, the purpose of the guide is to:

- define the elements of an effective watershed plan
- assemble all of Maryland's watershed planning resources in one place
- provide practical guidance on how to use watershed planning to meet federal funding requirements and address land use issues
- integrate regulatory drivers and programs such as Total Maximum Daily Loads (TMDL) and the Chesapeake Bay 2000 Agreement with local watershed planning efforts
- describe methods for completing an effective watershed plan within the proposed framework

Local government staff are the primary audience for this guide, however other groups writing watershed plans in Maryland, such as watershed organizations, are also encouraged to utilize the framework.

A. Benefits of Watershed Planning

Local governments across Maryland are finding that their water resources are facing degradation in response to growth and development. They are also discovering that they can only protect local water resources by thinking on a watershed scale. At this scale, local governments can identify specific pollutants and their sources, and create solutions. Watershed planning also provides local governments with a framework to prioritize valuable and sometimes scarce resources such as funding and staff time. Local governments with a good watershed plan in hand will also have access to a greater number of resources for project implementation including Section 319 funds through the Clean Water Act. Additional benefits of watershed planning are outlined in Table 1.1.

Table 1.1: Benefits of Watershed Planning	
Local Government Benefits	*Administrative Benefits*
• Enables analyses that are most meaningful at a watershed or subwatershed scale (e.g., nutrient loadings, impervious cover estimates, etc.) • Enables management at a scale necessary to ensure consistency with TMDLs • Provides a framework for prioritizing resources (staff, conservation dollars, etc.) • Provides educational opportunities for citizens to understand how natural resources management interacts with existing and future development • Gives citizens an active voice in protecting and restoring natural resources that are important to the community	• Provides a structure for communities to target geographic areas for land conservation and development to maximize the efficiency of community planning efforts • Enables more efficient management of permitting programs • Focuses data collection and analysis for environmental assessments • Provides benchmarks for measuring the success of management efforts
Environmental Benefits	*Financial Benefits*
• Improves quality of water for drinking and recreational use • Enhances water supply • Protects wildlife habitat and improves natural resources • Controls flooding by restoring riparian and wetland areas	• Avoids development in sensitive areas and can help minimize compliance and mitigation costs • Improves water supply protection to reduce the need for costly drinking water treatment • Provides a framework and rationale to pursue various funding opportunities • Prevention and planning is less costly than restoration
Source: Modified from CBP, 2004 TMDL: Total Maximum Daily Loads	

B. The Geographic Scale of Watershed Planning

When developing a watershed plan, it is useful to consider what the appropriate geographic scale should be. The largest watershed management unit is the basin. A **basin** drains to a major receiving water such as a large river, estuary or lake. In Maryland, the major drainage basins include the Chesapeake Bay, Ohio River, Delaware River and Coastal Bays. Basin drainage areas typically exceed several thousand square miles and often include major portions of a single state or even a group of states.

Within each basin is a group of **sub-basins** that extend over several hundred square miles. Sub-basins are a mosaic of diverse land uses, including forest, crops, pasture, and urban areas. All or part of 13 sub-basins are located in Maryland, 10 of which fall within the Chesapeake Bay Basin (see Chapter 2 for a map and sub-basin list). The sub-basins that are located in the Chesapeake Bay basin correspond to the Tributary Basins defined by the Maryland Department of Natural Resources (MD DNR) Tributary Strategy Program.

Sub-basins are composed of a group of **watersheds**, which in turn, are composed of a group of **subwatersheds**. Figure 1.1 illustrates these units using a map of all the watersheds and subwatersheds in Howard County. Within subwatersheds are neighborhoods and individual project sites (see Table 1.2), where individual protection and restoration projects are implemented.

Each method in the watershed planning framework outlined in this guide can be applied to one or more of the five geographic scales outlined in Table 1.2. Additional information regarding watershed scale is provided in Chapter 2.

Watersheds and subwatersheds are the most practical units for preparing local plans. Each watershed is composed of many individual subwatersheds that can have their own unique water resource objectives. A watershed plan is a comprehensive framework for applying management tools within each subwatershed in a manner that also achieves the water resource goals for the watershed as a whole. This guide focuses on the watershed as the primary planning unit, and while certain methods are conducted at the subwatershed scale, others might be more easily conducted at the watershed scale (e.g., stakeholder involvement and drafting the watershed plan). Table 1.3 presents a rationale for conducting specific methods of the watershed planning process at the subwatershed scale.

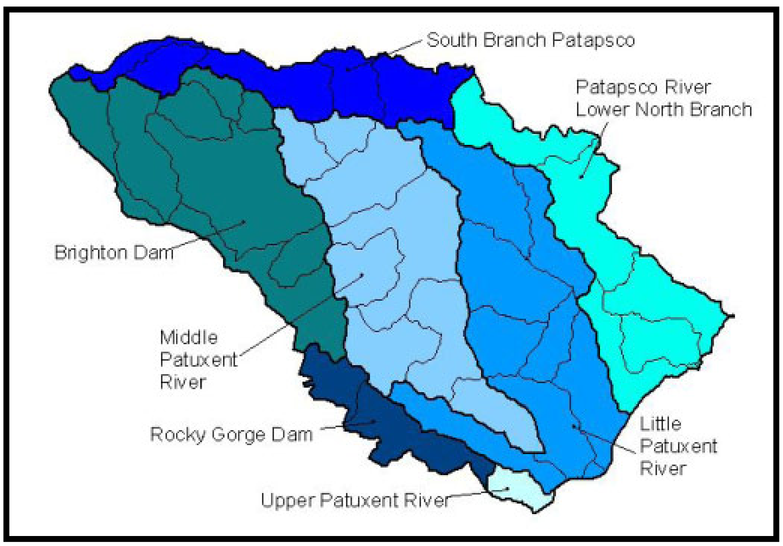
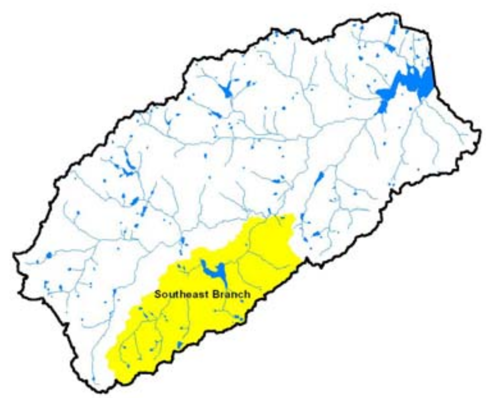
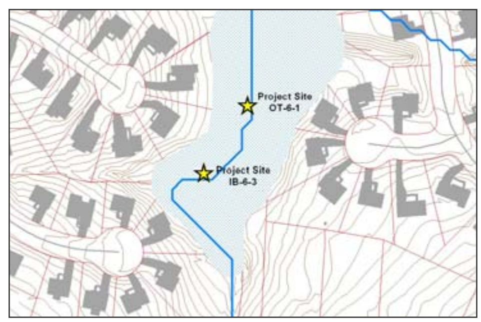


Figure 1.1: Howard County, MD watersheds (labeled) and subwatersheds

Table 1.2: Geographic Scales of Watershed Planning	
1. Community – Durham County, NC	
Community refers to the entire land area controlled by a single political jurisdiction such as a city, county, village or town. Most communities contain several different watersheds, not all of which may be fully contained within the political boundaries of the community. The community scale is where political decisions to take action on watershed management are made. The map at right shows the county and the location of Little Lick watershed.	
2. Watershed – Little Lick Watershed	
Watersheds consist of land areas that drain to a downstream water body such as a river, lake or estuary. Their total drainage areas range from 20 to 100 square miles, and they often encompass many different land uses and multiple jurisdictions. The watershed scale normally shapes the goals and objectives that drive community watershed planning efforts. They are the primary management unit in the context of this guide and are the focus of watershed plans.	
3. Subwatershed -- Southeast Branch Subwatershed	
Each watershed is composed of many smaller drainage units, known as *subwatersheds.* As a general rule of thumb, subwatersheds drain 10 square miles or less. This is the scale at which more detailed analyses are done as part of a watershed plan.	

<table>
<tr><th colspan="2">Table 1.2: Geographic Scales of Watershed Planning</th></tr>
<tr><td colspan="2">4. Neighborhood -- Lakeridge Corner</td></tr>
<tr><td>Neighborhoods are an even smaller management unit and are defined as relatively homogenous residential land uses within a subwatershed. Individual neighborhoods have markedly different characteristics and are the locations where protection and restoration projects are implemented. Neighborhoods are also the scale at which community acceptance of these projects is gauged.</td><td>
</td></tr>
<tr><td colspan="2">5. Project Site – Sites OT-6-1 and IB-6-3</td></tr>
<tr><td>The project site is the smallest scale for management, and is the location where a single protection or restoration project is implemented. It may be necessary to implement dozens or even hundreds of projects to achieve goals at the watershed scale.</td><td>
</td></tr>
</table>

<table>
<tr><th colspan="2">Table 1.3: Using the Subwatershed Scale in Watershed Planning</th></tr>
<tr><td>Watershed Planning Method</td><td>Rationale for Conducting at the Subwatershed Scale</td></tr>
<tr><td>Establish a baseline</td><td>The influence of impervious cover on hydrology, water quality, and biodiversity is most evident at the subwatershed scale where the influences of individual development projects are easily recognizable.</td></tr>
<tr><td>Classify and rank subwatersheds</td><td>In larger watersheds, the most vulnerable or most restorable subwatersheds should be identified in order to focus limited resources and provide rapid results.</td></tr>
<tr><td>Conduct stream and upland assessments</td><td rowspan="3">Locally, managers may prefer the subwatershed as a planning unit because it is small enough to perform monitoring and assessment tasks in a rapid time frame.</td></tr>
<tr><td>Conduct project investigations</td></tr>
<tr><td>Plan for indicator monitoring</td></tr>
<tr><td>Estimate pollutant loads and reductions</td><td>Subwatersheds are limited in size where few confounding pollutant sources that can confuse management decisions are present (e.g., agricultural runoff, point sources, etc.).</td></tr>
<tr><td colspan="2">Note that some specific methods or recommendations may be best implemented at the community scale. This may include regulatory and programmatic changes and contiguous forest inventory.</td></tr>
</table>

C. Watershed Planning Terminology

This section introduces some of the basic watershed terms that are at the heart of the watershed planning approach. It is helpful to fully understand these concepts before embarking on a local watershed plan.

- **Watershed plan recommendations** are the most important element of a watershed plan, and generally consist of three parts which are described below: 1) protection and restoration projects, 2) regulatory and programmatic changes, and 3) land use changes and management approaches.

    - **Protection and restoration projects** refer to a suite of site-specific projects that protect and restore watersheds by conserving and enhancing existing watershed resources, or correcting specific problems identified through stream and upland assessments. Protection and restoration projects generally fall into the following categories: stormwater retrofit, stream repair, reforestation, wetland restoration, discharge prevention, pollution source control, municipal operations, sensitive area conservation, and agricultural best management practices (Table 1.4). Some of these projects are structural and require detailed project designs, while others are non-structural in nature.

    - **Regulatory and programmatic changes** are developed in direct response to a review of local codes, ordinances, and programs related to watershed protection. Where local regulations and programs are found lacking, specific changes may be needed. The changes fall into eight general categories: land use planning, land conservation, aquatic buffers, better site design, erosion and sediment control, stormwater management, non-stormwater discharges, and watershed stewardship. Regulatory and programmatic changes are designed to protect watershed resources from future development impacts.

    - **Land use changes and management approaches** are derived from analysis of current and projected subwatershed development based on comprehensive plans and zoning. Land use and impervious cover analyses may indicate that projected changes in land use are incompatible with watershed or subwatershed protection goals or threaten specific sensitive water bodies, and changes are needed in terms of where development will be targeted within an overall watershed planning context. Land use change and management approaches can be accomplished through revisions to county comprehensive plans or area master plans, development of watershed-based functional master plans, and subsequent revisions to local zoning regulations. Other options include overlay zones that apply certain standards to existing land uses, such as transfer of development rights (TDR) programs that transfer development density to more suitable areas.

Table 1.4: Protection and Restoration Projects*	
Project	*Description*
Stormwater Retrofit	Stormwater retrofits are stormwater management measures installed in an urban or ultra-urban landscape where little or no prior stormwater controls existed.
Stream Repair	Stream repair practices enhance the appearance, stability, structure or function of streams.
Reforestation	Pervious area management projects increase tree cover on open lands in upland areas and along the stream corridor, and enhance the quality of remaining forests and wetland.
Discharge Prevention	Discharge prevention projects stop the entry of sewage and other pollutants into the stream.
Pollution Source Control	Pollution source control projects reduce or prevent pollution from residential neighborhoods or stormwater pollutant "hotspots".
Municipal Operations	Municipal operations projects reduce or prevent pollutants from entering the watershed by modifying municipal infrastructure maintenance policies.
Sensitive Areas Conservation	Land conservation projects provide permanent protection from development to sensitive areas (includes contiguous forest, wetlands, and rare, threatened and endangered species).
Agricultural Best Management Practices (BMPs)	Agricultural BMPs refer to a series of techniques that farmers and ranchers can implement to reduce erosion, pollution, water use, and runoff from their land.
* *Investigations for each project type are outlined in Chapter 5.*	

- **Stream corridors** include the existing network of stream channels and the lands that surround them.

- **Upland areas** include the remaining watershed area that drains to the stream corridor.

- **Headwater streams** include all first and second order streams in a watershed. A first order stream is a small stream with no tributaries or branches. When two first order streams combine, they form a second order stream. Similarly, when two second order streams join they form a third order stream and so on. Because headwater streams comprise roughly 75% of the total stream and river mileage in a watershed, they are the focus of watershed planning efforts.

- The **core team** refers to the local government staff and/or consultants that actually conduct the watershed planning process.

- **Stakeholders** are defined as any agency, organization or individual involved in or affected by the decisions made in a watershed plan. From a practical standpoint, it helps to think of four broad groups of stakeholders in each watershed planning effort: agencies, the public, watershed partners, and potential funders.

D. The Watershed Planning Process

The watershed planning process generally consists of eight steps, which are illustrated in Figure 1.2 and described below. Each local watershed is unique, with a different combination of impacts, planning objectives, development pressures, stakeholders and local protection capacity. Consequently, watershed planning is always somewhat improvisational, i.e., a unique sequence of planning methods is applied to arrive at the desired outcome. As a result, the order of the methods listed in Table 1.5 is not necessarily the exact order in which they should be conducted; instead, the table summarizes the watershed planning steps and corresponding methods and principles. The principles of watershed planning are discussed in further detail in the next section.

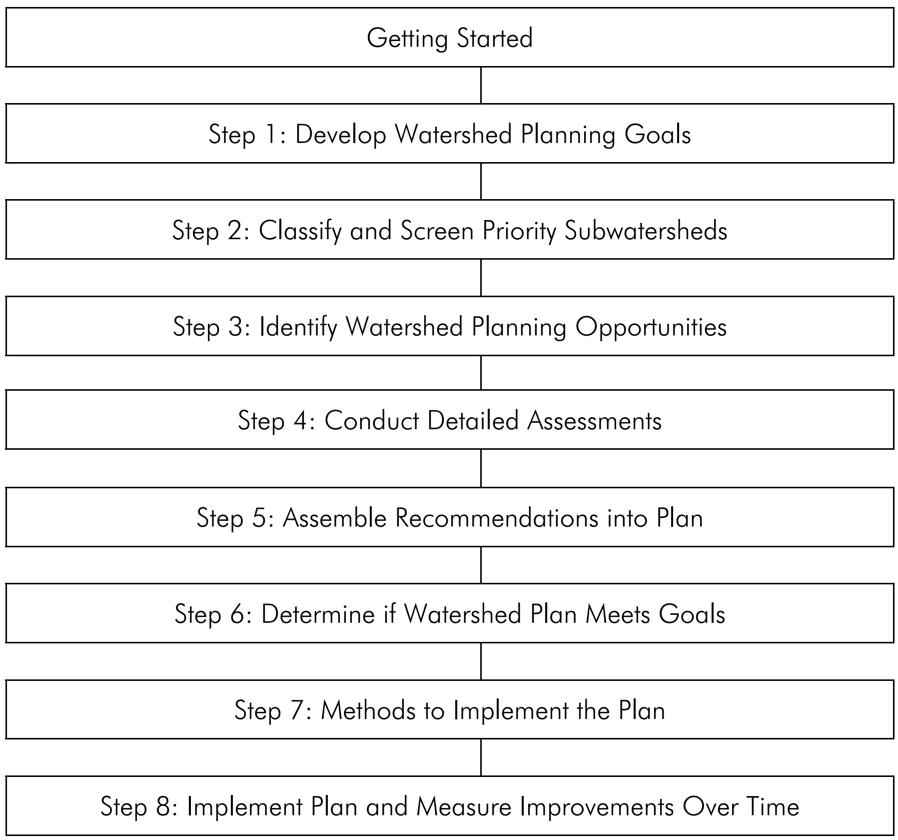


Figure 1.2: The Watershed Planning Process

Table 1.5: Watershed Planning Steps and Corresponding Methods and Principles		
Step	*Corresponding Methods*	*Corresponding Principles of Watershed Planning*[3]
GS[1]	Organize the Core Team	P-1
	Develop a Watershed-Based GIS	P-2
	Gather Existing Watershed Data	P-3
	Delineate Subwatershed Boundaries	P-5
	Develop Initial Goals	P-4
	Develop a Realistic Scope for a Watershed Plan	
	Develop an Overall Stakeholder Involvement Strategy	P-18
1	D: Identify Watershed Needs and Capabilities	P-6
	Establish a Baseline	P-8, P-9, P-10, P-11, P-12
	F: Gather Additional Data[2]	
	S: Recruit Stakeholders	P-18
	Educate Stakeholders	P-18, P-19
	M: N/A	
2	D: Classify and Rank Subwatersheds	P-13
	F: Field Verification[2]	
	S: N/A	
	M: Identify Priority Subwatersheds	P-13
3	D: Evaluate Watershed Programs and Regulations	P-7, P-11
	F: Conduct Stream Corridor Assessments	P-15, P-16
	Conduct Upland Assessments	P-16
	S: Refine Local Vision, Goals and Objectives	P-18
	Manage Stakeholder Meetings	P-18
	M: N/A	
4	D: Develop Project Concept Designs	P-16
	F: Conduct Project Investigations	P-16
	S: Hold Neighborhood Consultation Meetings	P-18
	M: Compile an Inventory of Potential Projects	P-22, P-24
5	D: Rate and Rank Individual Projects	P-14
	F: N/A	
	S: Manage Stakeholders, continued[2]	
	M: Draft the Watershed Plan	P-23, P-25, P-26
6	D: Estimate Pollutant Loads and Reductions	P-10, P-11, P-14, P-24
	F: N/A	
	S: Solicit External Plan Review	P-18
	M: Finalize Watershed Goals, Objectives, and Indicators	P-20, P-21
7	D: N/A	
	F: Plan for Indicator Monitoring	P-17
	S: N/A	
	M: Adopt the Final Plan	P-25, P-26, P-27
8	Implement Plan and Measure Improvements Over Time	

1: Getting Started
2: Methods shown in italics are optional and do not have a corresponding write-up later in the document.
3: Several of the watershed planning principles are listed under multiple methods (e.g., P-18).
Key
D: Desktop Assessment Methods (Chapter 4) ; F: Field Assessment (Chapter 5); S: Stakeholder Involvement Methods (Chapter 6); M: Management Methods (Chapter 7)
N/A: not applicable

Step 1: Develop Watershed Planning Goals

The first step in the watershed planning process analyzes watershed conditions to develop clear consensus among stakeholders on the goals, objectives and indicators that will guide watershed planning. The process starts by examining existing regulatory, programmatic, and scientific information that will influence the planning process. The core team should also consider its local capacity, existing data, and stakeholder concerns when setting goals.

Step 2: Classify and Screen Priority Subwatersheds

Local governments with limited resources may need to target a subset of subwatersheds within the context of a larger watershed. This step is particularly useful in communities that have limited funding for planning and implementation. The core team needs to generally identify the subwatersheds that are the most vulnerable to future development and/or have the greatest restoration potential.

Step 3: Identify Watershed Planning Opportunities

In this step, the core team evaluates current programs and regulations as they pertain to watershed planning and goes out in the field to identify potential protection and/or restoration opportunities. The resulting data is used to develop an initial strategy that scopes out the types of practices that best meet watershed goals.

Step 4: Conduct Detailed Assessments

The purpose of this step is to conduct detailed investigations of candidate projects in the subwatershed. Each candidate site is revisited to acquire more detailed information to work up an initial project design. The core team should also provide neighbors and adjacent landowners an early opportunity to comment on proposed projects and respond to their concerns prior to final design.

Step 5: Assemble Recommendations into Plan

This step transforms the inventory of projects, programmatic changes, and management approaches into a draft plan that recommends the most cost effective group of projects, programs and management approaches for the watershed.

Step 6: Determine if Watershed Plan Meets Goals

This step is perhaps the most frequently overlooked one in the watershed planning process – determining whether or not the plan can meet watershed goals and, if it does, how to ensure that support and funding will be available to implement it.

Step 7: Methods to Implement the Plan

As the watershed plan is being finalized, it is important to step back for a moment and plan for project implementation itself. From here on out, much of the time and expense is devoted to the final design, engineering and permitting of individual projects, programs and management approaches.

Step 8: Implement Plan and Monitor Improvements Over Time

The purpose of Step 8 is to sustain momentum and adapt the plan as more experience is gained in project implementation. It is important to institute tracking and monitoring systems under this step as well.

The watershed planning process can be applied in both watershed restoration and watershed protection scenarios. The core team should take care to note the differences between the two and make appropriate adjustments for local watershed conditions. Some key differences between watershed protection and restoration plans are outlined in Table 1.6.

Table 1.6: Differences Between Restoration and Protection Oriented Watershed Plans*

Parameter	*Protection*	*Restoration*
Watershed Condition	Few stream impacts observed. Meets most water quality standards, good aquatic habitat and biological communities. Lightly developed, and mostly forested or rural, relatively large, intact wetlands.	Impacted conditions. Lots of streams not meeting designated uses. Developed (over 15% impervious cover) or shows signs of significant agricultural impacts (if under 15% impervious cover); flooding problems. Extensive historic and recent wetland losses and floodplain impacts.
Drivers	Special resource protection (e.g., drinking water, trout stream), Tier II waters protected by antidegradation regulations; preventing water quality impairments; endangered species habitat.	Establish TMDLs; NPDES Phase I and Phase II MS4; flooding; public health.
Outcomes	Conserve and protect sensitive areas (e.g., wetlands) through land acquisition or conservation easements; update of local environmental regulations (e.g., stringent stormwater and development criteria, downzoning); revision of comprehensive plan.	Implement TMDL; conserve or restore remaining sensitive area fragments; identify restoration opportunities such as stream repair, IDDE, retrofits, source control, etc.
Scale	Conducted across jurisdictions and in larger watersheds (~100 square miles).	Often needs to be done at subwatershed scale (10 sq. mi. or less) as it is expensive and hard to measure results.
Costs	Low budget; little funding available for implementation; implementation costs reflect land prices, open space management, and cost of code revisions. Creating funding sources possible, such as TDR program and fee-in-lieu systems.	Larger budget; funding opportunities available for implementation, such as stormwater utilities, farm subsidies, restoration grants; can be costly to do assessments, design and permitting, construction, maintenance, and monitoring.
Planning Resources	Smaller jurisdictions may have few staff and planning resources; most plans begin with very little existing data and limited understanding of the nature of current and future impacts. Therefore, the process involves devoting significant effort to desktop and field assessment tasks to establish baseline future impact of development.	Monitoring data and planning resources often available; community has staff, utilities, and GIS capacity.
Stakeholders	Often a few large land owners - private and public; focus on private owner stewardship education; many stakeholders involved perceive that they stand to lose something as a result of greater protections — property rights, higher land development costs, more regulations, and simple changes in the ways things have traditionally been done.	Large number of residents and interest groups; focus stewardship education to target homeowner and business practices which may contribute to pollutants of concern; restoration project implementation will require neighborhood consultation meetings.

** Most watersheds will have some combination of both protection and restoration.*
TMDL: Total Maximum Daily Loads
NPDES: National Pollutant Discharge Elimination System
MS4: Municipal Separate Storm Sewer Systems
IDDE: Illicit Discharge Detection and Elimination
TDR: Transfer of Development Rights

E. Guidance for First Time Watershed Planning Efforts or Small Local Governments

Communities just getting started should also review the Chesapeake Bay Program's Community Watershed Assessment Handbook which was developed to assist communities with gathering and evaluating information prior to developing the watershed plan itself. It is available online: www.chesapeakebay.net/pubs/watershed_assess/

Smaller local governments conducting watershed planning for the first time may lack the resources or expertise to complete an extensive watershed plan. These groups should not be intimidated by the number of methods presented within the User's Guide, as many of them are optional. Selecting the methods needed to complete a watershed plan largely depends on the amount of funding available and purpose of the plan. Small local governments may consider utilizing a consultant to complete the plan. If funding is limited another option may be to complete the plan through a series of grants over several funding cycles.

Table 1.7 lists the essential methods recommended for first time watershed planning efforts. In addition to Table 1.7, two additional methods are necessary to comply with Environmental Protection Agency's (EPA) Watershed Plan Guidance Elements: "Estimate Pollutant Loads and Reductions" and "Plan for Indicator Monitoring." For more information on these methods, consults Chapters 4 and 5, respectively. Compliance with EPA's elements is necessary for watershed plans that are developed or implemented with EPA Section 319 funds. More information on EPA's Guidance Elements is provided in Chapter 2.

Table 1.7: Essential User's Guide Methods

Step	*Watershed Planning Methods*
GS	• Gather Existing Watershed Data • Develop Initial Goals • Develop a Realistic Scope for a Watershed Plan • Develop an Overall Stakeholder Involvement Strategy
1	• Establish a Baseline • Recruit Stakeholders • Educate Stakeholders
2	N/A
3	• Evaluate Watershed Programs and Regulations • Conduct Stream Corridor Assessments • Manage Stakeholder Meetings
4	Compile an Inventory of Potential Projects
5	Draft the Watershed Plan
6	Finalize Watershed Goals, Objectives, and Indicators
7	Adopt the Final Plan

F. Principles of Watershed Planning in Maryland

Several key ingredients need to be addressed in a watershed plan for effective and successful implementation. These include current regulations and requirements that require inclusion in local watershed plans to qualify for funding or to meet federal and state water quality criteria. To that end, 27 watershed planning principles are presented in this guide. These principles, outlined below, define the elements that comprise an effective and meaningful watershed plan and integrate all of the drivers and programs such as TMDLs and the Chesapeake 2000 Agreement, as illustrated in Chapter 2. (Note that the "P-#" presented below represents the principle number and is not a page number reference.)

A local watershed plan should:

Getting Started

P-1 Plan Management: Identify the core team and ongoing management structure that will oversee plan implementation and tracking, and indicate how stakeholders and partners will be involved.

P-2 Watershed GIS: Utilize a watershed-based GIS as the primary tool to store, organize and analyze all watershed data generated throughout the watershed planning process.

P-3 Existing Data: Gather existing watershed data. At a minimum, the data should include the watershed boundary, Maryland tributary basin, 303(d) listings, designated uses, and show State water quality monitoring stations. Existing data should also be utilized in the development of initial goals.

P-4 Pollutants of Concern: Specifically target one or more pollutants of concern. Nutrients will be the default pollutant of concern, but other pollutants may be added if the water body is listed for non-attainment of other chemical, physical or biological standards on the 303(d) list.

P-5 Subwatershed Delineation: Delineate and analyze the subwatersheds that comprise watershed, and conduct planning and management at that scale.

Desktop Assessment Methods

P-6 Local Capacity: Assess the capacity of existing local programs to protect and/or restore water resources.

P-7 Programmatic Change: Identify specific changes in local programs, codes, ordinances and development review that will be considered as part of the plan.

P-8 Baseline Analysis: Establish a watershed baseline by summarizing watershed characteristics, analyzing land use and impervious cover data, reviewing existing monitoring data, and evaluating sensitive areas.

P-9 Land Use Projections: Contain projections of future land cover in each subwatershed that corresponds to the local comprehensive plan.

P-10 Designated Uses: Explicitly consider how future land use change will influence designated uses and affect future loadings of the pollutant of concern including stressors that degrade biological integrity.

P-11 Comprehensive Plan: Explicitly consider land use changes and management approaches to current zoning, comprehensive plans, water and sewer and subdivision decisions that may be needed to maintain designated uses. This consideration should include simple nutrient load estimations that account for future growth implications of these planning tools to ensure that consistency with existing TMDLs or does not increase relative to an impairment on the 303(d) list for which a TMDL has yet to be completed.

P-12 Development Capacity Analysis: Conduct an analysis of future development capacity to ensure that future growth projections can be met under current zoning, development densities, and water and sewerage plans.

P-13 Subwatershed Metrics: Utilize impervious cover and other subwatershed metrics to identify the subwatersheds most vulnerable to future development, and/or restorable.

P-14 Pollutant Reduction: Document the expected reduction in the pollutants of concern as a result of plan implementation using spreadsheet or simulation models and pollutant removal efficiencies consistent with state and Bay program methods. Cost and pollutant removal estimates should be provided for each project where feasible.

Field Assessment Methods

P-15 Field Verification: Verify and refine desktop assessment assumptions in the field (such as current impervious cover classifications).

P-16 Field Assessments: Investigate potential protection and restoration projects in both the stream corridor and upland areas.

P-17 Environmental Indicators: Indicate the environmental indicators that will be used to track progress toward watershed goals. As a default, the plan shall tie into existing State and MBSS monitoring stations located within the watershed.

Stakeholder Involvement Methods

P-18 Stakeholder Involvement: Include meaningful stakeholder involvement throughout the entire planning process, including goal setting, plan development and external review.

P-19 Watershed Education: Document methods used to educate residents and increase watershed awareness.

Management Methods

P-20 Goals, Objectives and Indicators: Include measurable goals, objectives and indicators that are developed based on pollutants of concern, resources of concern, data from the sensitive areas analysis, future land use changes, current and future stream quality and stakeholder input.

P-21 Consistency: Be consistent with regulatory drivers and agreements such as the Chesapeake Bay Agreement, tributary strategies, source water protection plans, municipal NPDES Phase I or II MS4 permits and TMDLs (e.g., water quality standards, limit on load stressors, and control actions to achieve loading limits).

P-22 Recommendations: Identify specific short and long-term recommendations, with implementation phased over a five year period.

P-23 Implementation Planning Table: Include an implementation planning table that identifies the objective, responsible party, measurable indicator, public involvement, programmatic change, estimated cost, potential funding sources, and implementation timeframe for each recommendation. The table should ultimately be used to track the status of plan implementation over time.

P-24 Implementation Units: Express implementation efforts in common units used by the Chesapeake Bay Program's Watershed Model (e.g., stream miles fenced, acres reforested, etc.).

P-25 Plan Financing: Indicate the specific private, local, state and federal funding sources needed to finance plan implementation.

P-26 Adoption Mechanism: Outline a plan for adoption by the local government. The plan can be adopted in a number of ways including: adopted as an element of the comprehensive plan, commitment of funds for implementation, formal endorsement of the watershed plan goals by elected officials, and formal adoption of the entire plan. The precise vehicle for plan adoption will be different in each community.

P-27 Revisit Plan: Indicate the mechanism for revisiting and updating the plan and reviewing progress on a regular cycle.

Incentives for Adhering to the Principles

These 27 Watershed Planning Principles are intended to define the elements that make up a holistic and effective watershed plan. Additionally, compliance with the principles will help local governments meet multiple regulatory requirements (see Chapter 2 for additional details) and leverage funding for project implementation (e.g., stream repair or contiguous forest conservation). This framework provides consistency to the myriad of watershed related requirements and promotes the consolidation of efforts and reports into one plan. Other incentives may exist internally at the local level and may include response to citizen concerns (tree loss due to erosion along streams) and implementation of community goals (tree retention, recreation, neighborhood revitalization, etc.).

G. How to Use this Guide

The remaining chapters in this guide present the background for watershed planning in Maryland and the methods needed to complete each step in the watershed planning process. Watershed planning is always somewhat improvisational, i.e., a unique sequence of planning methods is applied to arrive at the desired outcome. As a result, the order of the methods presented throughout this guide is not necessarily the exact order in which they should be conducted. The remainder of the guide is organized as follows:

> Local governments and other watershed planners are encouraged to adapt and modify the methods presented in the remaining chapters to suit the unique conditions present in their community.

Chapter 2: *The Context for Watershed Planning in the State of Maryland* - provides some background on Maryland's watersheds, explains how watershed planning can meet the requirements of specific regulatory drivers in Maryland, and summarizes other key programmatic resources.

Chapter 3: *Getting Started* - outlines how to organize local efforts to support assessment, planning and implementation prior to receiving funding for a watershed plan.

Chapter 4: *Desktop Assessment Methods* – explains the methods that occur in the office and are used to organize, map and interpret subwatershed information to make better watershed planning decisions.

Chapter 5: *Field Assessment Methods* – summarizes the methods that take place in the stream corridor and subwatershed that are used to rapidly identify, design and rank restoration practices and conservation sites, and/or monitor improvements in stream quality.

Chapter 6: *Stakeholder Involvement Methods* – discusses the methods that are used to identify, recruit and structure the involvement of a diverse group of stakeholders during each step of the planning process.

Chapter 7: *Management Methods* – reviews the methods that develop products or processes that help agencies, partners and stakeholders agree on key watershed planning decisions.

Throughout this guide, the icon shown to the left is used to denote which watershed planning principle(s) line up with each method. The icons include the number and short principle descriptor and can be used to quickly locate where specific principles are addressed throughout the guide.

The primary format of the guide is web-based. This allows for frequent updates and revisions and provides users with easy access to the most up-to-date information. With this in mind, downloadable tools are provided in lieu of appendices. The User's Guide tools referenced throughout the guide are summarized in Table 1.7 and are available for download from MD DNR's website (www.dnr.maryland.gov)

Table 1.8: User's Guide Downloadable Tools	
Tool No.	*Title*
1	Maryland Contact and Website List
2	Maryland GIS Resources
3	Maryland Monitoring Resources
4	Funding Resources
5	Relevant State Programs, Requirements and Resources
6	Model Scope of Works for Watershed Plans
7	Estimated Scoping and Practice Costs
8	Needs and Capabilities Assessment (NCA)
9	Smart Watersheds Benchmarking Tool
10	MDP's Models and Guidelines: Estimating Residential Development Capacity
11	Leaf Out Analysis
12	Watershed Vulnerability Analysis
13	Comparative Subwatershed Analysis (CSA)
14	Assessing Local Watershed Protection Programs and Regulations: The Eight Tools Audit
15	Modeling Resources
16	Watershed Treatment Model (WTM)
17	Continuous Stream Walk Assessment Methods Field Sheets
18	Unified Subwatershed Site Reconnaissance (USSR) Field Sheets
19	• Candidate Project Investigation Field Sheets: • Retrofit Reconnaissance Inventory (RRI) Field Sheets • Stream Repair Investigation (SRI) Field Sheets • Urban Reforestation Site Assessment (URSA) Field Sheets • Discharge Prevention Investigation (DPI) Field Sheets • Sensitive Areas Assessment Field Sheets – Contiguous Forest Assessment – Rare, Threatened, and Endangered Species Assessment – Links to Additional Sensitive Area Assessments
20	Stakeholder Involvement Profile Sheets
21	Stakeholder Education Resources
22	Management Profile Sheets

Chapter 2: The Context for Watershed Planning in the State of Maryland

This chapter provides the context for conducting watershed planning in the state of Maryland. It provides some background on Maryland's watersheds and the major pollution problems they face. It also explains how local watershed plans can meet the requirements of specific regulatory drivers in Maryland, and describes other watershed planning resources that can be used to develop a local watershed plan. Chapter sections include:

> Key agency contacts for each driver and resource are provided in User's Guide Tool 1.

A. Maryland's Watersheds
B. Watershed Planning Drivers
C. Additional Watershed Planning Resources

Table 2.1 summarizes the watershed planning drivers and additional watershed planning resources that are included in this chapter.

<table>
<tr><th colspan="2">Table 2.1: Watershed Planning Drivers and Additional Watershed Planning Resources</th></tr>
<tr><td colspan="2">Watershed Planning Drivers
Encourage, require or otherwise shape local watershed planning in Maryland. By developing local watershed plans consistent with these drivers, local governments may be eligible for implementation funding, or may satisfy existing goals or requirements.</td></tr>
<tr><td colspan="2">• Anti-Degradation Policy
• Chesapeake 2000 Bay Agreement
• Coastal Bays Comprehensive Conservation Management Plan
• EPA Watershed Plan Guidance Elements
• National Pollutant Discharge Elimination System Program
• Total Maximum Daily Loads
• Maryland Nontidal Wetlands Protection Act of 1989</td></tr>
<tr><td colspan="2">Additional Watershed Planning Resources
Should be considered and utilized when preparing local watershed plans</td></tr>
<tr><td>Related Planning Resources
Existing planning policies and directives that should be integrated with local watershed plans include:

• Economic Growth, Resource Protection, and Planning Act of 1992
• Source Water Assessments
• Maryland's Tributary Strategy
• Water and Sewerage Facilities Planning</td><td>State Watershed Data Resources
Provide watershed data that can be used to develop and complete the local watershed plan including:

• Maryland DNR Critical Area Act
• Maryland DNR Forest Conservation Act
• Maryland DNR Green Infrastructure Assessment
• Maryland DNR Priority Funding Areas
• Maryland DNR Strategic Forest Lands Assessment
• Maryland's Flood Hazard Mitigation Program
• Maryland's Nongame and Endangered Species Conservation Act
• Maryland's Rural Legacy Areas
• Maryland State Scenic and Wild River System
• Maryland State Wetland Conservation Plan
• Priority Areas for Wetland Restoration, Preservation, and Mitigation in the Coastal Bays</td></tr>
<tr><td colspan="2">Note: This table lists the most pertinent planning and data resources, but the list is not comprehensive. See User's Guide Tools 1-5 for additional resources.</td></tr>
</table>

A. Maryland's Watersheds

As described in Chapter 1, watersheds and subwatersheds are the most practical units for preparing local watershed plans. Table 2.2 describes these units and how they relate to the sub-basin and basin scale within the State of Maryland. Maryland contains all or part of 13 major sub-basins, 10 of which fall within the Chesapeake Bay Basin (Figure 2.1). The Chesapeake Bay sub-basins correspond to the Tributary Basins defined by MD DNR's Tributary Strategy Program. Maryland's sub-basins are further divided into 138 watersheds. Based on the results of a MD DNR survey completed in 2004, watershed plans have been completed for about 47 of these watersheds by 12 Maryland counties and Baltimore City. The key pollution problems and characteristics of both the Chesapeake Bay watersheds and non-Chesapeake Bay watersheds in Maryland are described below.

Table 2.2: Maryland Watershed Scales

Scale	*Description*	*Maryland Examples*	*Related GIS Layers*
Basin	Drains to major receiving water such as a lake, river or estuary	• Chesapeake Bay Basin • Ohio River Basin • Delaware River Basin • Atlantic Ocean Drainage	Chesapeake Bay basin boundary available from CBP website
Sub-Basin	Covers several hundred square miles	• Maryland's Ten Tributary Strategy Basins • Youghiogheny • Brandywine-Christina • Coastal Bays	Tributary Strategy Areas available from MD DNR website
Watershed	Ranges from 20 to 100 square miles	Maryland DNR has defined 138 watersheds that include 3rd order stream drainage (based on Strahler method). These watersheds are also referred to as Maryland's 8-digit watersheds.	Watershed Information (filename swsub) available from MD DNR website
Subwatershed	Covers an area of ten square miles or less	Maryland DNR has defined more than 1100 subwatersheds. These delineations should be re-evaluated on a local level using more detailed analysis (see Chapter 3)	Watershed Information (filename swshed) available from MD DNR website

Notes:
- A description of the federal hydrologic unit system is provided at: http://water.usgs.gov/GIS/huc.html
- For a description and table showing how Maryland's 8-digit watersheds relate to the federal hydrologic units, see: www.dnr.state.md.us/cwap/extras.htm#App_I
- Yellow shading indicates the scales discussed throughout this guide in the context of local watershed planning.

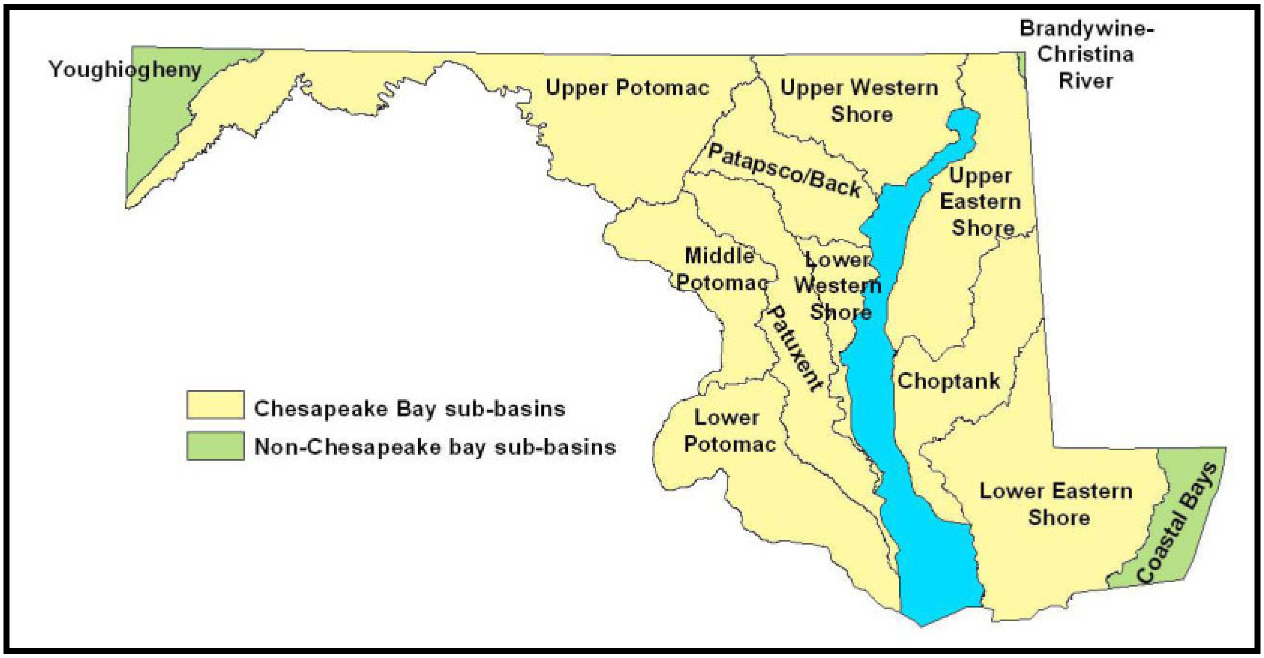


Figure 2.1: Maryland's Major Sub-Basins

Chesapeake Bay Watersheds

The Chesapeake Bay Basin encompasses 64,000 square miles of land and is the largest watershed on the eastern seaboard of North America. The Bay basin includes parts of six states (MD, VA, NY, PA, WV, DE) and the District of Columbia. An estimated 94% of the land in Maryland drains to the Chesapeake Bay (MD DNR, NDb). Maryland derives an enormous amount of economic benefit from the Bay, including income from the harvesting of fish and shellfish, commercial shipping and recreational boating.

Excessive nutrient loading has been identified as the most critical problem affecting the Chesapeake Bay. Excess nutrients may cause algal blooms that can reduce the amount of sunlight available to submerged aquatic vegetation, and decomposition of algae by bacteria can deplete bottom waters of oxygen and harm aquatic living resources. Major sources of nutrients include urban runoff, agricultural runoff, failing septic systems, sewage treatment plants, and atmospheric deposition. Several key initiatives have been developed in response to the nutrient problem, including the Chesapeake Bay Program, the Chesapeake 2000 Bay Agreement, and Maryland's Tributary Strategy, whose goal is to reduce nutrients in each of the 10 major sub-basins listed below:

- Choptank
- Lower Eastern Shore
- Lower Potomac
- Lower Western Shore
- Middle Potomac
- Patapsco/Back
- Patuxent
- Upper Eastern Shore
- Upper Potomac
- Upper Western Shore

Another major pollutant affecting the Bay is sediment, which comes from construction site runoff, agricultural runoff, and stream bank erosion, among other sources. The Chesapeake Bay Program website and the Maryland Tributary Strategies website are good resources for more information on pollutant problems in the Bay: www.chesapeakebay.net and www.dnr.state.md.us/bay/tribstrat/.

Non-Chesapeake Bay Watersheds

Maryland sub-basins not located within the Chesapeake Bay include the Youghiogheny, Brandywine-Christina River, and Coastal Bays. The Youghiogheny sub-basin (Figure 2.2), located in Western Maryland, is part of the Ohio River Basin. Nonpoint source pollution from agricultural activities, and acid mine drainage from abandoned mines are major causes of water pollution in this sub-basin. Waters with acid mine drainage are typically highly acidic and are high in iron and aluminum. This drainage can contaminate drinking water with heavy metals; disrupt growth and reproduction of aquatic plants and animals; and have a corroding effect on infrastructure such as bridges.

Figure 2.2: Youghiogheny Sub-Basin

A small part (eight square miles) of Cecil County in northeastern Maryland drains to the Brandywine-Christina River (Figure 2.3) and, as part of the larger Delaware River Basin, ultimately drains to the Delaware Bay. Major pollutants found in the Brandywine-Christina River sub-basin include nutrients, metals, polychlorinated biphenyls (PCBs), bacteria, and sediment. Sources of bacteria can include failing septic systems, sewer overflows, illicit discharges, wildlife, and runoff from farm activities such as manure application and combined animal feed operations, while industrial activities and urban runoff are major sources of metals and PCBs.

The Coastal Bays sub-basin (Figure 2.4) consists of several watersheds that drain to the Assawoman, Isle of Wight, Sinepuxent, Newport, and Chincoteague Bays, and ultimately to the Atlantic Ocean. The Coastal Bays sub-basin is approximately 175 square miles. Nutrient and chemical inputs from urban and agricultural runoff are major factors affecting water quality in the Coastal Bays.

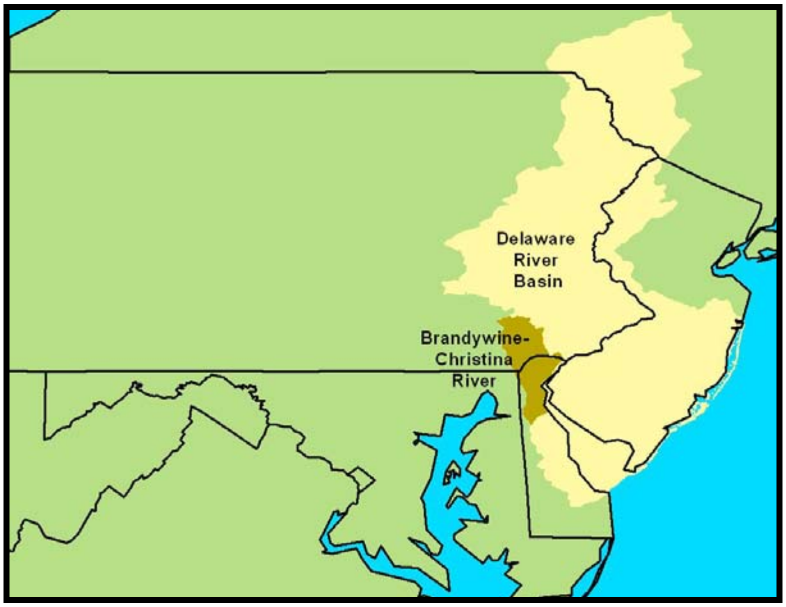


Figure 2.3: Brandywine-Christina Sub-Basin

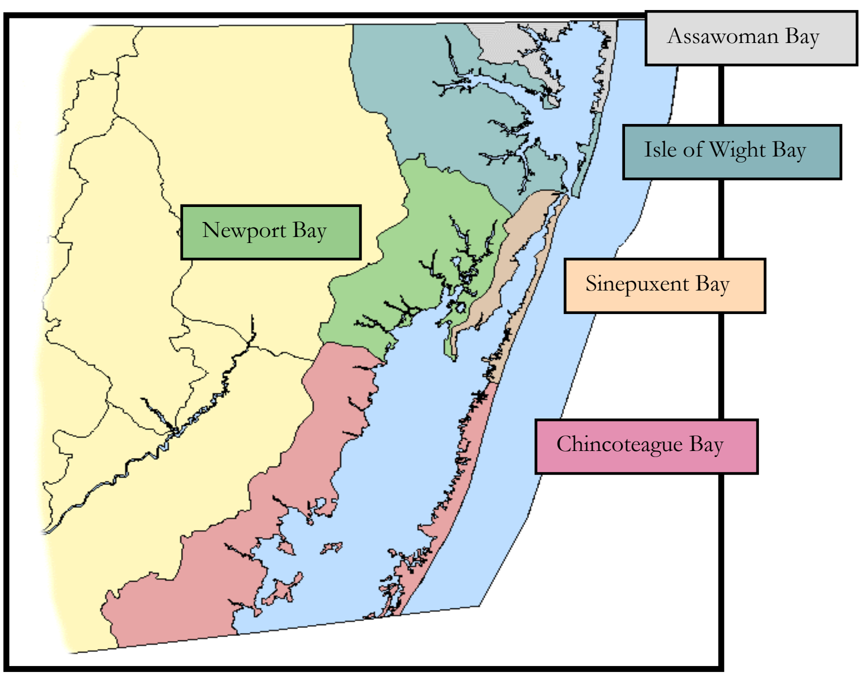


Figure 2.4: Maryland Coastal Bays CCMP Area
(Source: MD DNR, NDa)

B. Watershed Planning Drivers

Many federal and state drivers exist that encourage, require, or otherwise shape local watershed planning in Maryland. These drivers may provide incentives such as additional funding, or are requirements that, when met in conjunction with a watershed plan, conserve staff resources and reduce duplication. Table 2.3 provides a matrix that shows how the principles of watershed planning intersect with various regulatory drivers. For more information on the state programs associated with the watershed planning drivers presented in this section, consult User's Guide Tool 1.

It is important to note that not all of the drivers listed in Table 2.3 will always apply to every community. In addition, various local factors may serve as internal drivers to conduct watershed planning, such as political support, resident concerns, and alignment with existing local goals and ordinances.

- Antidegradation Policy
- Chesapeake 2000 Bay Agreement (C2K)
- Coastal Bays Comprehensive Conservation Management Plan (CCMP)
- Environmental Protection Agency's (EPA) Watershed Plan Guidance Elements
- National Pollutant Discharge Elimination System Program (NPDES)
- Total Maximum Daily Loads (TMDL)
- Maryland Nontidal Wetlands Protection Act of 1989

Table 2.3: Matrix of Watershed Planning Drivers

	Driver							
Unified Local Watershed Planning Principle	Anti-Degradation Policy	Chesapeake 2000 Agreement	Coastal Bays Mgmt Plan	EPA Watershed Planning Guidance	NPDES Phase I	NPDES Phase II	TMDL	Maryland Nontidal Wetlands Act
P-1 Plan Management			x			x	x	
P-2 Watershed GIS		x		x	x	x		
P-3 Existing Data	x			x			x	
P-4 Pollutants of Concern	x	x	x	x			x	
P-5 Subwatershed Delineation							x	
P-6 Local Capacity				x			x	
P-7 Programmatic Change		x	x			x	x	
P-8 Baseline Analysis	x	x	x				x	x
P-9 Land Use Projections							x	
P-10 Designated Uses	x	x		x			x	
P-11 Comprehensive Plan	x	x	x				x	
P-12 Development Capacity Analysis*								
P-13 Subwatershed Metrics				x				
P-14 Pollutant Reduction	x	x		x			x	
P-15 Field Verification	x							x
P-16 Field Assessments	x	x						x
P-17 Environmental Indicators				x		x	x	
P-18 Stakeholder Involvement		x	x	x		x	x	
P-19 Watershed Education			x			x	x	
P-20 Goals, Objectives and Indicators		x		x		x	x	x
P-21 Consistency	x	x		x	x	x	x	
P-22 Recommendations			x	x	x		x	x
P-23 Implementation Planning Table			x	x				
P-24 Implementation Units		x						
P-25 Plan Financing				x				
P-26 Adoption Mechanism		x	x					
P-27 Revisit Plan					x		x	

* A Memorandum of Understanding (MOU) signed in 2004 by the state of Maryland and its local jurisdictions states that local governments will voluntarily conduct an analysis of future development capacity at the time of comprehensive plan updates, and an Executive Order signed by the Governor charges MDP with providing technical assistance. Although conducting an analysis of development capacity as part of watershed plan does not meet a regulatory requirement, this MOU can be viewed as an incentive for communities to do so. Additional information on this MOU is provided in Chapter 4.

Antidegradation Policy

One element of the federal water quality standards is a required Antidegradation policy to protect waters at three tiers of quality, as follows: Tier 1) meeting existing minimum designated uses, Tier 2) maintaining high quality where it is better than the minimum requirement, and Tier 3) maintaining outstanding waters with special or sensitive aquatic life that may not yet be impacted. Maryland currently does not have any waters designated for Tier 3.

In June 2004, the State adopted about 85 non-tidal stream segments as Tier 2 waters based on high Maryland Biological Stream Survey scores. Tier 2 specifies an existing high quality water that is better than the minimum needed to support "fishable-swimmable" uses. While water quality can be slightly impacted, the State Antidegradation policy identifies procedures that must be followed before an impact to Tier 2 water quality can be allowed. Before a new or expanded discharge can be permitted to a Tier 2 water, the following three steps must be addressed:

- Can the discharge be avoided or placed elsewhere? If so, that should be done.
- If the discharge is necessary, has everything been done to minimize the water quality impact?
- If the impact has been minimized to the greatest extent feasible, but an impact to water quality will still occur, a social and economic justification for that impact must be prepared and approved by the MDE before the discharge can be permitted (MDE, 2005).

A watershed plan should recognize streams with Tier 2 designations and provide the framework for making sound land use decisions that help to maintain the designated use. More information on Maryland's Antidegradation Policy is available through MDE's TMDL Implementation Guidance for Local Governments which can be found at: www.mde.state.md.us/assets/document/TMDL_Implementation_Guidance_for_LG.pdf.

Chesapeake 2000 Bay Agreement

In June 2000, Chesapeake Bay Program partners adopted the Chesapeake 2000 Bay Agreement (C2K), a strategic plan to achieve a vision for the future of the Chesapeake Bay. The agreement details nearly 100 commitments important to Bay restoration, organized into five strategic focus areas:

- Engaging individuals and local communities
- Improving water quality
- Managing lands soundly
- Protecting and restoring vital habitat
- Protecting and restoring living resources

One particular commitment is key to watershed planning in the Chesapeake Bay Region: "By 2010, work with local governments, community groups and watershed organizations to develop and implement locally supported watershed management plans in two-thirds of the Bay watershed covered by this Agreement. These plans would address the protection, conservation and restoration of stream corridors, riparian forest buffers and wetlands for the purposes of improving habitat and water quality, with collateral benefits for optimizing stream flow and water supply."

Communities should take advantage of the resources that are available from State agencies to meet this commitment. In particular, communities should use this goal to help acquire funding for watershed planning. Several funding sources directly tie into the implementation of the C2K commitments (e.g., Chesapeake Bay Small Watershed Grants, administered by the National Fish and Wildlife Foundation). Other major C2K commitments that are related to watershed planning are shown in Table 2.4.

Watershed planning presents an opportunity to meet other C2K commitments, including those that address land use planning and land conservation. For example, many local communities have made meeting the C2K goals part of their local mission or have provided other incentives to meet these goals. For more information about the C2K agreement, see: www.chesapeakebay.net/c2k.htm.

Coastal Bays Comprehensive Conservation Management Plan (CCMP)

The CCMP is a partnership between the towns of Ocean City and Berlin, the National Park Service, Worcester County, U.S. Environmental Protection Agency, and the Maryland Departments of Natural Resources, Agriculture, Environment, and Planning. The CCMP was established by the Maryland Coastal Bays Program to protect the land and waters of Assawoman, Isle of Wight, Sinepuxent, Newport, and Chincoteague Bays (see Figure 2.4). The CCMP details goals and implementation strategies for ecological and economic prosperity, which should be coordinated with watershed planning efforts in these areas. For more information, see: www.mdcoastalbays.org/.

U.S. Environmental Protection Agency's Watershed Plan Guidance Elements

Beginning in fiscal year 2003, the U.S. Environmental Protection Agency (EPA) is requiring all watershed restoration projects funded under Section 319 of the federal Clean Water Act to be supported by a watershed plan that includes the nine minimum elements summarized below:

a) Identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the watershed plan
b) Estimates of pollutant load reductions expected through implementation of proposed nonpoint source (NPS) management measures
c) A description of the NPS management measures that will need to be implemented
d) An estimate of the amount of technical and financial assistance needed to implement the plan
e) An information/education component that will be used to enhance public understanding and encourage participation
f) A schedule for implementing the NPS management measures
g) A description of interim, measurable milestones
h) A set of criteria to determine load reductions and track substantial progress towards attaining water quality standards
i) A monitoring component to determine whether the watershed plan is being implemented

Watershed plans meeting the principles of watershed planning described in Chapter 1 will automatically be considered to meet these nine minimum elements. Communities that seek state of federal funding for implementation need to follow these criteria. The Frederick County Real

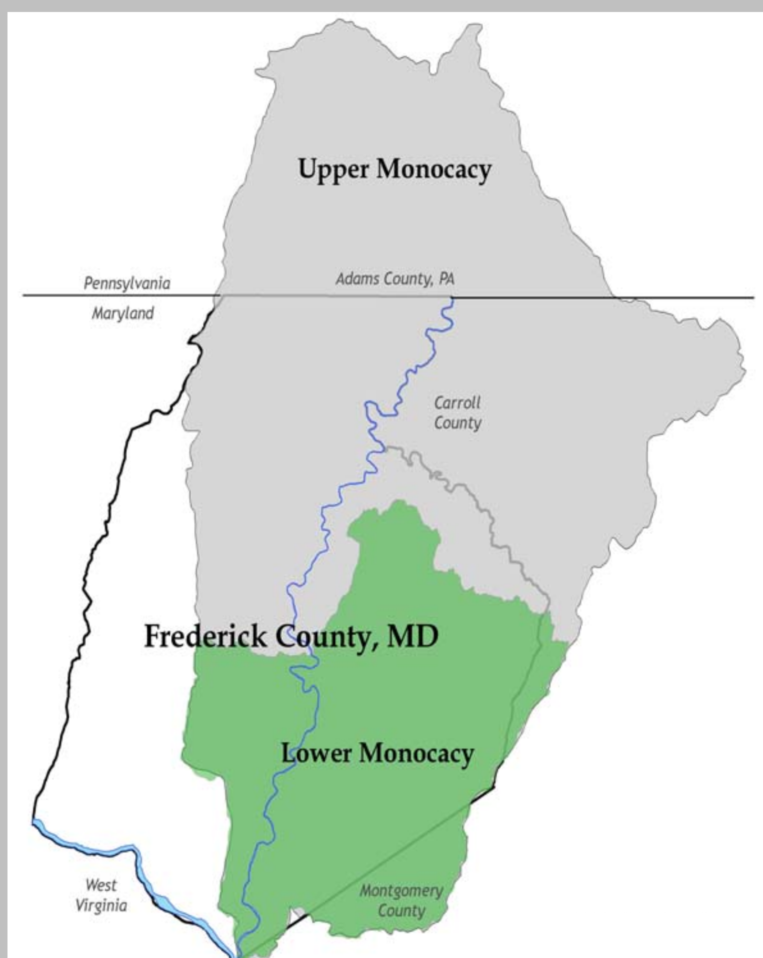
World Example illustrates how a community incorporated these criteria into a watershed plan enabling them to request funding of its recommended implementation projects through 319 funds. Additional information on EPA's watershed planning guidance elements can be found at: www.epa.gov/owow/nps/Section319/319guide03.html.

Table 2.4: Major C2K Commitments Related to Local Watershed Planning	
#	*Commitment*
C-17	By 2010, work with local governments, community groups and watershed organizations to develop and implement locally supported watershed management plans in two-thirds of the Bay watershed covered by this Agreement.
C-19	By 2002, each jurisdiction will work with local governments and communities that have watershed management plans to select pilot projects that promote stream corridor protection and restoration.
C-24	Establish a goal of implementing the wetlands plan component in 25% of the land area of each state's Bay watershed by 2010. The plans would preserve key wetlands while addressing surrounding land use so as to preserve wetland functions.
C-42	Support the restoration of the Anacostia River, Baltimore Harbor and Elizabeth River and their watersheds as models for urban river restoration in the Bay basin.
C-50	Provide technical and financial assistance to local governments to plan for or revise plans, ordinances, and subdivision regulations to provide for the sustainable use of forest and agricultural lands.
C-57	By 2002, develop analytical tools that will allow local governments and communities to conduct watershed-based assessments of the impacts of growth, development and transportation decisions.
C-58	By 2002, compile information and guidelines to assist local governments and communities to promote ecologically based designs in order to limit impervious cover in undeveloped and moderately developed watersheds, and reduce the impact of impervious cover in highly developed watersheds.
C-56	The jurisdictions will promote redevelopment and remove barriers to investments in underutilized urban, suburban and rural communities by working with localities and development interests.
C-60	By 2002, work with local governments and communities to develop land use management and water resource protection approaches that encourage the concentration of new residential development in areas supported by adequate water resources and infrastructure to minimize impacts on water quality.
C-64	Working with local governments, encourage the development and implementation of emerging urban stormwater retrofit practices to improve their water quality and quantity function.
C-80	Jurisdictions will work with local governments to identify small watersheds where community-based actions are essential to meeting Bay restoration goals...

Real World Example: Frederick County Upper Monocacy Watershed Plan

The Frederick County Department of Public Works recently completed a watershed management plan for its portion of the Upper Monocacy River with support from MD DNR under the Watershed Restoration Action Strategy program (WRAS program now discontinued). The Upper Monocacy River watershed encompasses parts of three counties in Maryland and Pennsylvania and is part of the larger Potomac River watershed. The watershed is influenced by a number of potential pollutant sources such as agricultural practices, municipal practices, business operations, and citizen behaviors. The watershed plan was specifically developed with U.S. EPA's Watershed Plan Guidance Elements in mind.

Each element is thoroughly addressed in the plan with a notation of the element covered in the text. The inventory of 38 priority projects includes tables with implementation schedules, potential funders and cost estimates, responsible parties and potential partners, monitoring components, and outreach techniques, as required by U.S. EPA. This process helped establish the foundation for Frederick County to request implementation funding through EPA's 319 program.



The plan is available at: www.dnr.state.md.us/watersheds/surf/proj/umon_strategy.html

Shultz, K., J. Hunicke, and S. Moore. 2005. *Upper Monocacy Watershed Restoration Action Strategy*. Frederick County Division of Public Works. Frederick, MD.

National Pollutant Discharge Elimination System Program (NPDES)

Phase I

Under its NPDES regulatory program, the Clean Water Act makes it illegal to discharge pollutants from a point source to the waters of the U.S without a permit. The NPDES Stormwater Phase I Rule established stormwater discharge control requirements for 11 categories of industrial activity and for municipal separate storm sewer systems (MS4s) serving populations of 100,000 or greater. These regulated MS4s must obtain an NPDES permit, and develop a stormwater management program to prevent harmful pollutants from entering the MS4 and being discharged into local waterbodies. Maryland is unique in that its Phase I MS4 permittees are required to prepare watershed restoration plans, and this requirement is a powerful driver. Because NPDES permits must be renewed every five years, watershed plans may be updated on this regular cycle as well. The specific requirements for creation of watershed restoration plans under Phase I are summarized below.

Phase I MS4 permittees must conduct a systematic assessment of water quality within all watersheds in the community. These assessments should include detailed water quality analysis, identification of water quality improvement opportunities, and the development and implementation of plans to control stormwater discharges. The overall goal is to evaluate and develop a plan for each watershed to maximize water quality improvements. During each permit term, 10% of the community's impervious area should be restored by implementing the watershed restoration action plans. Within one year of permit issuance, restoration efforts should be implemented to restore an additional 10% of the community's impervious surface area. All restoration efforts should be monitored to determine effectiveness in improving water quality. Annual reporting must be done on progress, implementation costs and monitoring (Summers, 2002).

In Maryland, 10 jurisdictions and the State Highway Administration are covered under the Phase I program and are required to obtain an individual municipal NPDES stormwater permit (Table 2.5). Figure 2.5 shows the locations of the MS4 Phase I and MS4 Phase II communities in Maryland.

Table 2.5: Maryland MS4 Phase I Communities	
• Maryland State Highway Administration	• Charles County
• Anne Arundel County	• Frederick County
• Baltimore City	• Harford County
• Baltimore County	• Howard County
• Carroll County	• Montgomery County
	• Prince George's County

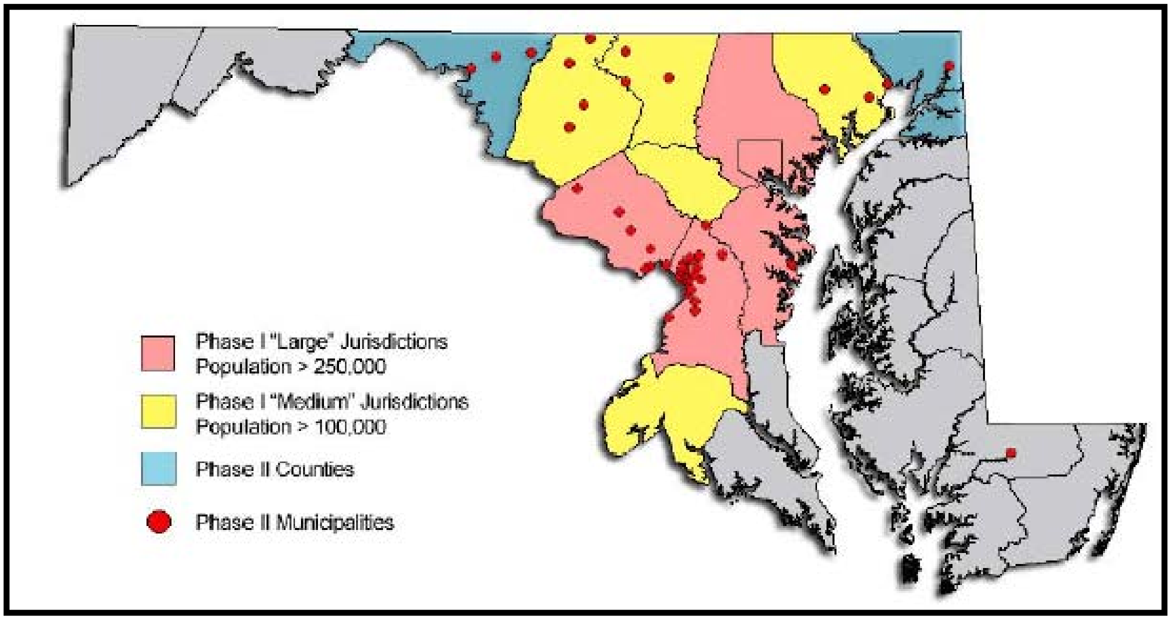


Figure 2.5: Maryland MS4 Phase I and MS4 Phase II Communities (Source: MDE, no date)

Phase II
The Stormwater Phase II Final Rule requires operators of small MS4s ("small" is defined by specific criteria set forth in EPA, 2000) to obtain an NPDES permit and develop a stormwater management program to prevent harmful pollutants from entering the MS4 and being discharged into local waterbodies. Phase II communities are also required to develop local programs to address six minimum management measures: public education and outreach; public participation and involvement; illicit discharge detection and elimination; construction site runoff control; post-construction runoff control; and pollution prevention/good housekeeping. These minimum measures are designed to improve the quality of Maryland's streams, rivers and the Chesapeake Bay, and a local watershed plan is frequently helpful in meeting these goals.

Approximately 49 municipalities in Maryland and two additional counties have been designated for coverage under Phase II (Table 2.6). For more information on NPDES permit requirements in Maryland, see:
www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/index.asp.

Table 2.6: Maryland Phase II Communities			
Municipality	*County Name*	*Municipality*	*County Name*
Cecil County	Cecil	Havre de Grace	Harford
Washington County	Washington	Hyattsville	Prince George's
Aberdeen	Harford	Landover Hills	Prince George's
Annapolis	Anne Arundel	Laurel	Prince George's
Bel Air	Harford	Manchester	Carroll
Berwyn Heights	Prince George's	Middletown	Frederick
Bladensburg	Prince George's	Morningside	Prince George's
Bowie	Prince George's	Mount Airy	Carroll
Brentwood	Prince George's	Mount Rainier	Prince George's
Brunswick	Frederick	Myersville	Frederick
Capitol Heights	Prince George's	New Carrollton	Prince George's
Cheverly	Prince George's	New Windsor	Carroll
College Park	Prince George's	Riverdale Park	Prince George's
Colmar Manor	Prince George's	Rockville	Montgomery
Cottage City	Prince George's	Salisbury	Wicomico
District Heights	Prince George's	Seat Pleasant	Prince George's
Elkton	Cecil	Smithsburg	Washington
Emmitsburg	Frederick	Sykesville	Carroll
Fairmount Heights	Prince George's	Takoma Park	Montgomery
Forest Heights	Prince George's	Taneytown	Carroll
Frederick	Frederick	Thurmont	Frederick
Gaithersburg	Montgomery	Union Bridge	Carroll
Glenarden	Prince George's	University Park	Prince George's
Greenbelt	Prince George's	Walkersville	Frederick
Hagerstown	Washington	Westminster	Carroll
Hampstead	Carroll		
Source: (MDE, no date)			

Total Maximum Daily Loads (TMDLs)

TMDLs are a requirement of the Clean Water Act, which calls on each state to list its polluted water bodies and to set priorities for TMDL development. Water bodies are classified as "impaired" when they are too polluted or otherwise degraded to support their designated and existing uses. The impaired waters list is called the 303(d) list, named after the section in the Act that requires it.

For each combination of waterbody and pollutant on the 303(d) list, states must estimate the maximum allowable pollutant load, or TMDL, that the water body can receive and still meet water quality standards. Many experts believe the loading or stressor goals set by a TMDL analysis provide the best hope for the clean-up and restoration of our most polluted waters. There are 659 listings in Maryland that may require a TMDL as of 2004. For a complete listing of these impaired waters in Maryland that may be subject to a TMDL, see: www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/final_2004_303dlist.asp.

A watershed plan can serve as the implementation framework and implementation mechanism for addressing a TMDL. At a minimum, any TMDL should be addressed within a watershed plan. Also having an impaired waterbody and/or TMDL may be utilized as a driver – an issue that can justify requests for new staffing and financial resources.

A TMDL is the sum of the allowed pollutant loads for point sources and nonpoint sources and includes a margin of safety. The basic requirements of a TMDL analysis are presented below within the context of key related elements of the Clean Water Act:

1. Set water quality standards (standards are refined every three years)
2. Assess water relative to the standards (a waterbody should be assessed every five years)
3. Identify and prioritize impaired waters (the 303(d) listing is updated every two years)
4. Collect data to verify the impairment and support TMDL analysis
5. Conduct the TMDL analysis
    a. Determine the water quality target consistent with the 303(d) listing
    b. Characterize the impairment: frequency, magnitude, duration, location
    c. Assess all point and nonpoint sources, including natural ones
    d. Determine the amount of the pollutant that the waterbody can absorb without exceeding the water quality standard. This is the TMDL
    e. The TMDL analysis must consider seasonal variations and critical conditions
    f. The TMDL analysis must include a margin of safety (MOS), which is conservative with respect to environmental protection
    g. Allocate the TMDL among point sources, nonpoint sources and the MOS if an explicit allocation is set aside for that purpose. A future allocation may be included to account for anticipated future needs.
    h. The TMDL should include a "reasonable assurance of implementation," which describes possible implementation measures, and is intended to ensure a balance between the point source and nonpoint source allocation.
6. Provide an opportunity for the public to comment on the TMDL analysis
7. Submit the TMDL to EPA for approval consideration. Revise if necessary
8. Reflect the TMDL in NPDES permits
9. Evaluate progress on achieving the TMDL goals
10. Revise the TMDL as necessary

The MDE Technical and Regulatory Services Administration (TARSA) is responsible for TMDL development, and has accepted the role of coordinating the implementation of TMDLs with local governments. For additional information, see www.mde.state.md.us/assets/document/TMDL_Implementation_Guidance_for_LG.pdf for the MDE draft document, "Evolving TMDL Implementation Framework," (MDE, 2005) which briefly describes the State's general strategy for TMDL implementation.

Maryland Nontidal Wetlands Protection Act of 1989

The Maryland Nontidal Wetlands Protection Act of 1989 regulates activities in the State's many nontidal wetlands, including placement of fill, grading, excavation, and building structures. The Act parallels many aspects of the Federal regulatory program under section 404 of the Clean

Water Act, but also requires 25-foot buffer zones around wetlands or 100 feet around nontidal wetlands of Special State Concern (defined in Chapter 4). The Act also regulates the alteration of wetland vegetation and hydrology, and seeks to achieve no net loss of acreage and functional quality of nontidal wetlands.

Under the Act, county governments may assume delegation of the regulatory program by developing nontidal wetlands protection programs. Watershed management plans must adhere to standards set by the Act, and can be used as the basis for regulatory decisions. The plans are developed in cooperation with local governments, and specifically protect wetlands by incorporating them into a jurisdiction's land use decisions. Local governments who wish to have their watershed plans adopted by MDE and used to guide nontidal wetland permit decisions, must adhere to the standards set by the act (COMAR 26.23.02.06). The Act also provides that counties and local governments may prepare watershed plans that, if adopted by MDE, can be used to guide state wetland permitting and decision-making.

To date, watershed plans developed under this act have been adopted for the Big Annemessex River watershed in Somerset County, and watershed plans or elements of watershed plans have been initiated or developed under this Act in Baltimore, Calvert and Montgomery Counties. For more information, see:
www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/index.asp.

C. Additional Watershed Planning Resources

In addition to the watershed planning drivers discussed earlier, several state and regional planning resources, policies, and directives should be considered and utilized when preparing local watershed plans. These resources fall into two categories – related planning resources and state watershed data resources.

Related Planning Resources
Related planning resources include existing plans, such as Source Water Assessment Plans, or directives that require the development of plans, such as Water and Sewerage Facilities Planning. Each should be integrated with a local watershed plan by incorporating goals, objectives, or other outputs, or by developing it in conjunction with the local watershed plan. Table 2.7 indicates where these programs can help the core team meet the 27 principles of watershed planning outlined in Chapter 1.

A description of related planning resources is provided below, and each includes a web link where more information on the program can be found. The four resources in this category are:

- Economic Growth, Resource Protection, and Planning Act of 1992
- Source Water Assessments
- Maryland's Tributary Strategy
- Water and Sewerage Facilities Planning

Table 2.7: Matrix of Additional Resources for Watershed Planning

		Resource/Tool			
		Planning Act	Source Water Assessments	Tributary Strategies	Water & Sewerage Planning
Unified Local Watershed Planning Principles	P-1 Plan Management			x	
	P-2 Watershed GIS		x		
	P-3 Existing Data			x	
	P-4 Pollutants of Concern		x	x	
	P-5 Subwatershed Delineation		x	x	
	P-6 Local Capacity				
	P-7 Programmatic Change	x			
	P-8 Baseline Analysis	x	x		
	P-9 Land Use Projections	x			x
	P-10 Designated Uses				
	P-11 Comprehensive Plan	x	x		x
	P-12 Development Capacity Analysis	x			x
	P-13 Subwatershed Metrics		x		
	P-14 Pollutant Reduction			x	
	P-15 Field Verification				
	P-16 Field Assessments			x	
	P-17 Environmental Indicators			x	
	P-18 Stakeholder Involvement	x	x	x	
	P-19 Watershed Education		x	x	
	P-20 Goals, Objectives and Indicators			x	
	P-21 Consistency		x	x	
	P-22 Recommendations	x	x		x
	P-23 Implementation Planning Table			x	
	P-24 Implementation Units			x	
	P-25 Plan Financing				x
	P-26 Adoption Mechanism	x			
	P-27 Revisit Plan	x		x	x

Maryland Department of Planning Economic Growth, Resource Protection and Planning Act of 1992

The Economic Growth, Resource Protection, and Planning Act of 1992 (the Planning Act) was enacted to organize and direct comprehensive planning, regulating, and funding by State, county, and municipal governments in furtherance of a specific economic growth and resource protection policy. The policy is organized around seven statutory vision statements. Both State and local funding decisions on public construction projects must adhere to the visions. The following visions must be incorporated into County and Municipal Comprehensive (or General or Master) Plans and then implemented through consistent ordinances and local laws by July 1, 1997:

- Development is concentrated in suitable areas
- Sensitive Areas are protected
- In rural areas, growth is directed to existing population centers and resource areas are protected
- Stewardship of the Chesapeake Bay and the land is a universal ethic
- Conservation of resources, including a reduction in resource consumption, is practiced
- To assure the achievement of [the] above, economic growth is encouraged and regulatory mechanisms are streamlined

Local governments are required by the Planning Act to update comprehensive plans every six years. All comprehensive plans prepared by local governments must include a Sensitive Areas element that contains goals, objectives, principles, and standards designed to protect these areas from the adverse effects of development. These sensitive areas include the following:

- 100-year floodplains
- Habitats of threatened and endangered species
- Steep slopes
- Streams and their buffer

The Sensitive Areas element permits local governments to designate other areas in need of special protection, and to determine the levels of protection. The Maryland Department of Planning (MDP) encourages protection of the following additional sensitive area categories:

- Agricultural land
- Anadromous fish spawning areas
- Bogs
- Caves
- Colonial waterbird nesting sites
- Eroding shorelines
- Groundwater
- Mineral resources
- Nontidal wetlands
- Oysters, clams, crabs, and benthic habitat
- Scenic vistas and geologic features
- Springs and seeps
- Submerged aquatic vegetation
- Tidal floodplains
- Tidal wetlands
- Trout stream watersheds
- Vernal pools
- Waterfowl areas
- Wellhead protection areas
- Wildlife corridors

Watershed planners should check to see if all applicable sensitive areas recommended in Sensitive Areas element are being protected. Two important resources are available regarding sensitive areas and comprehensive plans, and are part of MDP's *Managing Maryland Growth: Models and Guidelines* series. The first resource provides guidance on preparing a Sensitive Areas element for a comprehensive plan, and the second provides detailed guidance on how to map and protect the 20 additional categories listed above. These two resources are listed below.

1. Preparing a Sensitive Areas Element for the Comprehensive Plan www.mdp.state.md.us/planningact/download/mmg9303.htm
2. Sensitive Areas, Volume II www.mdp.state.md.us/planningact/download/98-18.htm

Local governments should consider integrating watershed plans into their comprehensive plans, which may help to ensure better alignment with land use issues, and guarantees a revisit of the watershed plan every six years. In particular, comprehensive plans should be modified to align with the recommendations in the watershed plan. Specific elements of the comprehensive plan that should be integrated with the watershed plan are the Sensitive Areas, Community Facilities, Land Use Plan, and Plan Implementation elements. More information on the Planning Act can be found at:
www.mdp.state.md.us/planningact.htm.

Source Water Assessments

The 1996 Safe Drinking Water Act Amendments require states to develop and implement source water assessment (SWA) programs to evaluate the safety of all public drinking water systems. SWAs are a process for evaluating the vulnerability to contamination of the source of a public drinking water supply. There are three main steps in the assessment process: delineating the drainage area that is likely to contribute to the drinking water supply, identifying potential contaminants within that area, and assessing the vulnerability of the system to the contaminants.

MDE is the lead agency in Maryland responsible for administering the source water assessment program. Working with local governments, MDE assesses drinking water contamination and risk, ultimately developing a plan for source water protection. SWAs include surface and groundwater system recommendations and water quality goals that should be incorporated into the watershed plan. There are over 3,700 public drinking water supplies in Maryland, including ground wells and surface water inlets.

SWAs can pull together a large amount of information that can be used in a baseline assessment for a local watershed plan. If an SWA exists within the watershed of interest, it should be directly integrated into the local watershed plan. The watershed plan should also reflect pollutants of concern, and actions specified in the SWA. Local watershed plans can be used as an implementation mechanism for SWAs. For more information, see:
www.mde.state.md.us/Programs/WaterPrograms/Water_Supply/sourcewaterassessment/index.asp.

Maryland's Tributary Strategy

The Chesapeake 2000 Agreement called for new water quality goals based scientifically on the conditions required to restore the living resources in the Bay. Maryland's nutrient loading goals are 37.3 millions pounds per year for nitrogen and 2.9 million pounds per year for phosphorus. These goals are also caps, meaning once Maryland and the other States achieve the necessary reductions, they must maintain that level in order to sustain improved water quality in the Bay. The state-wide Tributary Strategy was developed to achieve Maryland's nutrient reduction goals and includes actions from every source including agricultural fields, urban and suburban lands, waste water treatment plants, and atmospheric deposition.

The Tributary Strategy is structured to identify the level of effort needed to achieve measurable reductions in nutrients entering local waterways feeding to the Bay through the implementation of specific management practices. These practices are a combination of tried and true approaches as well as new technologies for which reduction efficiencies have been determined based on preliminary scientific study. The strategy also addresses such important issues as habitat restoration, erosion control, growth management, preservation of agricultural lands, and the protection of public water supply. The strategies, in essence, provide a blueprint for retrofitting prior land use impacts as well as a road map for future land use decisions.

Maryland's 10 Tributary Teams have the primary charge of facilitating the implementation of management practices and policy changes needed at the state and local levels to meet the nutrient reduction goals. The teams are composed of citizens, farmers, local government representatives, watershed groups, and business leaders, and are appointed by the Secretary of Natural Resources on behalf of the Governor.

Watershed plans provide a mechanism for identifying local opportunities and needs for implementing the Tributary Strategy. The goals of the Tributary Strategy should be considered as watershed plans are developed. Where appropriate, local watershed plans should include actions as recommended by the local Tributary Team. The Tributary Teams may also be a source of local community advocates to encourage local watershed plan creation and implementation. The local Tributary Team should be considered a key stakeholder during the local watershed planning process. For more information, see: http://dnr.maryland.gov/bay/tribstrat/index.html.

Water and Sewerage Facilities Planning

Every Maryland county and Baltimore City are required to prepare and update 10-year Water and Sewer Plans to demonstrate how safe and adequate water and sewerage facilities will be provided to support planned redevelopment and new growth. By law, these plans must be consistent with local comprehensive plans, must be approved by MDE (COMAR 26.03.01), and must be consistent with the new Antidegradation Policy, as water and sewer plans and NPDES permits are key triggers for mandatory antidegradation reviews. Water and sewer plans also must be reviewed on a biannual basis and updated every three years.

Water and sewer plans should be taken into consideration during the local watershed planning process as the plans may be a good source of data on where future growth will occur and the water and sewerage flows this growth will generate. It is recommended that if this data is utilized, the relevant local government department is contacted to verify that the data is current. Local watershed planners may also benefit from looking at population/development projections and capacity of sewer systems from a future loadings standpoint. Land use recommendations made in a local watershed plan may ultimately need to be reflected in water and sewer plans as well. For more information, see: www.mdp.state.md.us/water.html. Draft guidance for communities to develop wastewater and water supply capacity management plans is available from MDE at: www.mde.state.md.us/Water/index.asp.

State Watershed Data Resources

Many state agencies provide excellent mapping, monitoring, historical, or other watershed data that can be used to develop and complete the local watershed plan. Several important state watershed data resources are described below, including weblinks to obtain additional information. These data resources are important because they provide information on where and how development occurs, and may contain specific goals or recommendations that should be considered when developing watershed plans. The data resources in this category are:

> This is not a comprehensive listing of all state watershed data resources; additional resources are provided in User's Guide Tools 1-5.

- Maryland Department of Natural Resources Critical Area Act
- Maryland Department of Natural Resources Forest Conservation Act
- Maryland Department of Natural Resources Green Infrastructure Assessment
- Maryland Department of Planning Priority Funding Areas
- Maryland Department of Natural Resources Strategic Forest Lands Assessment
- Maryland's Flood Hazard Mitigation Program
- Maryland's Nongame and Endangered Species Conservation Act
- Maryland's Rural Legacy Areas
- Maryland State Scenic and Wild River System
- Maryland State Wetland Conservation Plan
- Priority Areas for Wetland Restoration, Preservation, and Mitigation in the Coastal Bays

Maryland Department of Natural Resources Critical Area Act

The Critical Area Act defines all lands within 1,000 feet of tidal waters or adjacent tidal wetlands as the "Critical Area," which affects 16 counties, Baltimore City, and 44 municipalities surrounding the Chesapeake Bay. There are three categories of land within the Critical Area: Intensely Developed Areas (IDAs), Limited Development Areas (LDAs), and Resources Conservation Areas (RCAs). IDAs are areas of concentrated development where little natural habitat occurs. Limited Development Areas (LDAs) are areas in which development is of a low or moderate intensity. RCAs are characterized by natural environments or by resource-utilization activities. To accommodate future growth, a local jurisdiction can change a land use designation and allow development at a density or intensity that exceeds the limits of a site's original designation. The Critical Area Commission developed guidelines for local governments regarding critical area development zones, stream buffers, non-tidal wetlands, endangered species, and habitat protection. Critical Area Commission recommendations should be considered in watershed plans that include these critical areas. For more information, see: www.dnr.state.md.us/criticalarea/.

Maryland Department of Natural Resources Forest Conservation Act

The Forest Conservation Act was passed in 1991 to protect forest resources during development. The Act requires developers to submit Forest Stand Delineations (FSD) and a Forest Conservation Plan (FCP) to direct development away from critical forest resources. Information from FSD and FCP reports can be included in local watershed plans to identify and protect these resources. Also, local watershed plans are an excellent way to locate good sites for future off-site reforestation for development sites and mitigation banks for counties that have fee-in-lieu programs. For more information visit: www.dnr.state.md.us/forests/programs/urban/explained.html.

Maryland DNR's Green Infrastructure Assessment

Maryland DNR's Green Infrastructure land network is a proposed concept to protect and link Maryland's remaining ecologically valuable lands. The purpose of the Green Infrastructure land network is to create a coordinated statewide approach to land conservation and restoration that will:

1) Systematically identify and protect lands with important ecological and biodiversity related characteristics
2) Address problems of forest fragmentation, habitat degradation and water quality
3) Maximize the influence and effectiveness of public and private land conservation investment
4) Promote shared responsibility for land conservation between public and private sectors
5) Guide and encourage compatible uses and land management practices

The proposed network would be linked by a system that connects large contiguous blocks of natural resource lands (hubs) through corridors that encompass the most ecologically valuable areas between these hubs (e.g. areas of high aquatic integrity, wetlands, wildlife migration routes and important forest lands). This concept is not a plan or a mandate to protect these valuable lands but rather it envisions the cooperative efforts of many people and organizations including government agencies, land trusts and interested private landowners.

The Green Infrastructure Assessment (GIA) evaluates Maryland's sensitive natural resources, focusing on forests and wetlands, to identify ecologically important lands, such as large wetland complexes, large contiguous tracts of forest lands, important wildlife habitats, wetlands, riparian corridors and areas that reflect key elements of Maryland's biological diversity. The emphasis of the GIA is on *regionally* important hubs and corridors.

Local governments can use the evaluations made through the GIA as a starting point to identify ecologically important and vulnerable sensitive areas in their watersheds. Additional information is available on the GIA website: www.dnr.state.md.us/greenways/gi/gi.html

Maryland Department of Planning Priority Funding Areas

Priority Funding Areas (PFAs) are geographic areas defined in state law and by local jurisdictions to provide a map for targeting state investment in infrastructure. All municipalities in Maryland automatically qualify as a PFA. Other types of land that may qualify as a PFA include:

- Neighborhoods designated by the Department of Housing and Community Development for revitalization
- Enterprise and Empowerment Zones
- Certified Heritage Areas within locally designated growth areas

- Areas inside the Washington and Baltimore beltways
- Areas with existing or planned water and sewer service, with an average permitted residential density of 3.5 units per acre
- Areas with industrial zoning or employment as the principle use, provided additional criteria are met
- Rural villages that have been designated as such by July 1, 1998 in county comprehensive plans

The 1997 Smart Growth Areas law governing PFAs restricts the use of state funding for roads, water and sewer plants, economic development, and other growth-related needs to PFAs, recognizing that these investments are the most important tool the state has to influence growth and development. As such, PFAs are a local tool for directing growth and development into specific areas. PFAs should be taken into consideration when making land use decisions in a watershed plan and when adjusting growth projections, comprehensive plans, and ordinances. There is potential for conflict between directing growth to a designated area and meeting water quality requirements and goals. In most cases (there are exceptions), growth should be directed to these areas. For more information, see: www.mdp.state.md.us/pfamap.htm.

Maryland DNR's Strategic Forest Lands Assessment

Maryland DNR's Strategic Forest Lands Assessment (SFLA) uses Geographic Information Systems (GIS) to identify where forest conservation efforts would make the greatest contribution towards achieving a sustainable forest resource land base. The SFLA evaluates the condition of Maryland's forests in terms of their long-term ecological and economic value and vulnerability to loss.

The goal of the SFLA ecological assessment is to identify the most ecologically significant forest lands of the state. Maryland's watersheds are being evaluated based on the spatial distribution and vegetation composition of forested lands, the abundance of riparian forests, and the presence of critical habitat and sensitive species. The influence of forests on ecological processes that translate across the watershed are also being evaluated. For example, riparian (streamside) forests improve surface water quality by filtering nutrients from water discharging into streams and reducing soil erosion. These beneficial effects are carried to downstream aquatic communities. Forest blocks of high ecological integrity will also be identified as priority areas for conservation and/or strategic management.

GIS data is being used to assess a variety of ecological attributes, including:

- Distribution of Forested Wetlands
- Distribution of Designated Wildlands
- Forest fragmentation patterns
- Forests providing habitat for sensitive species
- High Quality Forest Interior Dwelling Species Habitat
- Interior Forests
- Percent of Watershed Forested

Local governments can use the evaluations made through the SFLA as a starting point to identify ecologically important and vulnerable sensitive areas in their watersheds. Additional information is available on the SFLA web site: www.dnr.state.md.us/forests/planning/sfla/index.htm,

Maryland's Flood Hazard Mitigation Program
All Maryland counties and 92 municipalities participate in the National Flood Insurance Program. This program makes flood insurance available to property owners in participating communities. In return, local governments must adopt ordinances to manage development within 100-year floodplains to prevent increased flooding and minimize future flood damage. Floodway and Flood Insurance Rate Maps published by the Federal Emergency Management Agency (FEMA) are used to delineate the 100-year floodplain and identify regulated land. Local watershed plans should address the location of 100-year floodplains or floodway zones, and the impacts of stormwater management on 100-year floodplain elevation levels. More information can be found at:
http://textonly.mde.state.md.us/Programs/WaterPrograms/Flood_Hazard_Mitigation/index.asp.

Maryland's Nongame and Endangered Species Conservation Act
Maryland's Nongame and Endangered Species Conservation Act mandates Maryland DNR to list species that are in danger of extinction within the State; requires that State agencies use their authority to maintain and enhance nongame wildlife and endangered species populations; and directs the Secretary of the Department to set up programs to conserve these species. The Maryland Natural Heritage Program (NHP) is the lead state agency responsible for the identifying, ranking, protecting, and managing nongame, rare and endangered species and their habitats in Maryland. Data collected by NHP ecologists, contractors, and cooperators provide the scientific foundation for the Threatened and Endangered Species lists mandated by the Act. Natural Heritage program researchers conduct inventory and monitoring activities on nongame wildlife, rare species populations and natural communities, documenting trends in population and habitat health and viability. Information gathered through this research guides land management decisions and regulations designed to protect and conserve our state biological diversity. Results of inventories, site evaluations, taxonomic studies and other supporting research are maintained in hardcopy and digital form in the NHP database.

Data from the NHP database should be reviewed as part of a baseline assessment for a watershed plan to identify areas that may warrant conservation or other protection measure due to presence of sensitive species or communities. Specific protection recommendations can then be made as part of the plan. For more information, see:
www.dnr.state.md.us/wildlife/nhpdo.asp

Maryland's Rural Legacy Areas
Maryland's Rural Legacy Program is the counter part of Priority Funding Areas, and encourages local governments and private land trusts to identify Rural Legacy Areas and to competitively apply for funds to complement existing land preservation efforts or to develop new ones. Easements or fee estate purchases are sought from willing landowners to protect areas vulnerable to sprawl development. The Rural Legacy Advisory Committee, appointed by the Governor, and confirmed by the Senate, reviews all applications and makes recommendations to the Rural Legacy Board. The Rural Legacy Board, in turn, makes final recommendations to

the Governor and the Board of Public Works. The Board of Public Works designates the Rural Legacy Areas and approves the grants for Rural Legacy funding.

Local governments can apply to have conservation areas identified in their watershed plans designated as Rural Legacy Areas. Once designated as such, these areas are eligible for conservation funding. It is also helpful to know where existing Rural Legacy Areas are located in the watershed when making recommendations for a watershed plan. For more information, see: www.dnr.state.md.us/rurallegacy/

Maryland State Scenic and Wild River System

The State Scenic and Wild River System was created by the Scenic and Wild Rivers Act passed in the Maryland State Assembly in 1968 to preserve, protect and restore outstanding river resources. River resource management plans must be prepared for any river designated scenic and/or wild by the Maryland General Assembly. These plans identify river related resources, issues and existing conservation programs, and make recommendations on the recreational use of the river and the conservation and protection of special riverine features.

Sections of the following nine Maryland rivers have officially been designated "Scenic:" Anacostia, Deer Creek, Monocacy, Patuxent, Pocomoke, Potomac (Frederick and Montgomery Counties), Severn, Wicomico-Zekiah, and Youghiogheny. The section of the Youghiogheny between Millers Run and the southern corporate limits of Friendsville has been officially designated as the only "Wild" river in Maryland.

When developing watershed plans within Scenic and Wild river basins, goals and recommendations of the prior river resource plan should be considered and incorporated. The designation of a river as wild or scenic may serve to generate public support for a local watershed plan that protects the resource, and also to generate stakeholder interest. For more information, see: www.dnr.state.md.us/resourceplanning/scenicrivers.html

Maryland State Wetland Conservation Plan

The purpose of the Maryland Wetlands Conservation Plan is to establish a unified approach to comprehensive wetland management, resource identification, and wetlands conservation statewide. The Plan contains extensive information on management programs related to wetlands, a detailed wetlands inventory and baseline, and goals and objectives developed by the Wetlands Conservation Plan Workgroup to address the immediate, intermediate, and long-term needs of wetlands resource management.

The Plan is useful to those developing watershed plans because it serves as a reference for technical and baseline information, clarification of wetland policies and regulations, and as a guide to current wetlands conservation efforts in the State of Maryland. Goals and objectives defined in the Plan should be considered and incorporated where possible into local watershed plans. For more information on the Maryland State Wetland Conservation Plan, see: www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/wetland_conservation/index.asp

Priority Areas for Wetland Restoration, Preservation, and Mitigation in the Coastal Bays
MDE's Wetlands and Waterways Program has been working to prioritize areas for wetland restoration, mitigation, and preservation in Maryland's Coastal Bays watersheds in order to meet a goal set forth by the CCMP. The result of this EPA funded project is a report entitled *Priority Areas for Wetland Restoration, Preservation, and Mitigation in Maryland's Coastal Bays* (MDE, 2004). This report compiles information from numerous resource inventories and management plans in a comprehensive background document on Coastal Bays wetlands, their surrounding environment and conditions, land use, and management and restoration recommendations. The report includes maps and descriptions of proposed wetland restoration and preservation project sites, roughly ranked based on priority for water quality and habitat benefits, while not conflicting with other land use goals. This information can be directly incorporated into a Coastal Bays watershed plan and should be considered when identifying priority restoration and preservation sites. MDE is conducting a similar analysis for the entire state of Maryland, and this should be completed in 2005. The final Coastal Bays report is available for download at: www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/about_wetlands/prioritizingareas.asp.

Chapter 3: Getting Started

As local governments get started, they need to decide how to organize their efforts to support assessment, planning and implementation. The seven initial management tasks are:

A. Organize the Core Team
B. Develop a Watershed-Based GIS
C. Gather Existing Watershed Data
D. Delineate Subwatershed Boundaries
E. Develop Initial Goals
F. Develop a Realistic Scope for a Watershed Plan
G. Develop an Overall Stakeholder Involvement Strategy

In general, the tasks presented in this chapter would be completed prior to receiving funding for a watershed plan.

A. Organize the Core Team

Watershed planning can only be effective when the talents of many people are combined into a "core team" to take advantage of their diverse skills, professional disciplines, and experience. The team must also draw heavily from many different disciplines – local government planners, engineers, foresters, wetland scientists, hydrologists, geomorphologists, water quality experts, and educators to name just a few. The team is often physically located in many different places and plays different roles in the planning process – some may be local government staff, consultants, or watershed groups. If a Total Maximum Daily Load (TMDL) implementation committee currently exists for the watershed, there may be an opportunity to consolidate resources and meetings.

The core team should meet several times when scoping the preparation of a local watershed plan to oversee plan development and implementation, define team roles and tracking, and determine how stakeholders and partners will be involved.

The core team may decide that it does not have enough resources in-house to complete the watershed plan. In this instance, the core team may consider using its dollars more effectively by hiring a consultant to complete the plan. Tips for utilizing a consultant are outlined in Table 3.1.

Table 3.1 Tips for Utilizing a Consultant
• Select consultants with demonstrated capabilities to conduct the work, work experience in the region, and/or work experience with a particular type of watershed issue (e.g., source water protection, special habitat protection, floodplain management)
• Require multidisciplinary teams that include skills or expertise in GIS, land use planning, biology, water quality, hydrology, and engineering
• Require that the consultant use the framework presented in this guide to scope out the work
• Require a clear description of deliverables
• Require frequent meetings with the core team to track progress and solicit input
• Consider keeping some tasks in-house or designating them to a local watershed group to reduce costs
• Understand who the primary point of contact will be and be comfortable that the core team can work productively with them
• Evaluate where past consultant efforts stand with respect to implementation
• Evaluate past consultant work products and determine whether it seems to be compatible with project objectives
• Do not always go with lowest bidder, if possible
• The RFP/scope of services should always be as specific as possible

B. Develop a Watershed-Based GIS

A watershed-based Geographic Information System (GIS) provides the foundation for many subsequent desktop and field assessment methods outlined in Table 3.2. Local governments often have different GIS resources and analysis capabilities; the methods described in this guide assume a basic level of access to GIS resources. The core team should take advantage of the many excellent GIS resources available from State agencies (see User's Guide Tool 2 for a listing).

GIS mapping is the most effective way to organize and view all the data collected about a watershed and its subwatersheds. Spatial representation makes it easier to simultaneously analyze various types of data, visualize watershed impacts, view protection and restoration opportunities, and track changes over time. The basic concept is that the GIS will be the primary tool to store, organize and analyze all data generated throughout the watershed planning process.

The core team should evaluate current GIS resources to determine if they are versatile enough to support analysis at both the watershed and subwatershed scale, and can handle broad screening assessments as well as detailed project tracking. In many cases, the team will discover that their current GIS lacks key data layers and that new or expanded GIS layers must be developed. The core team should take care to indicate the resolution and date of any new layers developed as a result of the watershed plan.

In general the more local the data source is, the better the resolution (local vs. state vs. national). A wealth of GIS data is available from the State agencies, but local data should be used when available.

Table 3.2: Useful Mapping Data for Watershed Planning			
Data Type	*GIS Layer*[1]	*Commonly Used For*	*Sources*[2]
Hydro-geomorphic Features	• Hydrology • Topography (10 ft contour)	• Delineating subwatershed boundaries • Watershed characterization • Developing project concept designs • Estimating pollutant loads and reductions • Conducting stream and upland assessments • Conducting project investigations	CBP MD DNR USGS Local data NRCS
Boundaries	• Watersheds • Municipal boundaries • Property/Parcel boundaries	• Delineating subwatershed boundaries • Watershed characterization • Land use analysis • Impervious cover analysis • Developing project concept designs • Conducting stream and upland assessments • Conducting project investigations	MD DNR MDP Local data
Land Use and Land Cover	• Aerial photos • Land use • Zoning • Impervious cover layers	• Delineating subwatershed boundaries • Watershed characterization • Land use analysis • Impervious cover analysis • Classifying and ranking subwatersheds • Developing project concept designs • Estimating pollutant loads and reduction • Conducting stream and upland assessments • Conducting project investigations	MD DNR MDP Local data
Sensitive Areas	• Wetlands[3] • Contiguous forest[4] • Rare, threatened and endangered species[5] • Floodplain • Soils • Green infrastructure • Public drinking water supplies • Protected lands • Shorelines • Steep slopes	• Watershed characterization • Land use analysis • Impervious cover analysis • Impervious cover analysis • Sensitive areas analysis • Classifying and ranking subwatersheds • Developing project concept designs • Estimating pollutant loads and reduction • Conducting project investigations	MD DNR MDE MDP USGS FEMA FWS Local data NRCS
Utilities	• Sanitary sewer network • Storm drain network • Stormwater treatment practices • Stormwater outfalls	• Delineating subwatershed boundaries • Prioritizing subwatersheds • Classifying and ranking subwatersheds • Developing project concept designs • Estimating pollutant loads and reduction • Conducting stream and upland assessments • Conducting project investigations	Local data

Table 3.2: Useful Mapping Data for Watershed Planning

Data Type	GIS Layer[1]	Commonly Used For	Sources[2]
Point Sources and Hotspots	• Discharge permits • ESC construction permits	• Watershed characterization • Classifying and ranking subwatersheds • Developing project concept designs • Estimating pollutant loads and reduction • Conducting stream and upland assessments • Conducting project investigations	EPA Local data MDE
Stream Condition	• Fish health • Benthic macroinvertebrate health • Physical in-stream habitat • Water quality • Designated uses	• Delineating subwatershed boundaries • Watershed characterization • Summary of monitoring data • Classifying and ranking subwatersheds • Estimating pollutant loads and reduction • Planning for indicator monitoring • Conducting stream assessments	MD DNR EPA USGS Local Data MDE

Notes:
1: Derivatives from existing layers are not included in this table
2: Chesapeake Bay Program (CBP); Maryland Department of Natural Resources (MD DNR); United States Geological Survey (USGS); Maryland Department of Planning (MDP); U.S. Environmental Protection Agency (EPA); US Fish and Wildlife Service (FWS)
3: MD DNR's Wetlands Inventory layer is recommended over National Wetlands Inventory layer
4: Data layer is available through MD DNR but is referenced as potential Forest Interior Dwelling Species (FIDS) habitat
5: Data layer is available through MD DNR but is referenced as Sensitive Species Project Review Area and/or Natural Heritage Areas.

C. Gather Existing Watershed Data

Accessing existing watershed data and critically evaluating its quality is essential to derive key watershed management variables used in subsequent tasks. This task is really an expansion of the previous task, but here the team identifies data and studies that may not necessarily be available in GIS format. Instead, this data may be found in another electronic format, databases, and published or unpublished reports. The team should search for watershed data in the following documents and studies:

- Coastal Bays Management Plan(s)
- NPDES Phase I and II Permit Applications
- Source Water Assessments
- Tributary Strategy Basin Summary
- USGS hydrology gauging stations
- Volunteer monitoring data
- Local floodplain modeling studies
- Environmental Impact Statements and Assessments
- Comprehensive plans
- Water and sewer plans
- TMDL
- Local codes and ordinances
- Local data on watershed population and demographics
- Field Surveys (e.g., breeding bird inventory conducted by a local university)

The team then consolidates the data into a central repository such as a GIS where it can be organized and reviewed. The quality of each historical data source should be critically reviewed, since it often was collected using different sampling methods, protocols and detection limits. User's Guide Tool 3 provides an extensive listing of monitoring resources available for Maryland communities.

D. Delineate Subwatershed Boundaries

The first test of a watershed-based GIS is subwatershed delineation. If local governments do not have a watershed layer, they may want to consider downloading the Maryland 8-digit watershed boundary layer from MD DNR's website. Additional discussion on watershed scales can be found in Chapter 2.

In reality, teams should exercise considerable discretion when drawing subwatershed boundaries to make sure they serve practical management purposes. Subwatershed boundaries are typically defined by high points in the topography where a drop of water landing outside of the boundary would drain to a different stream. An exception may include urban areas where storm drainage networks can extend subwatershed boundaries beyond the topographic ridge. The steps for delineating subwatershed boundaries are outlined below:

Step 1: Define the Origin: The origin of the subwatershed is usually located slightly below the confluence of two second order streams. Additional considerations for defining the origin are illustrated in Figure 3.1 and are described below:

- Subwatershed size - The average size of subwatersheds should be 10 square miles or less.

- Subwatershed orientation - The general convention is to define subwatersheds along the prime axis of the mainstem of the primary water body, and then number them in clockwise fashion around the watershed.

- Jurisdictional boundaries - Wherever possible, subwatershed boundaries should be drawn so that they are wholly contained within a single political jurisdiction to simplify the planning and management process.

- Homogeneous land use - To the greatest extent possible, boundaries should try to capture the same or similar land use categories within each subwatershed. When sharply different land uses are present in the same subwatershed (e.g., undeveloped on one side, commercial development on the other) it may be advisable to split them into two subwatersheds.

- Ponds / lakes / reservoir - Where feasible, boundaries should be extended downward to the discharge point of any pond, lake, or reservoir present in the stream network.

- Existing monitoring stations - Boundaries should always be extended to include the location of any existing monitoring stations.

- Major road crossings - It is good practice to fix the subwatershed at major road crossings or bridges in the stream segment, since crossings often coincide with stream access and possible monitoring stations.

- Direct drainage - Direct drainage is often neglected in the delineation process, but it is advisable to aggregate all small direct drainage areas into a single "unit subwatershed" for analysis purposes.

Step 2: Evaluate Surrounding Topography: Use the contours to quickly evaluate the surrounding topography. Important features to note include ridges, which are high areas indicated by a series of contour lines that "point" toward a lower elevation, and valleys and ravines, which are indicated by contour lines that "point" to a higher elevation. The core team should utilize a topography layer that has a contour interval no greater than 10-foot.

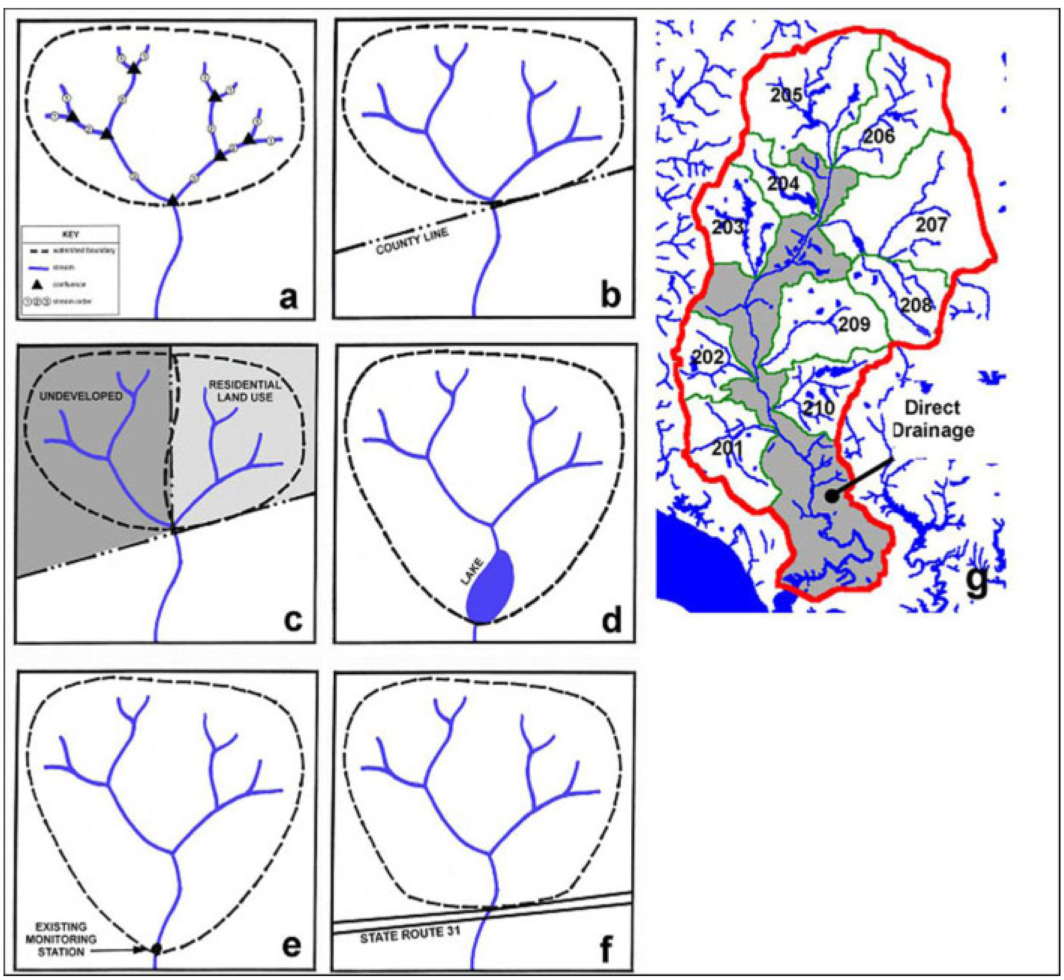


Figure 3.1: Subwatershed Origin Considerations

Step 3: Identify Breakpoints: Breakpoints are the points of maximum elevation from stream channels. Breakpoints are identified by following the banks of the stream to the highest elevation.

Step 4: Connect Breakpoints: Connect the breakpoints, beginning and ending with the origin, to form a polygon. When connecting the breakpoints the contour lines should be crossed at right angles (see Figure 3.2).

Step 5: Double Check: The core team should sample points along the edge of the boundary and make sure that points inside the boundary drain to the stream and points outside the boundary drain to another stream.

These steps should be repeated for each subwatershed within the Maryland 8-digit watershed. Once delineated, the subwatershed boundary should be transferred into GIS as a new layer. In some cases, automated watershed delineation tools may be available for GIS. While these tools may be a good starting point for determining initial boundaries, the resolution may be too coarse to accurately delineate subwatersheds as many rely on 30 meter Digital Elevation Models (DEMs). Local DEMs (2 meter resolution) can make for an accurate and easy method to depict subwatershed boundaries.

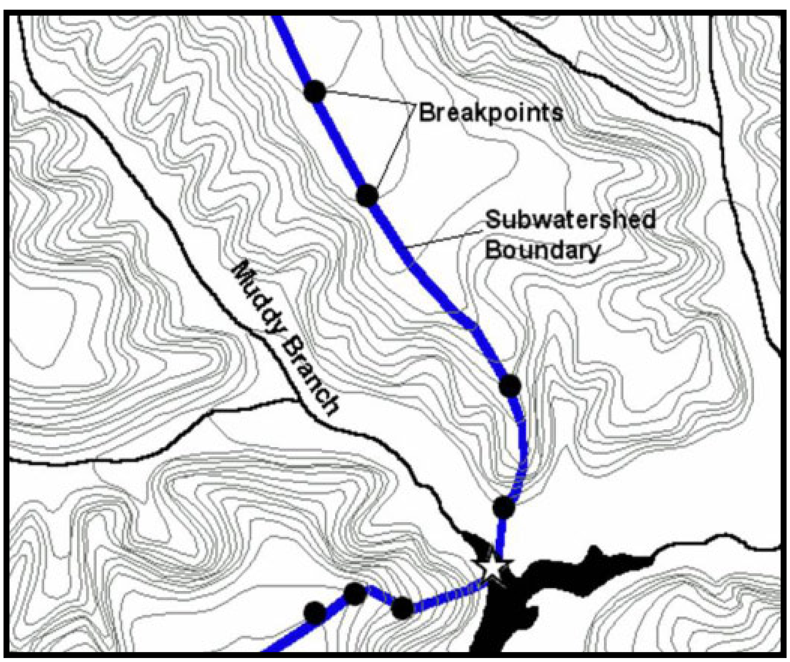


Figure 3.2: Connect breakpoints starting at the origin

E. Develop Initial Goals

Developing initial goals allows the core team to create a realistic scope for the watershed plan and focus planning dollars on the most critical data gaps and water quality priorities.

This task represents the first iteration of the goal setting process. Goals are revised, updated and expanded as the core team becomes more familiar with stream and upland conditions and receives stakeholder input. Goals are revisited again in Chapter 6, Stakeholder Involvement Methods and Chapter 7, Management Methods.

The core team should use the data gathered from the previous tasks to view the boundaries of the Maryland 8-digit watershed, tributary basin, 303(d) listings, TMDLs and supporting technical documentation and designated uses and get a general idea of the characteristics of the area. When combined with local expertise, the core team normally has enough background information to create initial watershed planning goals.

Goals are general statements of purpose or intent that express what watershed planning will broadly accomplish (see Table 3.3). Initial goals should reflect the general character of the area (highly urbanized vs. agricultural inputs) and address pollutants of concern. 303(d) impairments should automatically become the focus of one or more goals. Other important considerations include conservation areas vulnerable to development and erosion and physical impacts (e.g., floodplain disconnection). Goals should not only reflect what needs fixing but what needs protecting as well.

Table 3.3 Example Watershed Planning Goals (modified from the Lower Patuxent River Watershed Restoration Action Strategy)
• Reduce nutrient and sediment pollution to the Lower Patuxent River by addressing priority nonpoint pollution sources. • Increase understanding and awareness of watershed issues and promote action and stewardship responsibilities among commercial and residential stakeholders. • Have in place programs and development criteria to reduce the impact of future growth on the Patuxent River. • Protect and restore sensitive and natural resource areas such as contiguous and interior forests, environmentally sensitive areas and intact stream buffers. • Maintain current character of the county and quality of life.

F. Develop a Realistic Scope for a Watershed Plan

The core team needs to make hard choices on the scope of the plan given limited and uncertain budget resources. As an example, the total budget for a full-blown watershed plan following all the principles and methods presented within this guide can easily exceed $100,000. Even when funding is spread out over several years, it is certainly a hefty and often unaffordable investment for many local governments (see User's Guide Tool 4 for potential funding sources). Therefore,

most teams will really need to economize on the scope of work to get the maximum planning information for the least cost. Four tips are provided below:
Tip 1: Establish a realistic overall budget and planning horizon. As noted earlier, the price tag is high for a full watershed plan. The team should develop a ballpark estimate of how much total funding will be needed for the watershed plan and then estimate what funding is realistically available over the short term. Table 3.4 provides some basic rules of thumb on budgeting and estimating costs.

Table 3.4: Rules of Thumb on Budgeting and Estimating Costs
• Project management equals 5-10% of budget • Office time equals twice the field time for assessment tasks • Design and Contingency rules (20-30% of construction costs) • Don't forget travel, equipment, and printing • Overhead Costs – many funding sources only cover a small portion of this, if at all • Fringe Rate Costs (20-30% of direct salary) • Ratio between planning and implementation costs should be close to 15:85 • You should estimate \$150-\$200K for watershed planning costs (<50 sq mile)

Tip 2: Estimate the watershed factors that will drive the scope. The scope of most plans is directly related to the following watershed factors:

- Watershed area (square miles)
- Number of subwatersheds
- Number of stream miles
- Estimated number of projects
- Data gaps
- Number of existing stakeholders, partners, and agencies that participate

The cost to perform a plan generally increases in direct proportion to each factor. The core team should measure or estimate each watershed factor at the start of the budgeting process to get a more accurate handle on the scope for planning.

Tip 3: Decide which methods can be dropped or reduced in scope. While most methods are essential, some are optional and can be dropped, deferred or restricted in scope. Optional methods are desirable to perform and certainly contribute to effective plan implementation, but they may not be initially needed to support the process. At this time, the core team will also need to make key decisions regarding what desktop and field assessment methods are most appropriate (see Chapters 4 and 5). If a method does not help the core team to achieve one of the initial goals, the method may not be the best use of funding.

The team should carefully scrutinize the remaining essential methods to look for scope "creep." This refers to situations where the scope of a particular method produces more information than is really needed to make a good decision. In particular, the team should resist the temptation to over-analyze, over-report, over-monitor or over-model. User's Guide Tool 6 provides two examples of scopes written for very different watershed planning scenarios. These scopes illustrate how different methods are selected based on watershed characteristics, size, and available data.

Tip 4: Choose the methods that deserve greater investment. Just like regular investing, the scope should be analyzed to make sure funds are allocated properly. Several investment ratios can help allocate effort within a scope of work, including the ratio of funding allocated to:

- Planning vs. implementation
- Each of the four basic watershed planning methods

The desirable ratio of planning to implementation should be about 15:85 over the entire planning horizon. The basic idea is that on-the-ground project implementation should always be the ultimate outcome. While advance funding for full implementation seldom exists, stakeholders should clearly understand that planning efforts are merely a minor down payment compared to future implementation costs.

The second ratio looks at how funding is allocated to the four types of watershed planning methods – desktop analysis, field assessment, stakeholder involvement, and management (see Figure 3.3). In general, about 75% of the total work should be split between desktop analysis and field assessment methods. The remaining 25% of the work effort is normally allocated to stakeholder involvement and management methods, in roughly equal proportions. More funds should be invested into stakeholder involvement methods if awareness is low or watershed groups do not exist. Likewise, greater investment in management methods is warranted if local governments lack prior experience in watershed planning.

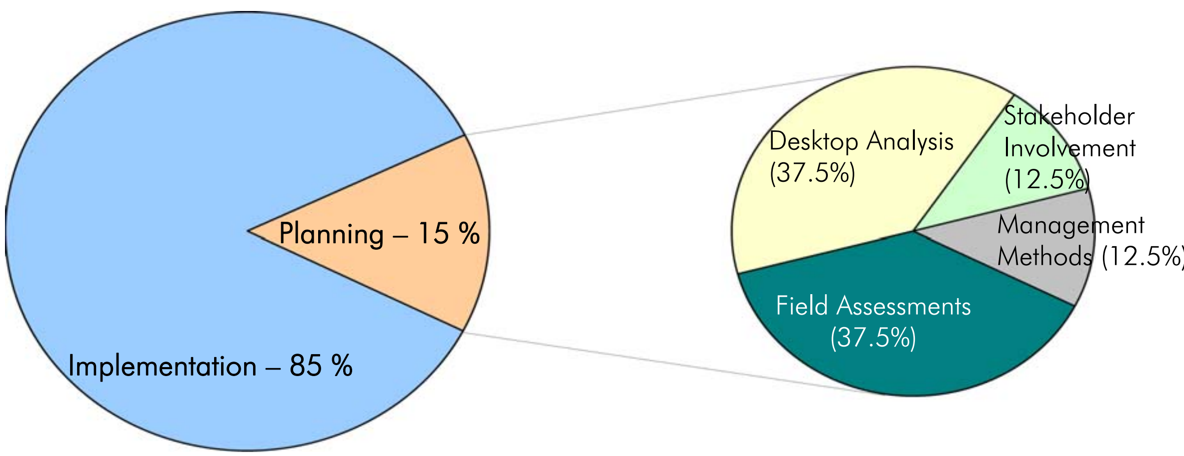


Figure 3.3: Breakdown of watershed planning funding

G. Develop an Overall Stakeholder Involvement Strategy

Watershed planning is driven by the goals of those that care for the watershed. Aligning the efforts and resources of stakeholders towards common goals is critical to the adoption and implementation of any watershed plan. Not all stakeholders are equal. In a literal sense, each has a different stake in the outcome of the plan, and each is expected to perform a different role in the local watershed planning effort. Each comes to the table with varying degrees of watershed awareness, concern and/or expertise. Stakeholders also have different preferences as to how, when and in what manner they want to be involved in the process.

Stakeholders can generally be grouped into four broad categories that include the public, agencies, watershed partners and potential funders (see User's Guide Tool 1 for contact information of potential agencies and funders to incorporate). As a result, the outreach methods used to educate and inform stakeholders must be carefully calibrated to match their different levels of knowledge and understanding. For example, some stakeholders are professionals expected to be at the table because of their job duties, whereas others are "night-timers" who are donating their time and expertise. An effective core team will recognize the wide diversity in stakeholders, and structure its planning process to provide multiple options and opportunities for involvement. Methods on stakeholder education and involvement are described in Chapter 6.

Considering these issues, the core team should think through an overall strategy to involve stakeholders during the watershed planning process that focuses on the following factors:

- What stakeholder groups need to be involved in the watershed planning process?
- Which organization will take the lead to manage stakeholders?
- What are the most effective and affordable techniques to reach out to them?
- What roles and responsibilities will they be assigned?
- Is a watershed planning website needed?

Chapter 4: Desktop Assessment Methods

Desktop assessment methods occur in the office and are used to organize, map and interpret watershed information to make better watershed planning decisions. The methods described in this chapter include:

A. Identify Watershed Needs and Capabilities
B. Establish a Baseline
C. Classify and Rank Subwatersheds
D. Evaluate Watershed Programs and Regulations
E. Develop Project Concept Designs
F. Rate and Rank Individual Projects
G. Estimate Pollutant Loads and Reductions

A. Identify Watershed Needs and Capabilities

The purpose of identifying watershed needs and capabilities is to establish community concerns and regulatory climate that shape watershed goals and objectives. This also helps to comprehensively evaluate local watershed planning capacity - including available resources, programs, mapping, and watershed data that can contribute to local watershed planning effort. By organizing and reviewing this information, watershed planning needs and gaps are easily identified. One tool designed specifically for this purpose is the Needs and Capabilities Assessment (NCA).

The NCA (User's Guide Tool 8) contains a checklist of 62 questions that help the core team understand its strengths and weaknesses, and identify programs and resources to conduct effective watershed planning and implementation. These questions are organized by the five major parts described below.

Part 1. Regulatory Forces Driving Watershed Planning. This part examines federal, state and local regulatory drivers that influence watershed planning in the community, and can provide financial or technical resources for implementation. Such drivers may include: NPDES MS4 Phase I and Phase II stormwater permits, TMDLs, and Source Water Assessments.

Part 2. Local Agency Capacity. This part is used to discern local program capacity to conduct watershed planning, including data availability, watershed planning and implementation experience, and funding and mapping resources. A more detailed evaluation of local agency capacity reviews local programs, codes and ordinances, and is described later in this chapter.

Part 3. Your Local Agency Rolodex. This part identifies key local agencies, staff, and programs that should be involved or included in local watershed planning efforts. Examples of local government contacts include appropriate staff from stormwater management, parks and recreation, planning, health, and development review departments.

Part 4. Non-Local Government Partners. This part helps recruit additional stakeholders and resources outside of local government such as private, non-profit, regional, state, or national partners that can provide financial, technical or programmatic assistance for watershed planning and implementation. Key regional, state, or federal government contacts may include the Tributary Teams, Army Corps of Engineers district office, the Chesapeake Bay Program, U.S. EPA Region 3, and various contacts from Maryland Department of the Environment, Department of Natural Resources, Department of Agriculture, and Department of Planning (User's Guide Tool 1). Other key contacts include non-profits, universities, land trusts, and local landowners.

Part 5. Community Attitudes. This part identifies current community attitudes towards streams, wetlands and watersheds. Community support can make or break watershed planning efforts. Smart watershed planners have their finger on the pulse of the community and can utilize local media and community groups to target their watershed planning endeavors.

Local governments should complete the NCA by first identifying and interviewing potential local and non-local restoration partners, and then reviewing the current technical resources and regulatory drivers in the watershed. The result of the NCA is a draft report to be reviewed with key stakeholders, and ultimately used to set watershed goals and objectives. The final NCA is also used as a resource when acquiring watershed data from local sources, and forming partnerships for plan implementation.

Smart Watersheds Benchmarking Tool

An alternative to the assessment is the Smart Watersheds Benchmarking Tool (User's Guide Tool 9; CWP, 2005), which has special application to Phase I MS4 NPDES communities that are required to do watershed restoration under their permits. The Smart Watersheds benchmarking tool is a detailed scorecard that assesses the degree to which a municipality integrates 14 local programs to treat stormwater runoff, restore stream corridors, and reduce pollution discharges in urban watersheds. The scorecard is intended as a self-assessment tool with the primary audience being local government program managers or watershed groups that are familiar with the scope of restoration effort in their community. The tool evaluates programs that are only likely to exist in larger, more developed communities that have the need and capacity to implement them.

B. Establish a Baseline

Establishing baseline conditions for the watershed is key to determine how best to manage it in order to maintain or improve designated uses and water resources condition. Under this method, the core team analyzes watershed data gathered previously (Chapter 3) in order to identify major impacts and pollutants of concern, identify key resources to protect, summarize current conditions, and evaluate how future changes in land use will affect these conditions. Establishing a baseline is primarily a GIS analysis, and involves data acquisition, map creation and generation of descriptive metrics. Where possible, most recent data should be used so that the most accurate conditions can be seen. Figure 4.1 illustrates how using more detailed land use data provides more accurate estimates of land use in a watershed, compared to land use data derived from satellite imagery.

For best results, preference should be given to the most recent and accurate data, and the resolution and date of all GIS data used should be indicated in the final watershed plan. Specific sources of GIS data are listed in this section as the minimum required layers, but communities should always follow up with state and local sources to acquire more detailed and timely data.

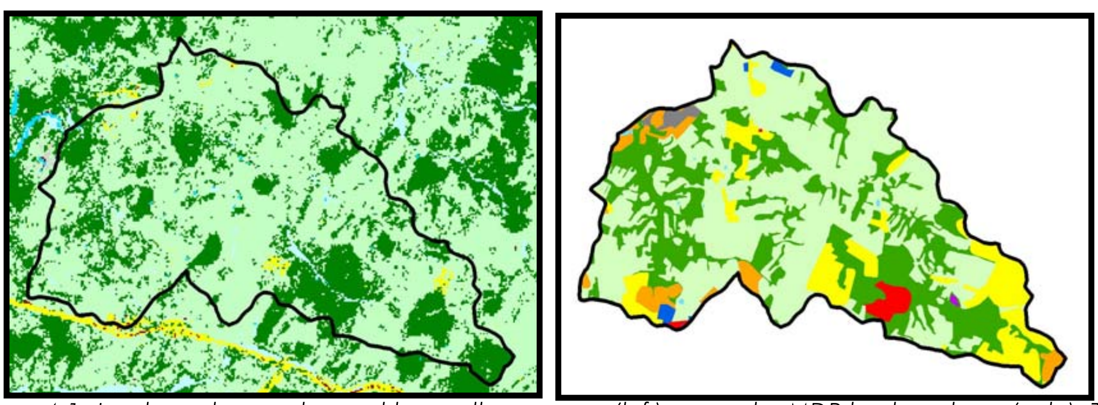


Figure 4.1: Land use data as depicted by satellite imagery (left) versus the MDP land use layer (right). The image on the left shows the watershed land use as primarily forest and agricultural, while the image on the right more accurately depicts the residential and commercial areas that also exist in the watershed.

Establishing a baseline includes five major components that are listed below.

1. Watershed characterization
2. Land use analysis
3. Impervious cover analysis
4. Summary of monitoring data
5. Sensitive areas analysis

Communities that have already compiled baseline data as part of a related analysis may be able to skip some steps.

1. Watershed characterization

A watershed characterization is a simple summary of basic watershed characteristics that provides some context to the plan. It is usually presented in narrative form, and is accompanied by maps and summary tables. Minimum elements to include in a watershed characterization are described below.

Geographic setting - the watershed characterization should identify the major basin in which the watershed is located. If it falls in the Chesapeake Bay basin, the watershed's Tributary Strategy sub-basin should also be identified. The watershed plan should identify the watershed using the name and identification number provided with the MD DNR's watershed boundary, known as the Maryland 8-digit watershed. The Maryland 8-digit watershed boundary information is available from the Geospatial Data Download (User's Guide Tool 2).

Regulatory status - the watershed characterization should identify all 303(d) listings and any TMDLs that exist for waterbodies in the watershed. It should also indicate all designated stream uses, and identify any Phase I or Phase II communities.

Watershed metrics – the watershed characterization should summarize basic watershed metrics, including watershed area, stream miles, number of subwatersheds, and population. Methods for subwatershed delineation are covered in Chapter 3. Additional watershed metrics can be summarized, if desired. Calculating subwatershed metrics is discussed later in this chapter.

2. Land Use Analysis

An analysis of current and future land use is an extremely important part of any watershed plan. Current land use can be easily summarized for the watershed with a map and a table with the acreage of land in each land use category. Future land use is more difficult to project; however, future land use projections can be used to determine if land use changes are compatible with watershed or subwatershed protection goals or if they will threaten specific sensitive water bodies. This analysis also enables the core team to estimate future pollutant loads based on land use changes and assess alternative zoning options to ensure that pollutant reduction goals are met. Methods for estimating pollutant loads and reductions are provided later in this chapter.

The ultimate future land use projection is a zoning map. However, many zoning categories, such as agriculture, simply act as 'holding zones' for future development and are ultimately re-zoned and developed, especially in watersheds with high development pressure. In other watersheds, economic or social factors may make full buildout of the watershed infeasible or impractical. Either way, zoning maps are not always an accurate depiction of future land use because they fail to take into account areas reserved for natural resource protection, large transportation projects and/or special exception uses.

Local governments should evaluate resources such as Priority Funding Areas (PFAs), water and sewerage plans, transportation plans, comprehensive plans, protected or unbuildable lands, real estate trends, population forecasts, and other data to project future land use in the watershed for specified time periods. A potential data resource for this analysis is Weber (ND), which predicts risk of loss to development of green infrastructure lands based on many of the above factors. This future land use projection should be done as part of a watershed plan and re-visited regularly on a schedule that coincides with other required updates, such as comprehensive plans (6 years), or water and sewerage plans (3 years). Watershed plans may be able to provide a framework for updating these other plans, although, ideally, these plans would be integrated as one plan.

One resource that is very useful in projecting future land use, and is being conducted by local governments anyway, is a Development Capacity Analysis. In 2004, the state of Maryland and its local jurisdictions signed a Memorandum of Understanding that stipulated local governments voluntarily measure their future development capacity. Under this agreement, local governments are now committed to conduct these analyses when updating their comprehensive plans, with technical assistance from the Maryland Department of Planning. The Development Capacity Analysis is an estimate of the total amount of development that may be built in an area under a certain set of assumptions, including applicable land use laws, zoning, environmental constraints, and more. Maryland's program focuses only on residential capacity. Steps for conducting this analysis are provided below.

1. *Identify vacant land.* The most efficient method is to identify parcels classified as vacant in tax assessor's records. Due to database errors, these should also be spot-checked using aerial photographs, which works best in rural areas.
2. *Identify environmental constraints.* Subtract out land that is "unbuildable" based on local regulations. This may include steep slopes, floodplains, wetlands, buffers, or areas subject to natural hazards.
3. *Identify potential for redevelopment and infill.* This can be based on an analysis of land values and assessed improvements, or past rates of infill. These are probably not the most accurate methods but are all that exists right now.
4. *Identify serviced land.* This is the supply of land with access to services such as water, sewer, schools, and emergency services. This is difficult to quantify and varies with the type of service. Montgomery County has a good example of an extensive planning system that tracks service capacities and delays development if capacity gets too low. Draft guidance for communities to determine the capacity of their wastewater and water supply systems is available from MDE at: www.mde.state.md.us/Water/index.asp.
5. *Identify development capacity of the net supply of serviced land.* Simple or complex assumptions and equations can be used to estimate the land needed for infrastructure. Common assumptions include setting aside 25% of all buildable land for streets, and 15 acres of parkland per 1,000 estimated population growth. After subtracting out land needed for infrastructure, do a buildout analysis based on the maximum allowable dwelling units for each zoning category.

Results of the Development Capacity Analysis should be used to estimate future land use to use in later analyses, such as impervious cover projections, and pollutant load estimates. They should also be used to determine if estimated growth projections for the watershed are realistic under current conditions. This analysis is key in determining if changes should be made to local land use plans and development regulations to align with the watershed plan. Additional guidance on conducting a Development Capacity Analysis is provided in MDP's *Models and Guidelines, Estimating Residential Development Capacity: A Guidebook for Analysis and Implementation in Maryland* (User's Guide Tool 10).

3. Impervious Cover Analysis

An important step in crafting a watershed plan is to evaluate current land use, and to project how future changes in land use, specifically the addition of impervious cover, will affect watershed conditions. An impervious cover analysis includes two components: current impervious cover and future impervious cover. Both are analyzed at the subwatershed scale. The importance of impervious cover is described below.

A wide array of research has documented the strong relationship between impervious cover and stream quality (CWP, 2003b). CWP (2003b) has integrated these research findings into a watershed planning model, known as the Impervious Cover Model (ICM). The ICM predicts that most stream quality indicators decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25% impervious cover. The ICM identifies four classifications of streams: sensitive, impacted, non-supporting, and urban drainage (Figure 4.2). The ICM predicts the average behavior of a group of indicators over a range of impervious cover; therefore, extreme care should be exercised if using to predict the fate of individual species.

From a watershed planning perspective, imperviousness is one of the few variables that can be explicitly quantified, managed, and controlled at each stage of land development. The ICM should be used to initially classify subwatersheds into one of these four categories based on current and future impervious cover estimates, to help managers set expectations about what can be achieved in each subwatershed, and guide decisions in the watershed plan. The ICM should only be used for an initial classification, as additional information such as field verification should be taken into account.

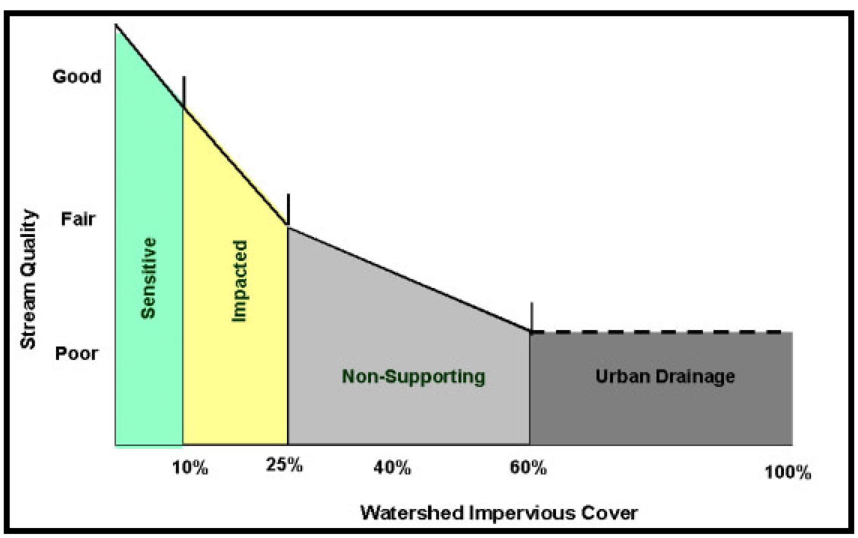


Figure 4.2: Representation of the Impervious Cover Model (Source: CWP, 2003b)

Current impervious cover

There are several methods to measure current impervious cover (IC) at the subwatershed scale. Deciding which method is best for a subwatershed depends largely on the resources and data available. The most commonly used methods are direct measurement and the land use method. The direct measurement method calculates the area of all rooftops, roads, parking lots, and other impervious surfaces in a subwatershed directly from the watershed-based GIS. This is the most accurate method of calculating current IC, but is also the most labor-intensive and expensive. Additional information on the direct measurement method and other methods to estimate IC is provided in Cappiella and Brown (2001). The land use method is summarized below.

The land use method is a simple four-step procedure that produces reliable estimates of current IC for subwatersheds. More detail on these steps and the input data required for the land use method is provided below. Table 4.1 can be used as a worksheet for calculating current IC.

Step 1: Large areas of known "unbuildable land" are subtracted from the subwatershed area. These include large tracts of land in floodplains, wetlands, stream valleys, easements, and major conservation areas.

Step 2: The current land use distribution for the remaining buildable portions of the subwatershed are multiplied by impervious cover coefficients (ICC) to yield a provisional estimate of current IC.

Step 3: The contribution of impervious cover from existing freeways and limited access arterial roads is calculated based on their length and width, and incorporated into the IC estimate.

Step 4: The percentage of imperviousness is calculated for the subwatershed.

Estimates of current IC for subwatersheds should be based on the Maryland Department of Planning (MDP) land use layer (User's Guide Tool 2), unless more detailed local land use data is available. Because highways are not included in the MDP layer, their area must be calculated separately based on local roads data. Table 4.1 provides ICCs that correspond to the Maryland Department of Planning (MDP) land use categories. ICCs represent the fraction of a particular land use category that consists of IC such as roads, parking lots and rooftops. These coefficients were derived from samples of urban and suburban land in four Chesapeake Bay region communities (Cappiella and Brown, 2001). Highly urban or rural communities may wish to use coefficients that are more appropriate for the type of development in their communities.

In the land use method, unbuildable lands must be subtracted from the total subwatershed area to yield a more accurate estimate of current IC (Cappiella and Brown, 2001). The amount and type of unbuildable land will depend on both the natural topography and local land use regulations, such as open space requirements, or stream buffer regulations. Information regarding unbuildable land can usually be acquired from the local planning department.

Table 4.1: Calculating Current IC Using Impervious Cover Coefficients for MDP Land Use Categories			
*MDP Land Use Category**	*Buildable Area (Acres)*	*Impervious Cover Coefficient***	*Impervious Cover (Acres)*
Low Density Residential (11)		0.14	
Medium Density Residential (12)		0.28	
High Density Residential (13)		0.41	
Commercial (14)		0.72	
Industrial (15)		0.53	
Institutional (16)		0.34	
Extractive (17)		0.02	
Open Urban Land (18)		0.09	
Rural Residential (191, 192)		0.04	
Cropland (21)		0.02	
Pasture (22)		0.02	
Orchards (23)		0.02	
Feeding Op (24)		0.02	
Ag Building (242)		0.02	
Crops (25)		0.02	
Forest/Brush (41, 42, 43, 44)		0.0	
Water (50)		0.02	
Wetlands (60)		0.0	
Beaches (71)		0.0	
Bare Rock (72)		0.09	
Bare Ground (73)		0.09	
Highway Corridors		0.95	
Total IC (Acres)			
Subwatershed Area (Acres)			
Current IC (%)			

** Includes all MDP land use categories. Highway corridors must be derived from local sources. MDP land use code(s) are provided in ( ) after each category.*
***All impervious cover coefficients except highway corridors were adapted from Cappiella and Brown (2001).*

Impervious cover data for Maryland is available from MD DNR (see User's Guide Tool 2), and was produced through the Mid-Atlantic Regional Earth Science Applications Center (RESAC). The RESAC data, at 30-meter resolution, is not of sufficient detail to provide an accurate estimate of impervious cover for a small watershed. However, this data can serve as a first cut or a check of the more detailed impervious cover analysis.

<u>Future impervious cover</u>

Future impervious cover (FIC) should be estimated to determine the potential changes in stream quality with future growth and buildout of the watershed. FIC should be estimated for each subwatershed, and used to classify subwatersheds based on the ICM to determine whether designated stream uses can be maintained in future land use scenarios.

FIC projections are based on a combination of current IC estimates and the most current version of local zoning data. To estimate FIC, all buildable land in the subwatershed (identified when calculating current IC) is divided into two categories: developed land and undeveloped land. Developed land can be identified based on local parcel data, but a simpler method is to assume that the following MDP land use categories are developed: commercial, industrial, institutional, medium density residential and high density residential. Highway corridors should also be considered developed land. All remaining land use categories are considered to be undeveloped for the purposes of this analysis. Low density residential falls into the undeveloped land category because it has some potential for future development if land is subdivided. Figure 4.3 illustrates the division of developed and undeveloped land in a watershed, and the different land use data sources used to estimate FIC for each.

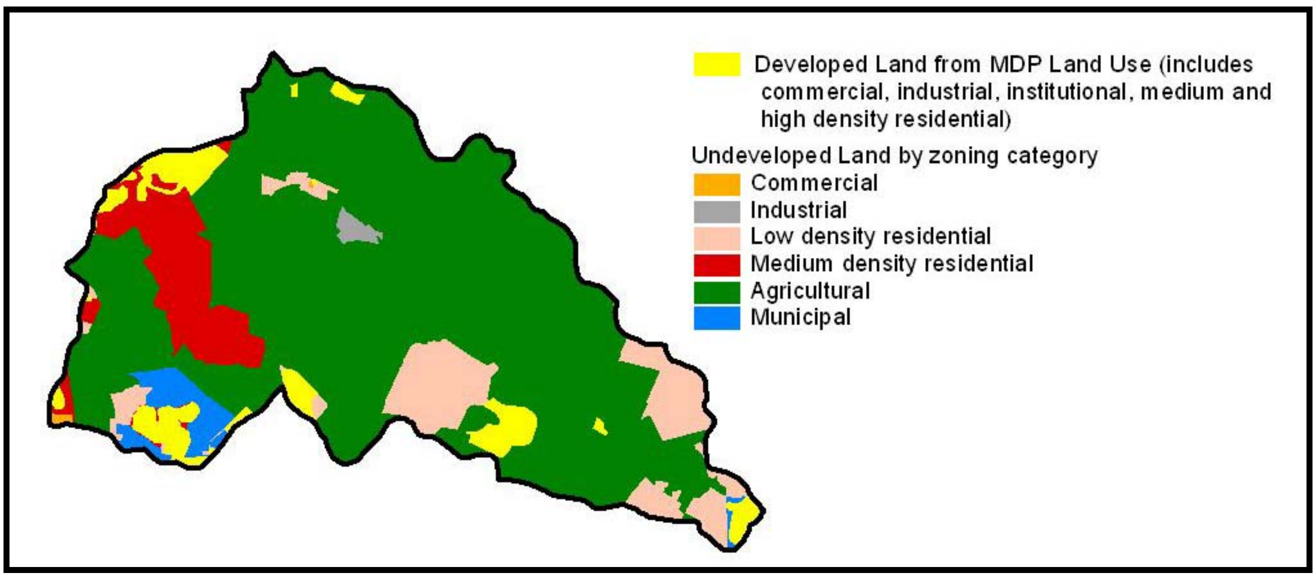


Figure 4.3: Developed and undeveloped land in a subwatershed of the Lower Monocacy watershed

To estimate FIC for developed land in the subwatershed, the buildable area of each land use category is multiplied by the corresponding ICC provided in Table 4.1. This is essentially the same as estimating current IC, but is only done for the developed portion of the subwatershed. To estimate FIC for undeveloped land in the subwatershed, zoning maps are used to calculate the area of each zoning category that falls within the undeveloped area. The buildable area of each zoning category is then multiplied by a corresponding ICC. ICCs for 12 zoning categories from Cappiella and Brown (2001) are provided in Table 4.2, and should be adapted to fit local zoning categories. Total FIC estimates for developed and undeveloped land are added together, and divided by the subwatershed area to determine the percent imperviousness. Table 4.2 provides a worksheet for estimating FIC for undeveloped land.

Table 4.2: Estimating Future Impervious Cover for Undeveloped Land			
Zoning Category	*Buildable Area (Acres)*	*Impervious Cover Coefficient**	*Impervious Cover (Acres)*
Agriculture		0.02	
Open Urban		0.09	
2 Acre Residential		0.11	
1 Acre Residential		0.14	
½ Acre Residential		0.21	
$^{1}/_{4}$ Acre Residential		0.28	
$^{1}/_{8}$ Acre Residential		0.33	
Townhomes		0.41	
Multifamily		0.44	
Institutional		0.34	
Light Industrial		0.53	
Commercial		0.72	
Highway Corridor		0.95	
Total IC (Acres)			
Subwatershed Area (Acres)			
Current IC (%)			
**All impervious cover coefficients except highway corridors are from Cappiella and Brown (2001).*			

The method described above gives a more realistic estimate of FIC than using zoning alone, because it accounts for development patterns that are already in place. However, this technique has potential to over-estimate impervious cover because it is based on the assumption that full buildout of zoning categories will occur, which may not be feasible due to economic conditions or lack of infrastructure. The method also cannot account for re-zoning that may occur in the future. Therefore, changes to local zoning may require a revision of FIC estimates. An FIC analysis can also be done for interim time periods based on the results of a Development Capacity Analysis.

<u>Management classification</u>
Once the current and future percent impervious cover is determined, subwatersheds should be classified into one of the following four management categories based on the percentage of impervious cover (CWP, 2003b):

- Sensitive <10% impervious cover
- Impacted 10-25% impervious cover
- Non-Supporting* 26-60% impervious cover
- Urban Drainage >60% impervious cover

*The term "non-supporting" as used in this management classification is generally defined as streams that are so degraded that they may no longer support certain types of aquatic life. This term bears no relation to the similar regulatory terminology that pertains to whether a water body is meeting its designated use.

Sensitive subwatersheds have an impervious cover of 0 to 10%. Consequently, streams in these subwatersheds are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects (CWP, 1998). The main goal for these types of subwatersheds is to maintain predevelopment stream biodiversity and channel stability.

Impacted subwatersheds have an impervious cover ranging from 11 to 25% and show clear signs of degradation due to watershed urbanization. Greater storm flows have begun to alter the stream geometry. Both erosion and channel widening are evident. Stream banks become unstable, and physical habitat in the stream declines noticeable. Stream biodiversity declines to fair levels, with the most sensitive fish and aquatic insects disappearing from the stream (CWP, 1998). The main goals for these types of subwatersheds are to limit the degradation of stream habitat quality and maintain a good biological community.

Non-supporting subwatersheds have an impervious cover ranging from 26 to 60%. Streams in this category essentially become a conduit for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, down-cutting and streambank erosion. The water and biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish. The goals for these subwatersheds are to minimize downstream pollutants, alleviate downstream flooding, and improve aesthetic appeal.

Subwatersheds with more than 60% impervious cover are classified as urban drainage. In these highly developed subwatersheds, streams are often piped underground, or consist of concrete channels that do not support any aquatic life and serve only to convey flows. The goals for these subwatersheds are usually similar to goals for non-supporting subwatersheds.

Subwatershed classification should be done for both current and future impervious cover estimates. Field verification may be necessary to verify current impervious cover classification. Subwatersheds whose management classifications change from one category to another with future buildout are of primary interest in watershed planning efforts because they are likely to experience significant degradation in stream quality unless changes are made to zoning, comprehensive plans and development regulations. Figure 4.4 illustrates current and future impervious cover classifications for the Appoquinimink Watershed in Delaware. These graphics powerfully illustrate the potential changes in stream quality based on future growth. In this example, subwatersheds near the ICM thresholds were classified using both of the stream quality categories in question (e.g., Sensitive/Impacted). More detailed methods to classify and rank subwatersheds are discussed later in this chapter.

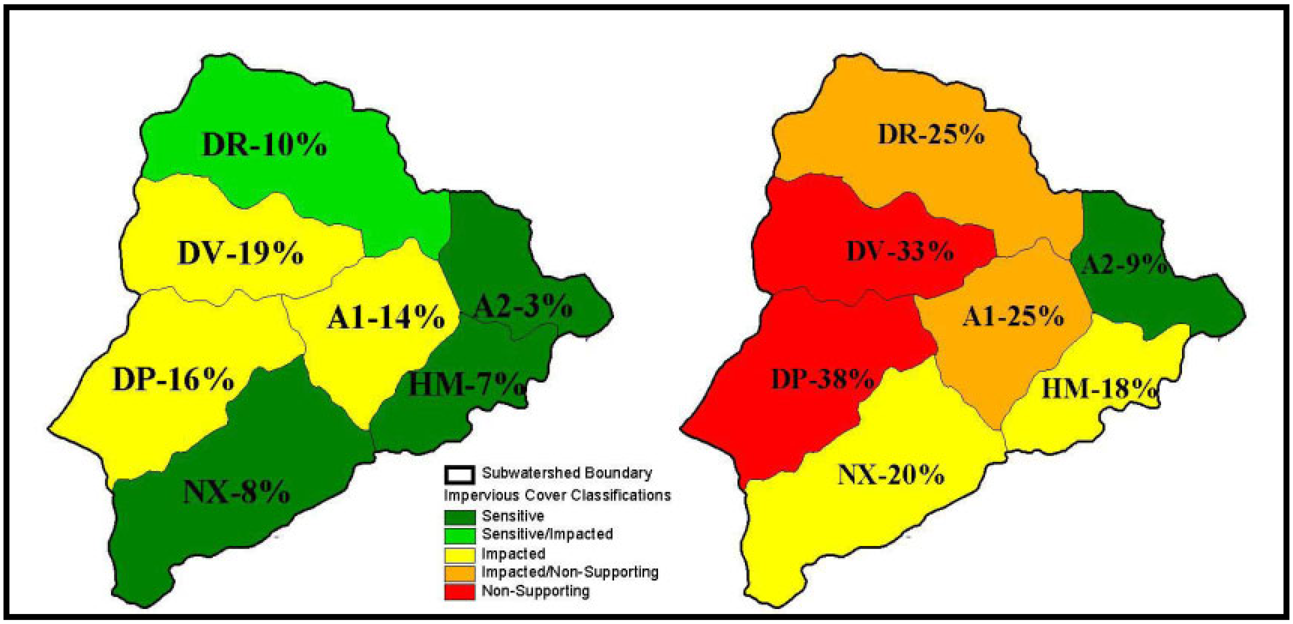


Figure 4.4: Subwatershed classification based on current (left) and future (right) impervious cover estimates for the Appoquinimink watershed in Delaware.

4. Summary of Monitoring Data

This task involves a review of existing monitoring data available for the watershed. Monitoring data falls into four general categories: hydrologic, physical, water quality, and biological. Hydrologic monitoring deals with stream flow or groundwater flow, while physical monitoring evaluates in-stream and near-stream habitat based on physical characteristics. Water quality monitoring involves analyzing water samples for various chemical parameters, and biological monitoring typically consists of surveys of plant and animal populations. Biological monitoring need not be limited to in-stream data, and often includes upland surveys of plant or animal communities.

While monitoring data is available from numerous state and local sources, planners should acquire the data described in Table 4.3 at a minimum. Water quality data is particularly important to summarize in order to provide a baseline, since reducing pollutants of concern is a major goal of the watershed plan. Methods for estimating current and projected pollutant loads for the watershed are provided later in this chapter. Website links for acquiring the monitoring data presented in Table 4.3 are provided in User's Guide Tool 3.

Table 4.3: Important Monitoring Data in Maryland		
Type of Data	*Data*	*Description*
Hydrologic, Physical, Water Quality	USGS National Water Information System	Surface water data, groundwater data, and water quality data for more than 1.5 million sites nationwide.
Biological, Water Quality, Physical	Maryland DNR Maryland Biological Stream Survey	Random sampling of wadeable streams and rivers in MD.
Biological, Water Quality, Physical	STORET	EPA Repository for water quality, biological, and physical data. MDE, USGS, and MD DNR data are reported here.
Biological	North American Breeding Bird Survey	Large-scale roadside survey of North American breeding birds.
	North American Amphibian Monitoring Program	Data collected by USGS and other partners to monitor populations of vocal amphibians.
	Maryland DNR Tidal Fishery Survey	Survey documents annual year-class success for young-of-the-year (YOY) striped bass and relative abundance of many other fish species in Chesapeake Bay.
Water Quality	Maryland DNR long-term water quality	Ambient fixed station water quality monitoring at 54 locations on major non-tidal rivers in MD that has been conducted since 1976. Results are incorporated into the 305(b) reports.
	Maryland DNR synoptic surveys	Comprehensive water quality surveys designed to provide a snapshot of nutrient levels and biological community quality in a specific watershed. So far, 16 surveys have been completed in MD.
	MDE MD 303(d) list	Online searchable database of the State's 303(d) list
Physical	Maryland DNR Stream Corridor Assessment (SCA) Survey	Streamwalk designed to identify environmental problems such as eroding stream banks, and inadequate stream buffers, and to collect habitat data. The SCA has been conducted on over 3,000 miles of MD streams.

Monitoring data should be summarized to provide an overview of stream conditions in the watershed and subwatersheds, and can even be used to update the current subwatershed classifications of stream condition based on the ICM. Results should be summarized using tables, and the bulk of raw data can be provided in an appendix to the watershed plan, if desired. Figures such as charts and maps are helpful for displaying this data. A Real World Example of a summary of monitoring data is provided below for the Liberty Reservoir Watershed in Carroll County.

Real World Example: Liberty Reservoir Watershed Characterization

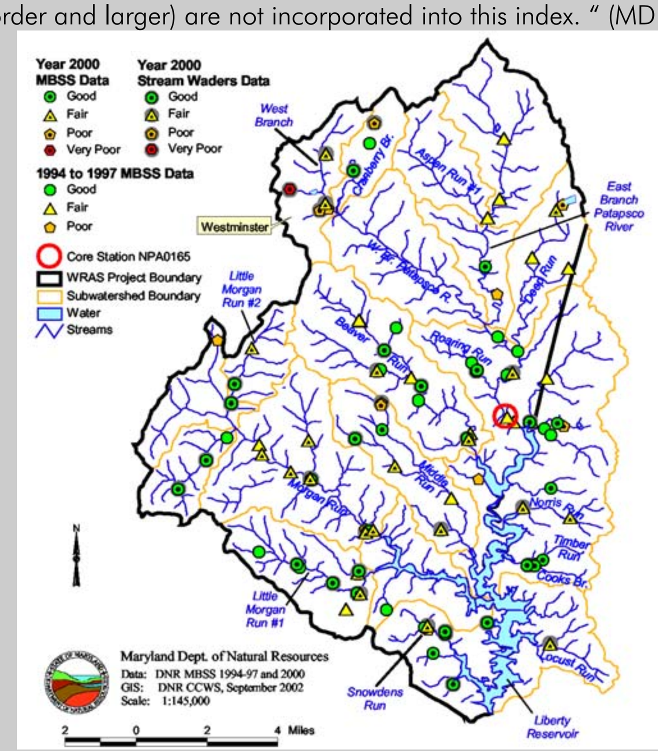
Carroll County, Maryland received federal funding to prepare a Watershed Restoration Action Strategy (WRAS) for its portion of the Liberty Reservoir watershed, which covers 87,040 acres. This drinking water supply watershed was a high state priority for protection and restoration. The remaining 17,762 acres of the watershed are in Baltimore County, Maryland.

MD DNR provided technical assistance and worked with the county to prepare a Watershed Characterization, a collection of available water quality related information and issues used to develop action strategies to improve water quality. Liberty Reservoir's characterization meets three objectives:

- Summarizes relevant information related to the watershed
- Describes the condition of the watershed from different perspectives (e.g., water quality, water supply, living resources, land use)
- Identifies sources for more information or analysis

The summary of watershed conditions includes a review of existing monitoring data related to water quality, benthic macroinvertebrates, fish, physical habitat, and restoration targeting such as Stream Corridor Assessments. Data from a 2000 Source Water Assessment for the surface water portion of the water supply system for the City of Westminster was also included. Below is an example of the benthic macroinvertebrate summary.

"Streams in the Liberty Reservoir watershed are generally in fair/good condition on average based on assessment of benthic macroinvertebrate communities (stream bugs). For this index, Liberty Reservoir streams scored an average of 6.89 on a scale of 1 (worst) to 10 (best). For this index, an average score for an 8-digit watershed less than 6.0 means that restoration is needed and a score of 8.0 or greater means that protection is recommended. To generate this index, each stream site that is assessed is compared to reference conditions that were established for comparable streams that are minimally impacted. Nontidal rivers (streams seventh order and larger) are not incorporated into this index. " (MD DNR, 2002a)



The Liberty Reservoir Watershed Characterization is available at:
www.dnr.state.md.us/watersheds/surf/proj/wras.html

5. Sensitive Areas Analysis

Sensitive areas include the following types of land that have special significance, provide watershed benefits, or are particularly vulnerable to land development:

- Streams and their buffers
- 100-year floodplains
- Habitats of threatened and endangered species
- Steep slopes
- Contiguous forest
- Hydric and erodible soils
- Public drinking water supplies
- Historic and archaeological sites
- Critical Areas
- Agricultural land
- Anadromous fish spawning areas
- Bogs
- Caves
- Colonial waterbird nesting sites
- Eroding shorelines
- Groundwater
- Mineral resources
- Nontidal wetlands
- Oysters, clams, crabs, and benthic habitat
- Scenic vistas and geologic features
- Springs and seeps
- Submerged aquatic vegetation
- Tidal floodplains
- Tidal wetlands
- Trout stream watersheds
- Vernal pools
- Waterfowl areas
- Wellhead protection areas
- Wildlife corridors

The purpose of a sensitive areas analysis is to inventory these resources in order to identify potential protection and restoration sites that can be further evaluated through field assessments, and ultimately recommended as part of the watershed plan. The products of a sensitive areas analysis include: an inventory of sensitive areas, an evaluation of future impacts to sensitive areas, and maps of potential protection and restoration sites.

Two key resources for a sensitive areas analysis are the Maryland DNR's Strategic Forest Lands Assessment (SFLA) and Green Infrastructure Assessment (GIA). The GIA evaluated Maryland's sensitive natural resources, focusing forests and wetlands to identify ecologically important lands, such as large wetland complexes, large contiguous forest patches, interior forest habitat, and unique grassland habitats. The SFLA evaluated the condition of all of Maryland's forests in terms of the long-term ecological and economic value and vulnerability to loss. Local governments can use the evaluations made through the SFLA and GIA as a starting point to identify important and vulnerable sensitive areas in their watersheds. The data is available for download on the MD DNR website (see User's Guide Tool 2). Additional information is available on the GIA web site www.dnr.state.md.us/greenways/gi/gi.html and the SFLA website www.dnr.state.md.us/forests/planning/sfla/index.htm.

Sensitive areas inventory

A sensitive areas inventory provides a desktop review of all sensitive resources in a watershed, and produces a map and associated data for each type of sensitive area. Maryland DNR provides free downloadable GIS data that can be used as part of a sensitive areas inventory (Table 4.4). Three important layers that are not provided by MD DNR are streams, stream buffers, and steep slopes. Sources of this data are discussed in MDP (1993) and additional sources of GIS data are provided in User's Guide Tool 2. MD DNR data provides an initial start to a sensitive area inventory, and local data of higher resolution should be substituted where it exists for greater accuracy.

Table 4.4: Maryland DNR GIS Data for Use in Sensitive Areas Inventory		
GIS Data Type	*Data Layer Name*	*Description*
Floodplain	Floodplain	100-year and 500-year floodplains derived from FEMA Q3 Flood data.
Shorelines	Recent Shorelines	Shorelines for the coastal regions of Maryland, including the Chesapeake Bay, its tributaries, the Coastal Bays and the Atlantic Coast.
Contiguous Forest	Forest Interior Dwelling Species – potential habitat	Potential habitat for Forest Interior Dwelling Species (FIDS) in the State of Maryland. These data are the results of a model depicting where FIDS habitat might occur based on certain criteria and have NOT been field-tested or field verified for actual FIDS presence.
Green Infrastructure	Green Infrastructure	Maryland's Green Infrastructure is a network of undeveloped lands that provide the bulk of the state's natural support system. An assessment of Green Infrastructure identified three types of important resource lands - "hubs," "corridors," and "gaps." Hubs are typically large contiguous areas, while corridors are linear features connecting hubs together to help animals and plant propagules move between hubs. Gaps are potential restoration sites (e.g., turf, agriculture or barren land) that have the potential to connect to hubs and corridors.
Protected Land	Protected Lands	Includes parks, conservation lands, agricultural preservation lands, easements, and state and federal protected land.
	Greenways	Greenways are natural corridors set aside by county, state or federal authorities to connect larger areas of open space and to provide for the conservation of natural resources, protection of natural resources, protection of habitat, movement of plants and animals, and to offer opportunities for linear recreation, alternative transportation, and nature study.
	Critical Areas	All land and water areas within 1000 feet of the tidal waters' edge or from the landward edge of adjacent tidal wetlands and the lands under them.
Rare, Threatened, and Endangered Species	Sensitive Species Project Review Areas	Contains buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Natural Heritage Areas	Natural Heritage Areas are areas designated in the state's Threatened and Endangered Species regulations because they: contain one or more threatened or endangered species or wildlife species in need of conservation; are a unique blend of geologic, hydrologic, climatologic or biological features; and are considered to be among the best statewide examples of its kind.
Wetlands	Wetlands of Special State Concern	Wetlands with RTE species or other unique habitat; requires a 100-foot buffer.
	MD DNR Wetlands Inventory	Statewide wetland inventory that includes records of wetlands location and classification as defined by the U.S. Fish & Wildlife Service's National Wetlands Inventory program.
	MDE Priority Wetlands	An inventory of priority wetland restoration and preservation sites that will be available from MDE by early 2006.
	National Wetlands Inventory	Although outdated, this inventory occasionally identifies wetlands that do not appear on the MD DNR Wetlands Inventory.

An inventory of all wetlands in the watershed should be conducted as part of a sensitive areas inventory. An inventory of wetlands in the watershed provides a starting point for a watershed approach to wetland permitting that can impact future permitting decisions. The MD DNR Wetlands Inventory should be used, as it is the best available statewide wetland layer. However, this data does have its limitations: it may underestimate certain types of forested wetlands, and it does not capture wetlands smaller than 0.5 acres. More detailed local wetlands data may be supplemented, if available, as part of the inventory. Alternatively, high-resolution aerial photos and local soils surveys can be used to update the MD DNR wetlands and/or NWI layer. Tiner (2003) describes a method for enhancing wetlands data using aerial photos.

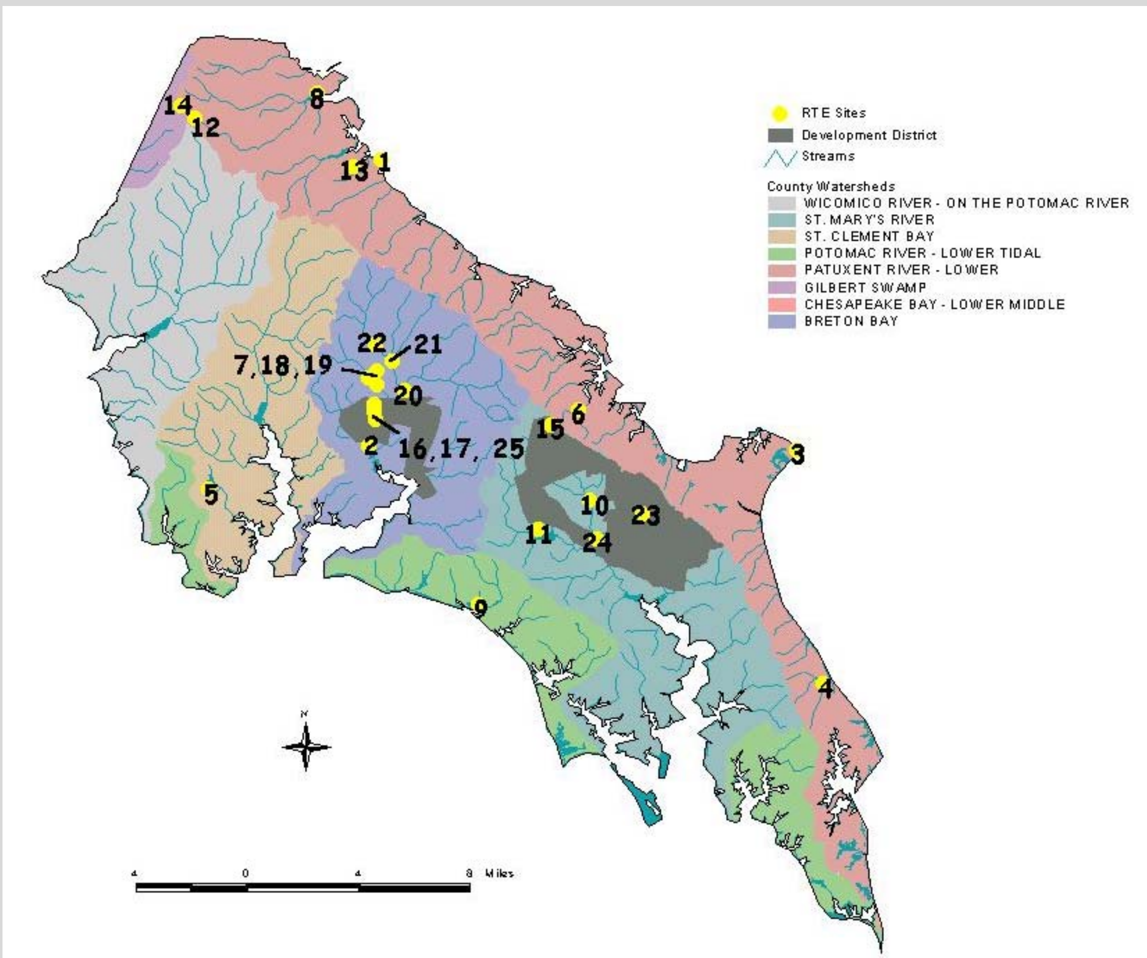
A sensitive areas inventory should also include a detailed assessment of forest cover in the watershed. It is important to know the percent forest cover in a watershed in order to set future goals for maintaining or increasing this cover, and to use in estimating future pollutant loads from different types of land. There is currently no statewide forest cover layer in Maryland that is of sufficient resolution to quantify forest cover at the watershed scale. A subpixel analysis of forest cover created through RESAC is probably the best available layer (30-meter resolution), and can be downloaded from MD DNR. Statewide *land use* data is also inadequate because it does not count forest that exists within other non-forest land uses such as residential land, and therefore underestimates forest cover. Local governments should use detailed local forest cover data, where available. If no such data exists, another option is to develop a detailed forest cover or forest canopy layer using high-resolution aerial photos or satellite imagery. Methods for creating such a layer are provided by Irani and Galvin (2002).

The results of a sensitive areas inventory include various maps and statistics that summarize the number and acreage of the different sensitive resources by subwatershed and are used to identify potential protection and restoration sites later on. The Real World Example drawn from St. Mary's County, demonstrates how RTE species were identified during a sensitive areas inventory.

Real World Example: St. Mary's County Natural Resource Conservation Inventory

St. Mary's County borders both the Potomac River and the Chesapeake Bay, covering 360 square miles in southern Maryland. As part of a U.S. Army Corps of Engineers investigation, the Center for Watershed Protection completed a Natural Resource Conservation Summary for the County in 2002. The purpose of the Conservation Summary was to provide planners and plan reviewers with a tool to evaluate proposed development and land use changes and avoid impacts to natural resources. The Conservation Summary identified and prioritized resources most in need of protection, and is a good example of a resource inventory used to identify conservation areas.

The four resources inventoried for the Conservation Summary were RTE species and their habitats; potential wetland areas; contiguous forest; and species habitat not listed as RTE but potentially in need of conservation. The report includes a description of RTE species and important habitat located in St. Mary's County as well as a map (below) and a description of each area where these resources are located. As a result of the resource inventory, two specific watershed areas were identified as important for their high species and habitat diversity.



Center for Watershed Protection. 2002b. *Natural Resources Conservation Summary for St. Mary's County, Maryland.* Ellicott City, MD.

Future impacts to sensitive areas

After completing an inventory of sensitive areas in the watershed, local governments should also evaluate the potential impacts to these areas, as a result of future growth and land use changes. Growth projections for Maryland are regularly completed by the MDP. Its latest projections of land use through 2020 are being incorporated into the Chesapeake Bay Program's Phase 4.3 Watershed Model. Using these statewide projections can provide a simple way to estimate future land use and land cover, and to quantify pollutant loads and the potential loss of sensitive areas. However, these projections may not be appropriate for use at the watershed scale. Future impacts to sensitive areas can be estimated using local land use data and assumptions. A proposed method for projecting future forest loss is provided below.

Projecting future forest cover is useful when the watershed plan incorporates forest cover goals such as maintaining or increasing forest cover by a specific percentage. Projecting future forest cover identifies potential forest loss with future buildout, which serves as a reality check of these forest cover goals, and also helps identify specific management methods needed to achieve these goals. Methods to reduce forest loss include adoption or modification of stricter regulations to protect existing forest during development, identifying priority reforestation sites, and acquiring key parcels of forest land for conservation.

Future forest cover can be estimated in a fashion similar to FIC, using forest cover coefficients instead of impervious cover coefficients (Cappiella *et al.*, 2005). Forest cover coefficients are the proportion of land in each zoning category, on average, that is covered by forest after development occurs. Forest cover coefficients for various land use categories are presented in Table 4.5 and are based on the forest cover thresholds required under the Maryland Forest Conservation Act (Greenfeld *et al.*, 1991). When estimating future forest cover, select numbers from the appropriate column in Table 4.5, based on whether undeveloped land in the subwatershed is primarily forest or agricultural.

Table 4.5: Forest Cover Coefficients for Maryland*

Land Use Category	*Forest Cover Coefficients for Pre-Existing Forest Land*	*Forest Cover Coefficients for Pre-Existing Agricultural Land*
Agricultural and Resource Areas - less than or equal to 1 dwelling unit/5 acres	0.50	0.20
Medium Density Residential - 1 dwelling unit/5 acres to 1 dwelling unit/acre	0.25	0.20
Institutional - schools, colleges & universities, transportation facilities, utility-sewer projects, government offices, golf courses, parks, cemeteries	0.20	0.15
High Density Residential - greater than 1 dwelling unit/acre	0.20	0.15
Mixed Use and Planned Unit Development	0.15	0.15
Commercial and Industrial	0.15	0.15

*Adapted from Greenfeld, et al. (1991)

Forest cover coefficients shown in Table 4.5 should be adjusted based on additional local forest conservation regulations and other regulations that may indirectly protect forests such as stream buffer or steep slope ordinances. More accurate numbers can be derived by using GIS to directly measure forest cover across various types of land use categories. Cappiella and Brown (2001) document a method for this analysis that can be adapted to derive forest cover coefficients. The result of this method is an estimate of future forest cover in the watershed that can be used to set future forest cover goals and define specific objectives that reduce forest loss. User's Guide Tool 11 provides additional detail on methods to evaluate and increase forest cover in a watershed.

An existing data resource that may be used to assess future forest loss is Weber (ND). This study evaluated the risk of forest loss in Maryland's Green Infrastructure, based on 1997-2000 development patterns. The data may be able to be applied to all forest land for the purposes of evaluating future forest loss in a watershed. The document is available at http://dnrweb.dnr.state.md.us/download/bays/development_risk_logit.pdf and the data is available for download from MD DNR as part of the Green Infrastructure layer.

Protection and restoration sites

The sensitive area inventory should be used to identify potential protection and restoration sites. MD DNR data provides a good starting point, but it is also necessary to review additional GIS data, and take a comprehensive look at all the sensitive areas in the watershed to identify additional sites. Table 4.6 provides guidance on identifying potential protection and restoration sites.

Potential protection sites are further evaluated through different sensitive areas assessments (Chapter 5), depending on whether the site is a forest, a wetland, stream buffer, steep slope, or RTE species habitat. Potential restoration sites are further evaluated through the Urban Reforestation Site Assessment (URSA) and wetland restoration assessments, for reforestation sites and wetland restoration sites, respectively (User's Guide Tool 19). The products of this method are maps of potential protection and restoration sites. Figure 4.5 is an example of a map created for potential protection sites. Chapter 5 provides guidance on using these maps and other data to further evaluate potential protection and restoration sites thorough field investigations.

Table 4.6: Identifying Potential Protection and Restoration Sites within a Sensitive Areas Analysis	
Potential Protection Sites	*Potential Restoration Sites*
• Green Infrastructure hubs and corridors • Wetlands of Special State Concern • Forest Interior Dwelling Species Potential Habitat • Sensitive Species Project Review Areas • Natural Heritage Areas • Officially designated reference sites • Other forests, wetlands, or agricultural lands that: – are large, contiguous tracts – are currently unprotected – have key position in the watershed (e.g., headwaters, adjacent to drinking water reservoir, trout stream, or existing protected lands) – contain sensitive areas such as 100-year floodplains, steep slopes, erodible soils, or stream buffers. – have special significance such as locally rare or difficult-to-replace wetland type, or prime farmland	• Green Infrastructure gaps • Former or existing degraded wetlands with land use and hydrology that are suitable for restoration (e.g., farm land, sand or gravel pits, high water table) • Public turf (e.g., schools, parks, rights-of-way) • Vacant land • Unbuffered streams • Other open lands that: – have key position in watershed (e.g., headwaters, adjacent to drinking water reservoir, trout stream, or existing protected lands) – contain sensitive areas such as 100-year floodplains, steep slopes, erodible soils, or stream buffers. – provide a connection between existing forest, wetlands, or other potential protection sites

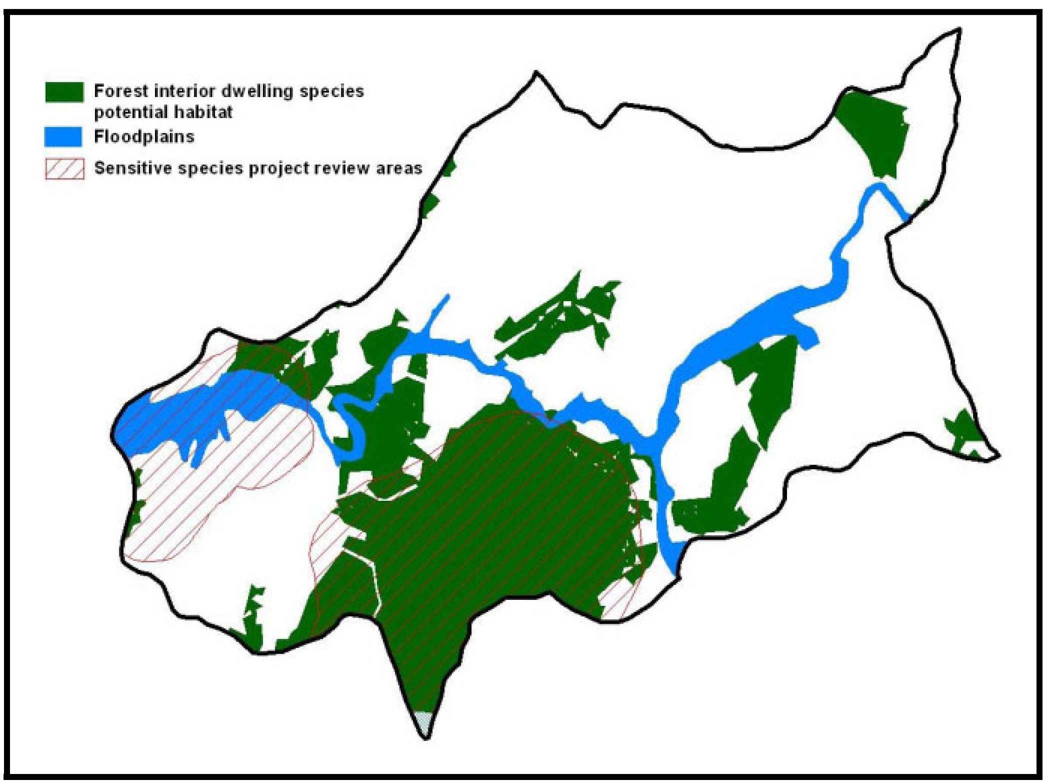


Figure 4.5: Potential protection sites identified for further evaluation in the field

C. Classify and Rank Subwatersheds

The purpose of classifying and ranking subwatersheds is to provide a basis for identifying priority subwatersheds on which planning efforts should be focused. Classifying and ranking subwatersheds is particularly useful in large watersheds where planning and implementation funding is limited. The classification and ranking process generally identifies the subwatersheds that are the most vulnerable to future development and/or have the greatest restoration potential.

While the ICM provides a first cut at classifying subwatersheds according to their current and expected stream quality, it is sometimes necessary to create subwatershed classification categories beyond those presented by the ICM. For example, in rural watersheds where most of the subwatersheds have less than 10% impervious cover, the ICM may be inadequate to distinguish differences between truly sensitive subwatersheds, and subwatersheds that are impacted by agricultural activities. Additional classification of these subwatersheds beyond the ICM can be done through a simple spreadsheet analysis of selected subwatershed metrics. Subwatershed metrics are usually numeric values that describe subwatersheds based on a single characteristic. A simple example is to use the percent forest and the percent agricultural land in each subwatershed to further classify "sensitive" subwatersheds into "sensitive forested" and "sensitive agricultural" (Figure 4.6).

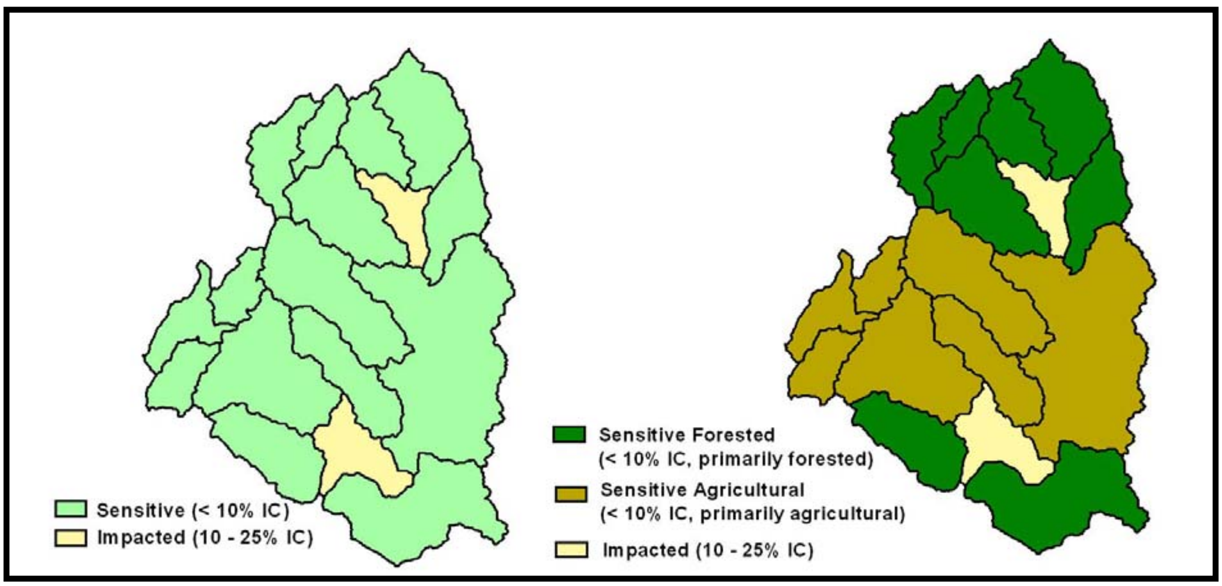


Figure 4.6: Subwatersheds classified using the ICM (left) compared to an expanded classification based on percent forest and agriculture (right).

The basic steps associated with classifying and ranking subwatersheds are presented below.

1. Review the initial ICM subwatershed classifications.
2. Expand the classification to account for factors other than impervious cover.
3. Select subwatershed metrics for use in ranking subwatersheds. Subwatershed metrics represent factors that determine the relative vulnerability or restorability of a subwatershed.

The metrics used to rank subwatershed vulnerability should be selected separately from the metrics used to rank subwatershed restorability. Various metrics can be estimated, depending on available data and the goals of the watershed plan. Table 4.7 lists the range of possible metrics that can be derived from the GIS data layers listed in Chapter 3. Potential sources of this data are provided in User's Guide Tool 2.

4. Assign points to each metric. To keep the subwatershed ranking system simple, the total number of possible points should be 100. More 'important' metrics should be assigned more points than others.
5. For each subwatershed, compute metrics and assign points for each metric.
6. Add the total points for each subwatershed to get a comparative ranking.

These steps are illustrated in the Real World Example of the Bush River Watershed presented later in this section.

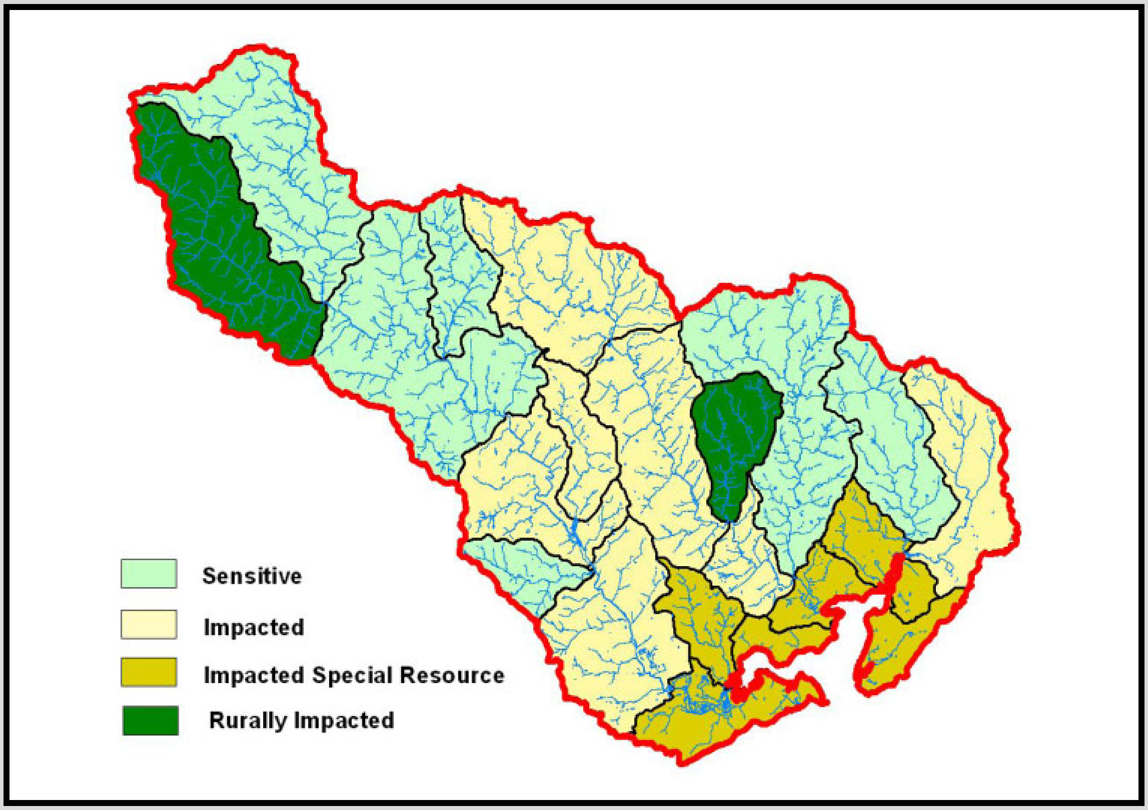
The ranking process refines the subwatershed classification, and is used to identify priority subwatersheds, which are typically the top-ranked subwatersheds in each classification category. Additional information on classifying and ranking subwatersheds is provided in User's Guide Tools 12 and 13. User's Guide Tool 12 is a vulnerability analysis to identify the subwatershed most vulnerable to future development, while User's Guide Tool 13 focuses on using subwatershed metrics to identify the most restorable subwatersheds through a Comparative Subwatershed Analysis.

Table 4.7: Examples of Metrics Used to Classify and Rank Subwatersheds	
• # road crossings per stream mile • # violations of water quality standards • % critical habitat for RTE species • % cropland • % current impervious cover • % detached residential land • % developable land • % forest cover • % forest interior • % forested stream buffer • % future forest loss • % industrial land • % public land • % streams with 303(d) listing • % wetlands • Age of development • Modeled pollutant loads (e.g., total phosphorus or total nitrogen)	• Benthic macroinvertebrate diversity • Condition of sewer system • Density of point sources or hotspots • Density of septic systems • Density of stormwater outfalls • Density of stormwater treatment practices • Density of streams • Fish diversity • Length of eroded stream bank • Livestock density • Net change in future impervious cover • Physical in-stream habitat • Presence of combined sewer systems • Presence of community or watershed organization • Presence of public drinking water supply • Modeled peak flow and runoff volume for 1- and 2-year storm events

Real World Example: Bush River Watershed Vulnerability Analysis

The Bush River Watershed Management Plan, completed in April 2003, provides a good example of subwatershed classification and ranking. Located in the northeastern corner of Maryland, the watershed is 117 square miles and contains 19 subwatersheds. Given its size, the core team wanted to choose priority subwatersheds to focus early action efforts. At the time of the investigation, abundant GIS data was available to conduct a vulnerability analysis.

The ICM subwatershed classification was expanded to include four categories (figure below), which differed from the typical ICM categories to account for agricultural impacts and sensitive resources. The Bush River watershed contains large expanses of tidally-influenced wetlands, and the Impacted Special Resource category was developed to identify subwatersheds that contain these valuable and unique resources that need to be managed differently from other subwatersheds. The Rurally Impacted category represents subwatersheds with low impervious cover but high potential for high nutrient loads from cropland.



Bush River Subwatershed Classifications

A scoring system was developed and applied to identify priority subwatersheds for each management category. The table on the next page summarizes the metrics used to rank subwatersheds in each of the classification categories. Each of the criteria listed in the table below was assigned a weight and a score, and each subwatershed was assigned a number of points based on this scoring system. The 10 subwatersheds with the highest points were defined as priority subwatersheds in the Bush River watershed.

Criteria for Prioritizing Subwatersheds in the Bush River Watershed, MD	
Subwatershed Management Classification	*Metrics for Determining Priority Subwatersheds*
Sensitive	• Has < 10% impervious cover • High % of forest suitable for interior dwelling species • High % of wetlands designated by state as special resources • High % of forested streamside • High % of locally significant habitat • Presence of good fish diversity • Presence of good benthic macroinvertebrate diversity • Presence of good physical in-stream habitat • High projected increase in percent impervious cover with future buildout
Rurally Impacted	• High % cropland • High % pasture • High % unforested streamside • Livestock access per stream mile • Eroded banks per stream mile • High nitrate concentrations • Presence of poor fish diversity • Presence of poor benthic macroinvertebrate diversity • Presence of poor physical in-stream habitat
Impacted	• Has 10-25% impervious cover • High # of stormwater facilities • High % industrial land • High % detached residential lots • High # fish blockages • High # eroded banks • High # trash dumping sites • High % public land • High % parks, forest and wetlands • High % of unforested streamside
Impacted Special Resource	• Presence of tidal influence • High % of forest suitable for interior dwelling species • High % of wetlands • High % of wetlands designated by state as special resources • High % of forested streamside • High % of locally significant habitat • Presence of good fish diversity • Presence of good benthic macroinvertebrate diversity • Presence of good physical in-stream habitat • High projected increase in percent impervious cover with future buildout
Note: A "high percentage" was defined in this analysis using a quartile approach.	

As indicated in the table above, subwatersheds with a high percentage of sensitive resources were prioritized for three of the four management categories. In addition, subwatersheds with a high vulnerability to development (as defined by change in future impervious cover) were prioritized for two of the management categories. Therefore, the Bush River Watershed vulnerability analysis identified and prioritized the most vulnerable subwatersheds.

Center for Watershed Protection. 2003a. *Bush River Watershed Management Plan.* Prepared for Harford County. CWP. Ellicott City, MD.

D. Evaluate Local Watershed Programs and Regulations

This evaluation involves an in-depth audit of local watershed planning capacity. The results of this audit allow the core team to make programmatic recommendations to include in the overall watershed plan, such as revisions to local codes, ordinances, programs, and incentives to provide better watershed protection. The Eight Tools Audit (User's Guide Tool 14) is designed specifically for this purpose, and includes 61 questions that are organized by the eight tools of watershed protection.

The eight tools of watershed protection, summarized in Table 4.8, are a comprehensive approach to protecting or restoring aquatic resources in a watershed. The eight tools roughly correspond to the stages of the development cycle from initial land use planning, site design and construction, through home ownership. Each watershed protection tool represents a general category of local ordinances and programs and often corresponds to a specific ordinance (e.g., stormwater management or stream buffer ordinances). Within each tool is a range of potential options for improving watershed protection at the local level.

Table 4.8: The Eight Tools of Watershed Protection

Watershed Protection Tool	*Description*
Tool 1. Land Use Planning	The application of land use planning techniques and zoning regulations that are designed to maintain or limit future land use change/impervious cover, redirect development where appropriate, and protect sensitive areas.
Tool 2. Land Conservation	Programs or efforts to conserve undeveloped, sensitive areas or areas of particular historical or cultural value using techniques such as acquisition, easements and transfer of development rights.
Tool 3. Aquatic Buffers	The protection, restoration, creation, or reforestation of stream, wetland, lake, and shoreline buffers.
Tool 4. Better Site Design	Local ordinances and codes incorporate techniques to reduce impervious cover and/or redirect runoff onto pervious surfaces in the design of new development and redevelopment projects.
Tool 5. Erosion and Sediment Control	The use of erosion control, sediment control, and dewatering practices at all new development and redevelopment sites.
Tool 6. Stormwater Management	The incorporation of structural practices into new development, redevelopment, or the existing landscape to help mitigate the impacts of stormwater runoff on receiving waters.
Tool 7. Non-Stormwater Discharges	Locating, quantifying, and controlling non-stormwater pollutant sources in the watershed. Operation and maintenance practices that prevent or reduce pollutants entering the municipal or natural drainage system.
Tool 8. Watershed Stewardship	Stormwater and watershed education or outreach programs targeted towards fostering human behavior that prevents or reduces pollution over a range of land uses and activities.

Local governments will generally need to apply some form of all eight tools in every watershed to provide comprehensive watershed protection. A local watershed plan defines how and where the eight tools are specifically applied to meet unique water resource objectives.

The core team should complete the Eight Tools Audit (see Tool 14), which involves interviews with local staff, and a review of local regulations and code and ordinance language. The audit questions may be modified to fit the community needs, and not all questions need be answered. The audit questions are structured so that programs and regulations that are currently lacking become very apparent. Local watershed plan recommendations for regulatory and programmatic changes can be derived directly from the audit results. Table 4.9 presents some example recommendations made as part of a watershed plan and based on the results of the Eight Tools Audit.

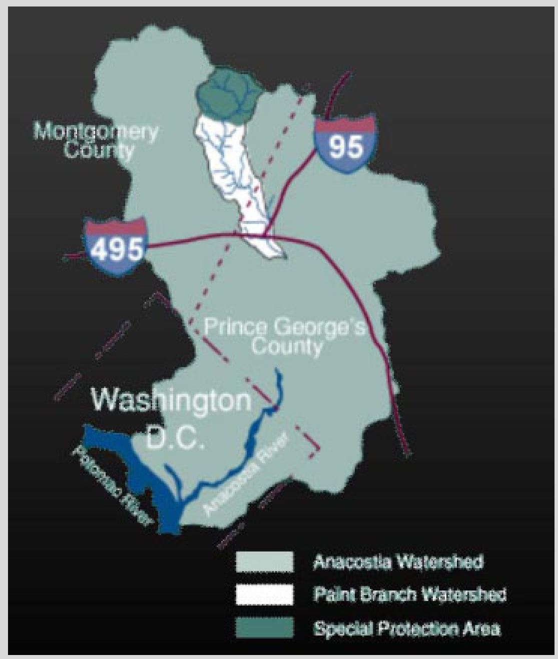
Table 4.9: Potential Regulatory and Programmatic Change Recommendations

Watershed Protection Tool	*Potential Watershed Plan Recommendation*
Tool 1. Land Use Planning	• Adopt overlay zoning to protect sensitive natural areas • Establish a transfer of development rights (TDR) program
Tool 2. Land Conservation	• Actively pursue forest or wetland conservation
Tool 3. Aquatic Buffers	• Adopt local wetland buffer ordinance • Require physical protection of buffer during construction
Tool 4. Better Site Design	• Adopt an open space design ordinance • Reduce residential street widths to 22 feet • Encourage site designers to minimize the number of stream and wetland crossings and revise design standards to reduce impacts of crossings (e.g., road crossings should be perpendicular to stream) • Review parking codes to see if based on real parking demand
Tool 5. Erosion and Sediment Control	• Hire part-time Erosion and Sediment Control (ESC) /stormwater inspector • Adopt more stringent design standards for ESC practices
Tool 6. Stormwater Management	• Enhance stormwater criteria • Allocate a portion of capital budget for implementation of priority stormwater retrofits and stream restoration projects
Tool 7. Non-Stormwater Discharges	• Develop an illicit discharge detection and elimination program • Require certification of septic system inspectors
Tool 8. Watershed Stewardship	• Develop watershed education program • Establish a volunteer monitoring program

Watershed Protection Tool 1 represents opportunities for land use changes and management approaches, and are perhaps the most important type of recommendation because they determine where and how a watershed can be developed. Changes to current zoning and comprehensive plans should be considered where necessary to maintain designated stream uses, ensure that future land use is consistent with projected development capacity, and achieve watershed goals. All regulatory and programmatic recommendations should be re-visited after estimating pollutant loads under future land use scenarios. Land use change and management approaches can be accomplished through revisions to county comprehensive plans or area master plans, development of watershed-based functional master plans, and subsequent revisions to local zoning regulations. Other options include overlay zones that apply certain standards to existing land uses such as TDR programs, to transfer development density to more suitable areas. Additional information regarding TDRs can be found at: www.mdp.state.md.us/mgs/pdf/MG9.pdf. Paint Branch Watershed represents a good example of a watershed plan that incorporated and implemented land use planning recommendations, is summarized below in the Real World Example.

Real World Example: Paint Branch Watershed Special Protection Area

Located approximately 15 miles northeast of Washington D.C. in Montgomery County, MD, Paint Branch is a 31.5 square mile watershed that supports a naturally-reproducing brown trout population that has been recognized and monitored since the early 1970s. The presence of trout, so close to a major metropolitan area, makes Paint Branch a unique and highly valued resource by local residents and a much broader community of natural resource agency staff and naturalists. As early as 1981 the County recognized the value of the fishery and took major steps to protect the resource. In 1981, the Eastern Montgomery County Master Plan identified the resource as warranting special protection and recommended that special management measures, including downzoning, be employed to protect the resource.



While the 1981 land use recommendations and protection measures helped to maintain the trout fishery, continuing development has resulted in signs of increasing stress on the trout population, including drops in trout spawning and the number of young born each year. These signs of stress and concerns about the remaining level of allowable development in the watershed, prompted the County and Planning staff to convene a technical committee to prepare a watershed management study for the Upper Paint Branch in preparation for the 1991 update of the land use Master Plan. This study revealed areas of "imperviousness creep" where actual impervious cover values were higher than what had been anticipated when estimates were made for the original 1981 master plan. Both existing and projected future imperviousness in the four upper subwatersheds once again became an area of serious concern.

The Paint Branch watershed planning effort recommended an environmental overlay zone in the headwaters – the Special Protection Area (SPA) - that included strong regulatory measures, a permit coordinator, comprehensive monitoring, and coordinated agency reviews. The Montgomery County council implemented these watershed planning recommendations by updating the Master Plan and designating the entire Paint Branch watershed above Fairland Road as the Upper Paint Branch SPA, requiring water quality plans for any land disturbance and limiting impervious surface area. A significant feature of the SPA is a 10% impervious cover cap on all new development, and post-construction monitoring requirements for developers. The updated Master Plan also resulted in the public acquisition of significant areas of the remaining forest cover in the subwatersheds critical to spawning.

Montgomery County, MD Department of Public Works. www.montgomerycountymd.gov

E. Develop Project Concept Designs

Watershed plans may include concept designs for all candidate protection and restoration projects that require a design or plan. After potential sites are investigated in the field, site data and mapping are analyzed to create simple concept designs for each project, which may or may not involve additional mapping work. Project design data is then entered into a master binder, spreadsheet and/or GIS. Relatively simple concept plans may be feasible for riparian reforestation or source control projects, with no final design needed. More complex structural projects such as stormwater retrofits and stream repair, however, may require additional engineering and design surveys before a final design can be completed.

Concept designs should be completed back in the office within a few weeks of the project investigations, while the sites are still fresh in mind. Mapping data should be analyzed for priority sites to derive more accurate estimates of the site area, and other features. This is where finer resolution topography or survey data comes in handy, with one or two-foot contours normally sufficient for this level of design. The drainage area and land cover (especially impervious cover) contributing to the project should always be located for stormwater retrofit or stream repair projects. Maps are also analyzed to evaluate project feasibility factors that cannot be easily seen in the field such as the boundaries of land ownership, presence of underground utilities, restrictive easements and access, and presence of wetlands.

The final concept should have a sufficient level of detail to thoroughly assess project feasibility, cost, and pollutant reduction, and allow groups of projects to be compared at the watershed scale. The term 15% design is often used to describe the scope of effort for concept designs. The concept should include a detailed description of the project goals, a decent plan view sketch that shows how the project will work, and estimated storage or treatment calculations for the proposed project. In order to later estimate pollutant reduction with implementation of individual projects, specific "reporting units" that correlate the project parameters to pollutant removal shall be quantified and recorded on the concept design (e.g., acres treated, linear feet installed). For consistency with state programs and the Chesapeake Bay Program modeling efforts, suggested reporting units for various protection and restoration projects are provided later in this chapter. Figure 4.7 shows an example concept design for a stormwater retrofit project.

Each concept should include an initial cost estimate for construction, which is usually derived using a simple unit cost approach. The first task is to define the unit of construction, which may be linear feet of stream, acres treated, acres planted, or simply the number of systems installed. The appropriate construction unit is then multiplied by an average construction cost derived from local data (see User's Guide Tool 7). The initial cost estimate should always indicate whether additional costs are anticipated to secure environmental permits, conduct engineering design studies or hold neighborhood consultation meetings. The initial planning estimate is only used to compare projects for ranking purposes; accurate project cost estimates are computed during final design and construction.

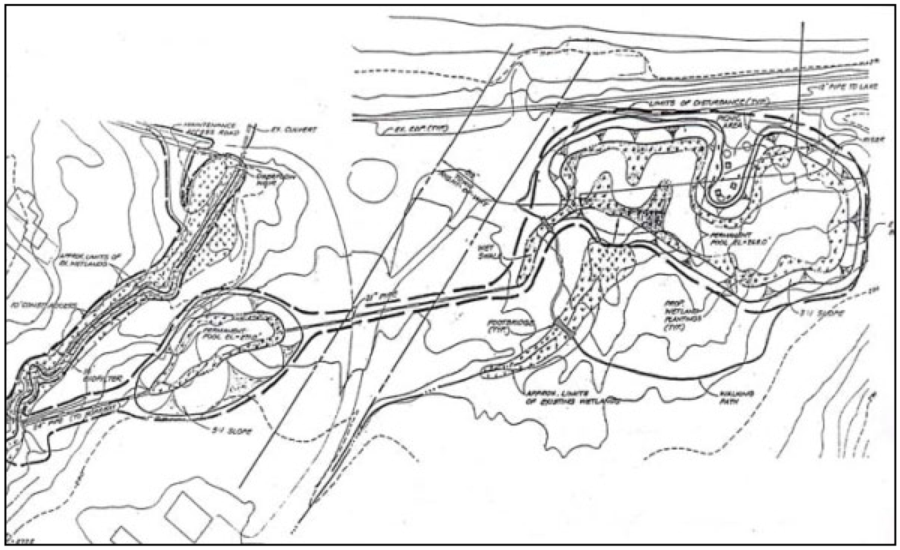


Figure 4.7: Example of a project concept design for a pond retrofit

After double-checking for accuracy and thoroughness, concept designs should be assigned a unique identification number. The designs, along with all supporting field forms, digital photos, sketches, field notes and mapping data, are compiled into an inventory of all potential protection and restoration projects (Chapter 7). This inventory is ultimately provided as an appendix to the watershed plan.

F. Rate and Rank Individual Projects

P-14 Pollutant Reduction

This method rates and ranks the entire range of projects contained within the inventory of protection and restoration projects. Ranking of projects typically occurs once field work has been completed and an inventory of potential projects has been completed (see Chapters 5 and 7, respectively). Each project is rated and ranked according to pollutant reduction, cost, feasibility, public acceptance, and other key implementation factors. Project ranking is typically done through a simple spreadsheet analysis, and the results are used to select the package of projects to go to final design.

Project ranking allows all the protection and restoration projects to be compared together on a common basis to find the most cost-effective and feasible projects in the watershed. One of the key decisions in project ranking is whether to evaluate projects within the same group (e.g., stream restoration reaches) or evaluate all different types of projects together. There are pros and cons to each approach. In general, it is preferable to assess all groups of projects at the same time, as long as the ranking factors are compatible among the groups. For example, it may be difficult to compare certain agricultural projects where implementation is done on an annual basis (e.g., conservation tillage), to projects such as stormwater retrofits that have a one-time implementation cost with associated long-term maintenance. Ranking factors and scoring rules may need to be adjusted to account for these differences.

More than a dozen ranking factors can be easily derived from individual project concept designs. These differences should be considered when developing the ranking system. Suggested ranking factors are presented in Table 4.10.

The exact ranking factors are unique for each watershed plan, but should reflect overall goals and stakeholder preferences, and allow a direct and fair comparison among all proposed protection and restoration projects in the watershed.

Each ranking factor should be assigned a number of points that reflects its relative importance to project success. The maximum score of all factors together should total 100. This ranking system is subjective and can be easily modified to reflect specific "hot buttons" within a particular community. However, three important screening factors should be given more weight: the degree to which the project meets watershed goals, pollutant reduction, and cost per reporting unit. Stakeholder input should be solicited in the selection of project screening factors and development of the scoring system (see Chapter 6). Putting all the candidate protection and restoration sites on a single watershed map greatly assists the ranking process because it allows a visual assessment of individual projects in relation to upstream and downstream conditions and proximity to other projects.

Table 4.10: Suggested Ranking Factors for Protection and Restoration Projects

Ranking Factor	*Description*
Helps accomplish watershed plan goals	Estimate the number of watershed goals addressed by the project, or rank the project based on how well it conforms to specific objectives.
Pollutant reduction	Estimate how the project reduces loads for pollutants of concern, based on reporting units contained in concept designs, and efficiencies provided later in this chapter.
Total construction cost	Derive from preliminary estimates made during concept design stage.
Cost per reporting unit	Estimate the project cost by reporting units provided in concept designs (e.g., acres planted, linear feet installed, systems installed).
Cost per pollutant removed	Use the total project cost and the pollutant reduction estimate to determine the cost per pollutant removed. Since pollutant reduction is a major goal, it is a good idea to rank projects based on the relative cost to remove pollutants.
Permitting burden	Evaluate what, if any, permits or approvals are required for project implementation (e.g., Section 404 wetland permits).
Maintenance burden	Determine the maintenance burden by estimating future long-term maintenance costs and identifying whether a responsible party has been designated to perform the maintenance.
Landowner cooperation	Rate the willingness of the landowner to have the project installed on their property.
Integration with other projects	Evaluate whether the project can be integrated with other protection or restoration projects at the same site to maximize benefits.
Neighborhood acceptance	Rank the community acceptance of the project based on feedback from neighborhood consultation meetings (Chapter 6).
Access to site	Assess the ability to access the site for construction and maintenance purposes. Sites with limited access due to steep slopes or other factors may not be feasible projects if heavy equipment is needed for installation.

Table 4.10: Suggested Ranking Factors for Protection and Restoration Projects	
Ranking Factor	*Description*
Location in watershed	Rank projects based on location in watershed. Headwater projects may be prioritized since they will affect conditions downstream.
Use of innovative practices	Determine if the project utilizes an innovative practice or technology that has not yet been implemented in the community, as these projects have value for demonstration purposes.
Partnership opportunities	Identify the number of partners that may be involved in project implementation.
Public visibility	Examine the visibility and potential demonstration value of the project.
Habitat value	Evaluate whether the project provides habitat value (e.g., conserves, enhances, restores or creates wildlife habitat).
Other community benefit	Identify other community benefits provided by the project (e.g., recreation, education, neighborhood revitalization).

To identify scoring rules that will be used to award or deduct points from individual projects, the core team must analyze the range or distribution of scores among all projects. Each individual project can then be assigned a score based on the proposed scoring and weighting rules. Scores should be tallied using a spreadsheet and aggregate scores compared to identify the top-ranked, or priority, projects. An example ranking system is provided in Table 4.11, where the top-ranked projects are shaded in green.

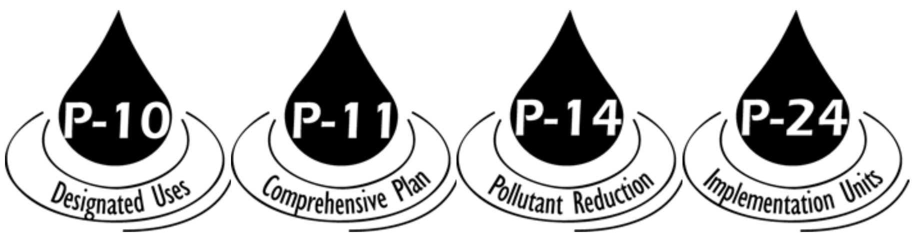
Table 4.11: Example Project Ranking System

Project ID	*Watershed Goals (20 pts)*	*Owner Coop. (15 pts)*	*Community Acceptance (10 pts)*	*Long-Term Maintenance (15 pts)*	*Cost (20 pts)*	*Pollutant Reduction (20 pts)*	*Access (10 pts)*	*Total (out of 100)*
RR-1	15	15	10	10	15	7	10	82
SC-1	20	4	10	10	10	18	5	77
MP-1	15	10	10	14	8	10	10	77
RR-3	15	9	10	10	15	7	5	71
SC-3	20	5	0	10	10	19	5	69
RR-2	15	14	9	5	10	5	10	68
SC-2	20	0	5	9	9	12	10	65
SW-1	15	10	5	3	5	14	6	58
PAR-1	10	15	6	5	12	7	3	58
PAR-2	10	7	10	2	11	12	5	57
DP-1	10	9	8	5	7	11	6	56
MP-2	15	5	8	5	10	7	5	55
SR-2	5	14	10	5	1	5	5	45
SR-1	5	15	3	5	5	7	3	43
DP-2	10	2	7	2	6	13	0	40
SW-2	5	8	0	2	2	16	3	36
DP-3	5	5	4	2	5	11	5	37
SR-3	5	9	0	1	4	5	2	26

After the ranking is complete, the individual scores for the highest scoring projects should be double-checked to look for hidden "project killers," and adjusted accordingly. This situation occurs when a project has a high total score, but one or more screening factors receives a low or zero score, suggesting the project may not be easy to implement (e.g., an unwilling landowner, or access to the site that is poor or non-existent). Once final adjustments are made, a draft priority project list is created along with a map of priority projects to be included in the draft watershed plan. The core team should document the rationale for selecting ranking factors and their corresponding weights. This documentation should be included as an appendix to the final watershed plan.

A Project Priority Ranking System to select projects for implementation has been developed by MDE. Local governments may wish to utilize this method when developing local watershed plans because state and federal loan and grant assistance for water quality projects are awarded in accordance with MDE's Project Priority List. See User's Guide Tool 1 for the MDE program contact information.

G. Estimate Pollutant Loads and Reductions



A major goal of any watershed plan is to reduce pollutant loads to the watershed. In the Chesapeake Bay Basin, nutrients are the pollutants of concern, and each Tributary Strategy Basin has associated nutrient caps that were developed to achieve statewide loading reductions as part of the C2K agreement. Therefore, the C2K agreement and Tributary Strategies, as well as Phase I MS4 Stormwater permits, require tracking of nutrient reduction achieved by watershed plan implementation. TMDL implementation also requires tracking pollutant loads and reductions. In order to perform this 'nutrient accounting' and assess consistency with TMDLs, local governments need a consistent framework for first estimating pollutant loads in the watershed, and then estimating the pollutant reductions attributed to plan implementation. A framework for estimating pollutant loads and reductions is described below.

Estimate Pollutant Loads

Local governments should estimate current and future pollutant loads for their watersheds for use in evaluating the effects of land use changes and project implementation on watershed goals. Since watershed plans generally focus on reducing pollution from nonpoint sources, pollutant loads are estimated based on land use/land cover data and pollutant concentrations. One fairly straightforward approach is the Simple Method. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration. As such, this method can be used to estimate average annual pollutant loads for a watershed, by estimating pollutant loads for each type of land in the watershed. Annual pollutant loads are derived using the equations presented in Table 4.12.

Table 4.12: Using the Simple Method to Estimate Pollutant Loads		
Factor	*Equation*	*Description*
Annual Pollutant Load (L, in pounds)	L = 0.226 * R * C * A	Where: R = Annual runoff (inches) C = Pollutant event mean concentration (mg/L) A = Area (acres) 0.226 = A conversion factor
Annual Runoff (R, in inches)	R = P * Pj * Rv	Where: P = Annual rainfall (inches) Pj = Fraction of annual rainfall events that produce runoff (usually 0.9) Rv = Runoff coefficient (fraction of rainfall that becomes runoff)
Runoff Coefficient (Rv)	Rv = 0.05 + 0.9Ia	Where: Ia = Fraction of land that is impervious (determined from Establishing a Baseline)

Several models also exist to estimate watershed pollutant loads under different land use scenarios. These are summarized in User's Guide Tool 15. The Watershed Treatment Model (WTM) is a simple spreadsheet model that is recommended for estimating current and future pollutant loads as part of a watershed plan. The WTM spreadsheet (Version 3.1) is provided in User's Guide Tool 16. More information about using the WTM is provided below and in Caraco (2001).

The WTM provides rapid, inexpensive, and reasonably accurate estimates of watershed loads of sediment, nutrients, and bacteria. The WTM is an ideal tool for planning in most watersheds, although more complex models may be warranted in some locations. The first component of the WTM estimates watershed pollutant loads without any implementation of projects. The WTM can be applied to current land use scenarios, or to future land use scenarios to assess the impacts of future growth on pollutant loads.

The WTM predicts annual pollutant loads from primary and secondary pollution sources (Table 4.13). Primary sources include stormwater runoff loads generated from general land use, as well as atmospheric deposition of pollutants over open water. Secondary sources are pollutant sources dispersed throughout the watershed whose magnitude cannot be directly estimated from land use data. Input data needed for secondary sources ranges widely, but most can be estimated using available GIS data. Land use data is the major input required to estimate loads from primary sources. Event mean concentrations (EMCs) of sediment, phosphorus and nitrogen for various land uses are provided in the WTM as defaults; however, Maryland-specific data that is consistent with the Chesapeake Bay Program (CBP) Watershed Model should be substituted, where available. CBP data can be accessed at www.chesapeakebay.net/datahub.htm. Table 4.14 provides EMCs for nutrients and sediment for three urban land uses in Maryland.

Table 4.13: Primary and Secondary Pollutant Sources Considered by the WTM		
Primary Land Uses	*Secondary Pollution Sources*	
• Residential land • Commercial land • Roadway • Rural land • Forest • Open water	• Septic systems • Active construction • Managed turf • Channel erosion • Marinas	• Hobby farms/livestock • NPDES dischargers • Sanitary sewer overflows • Combined sewer overflows • Illicit connections

Table 4.14: Maryland Event Mean Concentrations (EMCs) for Selected Stormwater Pollutants*

Urban Land Use	*Parameter (mg/L)*					
	Total Nitrogen (TN)	*Total Phosphorus (TP)*	*Total Suspended Solids (TSS)*	*Total Zinc*	*Total Copper*	*Total Lead*
Residential	2.72	0.37	55.08	0.0893	0.0141	0.0057
Commercial	2.85	0.22	56.18	0.1708	0.0204	0.0176
Industrial	2.31	0.34	82.94	0.1650	0.0231	0.0190

*Based on sampling of 107 storm events.
Source: MDE, 1997b

The values presented in Table 4.14 are based on monitoring data collected by Phase I communities in support of NPDES stormwater permitting. Jurisdictions with municipal separate storm sewer systems that serve (or are expected to soon serve) more than 100,000 people were required to monitor stormwater discharges from 5-10 representative land uses during three representative storms each (MDE, 1997b). MDE is responsible for compiling data from the 11 Phase I jurisdictions in Maryland. More recent data can be obtained directly from MDE.

Pollutant loads from non-urban sources such as forest, agriculture, and open water, are also provided as defaults in the WTM. If available, Maryland-specific data that is consistent with the CBP Watershed Model should be substituted. The Watershed Model estimates loadings from non-urban sources, and this data can be accessed for individual drainage areas in the Chesapeake Bay watershed at www.chesapeakebay.net/datahub.htm. Table 4.15 provides an example of this data with 2004 average annual pollutant loading rates for a drainage area in the Patuxent River watershed.

> Future pollutant loads should be estimated for a range of implementation scenarios, including no implementation to full implementation of recommended projects. Modeling results should be used to revise watershed plan recommendations, specifically those related to comprehensive land use planning, zoning, water and sewer plans, and development regulations, to offset increased pollutant loads and ensure that pollutant reduction goals, C2K water quality goals, and TMDLs are met.

Local governments should use the WTM or similar tool to estimate current pollutant loads in their watersheds and should also evaluate how these loads will increase under future land use scenarios. Future land use scenarios should reflect zoning and local growth projections, and development capacity analysis. Water and sewer projections are particularly useful in projecting future growth, as they provide a clue to both the timing and placement of future development. Methods to estimate pollutant reductions due to project implementation are described below.

Table 4.15: 2004 Estimated Average Annual Nutrient and Sediment Loading Rates for Watershed Model Segment 330			
Land Use	Parameter		
	TN (lbs/acre/year)	TP (lbs/acre/year)	TSS (tons/acre/year)
Agriculture	18.1	1.1	0.6
Atmospheric deposition to water	10.3	0.6	0
Forest	1.8	0	0.1
Mixed open space	5.6	0.6	0.2
Point sources	0	0	0
Urban	21.3	0.8	0.2

Estimate Pollutant Reductions

Pollutant reductions associated with individual protection and restoration projects are estimated as part of project design and ranking. It can be difficult to quantify the collective impact of land use changes and project implementation on attaining specific pollutant reduction goals for the watershed. Several good desktop models can assist in this effort by estimating the pollutant reduction associated with implementation of specific projects in a watershed. Models fall into two general categories: spreadsheet models and simulation models. Both types of models return information that is useful to evaluate watershed goals and develop TMDLs. Generally speaking, spreadsheet models have less input data and require less effort and funding to perform than simulation models. Several useful simulation models that are in the public domain that are reasonably well supported and can be easily downloaded and used are summarized in User's Guide Tool 13.

Local governments should apply modeling tools to estimate pollutant reduction as a result of watershed plan implementation. The WTM and the CBP Watershed Model are two good options. The WTM assesses the ability of land use and current or proposed projects such as stormwater retrofits, reforestation, and watershed education, to reduce pollutant loads. The WTM evaluates pollutant reduction by applying a pollutant removal rate to the treatable load, and then adjusting the total reduction achieved to reflect the projected level of watershed implementation. The reliability of pollutant reduction estimates made by the WTM varies with the type of project. Table 4.16 shows the range of projects that can potentially be evaluated by the WTM, along with a general indication of the reliability of the estimate.

Table 4.16: Protection and Restoration Projects Evaluated by WTM	
Stormwater Retrofits Storage Retrofits[1] On-Site Residential Retrofits[1] On-Site Non-Residential Retrofits[1]	Stream Repair Simple Practice[4] Comprehensive Applications[4]
Reforestation Riparian Reforestation[4] Upland Reforestation[2]	Discharge Prevention Illicit Connections Sewage[1] Failing Sewage Lines[1]
Municipal Operations Street and Storm Drain Practices[2] Pollution Prevention at Municipal Operations[2] Best Practices for Municipal Construction[3] Stewardship of Public Land[2]	Pollution Source Control Residential Pollution Prevention[2]
Other Land Reclamation[2] Management of Natural Area Remnants[2] Floodplain / Wetland Restoration[2] Hill-Slope Bioengineering[3]	Overall WTM Capability [1] provides reasonable estimate of treatment if detailed subwatershed data is available [2] provides ballpark estimate of treatment [3] provides very rough estimate of treatment due to data limitations [4] provides very rough estimate of treatment that is considered a secondary benefit, not primary benefit, of the project

Default pollutant removal rates are provided in the WTM and other models for various protection and restoration projects; however, Maryland-specific data should be used where possible. Tables 4.17a and b present nutrient and sediment removal efficiencies for various protection and restoration projects, most of which are accepted by the Chesapeake Bay Program for use in tracking pollutant reductions through the Watershed Model. For consistency with this model and other state-level efforts that are based on this model, local governments should use both the efficiencies and the reporting units presented in the tables when estimating pollutant reductions as part of watershed plans. For more information on how to get a new type of project accepted for input to the Watershed Model, and for updates to the efficiencies presented here, see: www.chesapeakebay.net/pubs/CBP_BMPs_091205.pdf.

Table 4.17a: Pollutant Reduction Efficiencies and Reporting Units for Urban Best Management Practices				
Urban Practice	*Total Nitrogen (TN) Efficiency (%)*	*Total Phosphorus (TP) Efficiency (%)*	*Total Suspended Solids (TSS) Efficiency (%)*	*Reporting Units*
Wet ponds/stormwater wetlands	***30***	***50***	***80***	Acres treated by practice
Dry detention ponds	***5***	***10***	***10***	
Hydrodynamic structures*	0	5	10	
Dry extended detention ponds	***30***	***20***	***60***	
Infiltration practices	***50***	***70***	***90***	
Filtering practices	***40***	***60***	***85***	
Bioretention areas *	40	40	90	
Impervious cover reduction*	90	90	90	
Storage retrofits*	35	45	80	
On-site retrofits*	40	60	90	
Stream repair	***0.02 lbs/ft***	***0.0035 lbs/ft***	***2.55 lbs/ft***	Linear feet
Erosion and sediment control	***33***	***50***	***50***	Acres
Residential nutrient management	***17***	***22***	0	Acres
Forest conservation*	same as impervious cover reduction			Acres
Riparian forest buffer planting	*25*	*50*	*50*	Acres
Upland reforestation (from turf) *	90	90	0	Acres
Upland reforestation (from Impervious Cover) *	95	95	50	Acres
Hotspot pollution prevention*	derived	derived	derived	Site
Septic denitrification	***50***-60	0	0	Systems
Septic pumping	***5***	0	0	
Septic connections/hookups	55	0	0	
Emergent marsh wetland restoration	42	55	75	Acres
Palustrine forested wetland restoration	43	58	75	
Street sweeping *	5	15	20	Miles
Catch basin cleaning *	5	15	20	Inlet

Note: To find out if additional BMPs are under consideration by CBP for inclusion in the Model, see www.chesapeakebay.net/pubs/CBP_BMPs_091205.pdf.
Values in bold italics are accepted rates used in the CBP Watershed Model
** = provisional estimate*
Sources: Removal efficiencies derived from CBP, 2005; MD DNR, 2002b; Cappiella *et al*., 2005, and land cover loading analysis

Table 4.17b: Pollutant Reduction Efficiencies and Reporting Units for Rural Best Management Practices				
Rural Practice	*Total Nitrogen (TN) Efficiency (%)*	*Total Phosphorus (TP) Efficiency (%)*	*Total Suspended Solids (TSS) Efficiency (%)*	*Reporting Units*
Forest harvesting practices	***50***	***50***	***50***	Acres
Tidal shoreline erosion control	0.73 lbs/ton of sediment not eroded	0.48 lbs/ton of sediment not eroded	Derived at site	Linear feet
Septic connections/hookups	55	0	0	System
Septic denitrification	50-60	0	0	
Septic pumping	5	0	0	
Conservation tillage*	25	30	75	Per acre treated
Riparian forest buffers*	60	70	75	
Riparian grass buffers	***17-57***	***50-75***	***50-75***	
Land retirement *	50	80	80	
Reforestation (from row crops)*	90	95	90	
Nutrient management plan implementation	derived	derived	0	
Cover crops	***17 - 45***	***0 - 15***	***0 - 20***	
Conservation plans	***3 - 8***	***5 - 15***	***8 - 25***	
Livestock Animal Waste Management System (AWMS)	***100***	***100***	0	Per operation
Poultry AWMS	***100***	***100***	0	
Barnyard runoff control	***100***	***100***	0	
Stream fencing, rotational grazing and off-stream watering	***20***	***20***	***40***	Acres, linear feet
Stream fencing and off-stream watering	***60***	***60***	***75***	Acres
Off-stream watering only	***30***	***30***	***38***	Acres
Wetland restoration*	40	55	75	Acres

Note: To find out if additional BMPs are under consideration by CBP for inclusion in the Model, see www.chesapeakebay.net/pubs/CBP_BMPs_091205.pdf.
Values in bold italics are accepted rates used in the CBP Watershed Model
* = *provisional estimate*
Removal efficiencies derived from CBP, 2005; MD DNR, 2002b; and land cover loading analysis.

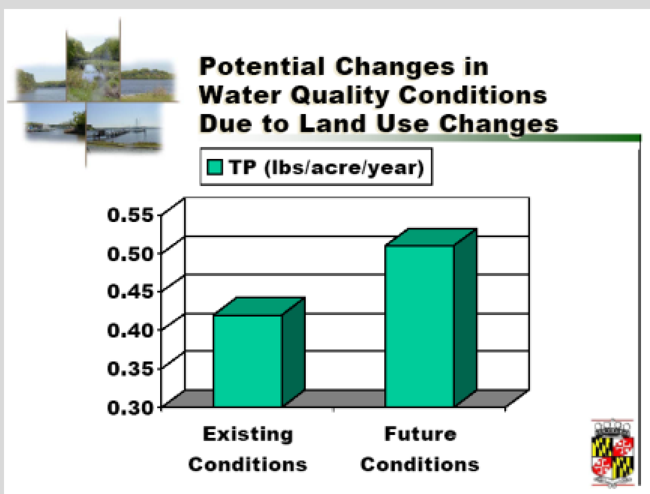
Pollutant loads can also be estimated using the CBP Watershed Model. This model estimates nutrient loads for 10 urban and non-urban land uses for specific stream segments within the Chesapeake Bay Watershed. While the model itself cannot be downloaded, data from model scenarios can be obtained, and a simpler version of the model, the Chesapeake Bay Program Scenario Builder, is available for download. The Scenario Builder enables Tributary Teams to assess various agricultural, urban and Chesapeake Bay implementation scenarios necessary to achieve tributary basin cap load allocations. A similar model, called GIShydro2000, has recently been developed by MD DNR. Specific instructions on using the Watershed Model to estimate pollutant loads for different land use scenarios are provided in MDE (2005). Additional information about the Watershed Model, Scenario Builder, and GIShydro2000 is provided in User's Guide Tool 15.

The results of the modeling efforts to estimate pollutant loads and reductions should be used to revisit project ranking or modify recommendations made as part of the plan, if future pollutant reduction with full plan implementation is not sufficient to meet TMDLs or pollutant reduction goals. As projects are implemented, they should be reported to the Tributary Teams, and the CBP for input to the Watershed Model to facilitate the nutrient accounting process required as part of the C2K agreement. Anne Arundel County's Watershed Management Tool, summarized below, provides a real world example of how pollutant loads and reductions can be estimated in the context of a watershed plan.

Real World Example: Anne Arundel County's Watershed Management Tool

As part of its ongoing Watershed Master Planning process, Anne Arundel County has developed a Watershed Management Tool (WMT) to help watershed managers determine which subwatersheds and stream reaches are most in need of restoration, and evaluate the outcome of alternative land use scenarios. The WMT has four major components: 1) Database Repository, 2) Modeling, 3) Management and 4) Visualization. These components function as an integrated system the County can use to examine management practices related to watershed health. The WMT has already been used for the Severn River Watershed and will ultimately be used in all 12 County watersheds.

A primary function of the WMT is to estimate pollutant loads in a watershed for both current and projected land use conditions, and to estimate pollution reductions associated with implementation of various preservation and restoration actions. In the Severn River Watershed, the WMT was used to evaluate, prioritize, and rank over 70 subwatersheds and 152 miles of stream. This was done by conducting stream walks to assess physical and biological parameters, scoring each reach based on the results, using the Simple Method to estimate runoff and pollutant loadings, and conducting hydrologic and hydraulic modeling. Runoff and pollutant loadings were estimated for existing land use conditions, and for future projected land use conditions. The effects of proposed preservation and/or restoration efforts on reducing these pollutant loads were modeled. The results allow County staff to make informed decisions regarding land use and development and selection of management practices. For more information about the Watershed Management Tool, see: www.aacounty.org/LandUse/OECR/WatershedManage.cfm



Anne Arundel County Department of Environmental and Cultural Resources

Chapter 5: Field Assessment Methods

Field assessment methods take place in the stream corridor and subwatershed, and are used to rapidly identify, design and rank potential protection and restoration projects and/or monitor improvements in stream quality. The watershed planning process relies on field assessment methods to identify and verify on stream impairments, define protection and/or restoration potential; and acquire information needed for project implementation.

While many different types of field assessment methods are presented here, the core team will most likely have to determine which methods to pursue during the scoping stage (see Chapter 4). Methods should be selected based on data gaps and available financial and technical resources. At a minimum, the core team should make sure that they have data from recent stream corridor and upland surveys. Field sheets for many of the methods described below are provided in User's Guide Tools 17 - 19. The methods described in this chapter include:

A. Conduct Stream Corridor Assessments
B. Conduct Upland Assessments
C. Conduct Project Investigations
D. Monitor Watershed Indicators

A. Conduct Stream Corridor Assessments

P-15 Field Verification

P-16 Field Assessments

Tables 5.1 and 5.2 provide a summary of some of the most commonly used stream assessment methods in Maryland. A basic stream assessment will include a semi-quantitative method that asks an investigator to assign a numeric score to various stream habitat or channel parameters by comparing what is seen at points along the stream to a series of descriptions. The numeric score is then used as a basis for classifying the stream's habitat quality (Figure 5.1). This characterization can be used in a number of ways throughout the watershed planning process by:

- Providing a current picture of stream conditions
- Monitoring stream conditions over time
- Indicating stream response to restoration projects
- Verifying certain desktop assessments outcomes such as subwatershed management classifications

Table 5.1 summarizes the stream assessments that are primarily used to score in-stream habitat.

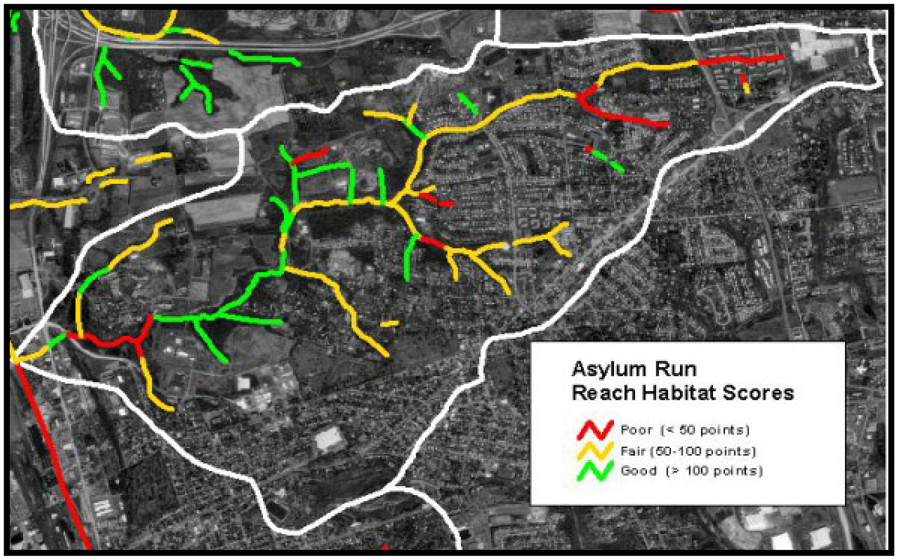


Figure 5.1: Reach Habitat Quality in Asylum Run subwatershed, Pennsylvania

Table 5.1: Comparison of In-Stream Habitat Assessment Methods

Characteristics	*RSAT*[1]	*RBP*[2]	*SVAP*[3]
General Description	- Evaluation of in-stream habitat - Developed for Montgomery County - Identifies channel erosion problem areas - Parameters measured at 400 ft intervals	- Evaluation of in-stream habitat - Developed by US EPA - Originally designed as a screening tool for determining if a stream is or is not supporting a designated aquatic life use	- Basic evaluation of in-stream habitat - Designed to be conducted by Soil Conservation District agents with landowner
Scoring System	6 parameters, pts vary for each	10 parameters, 20 pts each	Up to 15 parameters, 10 pts each
Land Type	High gradient streams	High and low gradient streams	High gradient streams
Watershed Type	Urbanized, nontidal	Relatively natural, nontidal	Rural or agricultural, nontidal
Experience Level	Moderate	Moderate	Low
Strengths	- User friendly - Can evaluate both channel conditions and macroinvertebrates - Tailored specifically for the Maryland Piedmont region	- User friendly - Rapid assessment - Can be integrated with bug and WQ monitoring - Great for volunteers - Can be done state-wide with little modification - Widely accepted and used protocol	- Designed to educate the landowner - Can provide landowners with ideas for improvement - Can pick and choose from parameters to customize to site conditions
Weaknesses	- Stream drainage area should be less than 100 – 150 sq. mi. - Not intended for use in Coastal Plain streams - Frequency of intervals may be time intensive	- Minor modifications may be needed to reflect local characteristics	- Meeting with each landowner could be time intensive - Would require modifications for more developed areas

1: Rapid Stream Assessment Technique (RSAT) (Galli, 1992)
2: Rapid Bioassessment Protocol (RBP) (Barbour *et al.* 1999); table only addresses the Habitat Assessment and Physiochemical Characterization portion of the RBP
3: Stream Visual Assessment Protocol (SVAP) (USDA, 1998)

In addition to characterizing stream reaches, the Stream Corridor Assessment (SCA; Yetman, 2001) and the Unified Stream Assessment (USA) (Kitchell and Schueler, 2004) are continuous stream walking methods that systematically assess the range of impacts and potential protection and restoration projects found along the entire stream corridor (see Figure 5.2). Both include forms to record the severity of stream impairments (e.g., inadequate buffer and channel modification) and potential for mitigation. A summary of continuous stream walk assessment characteristics is provided in Table 5.2.

In order to devise a comprehensive picture of subwatershed conditions, the SCA or USA should be combined with an assessment of upland areas. One such technique, the Unified Subwatershed and Site Reconnaissance (Wright *et al.,* 2004) is described in the following section.

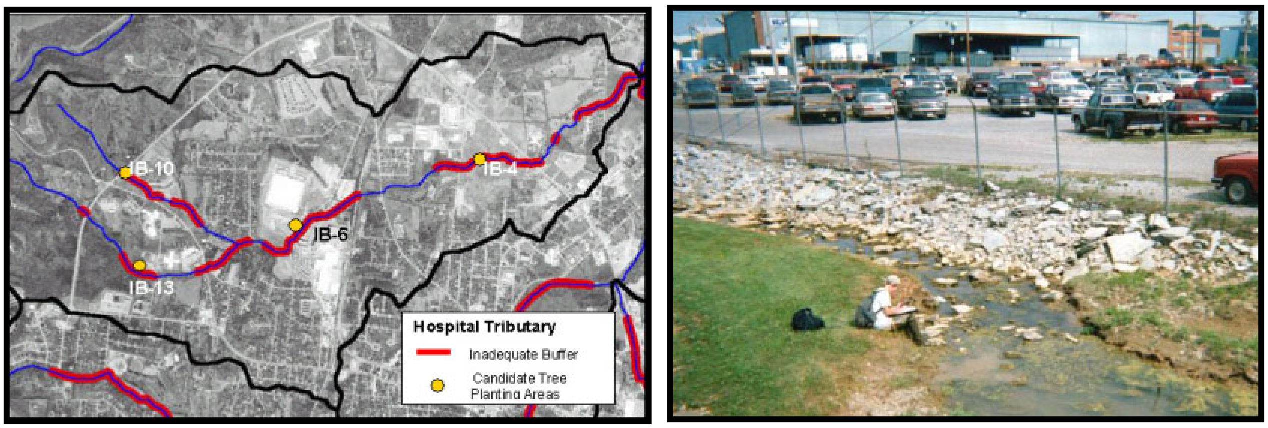


Figure 5.2: Location of impacted buffers and potential reforestation sites in Hospital Tributary subwatershed in Tennessee

Table 5.2: Summary of Continuous Stream Walk Assessment Characteristics	
Characteristics	Description
General Description	• Identifies potential projects in stream corridor • Characterizes in-stream habitat by reach
Scoring System	• Potential projects: 1-5 scale for impacts for severity, correctability, and accessibility • In-stream habitat: 10 parameters rated as optimal, suboptimal, marginal or poor
Land Type	• High-gradient and low-gradient streams
Type of Watershed	• Non-tidal[2]
Experience Level	• Moderate
Strengths	• Developed, tried, and tested in Maryland streams • Identifies eight potential types of impacts for streams and records locations • Allows for ranking of projects • Allows for comparison of stream reaches • Can be integrated with outfall mapping and IDDE[3] programs
Weaknesses	• Require modifications for agriculturally impacted and coastal plain streams • Can be time intensive for staff • Requires major post processing effort
1: Field sheets are provided in User's Guide Tool 17 *2: Protocols should and can be customized to address regional stream conditions and unique planning goals*	

B. Conduct Upland Assessments

Watershed-related field assessment methods typically focus on the stream corridor with less attention paid to upland areas where neighborhoods and businesses are located. However, these upland areas are important in watershed planning since they contribute stormwater pollutants to the stream corridor. The Unified Subwatershed and Site Reconnaissance (USSR) is a comprehensive survey of upland areas to identify potential pollutant sources and restoration opportunities of the watershed (see Table 5.3 and Figure 5.3). When the USA or SCA is combined with the USSR, they generate sufficient data to devise and select which project investigations will be pursued in the next step. Field sheets for the USSR are provided in User's Guide Tool 18, and more details can be found in Wright *et al.*, 2004.

Table 5.3: How the USSR Helps in Watershed Planning

Neighborhoods

- Evaluates pollutant-producing behaviors in individual neighborhoods and assigns a pollution severity index for screening purposes
- Rates each neighborhood for overall restoration potential and identifies specific restoration projects
- Examines the feasibility of on-site stormwater retrofits
- Indicates restoration projects that may require more direct municipal assistance for implementation (tree planting, storm drain stenciling, etc.)

Hotspots

- Creates an inventory of stormwater hotspots, including regulated and non-regulated sites
- Rates the severity of each hotspot with regard to its potential to generate stormwater runoff or illicit discharges
- Suggests appropriate follow-up actions for each hotspot, including referral for immediate enforcement
- Examines the feasibility of on-site stormwater retrofits

Pervious Areas (see Figure 5.3)

- Evaluates the current condition of natural area remnants and their potential management needs
- Determines the reforestation potential of large pervious areas

Streets and Storm Drains

- Estimates the severity of pollutant accumulation on roads and within storm drain systems
- Assesses large parking areas for stormwater retrofit potential
- Rates the feasibility of four municipal maintenance strategies

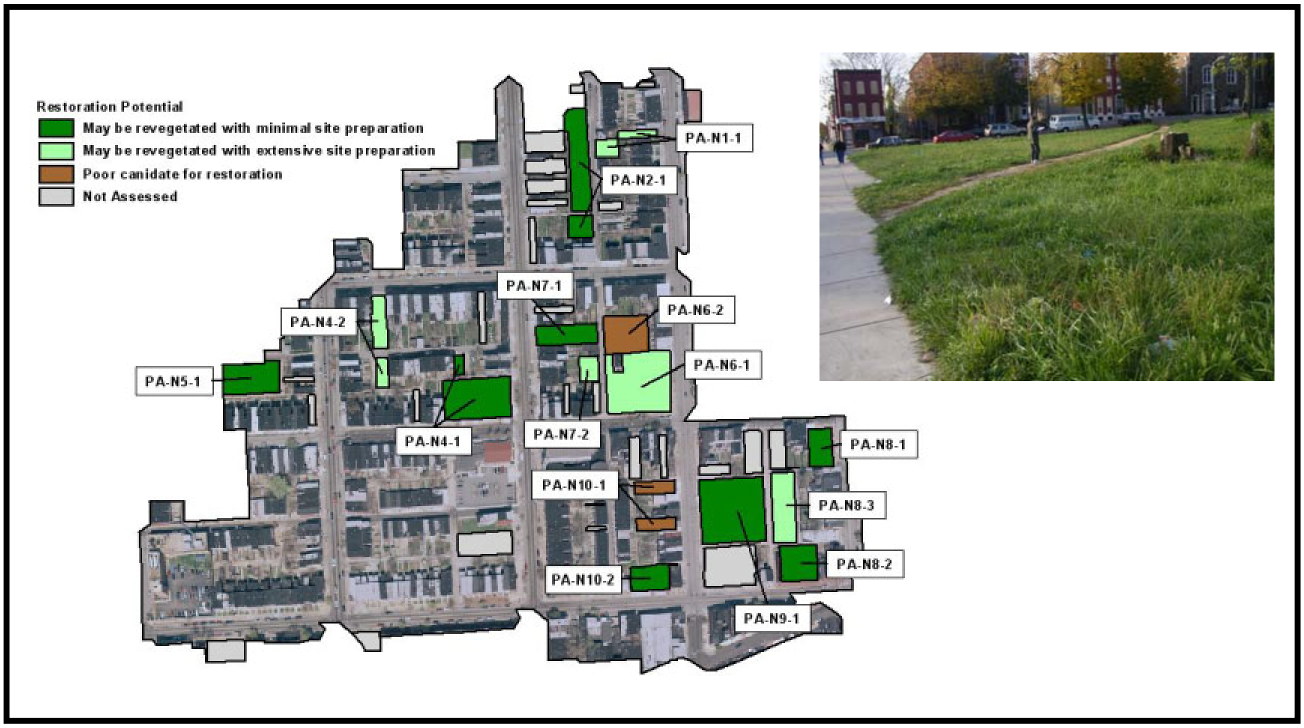


Figure 5.3: Restoration potential of pervious areas identified during the USSR in a subwatershed of Watershed 263 in Baltimore, Maryland

C. Conduct Project Investigations

P-16 Field Assessments

This method involves field assessment to collect the data needed to develop workable concept designs for individual protection and restoration projects. Nine different types of project investigations can be performed with the exact number determined during the scoping phase (see Chapter 3). After potential sites are investigated in the field, site data and mapping are analyzed to create simple concept designs for each project. For more information on developing project concepts designs, see Chapter 4.

Most project investigations can be completed in a manner of a few hours or days, and are used to develop a basic concept design for each project. Most project investigations are initially identified through stream and upland assessments. Table 5.4 indicates the approximate level of effort needed to visit and assess each candidate site for each of the eight surveys. Each project investigation also requires additional analysis back in the office to work up the project concept design; the average staff time needed for each type of concept design is also provided in Table 5.4. The basic scopes of the nine project investigations are provided below and where possible field forms are provided in User's Guide Tool 19. Because of the time intensive nature of these investigations, they are typically conducted in a few select subwatersheds rather than the entire watershed. The method, "Classifying and Ranking Subwatersheds" presented in Chapter 4 may be able to help the core team identify what project investigations are appropriate for which subwatersheds.

Table 5.4: Summary of the Project Investigations			
Project Investigation	Staff Time Per Investigation		
	Unit	Project Investigation	Project Concept Design
Retrofit Reconnaissance Inventory (RRI)	Storage site	4 hrs	8 hrs
Stream Repair Inventory (SRI)	Survey reach	4 hrs	6 hrs
Urban Reforestation Site Assessment (URSA)	Planting site	2 hrs	6 hrs
Discharge Prevention Investigations (DPI)	Problem outfall	1 hr	4 hrs
Source Control Plan (SCP)	Subwatershed	20 hrs	140 hrs
Municipal Operations Analysis (MOA)	Community	8 hrs	24 hrs
Sensitive Areas Assessment	Sensitive area	Varies	N/A
Pasture Assessment for Water Resource Protection *(Ladd and Frankenburger, no date)*	Pasture and farm	4 hrs	Varies by project

Retrofit Reconnaissance Inventory

A retrofit reconnaissance inventory (RRI) is a rapid field assessment of potential storage and on-site retrofit sites conducted across a subwatershed. Retrofits provide stormwater treatment in locations where practices previously did not exist or were ineffective, and include modification to existing stormwater practices or construction of new practices (see Figure 5.4). The purpose of the RRI is to verify the feasibility of candidate sites and to produce an initial retrofit concept design. Typical sites that may be investigated for possible retrofitting include culverts, storm drain outfalls, highway rights-of-way, open spaces, parking lots, and existing detention ponds.

Candidate retrofit sites are identified through the SCA or USA and USSR surveys and detailed analysis of storm drain maps. RRI field forms are provided in User's Guide Tool 19.

Figure 5.4: Retrofit inventory map (left) and one retrofit example (right) in the Weems Creek watershed in Annapolis, Maryland.

Stream Repair Investigation

The problem reaches identified during the SCA or USA are used as the starting point for a Stream Repair Investigation (SRI). The SRI is used to rapidly develop concept designs for stream repair projects within defined survey reaches. Each concept provides a general sense of the type or combination of stream repair practices to be applied, along with their estimated cost and feasibility. The SRI involves a visit to the project reach to collect more stream assessment data, and work up a more detailed design sketch. Basic information is recorded on an SRI field form for each defined project reach (see User's Guide Tool 19). More information and guidance on completing the field form can be found in Schueler and Brown (2004).

Urban Reforestation Site Assessment

The purpose of an Urban Reforestation Site Assessment (URSA) is to collect data on the most promising reforestation sites in a watershed. Potential reforestation sites are identified initially through the sensitive areas analysis, and additional sites are obtained directly from the inadequate buffer data compiled as part of the SCA or USA, and the pervious area data completed during the USSR. If conducting this assessment, the Core Team should utilize the expertise of the local County forester.

Information collected during an URSA is used to select appropriate species for the site, determine the size and layout of the planting area, and develop a detailed planting plan. The URSA evaluates the following major elements at each potential reforestation site to develop an effective planting strategy: climate, topography, vegetation, soils, hydrology, potential planting conflicts, and planting and maintenance logistics. This data is then used to design reforestation projects. An URSA field form is provided in User's Guide Tool 19. More information and guidance on completing the field form can be found in Cappiella *et al.*, (2006; in press).

Discharge Prevention Investigations

A Discharge Prevention Investigation involves three phases of field assessments (see User's Guide Tool 19) to find suspect outfalls or discharges and track down and fix their specific source:

1. <u>Find Suspect Outfalls in the Subwatershed:</u> Two monitoring techniques can be used to isolate the problem outfalls. The first technique involves dry weather monitoring of in-stream indicators such as bacteria that signify the presence of a possible wastewater discharge. The second technique systematically inspects all outfalls in the stream network to discover flowing outfalls or evidence of past discharge events. Problem outfalls are then tested using a group of water quality indicators to determine the nature and probable source of the discharge. The SCA or USA can be used to initially screen for suspect outfalls within the stream corridor.

2. <u>Trace Problem Back up the Storm Drain Network:</u> The search may involve a drainage area investigation at the surface of the catchment to match the discharge to a specific business operation, or may entail an underground trunk investigation whereby strategic manholes are sampled to narrow down the probable location of the discharge source within the storm drain pipe network.

3. Isolate Specific Illicit Connections within the System: Once a discharge has been narrowed down to a specific pipe segment, the last phase isolates the problem connection through dye testing, smoke testing or video surveillance so that the discharge can be matched to a specific owner or operator. Once the connection is traced, enforcement actions are taken to fix or eliminate the discharge.

These methods are designed to find illicit discharges within the storm drain system; slightly different methods are utilized to investigate leaks, spills and overflows from the sanitary sewer system. More guidance on methods for finding and fixing illicit discharges and completing the field form can be found in Brown *et al.* (2004).

Source Control Plan

A Source Control Plan (SCP) represents the concept design for the delivery of neighborhood stewardship and hotspot pollution prevention practices. An SCP defines the focus, targets and methods to deliver source control practices within a subwatershed, and is based on the results of earlier USSR surveys. The product of the SCP is a program to target source control practices to reduce priority pollution source areas, along with a budget and delivery system to implement them. This enables non-structural source control practices to be directly compared against structural restoration practices such as retrofits and stream repairs. The 10 basic steps involved in preparing an SCP are briefly summarized below:

1. Select key pollutant of concern
2. Link pollutant to key subwatershed indicators
3. Locate specific pollutant source areas in the subwatershed
4. Identify and understand priority outreach targets
5. Develop overall source control strategy
6. Craft a clear and simple message
7. Select the most effective outreach techniques
8. Choose the mix of source control practices
9. Estimate subwatershed source control budget
10. Put together partnership to distribute practices

More guidance on the methods to prepare an SCP for a subwatershed can be found in Schueler *et al.* (2004).

Municipal Operations Analysis

A Municipal Operations Analysis (MOA) investigates opportunities in the subwatershed where municipal operations could be improved to better support watershed planning goals. While technically not a field assessment, the analysis requires visits to many local offices and municipal sites to determine the current level of practice. As many as 10 different municipal operations are inspected to evaluate whether changed practices could improve water quality, including:

1. Assessing street sweeping feasibility
2. Assessing catch basin cleanouts
3. Inspecting municipal hotspot facilities
4. Reviewing road maintenance practices
5. Reviewing employee training

6. Investigating subwatershed sewage discharges
7. Assessing pollution hotline reports and spill response
8. Identifying existing municipal stewardship services
9. Analyzing future subwatershed development
10. Inspecting existing stormwater treatment practices

More guidance on conducting the MOA can be found in Schueler and Kitchell (2005).

Sensitive Areas Assessments

The purpose of sensitive area assessments is to generate a list of priority areas for land conservation. Potential assessment areas are initially identified through the sensitive areas inventory outlined in Chapter 4. Field data gathered from the assessments, combined with vulnerability to future development should dictate each sensitive area's prioritization for conservation (see Figure 5.5). Many assessments are available that evaluate the quality of each area. A select few are discussed below.

Contiguous Forest Assessment

According to MD DNR, contiguous forest, also referred to as potential Forest Interior Dwelling Species (FIDS) habitat, is defined as "a forest tract that meets either of the following conditions: a) greater than 50 acres in size and containing at least 10 acres of forest interior habitat (forest greater than 300 feet from the nearest forest edge) or b) riparian forests that are, on average, at least 300 feet in total width and greater than 50 acres in total forest area."

Initial screening of field candidate tracts should be determined using the sensitive areas inventory (see Chapter 4). Field assessments should be performed at randomly selected sites along a pre-determined tract transect. For a tract less than 100 acres, three points per tract are usually enough; larger tracts may warrant additional sampling points. Each site should be evaluated in the field by assessing forest community, structure and canopy. The field assessment also verifies forest contiguity by looking for roads, clearing or recent development. Other factors evaluated in the assessment include forest structure, understory conditions, invasive species, and diseases. A contiguous forest field data sheet is provided in User's Guide Tool 19.

Rare, Threatened and Endangered Species Assessment

Habitat is the key factor while trying to locate and protect Rare, Threatened and Endangered species (RTE). RTE species are commonly reduced to that status due to reduced or negatively impacted habitat in the past. Prior to conducting a field assessment of RTE habitat, the core team should contact MD DNR to obtain existing data and then identify these habitats through the sensitive areas inventory presented in Chapter 4. At a minimum, the field assessment should survey the site to assess population status and potential threats to their health (e.g., the presence of invasive species or development). A rare, threatened and endangered species field data sheet is provided in User's Guide Tool 19.

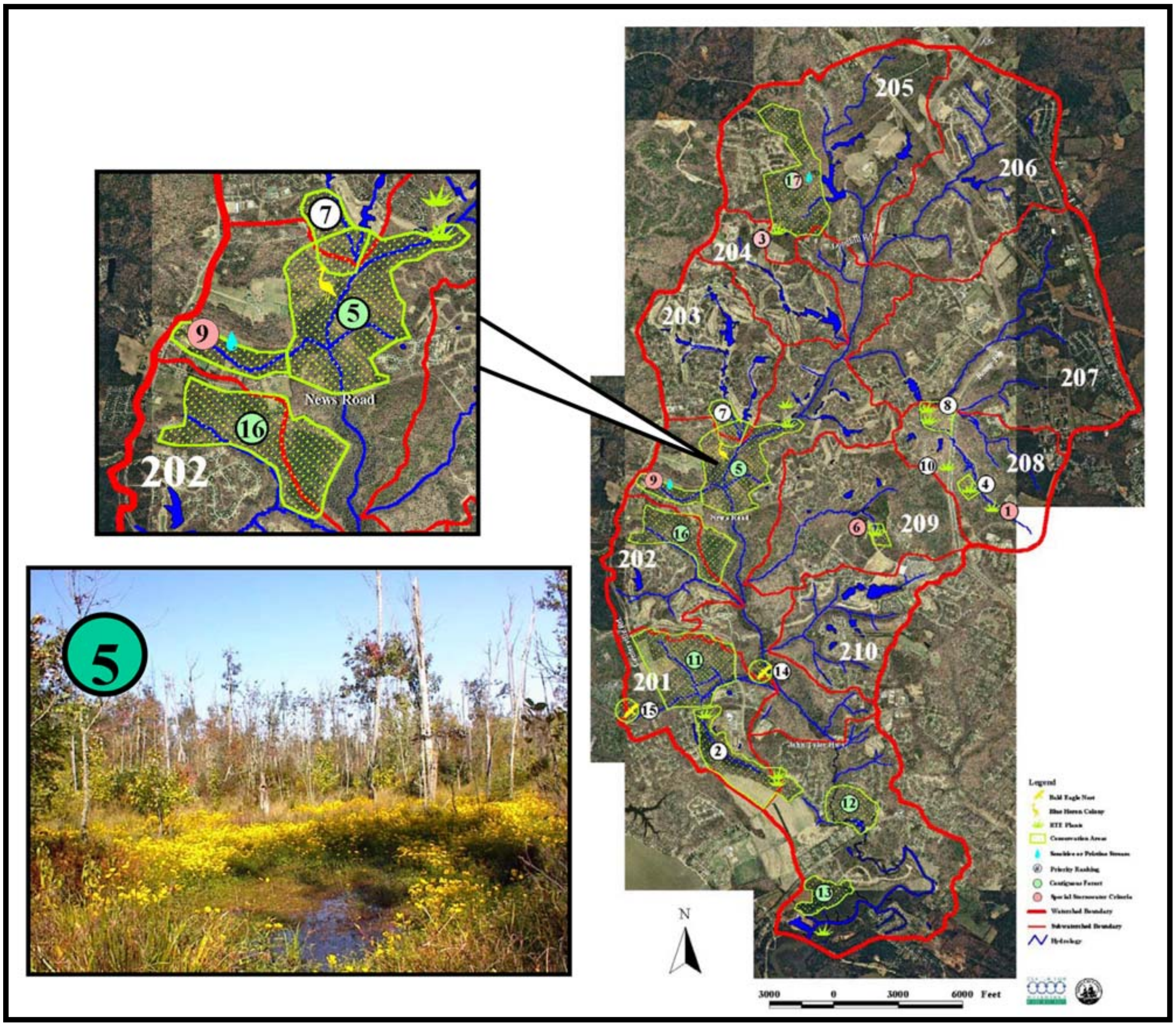


Figure 5.5: Sensitive areas assessment for Powhatan Creek watershed, Virginia

<u>Wetland Assessment</u>

The purpose of a wetland assessment is to evaluate potential wetland protection and restoration sites identified through the sensitive areas inventory (Chapter 4) to verify their existence and type, and assess their condition, functional capacity, and restorability. Wetland condition refers to the degree to which the wetland has been impacted by surrounding land use and other activities, while wetland functional capacity refers to the capacity of a wetland to perform specific functions, such as provide wildlife habitat, water quality treatment, or flood control. More than 90 wetland assessment protocols exist to evaluate wetland function and/or condition. Guidance on selecting a method appropriate for the wetland type(s), purpose, region, and parameters of interest is provided by Bartoldus (2000), Kusler (2003), and MDE (1997a). A Maryland-specific method called A Method for the Assessment of Wetland Functions (MDE, 1997a; Fugro East, 1995) was developed by MDE for the evaluation of non-tidal palustrine vegetated wetlands. This method is used for inventory or planning purposes, and evaluates hydrology, water quality, and habitat functions.

Some wetland assessment protocols also evaluate the restorability of a site. Wetland restoration modifies the site hydrology, elevation, soils, or plant community to enhance the functions of a degraded wetland or a former wetland. Potential wetland restoration sites identified during the sensitive areas analysis can be evaluated during a wetland assessment to determine restoration feasibility. This includes looking at whether the proposed project is compatible with surrounding land use, determining the extent of modifications to elevation and hydrology, and determining if a nearby seed source is available.

Pasture Assessment for Water Resource Protection

This pasture assessment (Ladd and Frankenburger, ND) is used to locate potential water quality degradation areas of farms and create an action plan to help remediate the problems. Areas of concern are identified using the "Quick Check" assessment, which covers well protection; grazing, forage, stream, ditch, and wetlands management; nutrient management; and soil conservation. The assessment also includes an Action Plan form which utilizes information from the worksheet to provide recommendations to address the areas of concern. Various references are provided to help design solutions for problem areas. Project concept designs will vary based on the problem(s) found and may include well testing, grazing management, erosion control, cattle exclusion fencing, stream buffer plantings, pasture monitoring, or pollution control. Completing an action plan and recording actions can help farmers create a record of their efforts to protect water quality. This assessment is available online at: www.ecn.purdue.edu/SafeWater/farmasyst/surveys/WQ-39.pdf.

Core teams conducting a watershed plans which include an agricultural project investigation component should contact and/or include the local Soil Conservation District for additional resources, expertise and assessments.

D. Plan for Indicator Monitoring

P-17 Environmental Indicators

As part of the watershed planning process, the core team should map out a plan for measuring success through indicator monitoring. A good monitoring plan should include sentinel monitors, which are fixed, long-term stations that measure long-term trends in selected aquatic indicators over five to ten years. Sentinel monitors measure key biological, physical, habitat or water quality indicators in stream health. (e.g., State's water quality monitoring stations and MD DNR's Maryland Biological Stream Survey stations). Trend monitoring is the best way to determine if stream conditions are improving, watershed goals are being met, and progress towards TMDL implementation is being made. A monitoring plan consists of four basic tasks:

> Where possible, the core team should plan to install sentinel monitors at the onset of watershed implementation and tie-in with existing state monitoring stations.

1. *Identify the right stream quality indicators:* Any indicators measured at sentinel monitoring stations should be directly linked to watershed goals. In addition, the core team should choose indicators that are repeatable, sensitive,

discrete, and relatively inexpensive. Obviously, not all indicators can meet all four of these selection criteria. Table 5.5 summarizes the range of potential indicators that can be used for sentinel monitoring, and compares how well they meet the four indicator selection criteria. The State of Maryland has also developed a set of environmental indicators that are available at www.mde.state.md.us/aboutmde/reports/indicators.asp. These indicators should be used wherever possible for consistency.

Table 5.5: Examples of Sentinel Indicators to Measure Progress Toward Goals

Indicator	*Indicator Strength*	*Potential Source of Information**
Dry Weather Water Quality		
Fecal coliform (or other pathogen indicator)	●	CBP, MD DNR
Nutrients (nitrogen or phosphorus concentrations)	●	EPA, MD DNR
Algal growth (Chlorophyll a or plankton)	⦿	CBP
Dissolved oxygen	⦿	MD DNR
Chemical concentrations (pesticides, metals, etc.)	○	CBP
Chemical concentrations in sediment (pesticides, metals, etc.)	○	CBP, USGS
Total Suspended Solids	⦿	CBP, EPA, MD DNR
Water clarity (turbidity)	⦿	CBP
Biological		
Fish diversity (F-IBI)	●	MD DNR
Aquatic insect diversity (B-IBI)	●	MD DNR
Single indicator species (e.g., striped bass, blue crab, shellfish)	●	MD DNR
Spawning or migration success	⦿	MD DNR
Submerged Aquatic Vegetation (SAV) Coverage	⦿	CBP
Riparian plant diversity	⦿	CBP
Finfish/shellfish contaminant monitoring (metals and pesticides)	○	MDE, MD DNR
Physical and Hydrologic		
Stream habitat index (RBP or RSAT)	●	MD DNR
Riparian habitat index	⦿	MD DNR
Channel/Bank stability (in Physical Habitat Index or SCA)	⦿	MD DNR
Summer stream temperature	⦿	CBP, MD DNR
Average summer baseflow	○	USGS
Community		
Trash and debris levels during annual cleanup	●	
Recreational use	⦿	
Public access	●	
Citizen attitudes toward streams	⦿	

Key
● = Excellent indicator, meets all of the selection criteria
⦿ = Decent indicator, meets 2 or 3 of the selection criteria
○ = Specialized indicator, meets only one selection criteria
* Resources presented here were selected from Tier 1 of the Monitoring Resources in User's Guide Tool 3.
CBP = Chesapeake Bay Program; MD DNR = MD Department of Natural Resources; EPA = U.S. Environmental Protection Agency; USGS = United States Geological Survey.

2. *Locate representative fixed monitoring stations:* At least one fixed sampling station should be located in every subwatershed. Ideally, each station should be established in the same basic location in the subwatershed (e.g., below the most downstream road crossing). Care should be taken to ensure that each station represents stream conditions for the subwatershed as a whole and is not unduly influenced by local factors such as outfalls or pollution discharges.

3. *Create a schedule for annual sampling across all subwatersheds:* The sampling schedule at a sentinel station is determined by the aquatic indicators selected. In most cases, sampling will be scheduled during a common "window" every year at the sentinel station – the same time of day during the same season and under the same flow conditions.

4. *Set up a tracking system to analyze indicator data for long-term trends:* The last consideration in setting up a long-term monitoring plan is setting up a tracking system in anticipation that indicator data will be entered and analyzed from year-to-year. The analysis conducted on this data should be used to track watershed improvement.

Chapter 6: Stakeholder Involvement Methods

Stakeholder involvement methods are used to identify, recruit and structure the involvement of diverse stakeholders throughout the watershed planning process. The methods help align the resources of stakeholders toward common goals and are essential in adopting and implementing any watershed plan. Stakeholder involvement helps ensure that the watershed plan is realistic and scientifically sound, and that it reflects community values and desires. The goal is to progressively transform stakeholders into partners that support and implement the plan. More details on each of the six methods for stakeholder involvement are provided in User's Guide Tool 20. The methods are:

A. Recruit Stakeholders
B. Educate Stakeholders
C. Refine Local Vision, Goals and Objectives
D. Manage Stakeholder Meetings
E. Hold Neighborhood Consultation Meetings
F. Incorporate External Plan Review

A. Recruit Stakeholders

P-18 Stakeholder Involvement

This method is used to identify and recruit stakeholders that live or work in the watershed to participate in the planning process. Common stakeholder targets include civic groups, churches, neighborhood associations, schools, institutional landowners, businesses, and other groups.

Effective stakeholder identification and recruitment consists of six basic tasks, as described below:

1. *Analyze subwatershed maps:* Subwatershed maps should be carefully analyzed to locate potential stakeholders such as schools, large institutions, churches, parks, and large landowners. The core team should also identify other cooperatives with similar goals such as hunt and fish clubs. Other organizations such as power plants and local businesses may represent an opportunity for corporate sponsorship.

2. *Get contact data for neighborhood associations and civic groups:* Not all stakeholders show up on maps so the local agency responsible for community planning should be contacted to find out if any active neighborhood, civic or homeowner associations are present in the subwatershed and acquire current contact information.

3. *Interview community multipliers:* Community multipliers are people who not only actively seek environmental information, but also are predisposed to support and adopt stewardship practices. Examples include participants in churches, schools, recreational groups, parks, and business organizations. These individuals should be interviewed to expand the stakeholder list. Community multipliers are very active and influential in

civic affairs, and are five times more likely to attend a community meeting than their peers (NEETF, 2003) and can bring in additional stakeholders.

4. *Develop a contact database:* In this task, a database is assembled that contains up-to-date contact information on existing, new and potential stakeholders in the subwatershed. The database should contain names, mailing addresses, phone numbers, and email information for each stakeholder, and be capable of quickly printing mailing labels and email lists for outreach efforts.

5. *Survey stakeholders*: The team should find out how individual stakeholders want to be involved in the planning process, and more specifically, their preferences as to where and when they want to meet. This intelligence is critical to schedule meeting times and places.

6. *Deliver materials:* In the last task, invitations and educational materials are sent to potential stakeholders to recruit them into the planning process. Several different outreach techniques (invitation letters, fact sheets, newspaper articles, etc.) should be used to recruit the greatest number of stakeholders, and let them know about the watershed planning process.

Local governments may want to consider taking advantage of the stakeholder involvement expertise of the Chesapeake Bay Program's Watershed Planning Assistance office. Available assistance includes staff training on stakeholder involvement and organizing, facilitating, and holding stakeholder meetings. For more information visit: www.chesapeakebay.net/info/watershedplanningassist.cfm.

B. Educate Stakeholders

Stakeholders need to be educated about key watershed problems and solutions, become familiar with watershed planning efforts, and learn the roles they play in the process. Stakeholders may also be given the opportunity to help develop the list of priority subwatersheds. Many stakeholder education resources are available to Maryland communities, which are outlined in User's Guide Tool 21.

Three basic tasks are used to translate and condense data into effective outreach materials to educate new and existing stakeholders:

1. *Translate data:* The real challenge is to distill watershed data into formats that are both accessible and understandable. Simple maps and compelling photographs help stakeholders visualize watershed problems. These images can be combined with extremely concise statements about watershed problems and issues to create a powerful educational message.

2. *Choose outreach techniques:* A broad range of outreach techniques can deliver basic watershed protection and restoration messages to watershed stakeholders (see Table 6.1). Outreach techniques should always include a place where stakeholders can get

more information and offer a way for them to participate, preferably with options for the amount of time and effort needed. Baltimore County's Stream Watch Program is an excellent example of providing stakeholders with varying levels of involvement and is highlighted in the Real World Example below.

4. *Create forums:* Education is intended to motivate stakeholders into action. Therefore it is important to create opportunities for stakeholders to use the information they learn to make better watershed planning decisions. Classifying and Ranking Subwatersheds (see Chapter 4) provide an early opportunity for stakeholders to weigh in and provide direct input into metrics related to citizen concern and community organization.

Table 6.1: Summary of Techniques to Reach Out to Stakeholders	
• Advisory Committees • Bill Stuffer • Briefings • Brochures • Community Facilitators • Community Fairs • Consensus Building Techniques • Daytime Meetings • Displays in Public Spaces • E-mail Updates • Expert Panels • Fact Sheets • Focus Groups • Hotlines • Interviews • Issue Papers • Mail Surveys • News Conference • Newsletters	• Newspaper Advertisements • Newspaper Inserts • Newspaper Story • Night Meetings • Open Houses • Photo Opportunity • Press Releases • Response Sheets • Signing Ceremony • Stream Tours • Subwatershed Plan • Task Forces • Technical Reports • Telephone or Internet Surveys • Watershed Festivals • Watershed Maps • Watershed Website • Workshops
Adapted from IAP2 (2003) and other sources	

Real World Example: Baltimore County's Stream Watch Program

In 2002, Baltimore County initiated a "Stream Watch" pilot program to provide citizen involvement in stream assessment and restoration activities at a level of their own choosing. The pilot program is a joint partnership between the Jones Falls Watershed Association (JFWA), Center for Watershed Protection and Baltimore County Department of Environmental Protection and Resource Management (DEPRM).

There are five levels of adoption under the Stream Watch Program. Each level varies in the type of activities volunteers will complete in their adoption section(s). The following table provides a description of and incentives for each adoption level.

Stream Watch Program Volunteer Descriptions and Incentives		
Level	*Description*	*Incentive/Recognition*
I. Stream Cleaner	Pick up trash and debris	• Web listing/newsletter recognition • Certificate • Bumper sticker • Thank you letter
II. Stream Walker	Identify major in-stream and riparian problems	• Level I incentives • T-shirt
III. Stream Watcher	Assess major in-stream and riparian problems	• Level I and II incentives
IV. Stream Monitor – Bug Collector	Collecting aquatic insects at fixed stations	• Level I incentives
V. Stream Monitor – Snapshot Sampler	Collecting water samples at fixed stations	• Level I incentives
Additional Awards for Multiple Levels of Adoption: • Special Certificate • Additional Mention in Annual Report • Rain Gauge • Volunteer Award		

The data gathered by volunteers is maintained in a database by JFWA and is used to provide DEPRM and JFWA with data on stream health and identify potential stream protection and restoration projects. To date, more than 14 miles have been adopted, with volunteer leaders heading up approximately 40 teams and a total participation of more than 100 volunteers.

In addition to the program, DEPRM also offers grants to locally based non-profit watershed associations to support the Stream Watch program and other citizen-based environmental restoration activities. DEPRM intends to expand "Stream Watch" to all 14 watersheds located within Baltimore County after the successful implementation of the pilot program in the Jones Falls watershed.

Center for Watershed Protection and Jones Falls Watershed Association. 2004. *Developing and Implementing a Stream Watch Program*. Center for Watershed Protection. Ellicott City, MD.

C. Refine Local Vision, Goals and Objectives

Goal-setting requires extensive input from stakeholders to identify important community concerns that should drive local watershed planning efforts. This method creates forums to find out what stakeholders think about watershed planning and the issues they want incorporated into the plan. By listening to a broad group of stakeholders, it is possible to gain broader agreement on the overall goals that will drive local watershed planning efforts.

Many stakeholders have trouble distinguishing between goals and objectives, and many meetings get seriously side-tracked as folks argue about how each should be defined. The core team should devote upfront time to discuss precisely what is meant by each term and provide specific examples. It may be helpful to provide stakeholders with a copy of Table 6.2, which helps identify the differences in terminology.

Table 6.2: Differences between Watershed Goals, Objectives and Indicators

Goals (broad)	*Objectives (specific)*	*Indicators (numeric)*
General statement of purpose or intent	Precise statement of what needs to be done	Measurable parameter of aquatic health directly linked to goal
Expresses what will be broadly accomplished	Outlines the specific actions that need to happen to achieve the goal	Tracks progress made over time in reaching goal
Understood by the public	Instructions to managers	Interpreted by scientists
Single phrase or slogan	Series of bullets that outline what, how, who, when and where	Chart or statistic showing indicator change over time
Examples		
Maintain yellow perch populations	County to prohibit the creation of new fish barriers to upstream spawning areas	Annual change in fish IBI counts measured at station X in Bear Creek
Reduce nitrogen loading to the Bay	Reduce nitrogen loading from residential land by 40% through fertilizer education program	Before and after responses to resident surveys on fertilizer use

The real work in goal-setting should be done in small groups that work to refine and narrow choices. An independent facilitator and notetaker should be pre-designated for each group, taking care to try to achieve the greatest stakeholder diversity. Groups may be assigned specific goal areas to focus on or tackle the job of ranking their most important goals.

It can be frustrating for stakeholders to create goals and objectives from scratch. It is often helpful to kickstart the process by proposing a "strawman" of potential goals and objectives to prompt reaction and stimulate thinking. The strawman should be general and provide several options so that stakeholders do not feel that they are being railroaded toward a preordained conclusion. The initial goals developed prior to scoping out the watershed plan (see Chapter 3) should be included in this list.

The full group is then reconvened, with each small group reporting out its work. The meeting facilitator then looks for common themes among the group, and seeks a general sense of concurrence on major goals and objectives. Extensive word-smithing should be avoided at this stage. Instead, the facilitator should try to get enough detail on key themes and headlines from the group as a whole so that more polished goals can be drafted quickly after the meeting.

All stakeholders should be offered a chance to comment on the final language of the goals, objectives and indicators after they are drafted. In many cases, this may simply involve e-mails or mail-outs to stakeholders, with a fax-back or e-mail reply request to affirm whether they agree, or have additional comments to make. If consensus remains elusive, then a second facilitated meeting or retreat may be needed to hammer out agreement on the final language.

D. Manage Stakeholder Meetings

The first stakeholder meeting is a chance to report on initial results and get feedback from the "nighttime" stakeholders that live and work in the subwatershed. While evening meetings are frequently used for this purpose, it may also be helpful to arrange a weekend subwatershed tour or stream walk. Stakeholder meetings help the core team get the pulse of the community and discover the issues and concerns that should be incorporated into the subwatershed plan. Three tasks are needed to conduct effective stakeholder meetings:

1. *Prepare for the meeting in advance:* The real challenge for most stakeholder meetings is how to develop effective presentation materials to educate stakeholders. A great deal of technical information must be translated into understandable, accessible and condensed formats. One approach that works well is fact sheets that summarize key elements of the initial subwatershed strategy.

2. *Conduct stakeholder meeting*: The meeting should be structured to give stakeholders meaningful outlets to provide input such as small group exercises, brainstorming sessions, and listening stations. It is sometimes hard to resist the temptation to present to stakeholders rather than listen to them, but at least a third of the meeting time should be devoted to listening to their concerns, questions and opinions.

3. *Perform follow-up tasks after meeting:* Follow-up after the initial stakeholder meeting is critical. The outcome of every meeting should be documented, including attendees, action items, upcoming meetings and how stakeholder concerns will be addressed.

   A number of formats can be used to keep stakeholders informed such as meeting minutes, progress reports, project updates and thank you letters. Email is probably the least costly technique, but hard copies probably have a greater hit rate. A few randomly-selected stakeholders should be contacted after the meeting to get their opinion on how future meetings could be improved. The Real World Example from Howard County's Centennial and Wilde Lakes Restoration Plan shows how all residents living in these watersheds were contacted and invited to meetings.

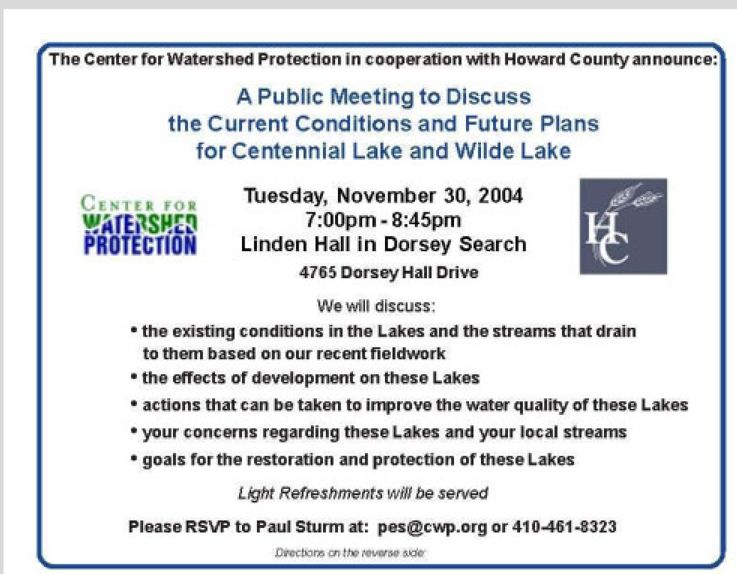
Real World Example: Centennial and Wilde Lakes Watershed Restoration Plan

The Centennial and Wilde Lakes Watershed Restoration Plan, completed in 2005, was undertaken by Howard County as part of their NPDES Phase I MS4 permit requirements. Centennial and Wilde Lakes are located in the Little Patuxent River Watershed and are less than 3.5 square miles and 1.9 square miles, respectively. The plan provided watershed restoration and implementation plans for the two subwatersheds, and is a good example of successful stakeholder contact.

A series of stakeholder meetings were orchestrated to elicit input from stakeholders early in the development of the Restoration Plan. Throughout the process meetings were also held with a number of significant landowners in the watershed including the Howard County Board of Education, Howard County Recreation and Parks Department, and the Columbia Association. The purpose of these meetings was to apprise them of the planning effort and support that may be needed for restoration efforts.

In the Centennial Lake drainage area letters were sent to all the residents living in the watershed, informing them of the project and upcoming meetings (see figure below for an example of how the county contacted residents). In the Wilde Lake watershed, a significantly more developed area, existing community organizations were used to contact and inform residents. As a result of these outreach efforts, approximately 50 stakeholders attended each of the community meetings.

The beginning of each meeting focused on stakeholder education of general watershed principles and findings specific to the Centennial and Wilde Lake watersheds. This gave attendees additional background to thoughtfully develop watershed goals, identify problem areas, and eventually comment on proposed projects.



Center for Watershed Protection and Tetra Tech. 2005. *Centennial and Wilde Lake Watershed Restoration Plan*. Center for Watershed Protection. Ellicott City, MD.

E. Hold Neighborhood Consultation Meetings

Stormwater retrofits and other restoration projects can significantly alter the local landscape that has been around for years. Neighbors and landowners often have many real or perceived concerns about projects such as tree loss, public access, safety, mosquitoes, vermin, ragweed, maintenance, and other competing public/private uses of the land. Consequently, it is important to give neighbors and adjacent landowners an early opportunity to comment on proposed projects and respond to their concerns prior to final design. Forums and field trips are a good way to get feedback from adjacent residents about proposed projects, and are conducted in four tasks:

1. *Define who is adjacent to the project*: The core team should carefully consider how to define who is considered adjacent to each project.

2. *Notify every address within the boundary*: The goal is to notify everyone within the boundary about the proposed project and invite them to the neighborhood consultation meeting. Consequently, a combination of outreach techniques is needed to advertise neighborhood consultation meetings, including letters sent to affected homeowners and landowners and notices placed in community newsletters.

3. *Arrange meeting or project field visit to discuss project*: Neighborhood consultation meetings are normally scheduled in the evening to coincide with a regular homeowner/civic association meeting. Other methods include weekend project walks, one-on-one briefings, and project evaluation workshops. The meetings should clearly explain what is being proposed, what will happen during construction, and what the project will look like when finished.

4. *Incorporate into the project ranking:* Based on the meeting, the team can gauge the degree of neighborhood acceptance for the project, and derive an index value to include in project ranking. In addition, the team should make sure residents know how their input was reflected in project ranking and design, and immediately follow-up with individuals that raise serious project concerns. In many cases, project designs can be easily modified to satisfy neighborhood concerns, but if controversy continues, it may be necessary to drop the projects from further consideration.

F. Solicit External Plan Review

External review is an important ingredient of a watershed plan as it ensures the plan meets the unique needs of both the subwatershed and the community. Generally, at least one final stakeholder meeting is needed to give stakeholders a chance to express their comments on the draft plan. While it may seem redundant to have yet another round of stakeholder involvement, it is inevitable that some important stakeholders that still want to provide input to the final plan have slipped through the cracks. Their input is not merely editorial; stakeholders and partners are asked to endorse the plan and possibly even commit to specific short-term projects. The goal of external plan review is to solidify support for watershed planning and identify and resolve any implementation issues that may arise. Successful external plan review helps demonstrate a broad community consensus for watershed planning, which is often essential to attract the political support needed to get reliable funding.

Upon completion of the plan, it is time to review it to assess how it aligns with the watershed planning principles and watershed goals and objectives. Once this is done, it is time to send the draft plan out for external review. All stakeholders should be included in the review. It may be necessary to take the time to craft a less technical and "glossy" version of the plan for review by the general public and local officials that may not have the knowledge and experience needed to sort through a technical watershed plan. State agencies should be included in the review process, as well. They may be able to provide additional resources, and they will likely need to approve, permit, fund, track and/or monitor implementation projects. Some of the state agencies that should be included in the review of the draft plan are:

- Department of the Environment
- Department of Agriculture
- Department of Natural Resources
- Department of Planning
- Department of Transportation

Once all comments are addressed, the plan is ready to be finalized and adopted by the local government.

Chapter 7. Management Methods

Management methods refer to the products or processes that help agencies, partners and stakeholders agree on key watershed planning decisions. Management methods are described in this chapter, and User's Guide Tool 22 provides additional information on each. The management methods are:

A. Finalize Watershed Goals, Objectives, and Indicators
B. Identify Priority Subwatersheds
C. Compile an Inventory of Potential Projects
D. Draft the Watershed Plan
E. Adopt the Final Plan

A. Finalize Watershed Goals, Objectives and Indicators

The purpose of this method is to finalize clear and measurable goals and objectives to guide the watershed planning process, as well as the indicators that will be used to measure progress. Initial watershed goals were developed prior to beginning the watershed planning process, based on the pollutants of concern (Chapter 3), and these goals were developed further, along with specific objectives and indicators through the stakeholder process (Chapter 6). In this step, the goals, objectives and indicators identified earlier are finalized to ensure that they align with goals of all applicable watershed planning drivers, and to decide whether they should be formally adopted.

Local watershed goals and objectives should always be aligned with the goals from other environmental and planning initiatives and regulatory drivers. The core team should review the following documents to ensure their goals are consistent:

- Chesapeake 2000 Agreement
- Coastal Bays Comprehensive Conservation Management Plan*
- Local comprehensive plans
- Local flood management plans
- Local water and sewer facilities plans
- Maryland Clean Water Action Plan
- Maryland Wetland Conservation Plan
- NPDES Phase I watershed restoration plans*
- Scenic and Wild River resource management plans*
- Source Water Assessment plans*
- TMDL plans*
- Tributary Strategies

** may not apply to all communities*

The final product of this step is a watershed agreement, memorandum of understanding, interagency directive, or consensus statement that is used to clearly articulate and formalize the goals of the watershed plan. This agreement can be executed by elected officials, key stakeholders and/or senior agency leaders, and may be extremely useful in elevating the profile of watershed planning and ensuring greater interagency coordination in subsequent steps. This language can be submitted to agency heads, elected officials or boards of directors for formal adoption.

One way to ensure that watershed goals are met is by incorporating the watershed plan into the comprehensive plan. This can help promote interagency cooperation and consistency, and make implementation a higher priority. Comprehensive plans must be updated every six years, and incorporating watershed plan recommendations at that time can save effort or money. For example, comprehensive plans require a Sensitive Areas element. Many watershed recommendations can be directly incorporated into comprehensive plan sections that address protection of steep slopes, streams, and other sensitive areas.

B. Identify Priority Subwatersheds

The product of this management method is simple: an agreement on which subwatersheds to work on first. Subwatersheds are ranked by the core team (see Chapter 4), primarily based on subwatershed metrics that are a synthesis of mapping and field data, and input from stakeholders. A number of top-ranked subwatersheds are then identified as priorities for further assessment and planning. A short report is prepared that supports the choice of priority subwatersheds, documents assumptions used in the ranking process, and depicts their locations on a simple watershed map. The report should be fewer than 10 pages long, and include longer appendices that detail ranking methods, subwatershed data and stakeholder input.

The draft list of priority subwatersheds is then circulated to local agencies and other stakeholders for review and comment. Further meetings or open forums may be necessary if stakeholders cannot agree on the basis for the ranking. If desired, a long-range plan can be identified for assessing all subwatersheds in the community. This may be particularly important if stakeholders are concerned that watershed planning efforts are being deferred in lower priority subwatersheds.

C. Compile an Inventory of Potential Projects

The management product for this step is an inventory of all feasible projects and land use changes that could be used to protect or restore the watershed to meet the overall goals and objectives. To create this inventory, projects are compiled into a master binder or into the watershed-based GIS. Before assembling the inventory, draft project concept designs should be checked for accuracy and thoroughness, and unique ID numbers should be assigned to each project if this has not already been done. Handwritten entries may need to be neatened and sketches redrawn. The team should also check to see that all field forms, digital photos, sketches, field notes, and other project data are organized into a single project folder. Individual project concept designs are then finalized in the form of a two to four page project summary that includes the feasibility assessment, sketch, narrative and initial cost estimate.

Individual recommendation summaries are then assembled into a master binder that is divided into sections according to the type of project. A table is then created for each section that summarizes the projects by ID number, cost, area treated, and basic description. The table also serves as an index for the section with, individual projects listed in descending order based on size or treatment area, which should always be shown in units consistent with the Chesapeake Bay Model. When completed, the master binder serves as the watershed project archive.

The front-end of the inventory should contain a subwatershed project locator map and a summary matrix that compares the various projects. At this point, the inventory sufficiently organizes the project data to permit project ranking needed for the watershed plan. Figure 7.1 illustrates a map of all restoration projects identified in the Paxton Creek North Subwatershed near Harrisburg, PA.

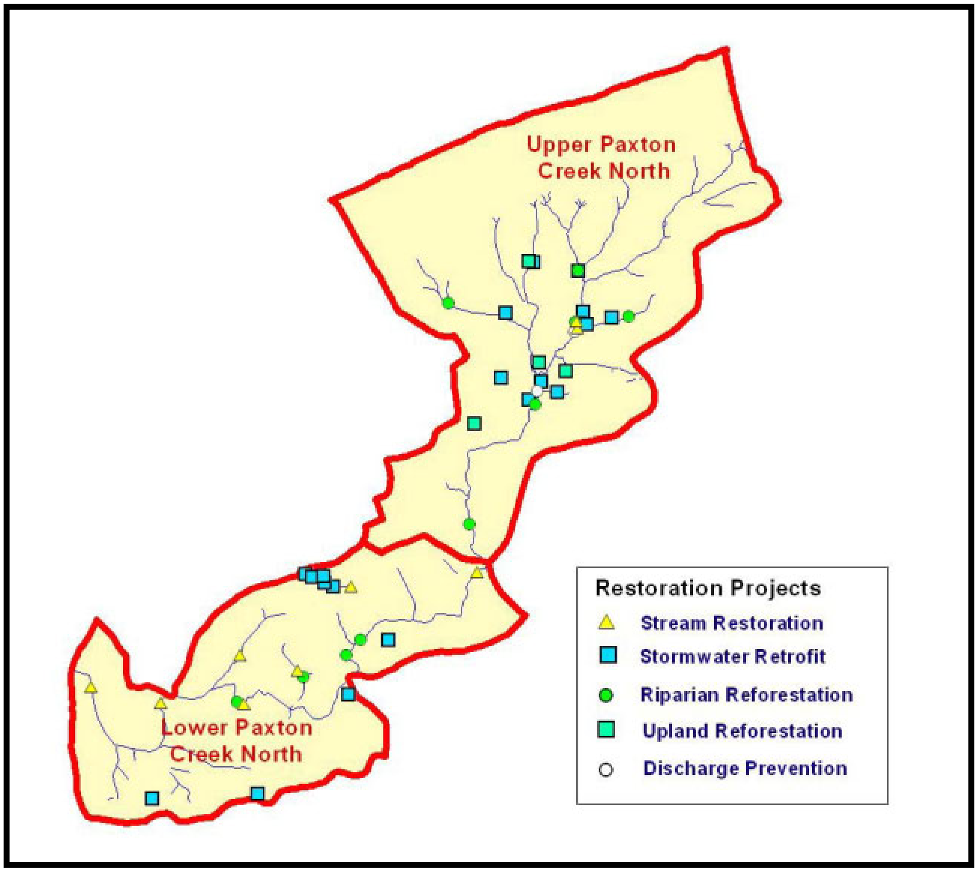


Figure 7.1: Restoration projects in the Paxton Creek North subwatershed, Pennsylvania

D. Draft the Watershed Plan

The product of this management method is a short and concise watershed plan that recommends specific projects and programs to be implemented, along with a watershed management map. Good watershed plans do not need to be long or complex. Instead, they should be written with the punch of a newspaper article, and clearly specify the "what," "why," "when," "where," "how much," and "by whom" of the recommended projects. The core team should brainstorm at this stage to define the specific objectives that the plan is expected to accomplish. The team should try to define objectives that are clear, time-based and measurable. The main body of a good watershed plan should be no more than 20 to 40 pages long, with a table of key recommendations and a watershed map showing specific project locations. The extensive supporting data produced in earlier steps should be consigned to technical appendices, preferably in a second volume. The core team should draft and carefully review the plan outline to make sure it only contains the most essential information needed to make good decisions.

The most important part of the watershed plan is the recommendations. Some examples of potential projects and recommendations are described below and illustrated in Table 7.1.

- Priority protection and restoration projects include the top-ranked protection projects, which may include land conservation projects, and restoration projects identified through project investigations, which include stream restoration, stormwater retrofits, and riparian reforestation

- Regulatory and programmatic recommendations include recommended changes to local codes, ordinances and programs that are derived from the audit of local government capacity to protect the watershed, examples include adopting a stream buffer ordinance, encouraging open space design, and establishing watershed education program.

- Land use changes and management approaches include changes needed to comprehensive plans and subsequently the zoning regulations to align with watershed and subwatershed goals, examples include a transfer of development rights (TDR) program that would transfer development density to a more suitable area.

Table 7.1: Example Recommendations Included in a Watershed Plan

Protection/Restoration Projects	*Regulatory/Programmatic Recommendations*
• Conduct shoreline restoration using living shoreline techniques along Battle Creek to provide protection of an archaeological site and reduce erosion • Retrofit at the unmanaged stormwater outfall located in the Cavalier Country subdivision with an infiltration basin • Conduct stream clean-ups in Middle and Lower Bynum • Preserve the contiguous forest located in the Lower Winters Run and Cranberry Run subwatersheds	• Hire a watershed coordinator who can work with watershed groups to implement recommendations, secure funding, and track progress of project implementation. • Establish river and stream crossing standards to avoid impact and disruption of fish passage • Implement an onsite sewage disposal system management strategy that will include a requirement for septic system inspection at time of sale and tax incentives for homeowners to upgrade • Develop a heightened stormwater plan review for Special Resource Subwatersheds

The recommendations should include an implementation planning table with detailed information on each recommendation that includes the objective, responsible party, measurable indicator, public involvement, programmatic change, estimated cost, potential funding sources, and an implementation timeframe. Table 7.2 provides an example of such a table. At this stage the core team should also consider future partnerships and availability of funding sources such as capital improvement program (CIP) expenditures. The linkages between certain projects are important to maintain and note as well. The success of one project may be dependant on the implementation of another (e.g., stream repair and upstream stormwater retrofit).

The watershed plan should include both short-term (commitments that can be completed within the first year of the plan) and long-term (commitments that will be implemented over the next five to seven years) recommendations, which allows the core team to estimate the annual implementation budget over five to seven years. Make sure the elements needed for restoration projects are specifically identified in the project concept design and project ranking stages.

The core team may also want to consider breaking the full compilation of recommendations into three prioritization tiers with the first tier representing the top watershed recommendations. Tier 2 and 3 recommendations should still be pursued, but monetary and staff resources should initially be directed towards Tier 1 recommendations. There is no exact methodology for prioritization as it will vary from watershed to watershed. However the core team may want to base the prioritization on the following factors:

- Does the recommendation affect a priority subwatershed?
- What is the overall benefit to watershed health?
- Does the recommendation directly meet watershed goals?
- Does the recommendation require more assess or program development?
- Is there strong stakeholder interest or support in the recommendation?
- Is there a time sensitivity element associated with the recommendation (e.g., conservation of a contiguous forest tract that is under development pressure)?

Table 7.2 Example of an Implementation Planning Table (modified from the Upper Monocacy WRAS)

Objective/Recommendation	*Responsible Party*	*Schedule*	*Measurable Indicators*	*Public Involvement*	*Additional Benefit*	*Cost Estimate and Funding Sources*
#1: Fence livestock herds out of streams in Glade and Fishing Creek subwatersheds	Agricultural Practices Working Group, landowners, SCD*	3 properties each year	25,315 linear ft in pasture; increase in IBI score	Outreach to farmers whose livestock have stream access	Improved herd health	cattle fencing: ~2.60/linear foot; CBT or NFWF grant
#30: Teach homeowners six "greener" lifestyle practices; increase participation by 5%/ year	Citizen Practices Working Group	Ongoing	Number of those attending workshops	Outreach to homeowners	Rain barrels retrofitted by developmentally disabled	$15,000/yr

*SCD: Soil Conservation District

The last step in plan writing involves assembling the appendices that provide the technical support to the overall plan. As noted earlier, it may be preferable to include these in a second volume, since fewer stakeholders are interested in the technical details of the plans. Table 7.3 recommends a table of contents for a watershed plan that organizes information in a relatively condensed format.

Table 7.3: Typical Table of Contents for a Watershed Plan
Executive Summary • List of priority projects – both a table and a map of project locations • Programmatic/regulatory recommendations • Implementation schedule and costs
Introduction • Background discussion on the watershed and its natural/historical/environmental resources • Layout of the document
Management Practices/Projects • Brief introduction to methods and assessments conducted with a few examples of the types of projects recommended by each assessment
Watershed-wide Goals and Recommendations • These include regulatory and programmatic recommendations as well as additional staffing needs, etc.
*Subwatershed Management Strategies** • Review of subwatershed objectives • Table and brief discussion of subwatershed characteristics (area, land uses, current and future IC) • Review of existing conditions (brief discussion of stream and upland surveys) and problems found during field work • Recommendations (with a paragraph and picture discussing each one and a table summarizing costs, responsible party, implementation schedule)
Appendices - potential appendices include: • Summary table and map of all potential projects • Memos outlining WTM or modeling results and methods for ranking projects • Summary of stakeholder meetings organized by subwatershed • Baseline report
** If the watershed is less than 100 square miles and consists of approximately 10 subwatersheds, each one should have its own chapter. If, however, there is a significantly higher number, it may be worth grouping similar subwatersheds together into chapters based on management classification.*

E. Adopt the Final Plan

The purpose of this management method is to put together a strategy to get the watershed plan adopted, funded, and implemented over time. This requires a keen grasp of the local political landscape, partnership structure, and budgetary process. The core team should think through how it will navigate the plan through the political and bureaucratic system. The strategy will be unique in every community, but often involves identifying funding strategies and a timeframe for implementation, establishing a partnership structure for getting the plan implemented, deciding on commitments for short-term protection and restoration projects, establishing capital and operating budget needs, and scheduling the briefings needed for plan adoption.

There is no universal method to adopt the final plan since the local political process, partnership structure, and budgetary system are different in every community. Elected officials are obviously the most important stakeholder group, but they often want to know if local agencies, regulators, local media, and other constituent groups support its adoption. Some potential options for getting the plan adopted include:

- *Community incorporates the watershed plan as part of the comprehensive plan* - comprehensive plans require a Sensitive Areas element, and many of the recommendations from the watershed plan can be incorporated into this section. The Real World Example on the next page provides an example of a county that incorporated certain watershed plan recommendations into its comprehensive plan.

- *Elected officials endorse the entire plan* – the best outcome would be that local elected officials would endorse the watershed plan in its entirety.

- *Elected officials endorse the goals of the plan* – watershed goals are best formalized through a watershed agreement, memorandum of understanding, interagency directive or consensus statement that clearly articulates the goals and the local commitment to achieve them. Assuming consensus is reached, final language is then submitted to agency heads, elected officials or board of directors for formal adoption.

- *Local government commits to funding implementation of the plan* – by agreeing to fund implementation, the local government is endorsing the recommendations of the watershed plan. This may be a more feasible option for the local government, depending on the political atmosphere.

The core team may want to consider the following factors carefully before introducing the plan into the political process.

The political landscape and budgetary situation is different in every community, but it is surprising how many local watershed plans are developed with little regard to either important factor. Quite simply, a good plan submitted at a bad time may not be adopted. At this stage, the core team should make sure they know which way the political and budgetary winds blow, by getting good answers to the following questions:

- When is the next election cycle in the community?
- Should critical decisions for political bodies be deferred into non-election years?
- How tight are local budgets expected to be in the next few years?
- How favorably disposed are elected officials to watershed planning issues?
- Is more education needed to get them up to speed?
- What key issues will motivate them to support watershed planning (community support, environmental concern, regulatory compliance, etc.)

- What issues might introduce barriers to additional spending? (budget shortfalls, concern about new spending, competing priorities, etc.)
- How much lead time is needed to get projects inserted into local operating and capital budgets?
- How much time is needed to complete project designs? To complete construction?
- Who are the key staff that make budget decisions and when is the right time and the right way to approach them?
- Are there any existing budget accounts or line items where funds can be added to support watershed planning and implementation?

Real World Example: Worcester County Comprehensive Plan Update

In 2001, Worcester County on Maryland's Eastern Shore set out to update its comprehensive plan. During the course of the update, in 2004, the County worked with MD DNR under its Watershed Restoration Action Strategy program to craft a watershed plan for the Isle of Wight Bay watershed. This plan offered many recommendations for both programmatic/regulatory changes and for conservation and restoration projects. The county incorporated some of these recommendations along with additional recommendations made during a review of its development codes into its updated comprehensive plan.

One example of the goals and objectives set forth in the updated comprehensive plan recommended in the watershed plan calls for implementation of wetland, waterway and other restoration projects consistent with the watershed plans crafted for Isle of Wight and two other Coastal Bays' watersheds that are in progress. It also recommends continuing the watershed planning and restoration process throughout the remainder of the Coastal Bays' watersheds. A third recommendation is to develop a strategy to implement TMDL standards. A final recommendation includes outreach to landowners and citizens to educate them on how they can protect sensitive habitats on their property.

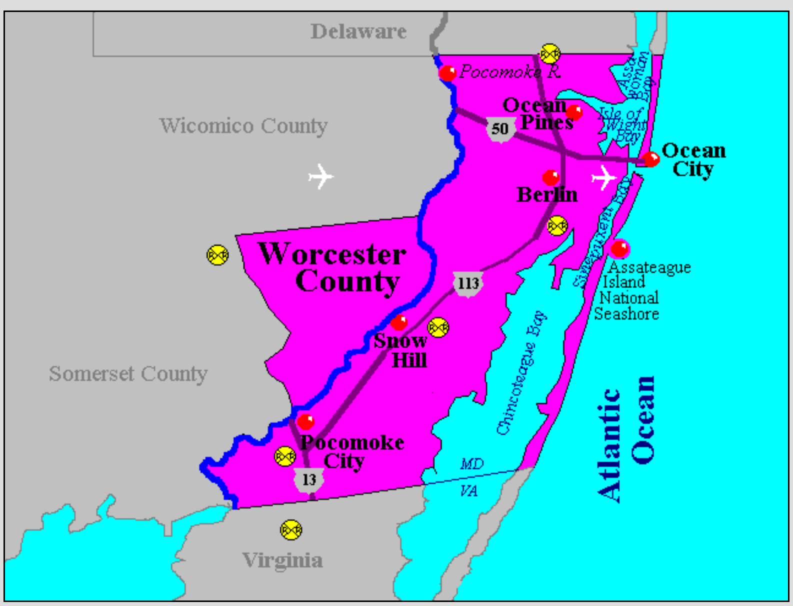


Photo from www.worcestercountyonline.org © 2004 Worcester County Economic Development
Worcester County Department of Comprehensive Planning. 2005.

It is a good idea to try to shift funding toward capital budgets or some other dedicated funding source, which can provide funding over multiple years, and decrease reliance on operating budgets and grants (which seldom can be obligated for more than a year, and can disappear quickly during a budget crunch).

A survey by MD DNR (2004) has assembled data on how many watershed plans have been created and successfully navigated through local political systems across the state. According to the survey of communities that have completed plans for 47 MD watersheds, more than 90% of the plans have been formally adopted or endorsed, or have received funding, and in more than 80% of these watersheds, successful implementation has occurred. The second highest ranked funding source was capital program budgets.

Implementation planning table and project tracking

Data from the implementation planning table should be incorporated into a system that can be used to track projects as they are implemented. The system should store essential data on the design, construction, maintenance and performance of individual protection and restoration projects contained in the watershed plan including costs, responsible parties and complete schedule. For certain water bodies, tracking implementation is required to document the ways in which various projects represent TMDL implementation. The tracking system typically uses a common spreadsheet or GIS to keep the team apprised on project status and stream response and to help improve the delivery of future protection and restoration projects. The core team is responsible for ensuring the implementation of the watershed plan. The core team should consider establishing a citizen committee at the end of the planning process to track implementation over time. This may also have the secondary benefit of sparking the creation of a watershed organization in some areas.

Three tasks are used to create a watershed project tracking system:

1. Determine key project management information to track
2. Continuously update project information in a tracking system
3. Periodically report on status of project implementation

Initial project information can be extracted from the project tracking file prepared during final design and construction. Subsequent project information is entered as the project is inspected, maintained and monitored, using standard forms. No major mapping needs are required for the tracking database, although the geospatial coordinates of projects should be provided so that their locations can be mapped in the watershed.

Progress in project implementation should be compiled in a short annual report or memo distributed to key stakeholders, if budget resources allow. The report should summarize the number, type, and extent of protection or restoration practices implemented in the watershed, with an emphasis on both project successes and failures.

Project tracking also helps ensure that all restoration or protection projects are reported as contributions to TMDL implementation requirements to reduce or offset nonpoint source (NPS) pollution. Sometimes these projects are known by another name such as a stormwater management retrofit or forest conservation, but many of these projects count towards TMDL implementation requirements. These projects also need to be incorporated into the Chesapeake Bay watershed model, and local governments should plan on reporting their activities to the Chesapeake Bay Program in units that the model uses to track NPS pollution reduction. Local governments should also consider reporting project implementation to MD DNR for entry into their BMP Tracking Implementation database that can be found at: http://dnrweb.dnr.state.md.us/watersheds/surf/bmp/.

F. A Concluding Note on Implementation

Implementation is by far the longest step associated with a watershed plan. The purpose of this final step is to sustain momentum and adapt the plan as more experience is gained in project implementation. Much of the watershed planning field is so new that each plan is basically its own watershed experiment. As a result, it is important to institute tracking and monitoring systems. These systems include the internal tracking of the delivery of restoration projects, monitoring of stream indicators at sentinel monitoring stations or performance monitoring of individual restoration projects. Information gathered from tracking systems are then used to revise or improve the plan over a five to seven-year cycle.

The management endpoint is fairly simple – a measurable improvement in the indicators used to define subwatershed quality. Full implementation of the plan may take five years or longer. The core team faces many challenges during this period in how to:

- Sustain progress in delivering restoration projects over time
- Create or sustain a watershed group or similar structure to advocate for the plan
- Monitor trends in stream indicators
- Monitor the performance of practices installed
- Adapt the plan to if the expected improvements do not occur

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