A User's Guide to Watershed Planning in Maryland

December 2005

Prepared by:

Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, MD 21043
www.cwp.org

Prepared for:

Maryland Department of Natural Resources
Watershed Services
580 Taylor Avenue
Tawes State Office Building
Annapolis, MD 21401
www.dnr.maryland.gov

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Prepared by:
Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, MD 21043
www.cwp.org
www.stormwatercenter.net

Prepared for:
Maryland Department of Natural Resources
Watershed Services
580 Taylor Avenue
Annapolis, MD 21401
Toll Free in Maryland: 1(877) 620-8DNR x8809
Out of State: 410-260-8809
TTY Users call via the MD Relay
www.dnr.maryland.gov

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Robert L. Ehrlich, Jr., Governor
Michael S. Steele, Lt. Governor
Ronald Franks, Secretary

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:

- Rebecca Winer
- Karen Cappiella
- Tom Schueler
- Tiffany Wright
- Jennifer Tomlinson
- Emily Corwin
- Chris Swann
- Lauren Lasher

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State and Federal Agency Reviewers:
- Andrea Clarke, USDA, Natural Resources Conservation Service
- Denise Clearwater, Maryland Department of the Environment
- Christine Conn, Maryland Department of Natural Resources
- James George, Maryland Department of the Environment
- Tay Harris, Maryland Department of Planning
- Elizabeth Horsey, Maryland Department of Agriculture
- Danielle Lucid, Maryland Department of the Environment
- Catherine Shanks., Maryland Department of Natural Resource
- Ken Sloate Maryland Department of Natural Resources
- Ken Yetman, Maryland Department of Natural Resources

Local Government Reviewers:
- Shannon Moore, Frederick County
- Nancy Pentz, Baltimore County
- Mary Searing, Anne Arundel County
- Martin Sokolich, Talbot County
- Lise Soukoup, City of Rockville

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- Jamie Baxter, Maryland Department of Natural Resources
- Elizabeth Chaisson, City of Bowie
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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.

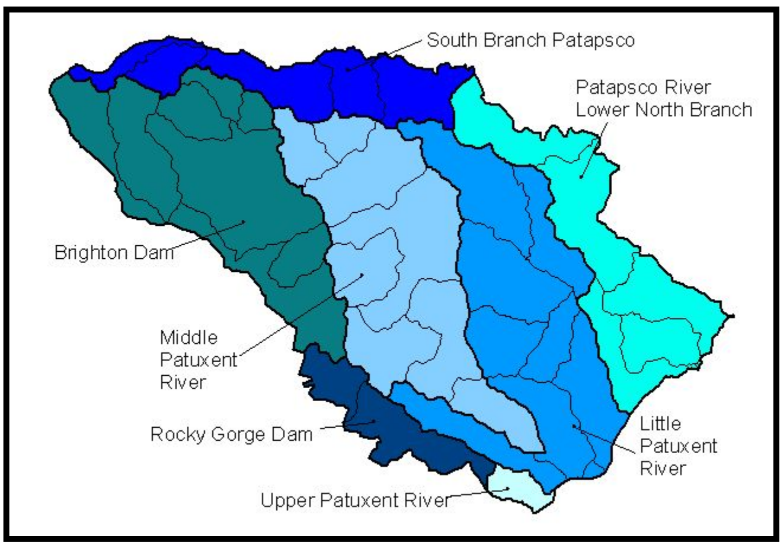


Figure 1.1: Howard County, MD watersheds (labeled) and subwatersheds

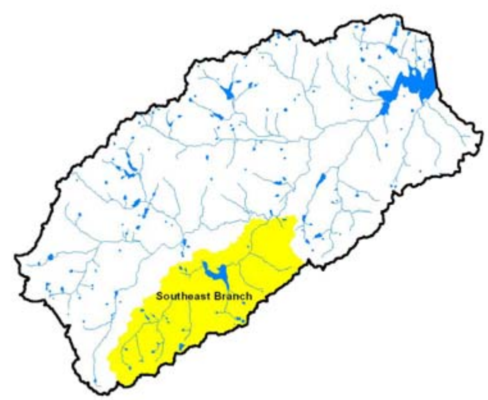
Table 1.2: Geographic Scales of Watershed Planning	
1. Community – Durham County, NC	
Community refers to the entire land area controlled by a single political jurisdiction such as a city, county, village or town. Most communities contain several different watersheds, not all of which may be fully contained 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.	

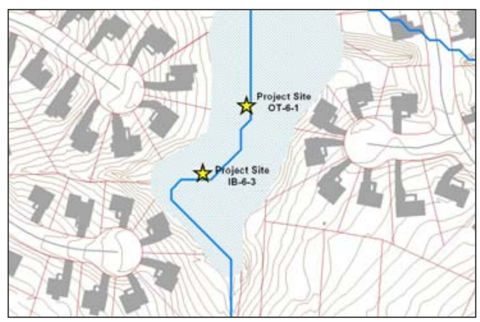
Table 1.2: Geographic Scales of Watershed Planning	
4. Neighborhood -- Lakeridge Corner	
Neighborhoods are an even smaller management unit and are defined as relatively homogenous residential land uses within a subwatershed. Individual neighborhoods have markedly different characteristics and are the locations where protection and restoration projects are implemented. Neighborhoods are also the scale at which community acceptance of these projects is gauged.	
5. Project Site – Sites OT-6-1 and IB-6-3	
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.	

Table 1.3: Using the Subwatershed Scale in Watershed Planning	
Watershed Planning Method	*Rationale for Conducting at the Subwatershed Scale*
Establish a baseline	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.
Classify and rank subwatersheds	In larger watersheds, the most vulnerable or most restorable subwatersheds should be identified in order to focus limited resources and provide rapid results.
Conduct stream and upland assessments	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.
Conduct project investigations	
Plan for indicator monitoring	
Estimate pollutant loads and reductions	Subwatersheds are limited in size where few confounding pollutant sources that can confuse management decisions are present (e.g., agricultural runoff, point sources, etc.).
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.	

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.

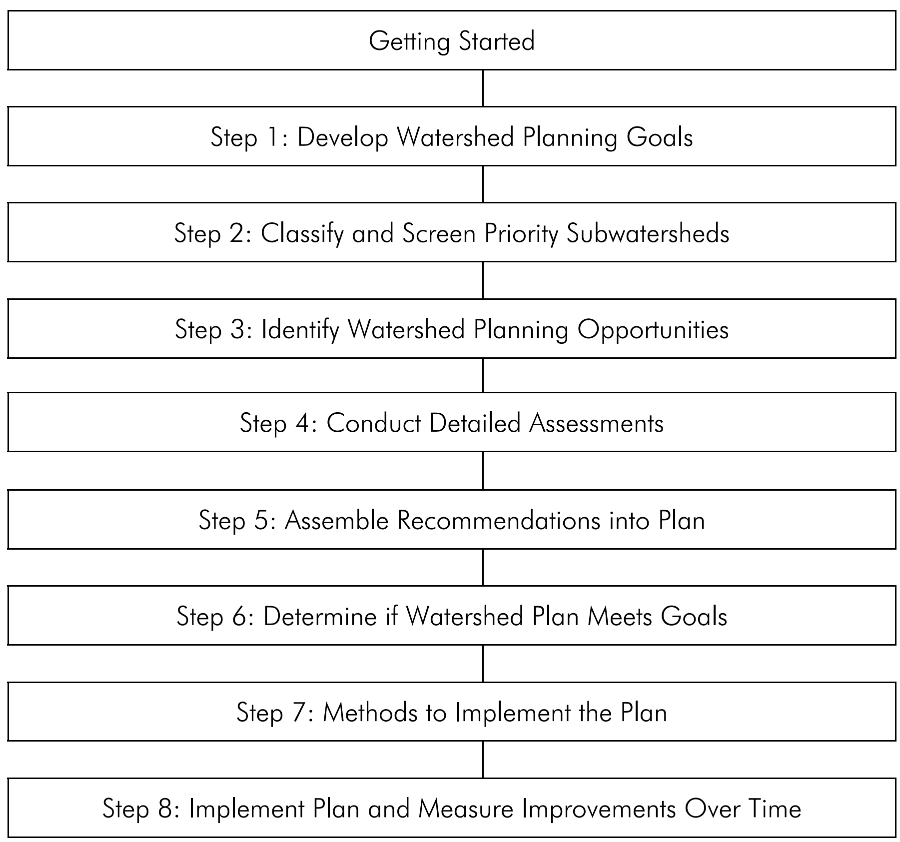


Figure 1.2: The Watershed Planning Process

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

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.

> 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/

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 • Youghioheny • 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.

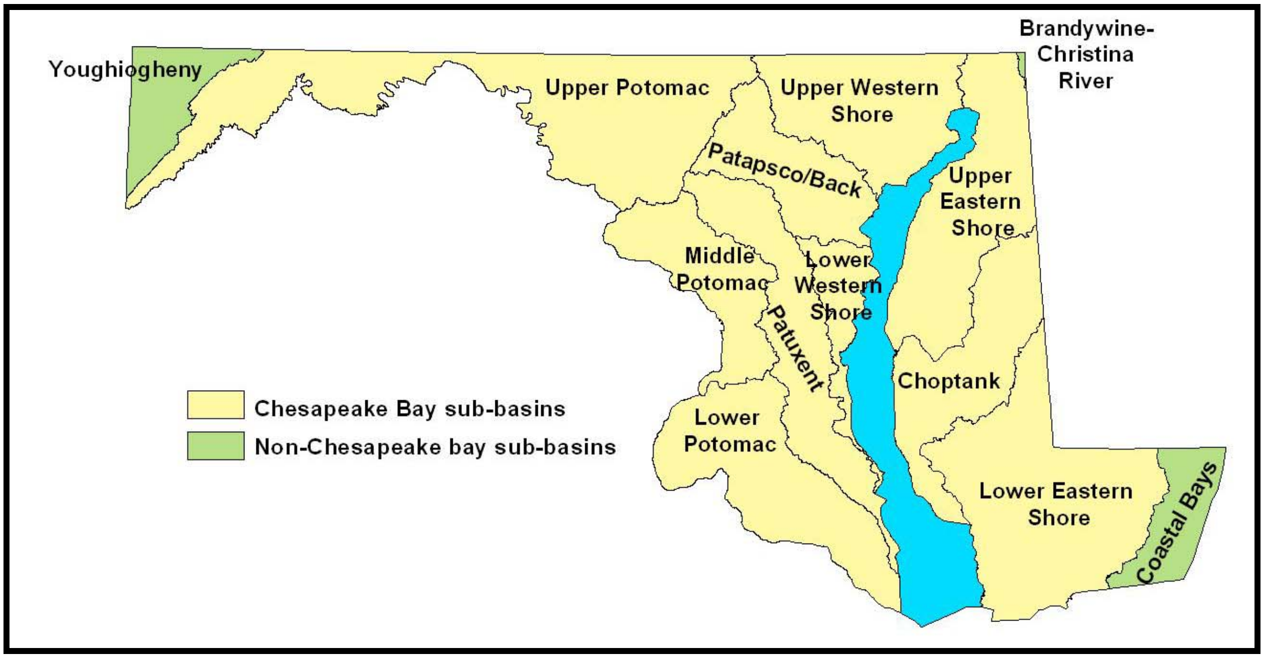


Figure 2.1: Maryland's Major Sub-Basins

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.

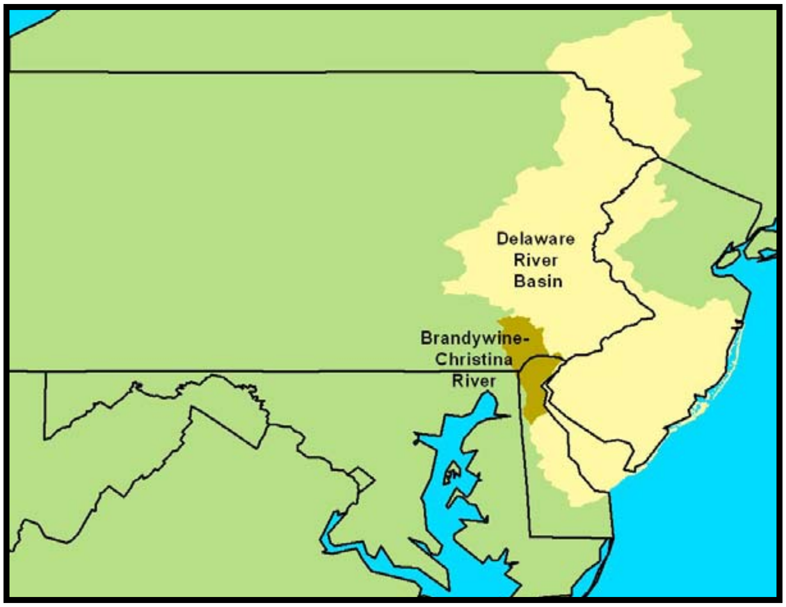


Figure 2.3: Brandywine-Christina Sub-Basin

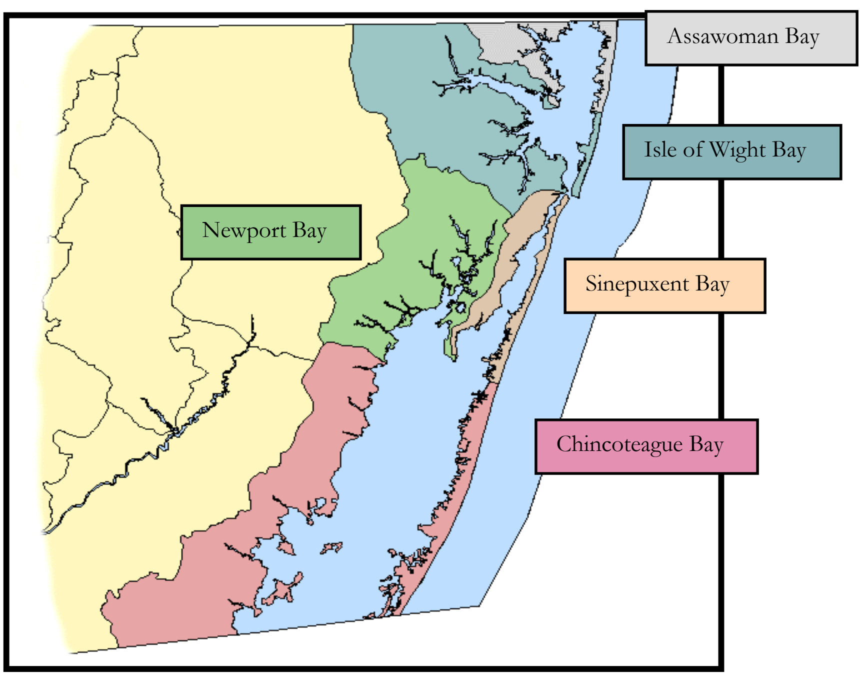


Figure 2.4: Maryland Coastal Bays CCMP Area
(Source: MD DNR, NDa)

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

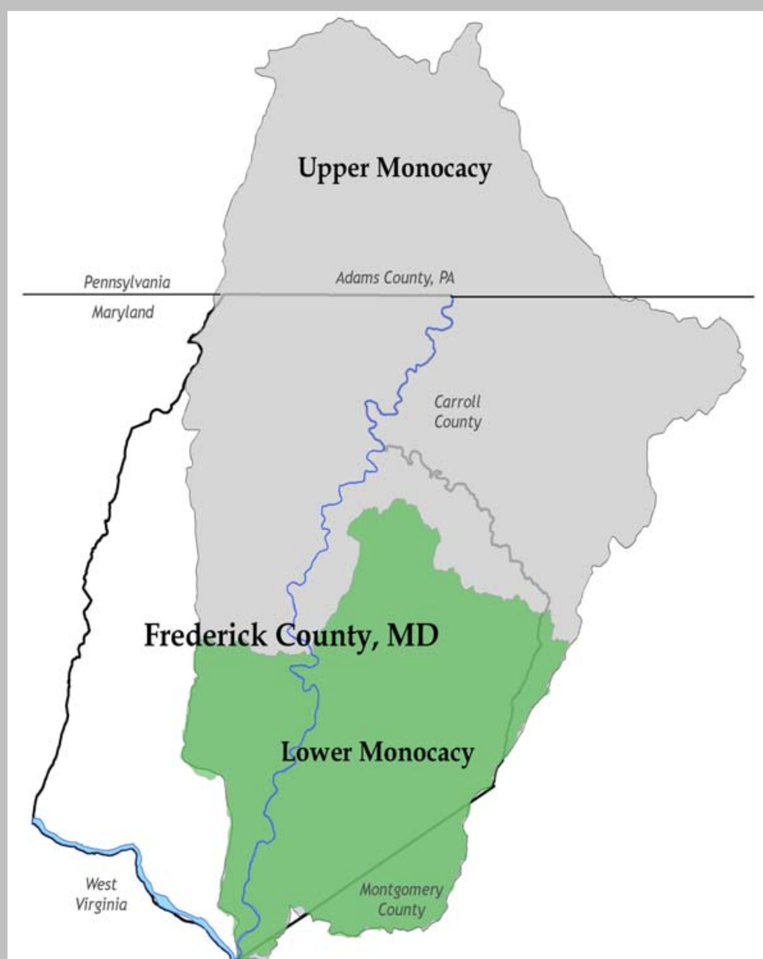
World Example illustrates how a community incorporated these criteria into a watershed plan enabling them to request funding of its recommended implementation projects through 319 funds. Additional information on EPA's watershed planning guidance elements can be found at: www.epa.gov/owow/nps/Section319/319guide03.html.

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)

<u>Phase I</u>

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

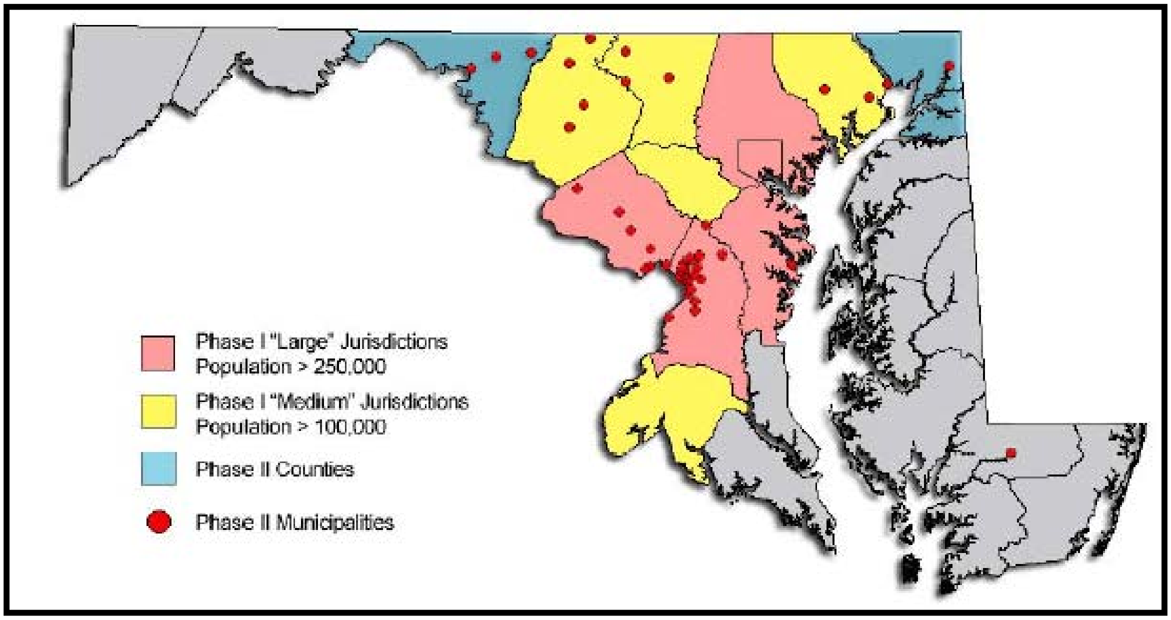


Figure 2.5: Maryland MS4 Phase I and MS4 Phase II Communities (Source: MDE, no date)

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

Unified Local Watershed Planning Principles	Planning Act	Source Water Assessments	Tributary Strategies	Water & Sewerage Planning
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://www.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.

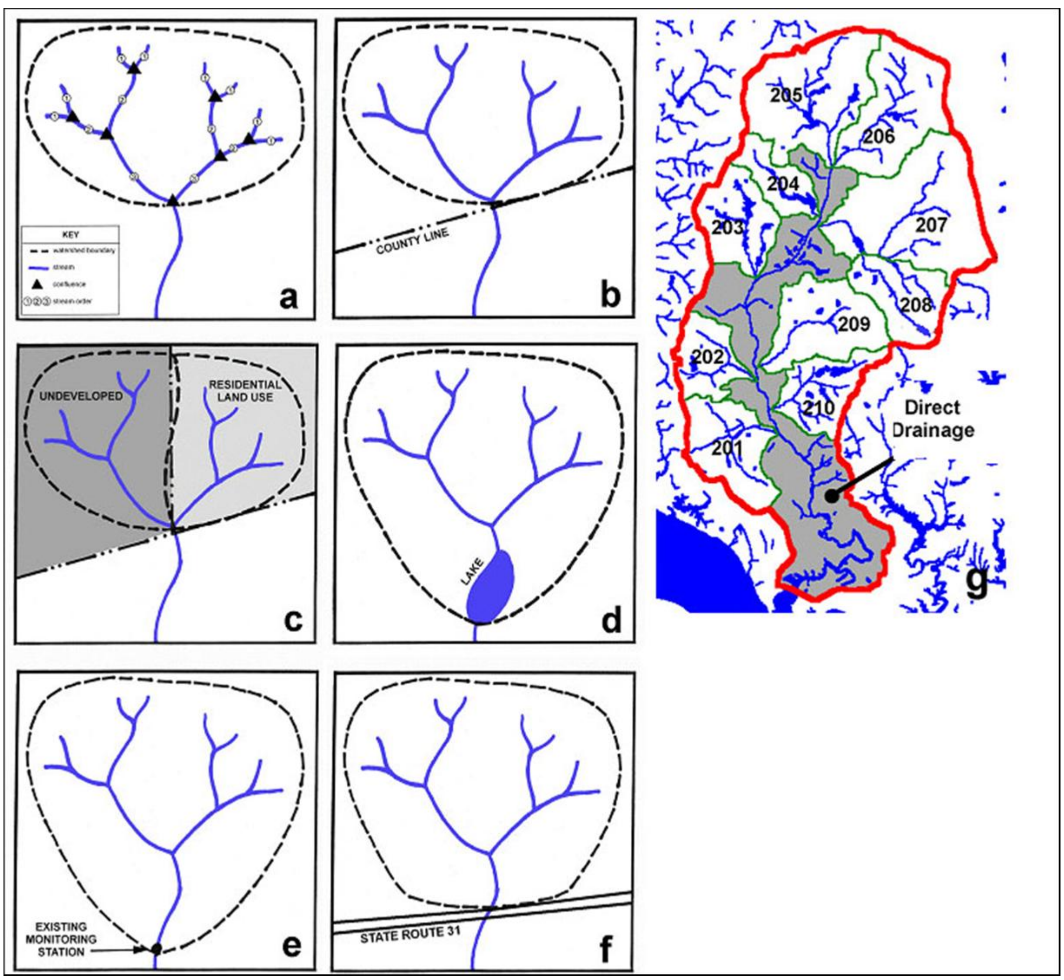


Figure 3.1: Subwatershed Origin Considerations

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.

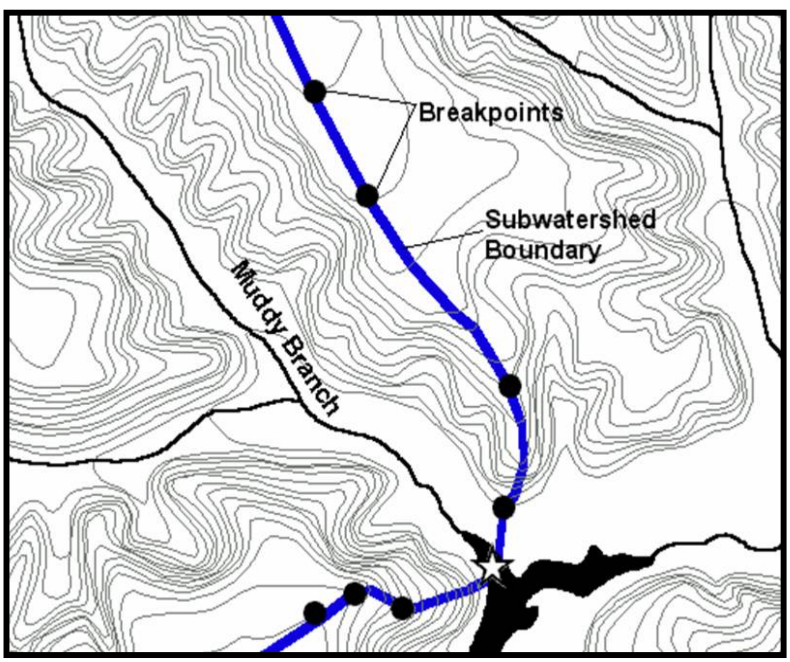


Figure 3.2: Connect breakpoints starting at the origin

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.

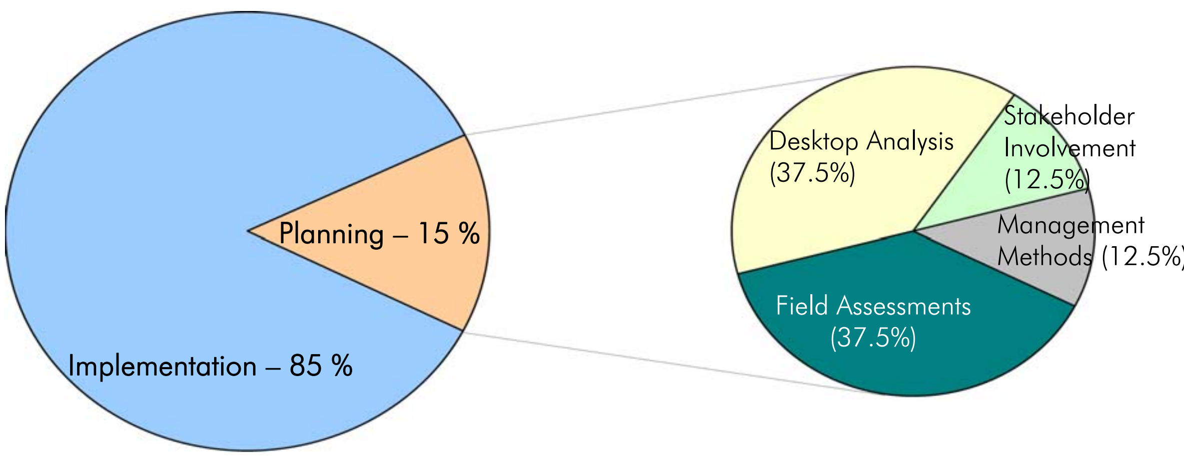


Figure 3.3: Breakdown of watershed planning funding

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.

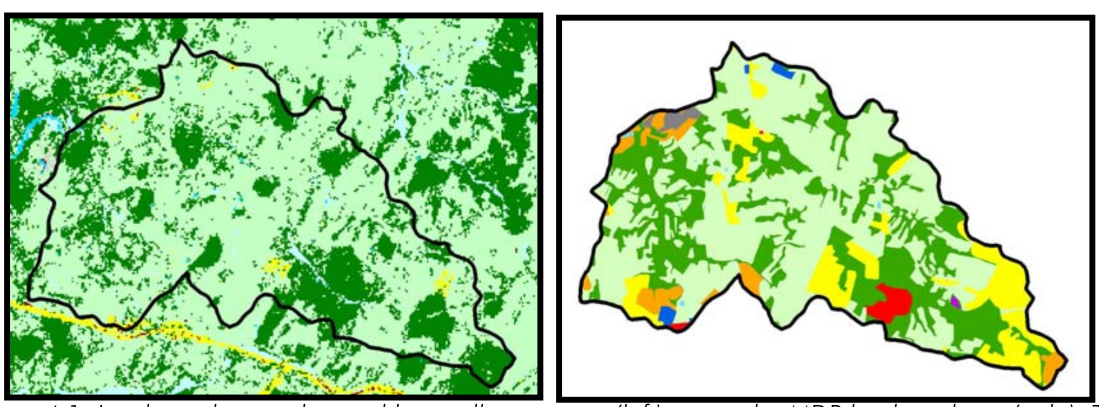


Figure 4.1: Land use data as depicted by satellite imagery (left) versus the MDP land use layer (right). The image on the left shows the watershed land use as primarily forest and agricultural, while the image on the right more accurately depicts the residential and commercial areas that also exist in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

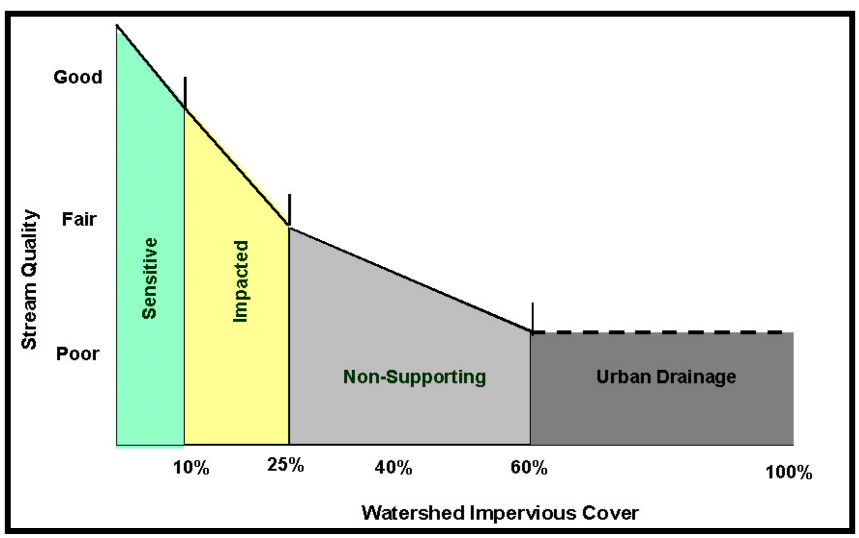


Figure 4.2: Representation of the Impervious Cover Model (Source: CWP, 2003b)

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.

Future impervious cover

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.

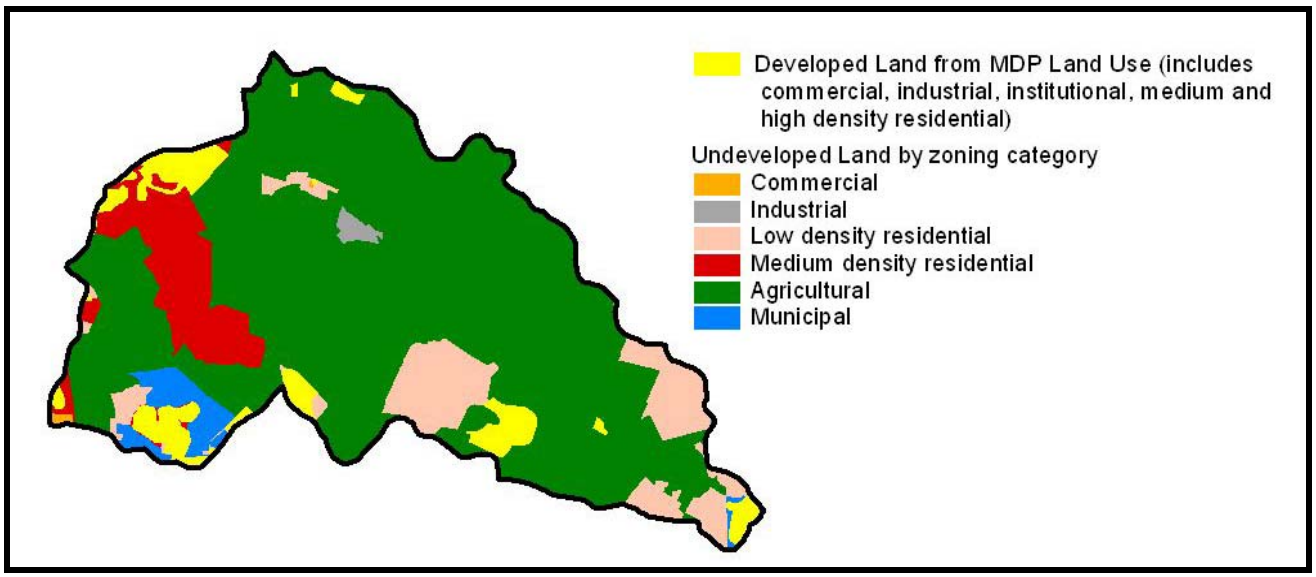


Figure 4.3: Developed and undeveloped land in a subwatershed of the Lower Monocacy watershed

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	
¼ Acre Residential		0.28	
⅛ 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.

Management classification

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.

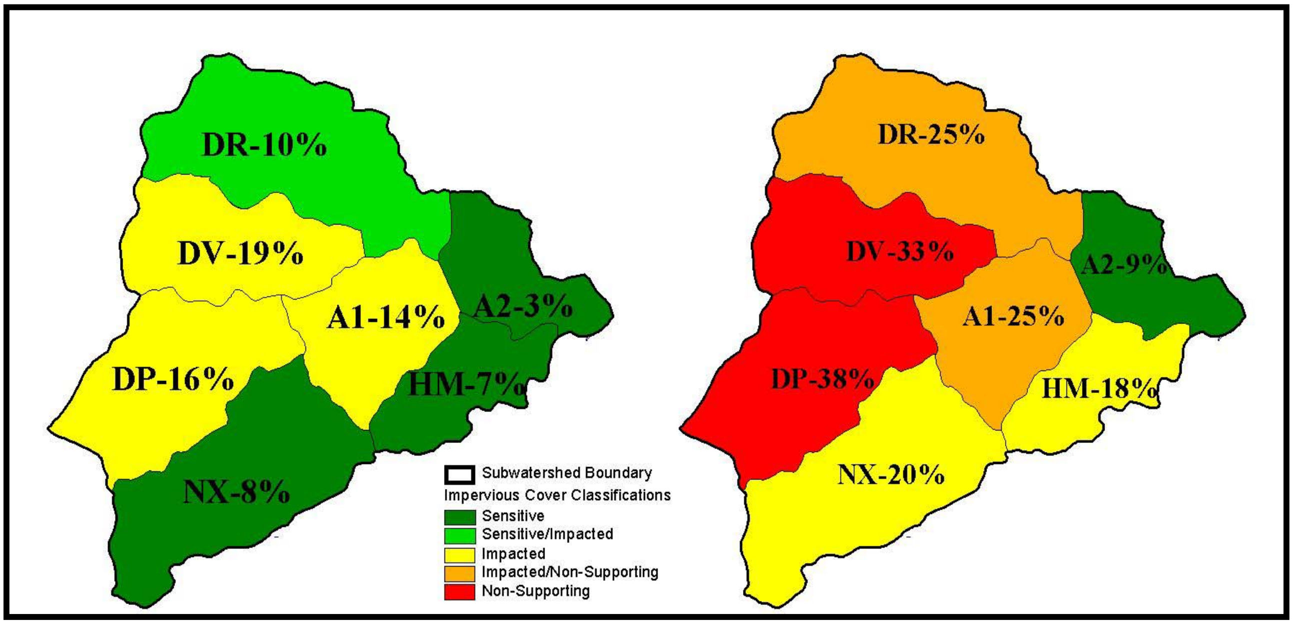


Figure 4.4: Subwatershed classification based on current (left) and future (right) impervious cover estimates for the Appoquinimink watershed in Delaware.

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

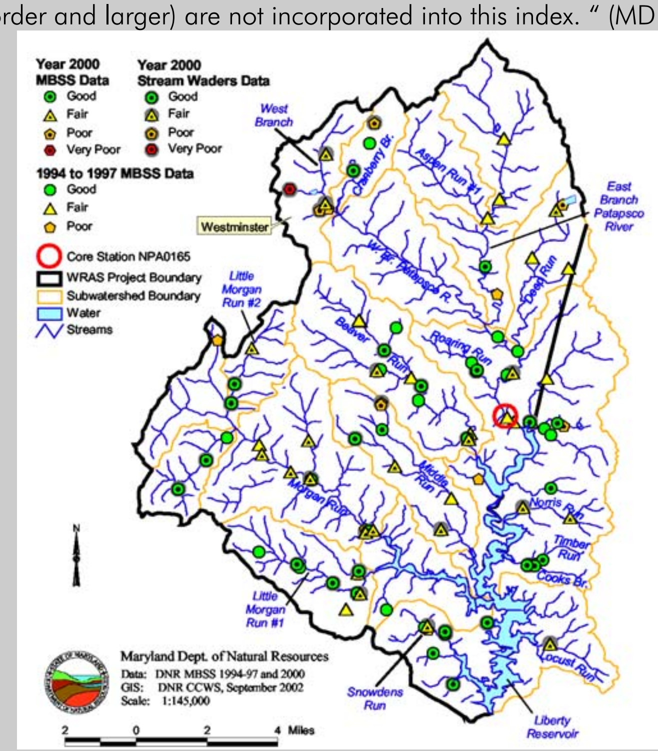
Carroll County, Maryland received federal funding to prepare a Watershed Restoration Action Strategy (WRAS) for its portion of the Liberty Reservoir watershed, which covers 87,040 acres. This drinking water supply watershed was a high state priority for protection and restoration. The remaining 17,762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

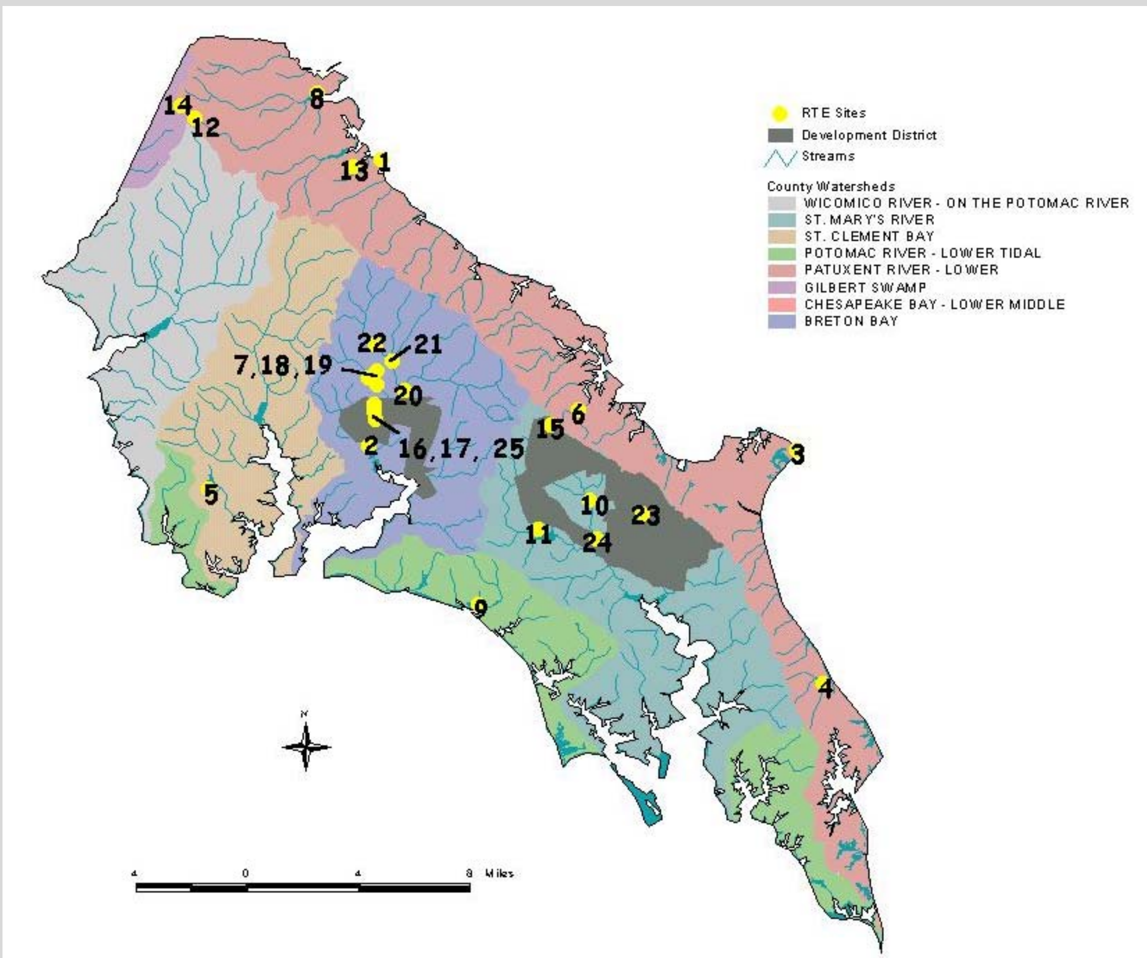
A sensitive areas inventory should also include a detailed assessment of forest cover in the watershed. It is important to know the percent forest cover in a watershed in order to set future goals for maintaining or increasing this cover, and to use in estimating future pollutant loads from different 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

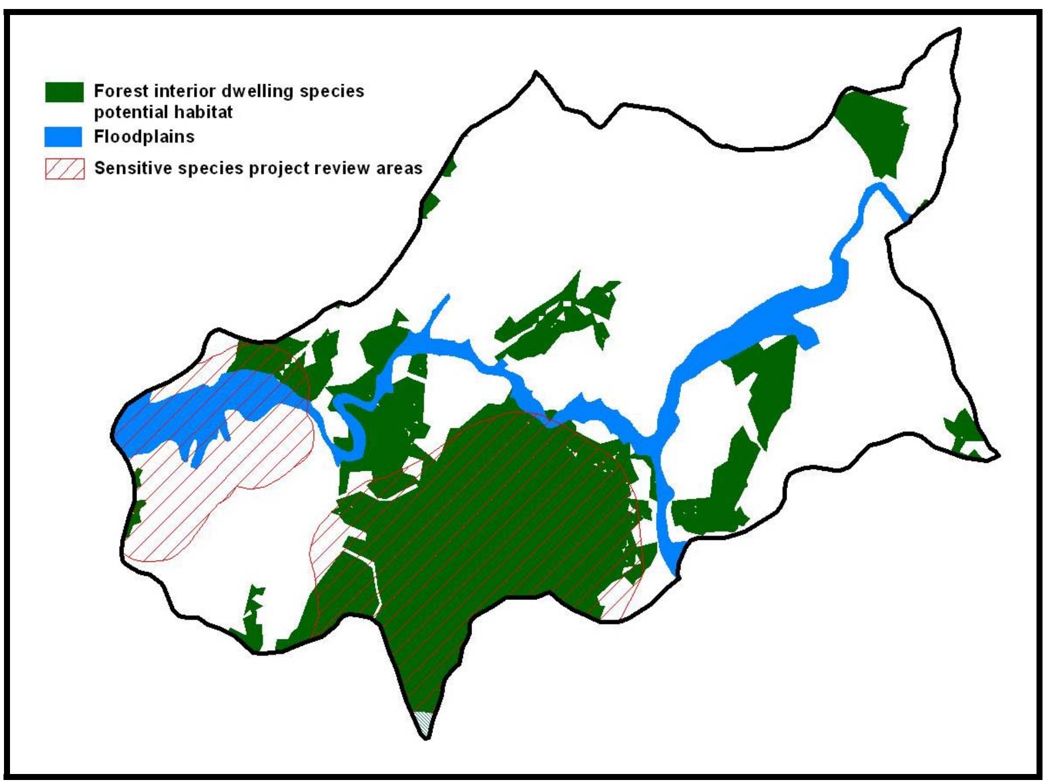


Figure 4.5: Potential protection sites identified for further evaluation in the field

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).

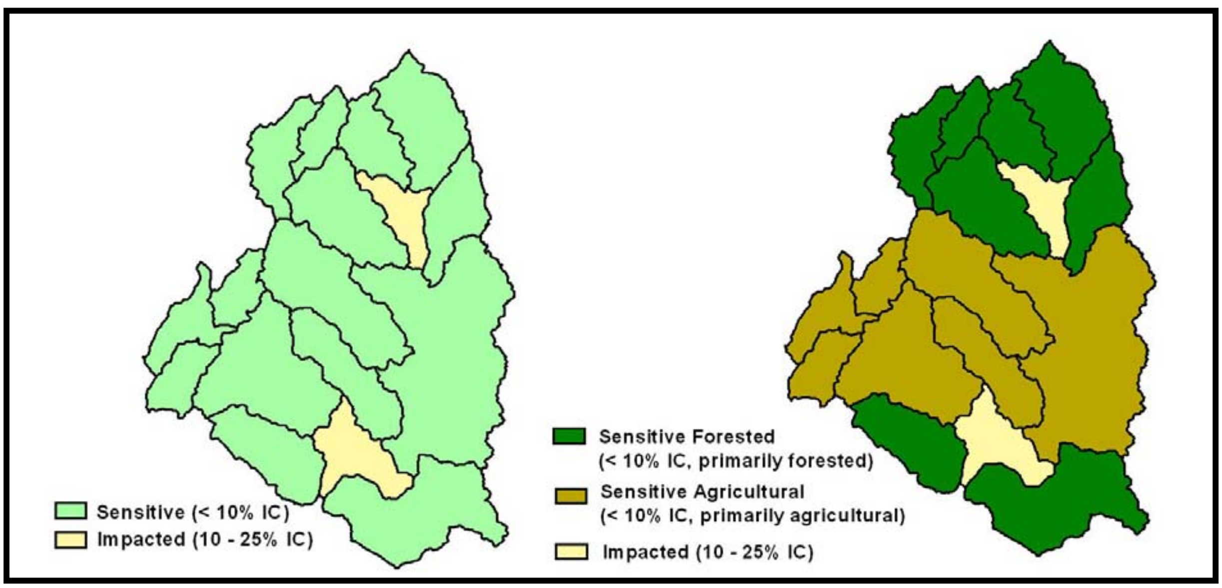


Figure 4.6: Subwatersheds classified using the ICM (left) compared to an expanded classification based on percent forest and agriculture (right).

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.

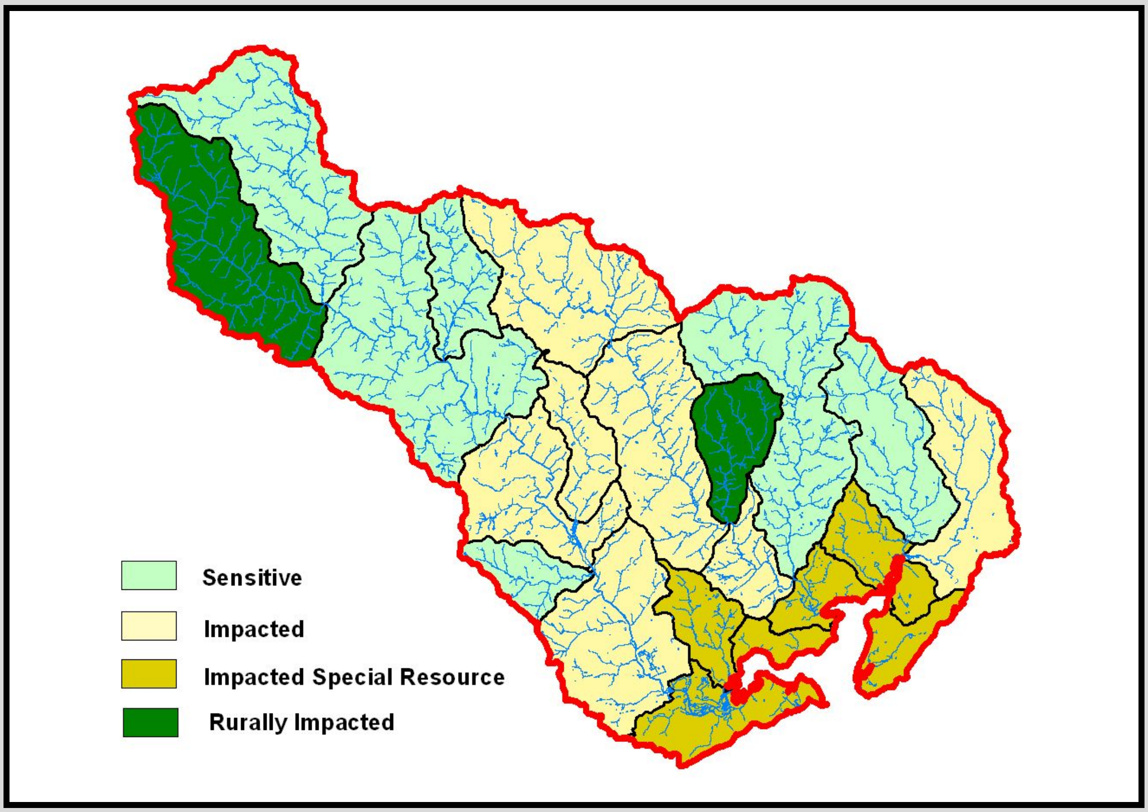
The ranking process refines the subwatershed classification, and is used to identify priority subwatersheds, which are typically the top-ranked subwatersheds in each classification category. Additional information on classifying and ranking subwatersheds is provided in User's Guide Tools 12 and 13. User's 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.

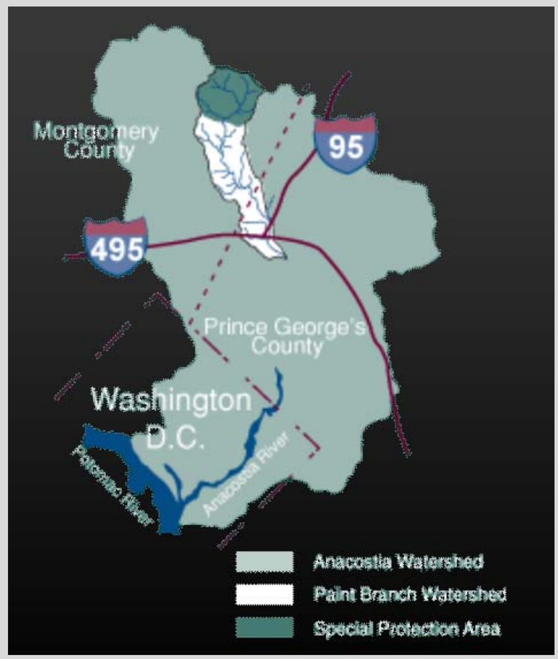
Table 4.9: Potential Regulatory and Programmatic Change Recommendations

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.

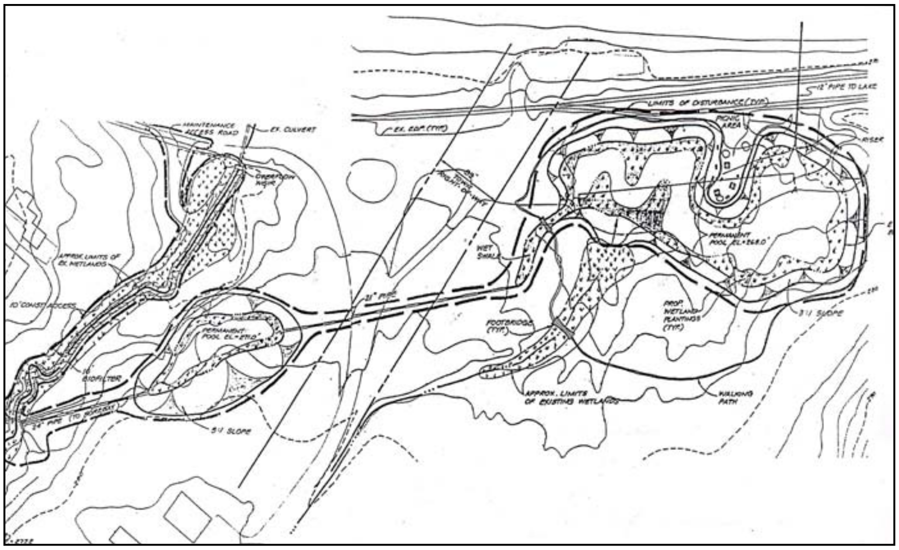


Figure 4.7: Example of a project concept design for a pond retrofit

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.

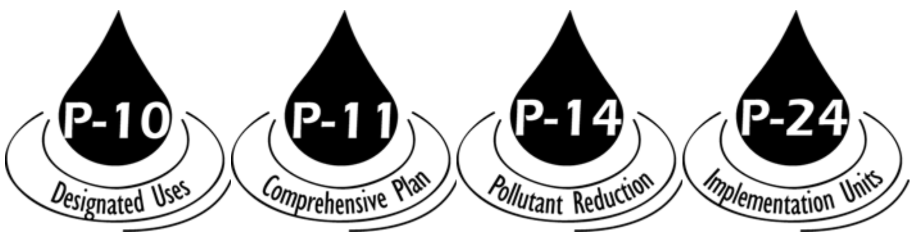
Table 4.11: Example Project Ranking System

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)	$R = P * P_j * Rv$	Where: P = Annual rainfall (inches) P_j = 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.

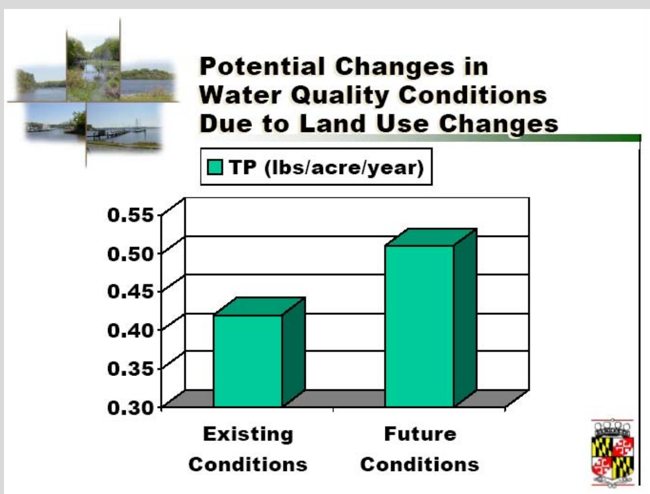
Pollutant loads can also be estimated using the CBP Watershed Model. This model estimates nutrient loads for 10 urban and non-urban land uses for specific stream segments within the Chesapeake Bay Watershed. While the model itself cannot be downloaded, data from model scenarios can be obtained, and a 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

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.

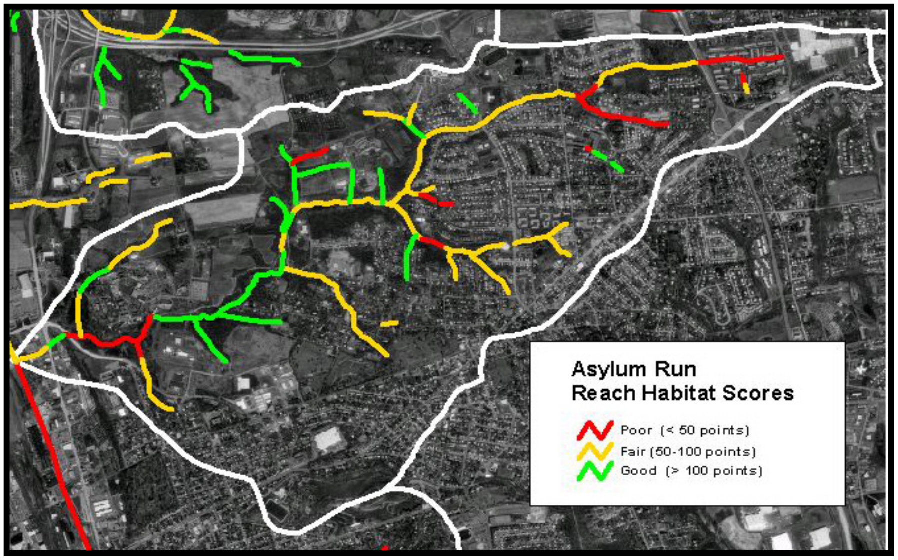


Figure 5.1: Reach Habitat Quality in Asylum Run subwatershed, Pennsylvania

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.

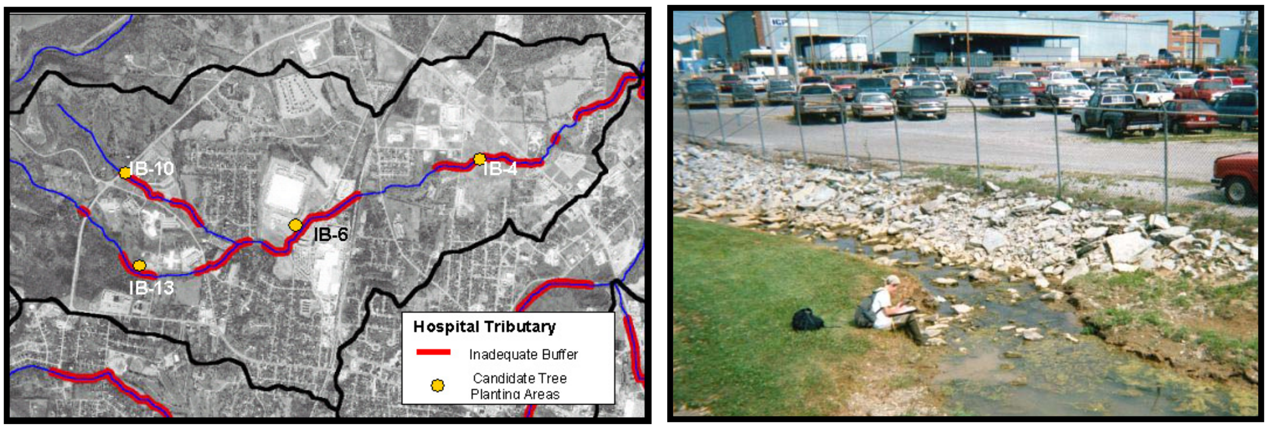


Figure 5.2: Location of impacted buffers and potential reforestation sites in Hospital Tributary subwatershed in Tennessee

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

<u>Neighborhoods</u>

- 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.)

<u>Hotspots</u>

- 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

<u>Pervious Areas</u> (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

<u>Streets and Storm Drains</u>

- 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

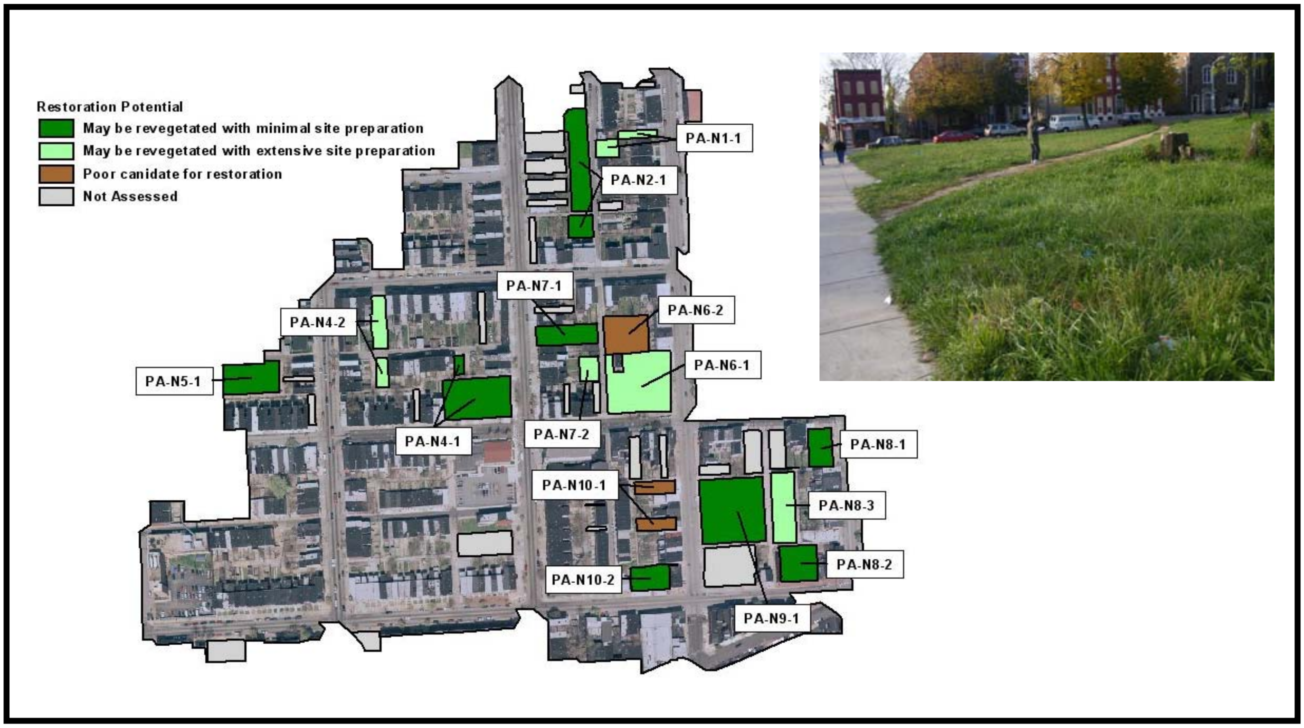


Figure 5.3: Restoration potential of pervious areas identified during the USSR in a subwatershed of Watershed 263 in Baltimore, Maryland

C. Conduct Project Investigations

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.

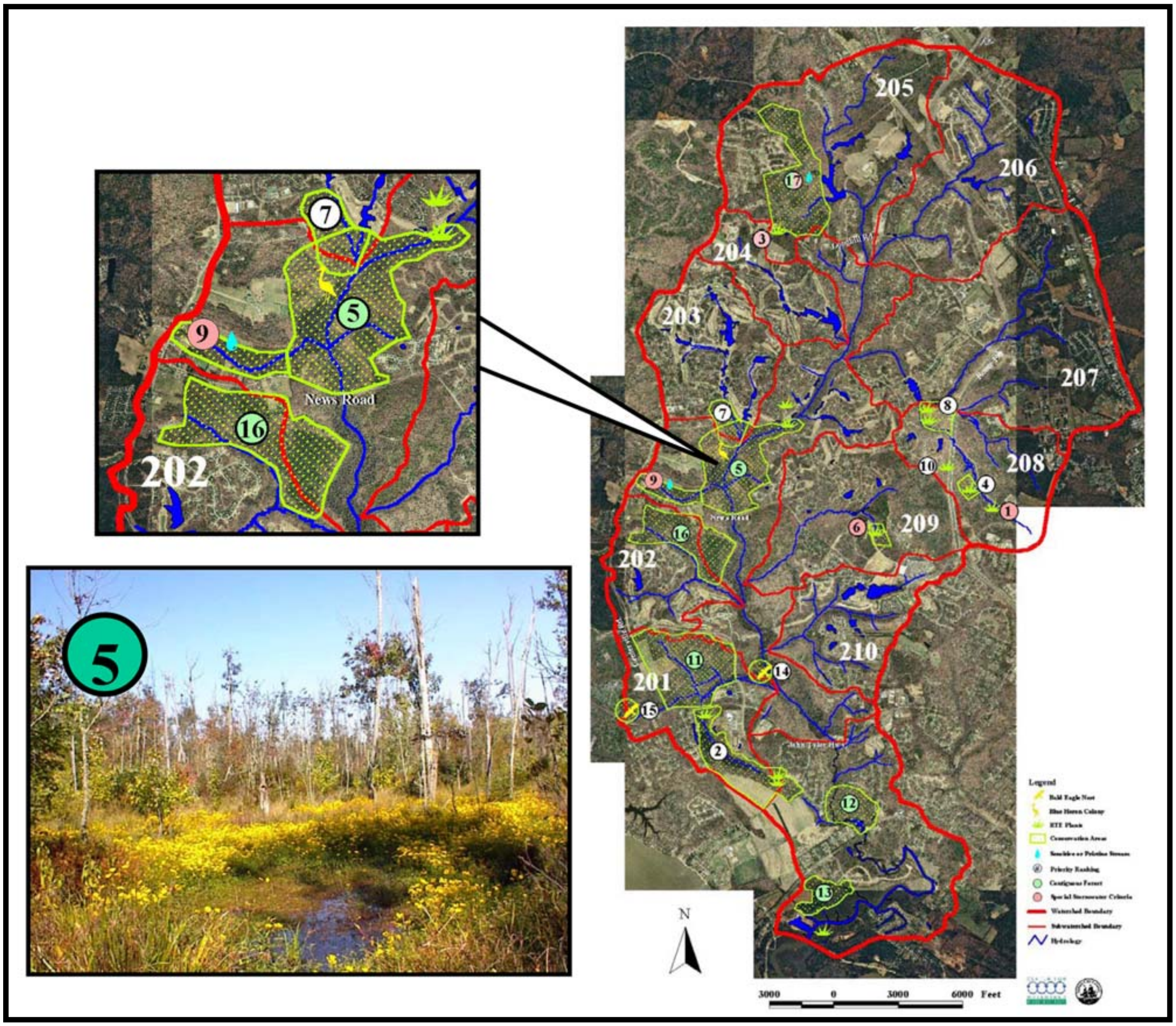


Figure 5.5: Sensitive areas assessment for Powhatan Creek watershed, Virginia

Wetland Assessment

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

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

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

P-18 Stakeholder Involvement

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.

P-19 Watershed Education

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

P-18 Stakeholder Involvement

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.

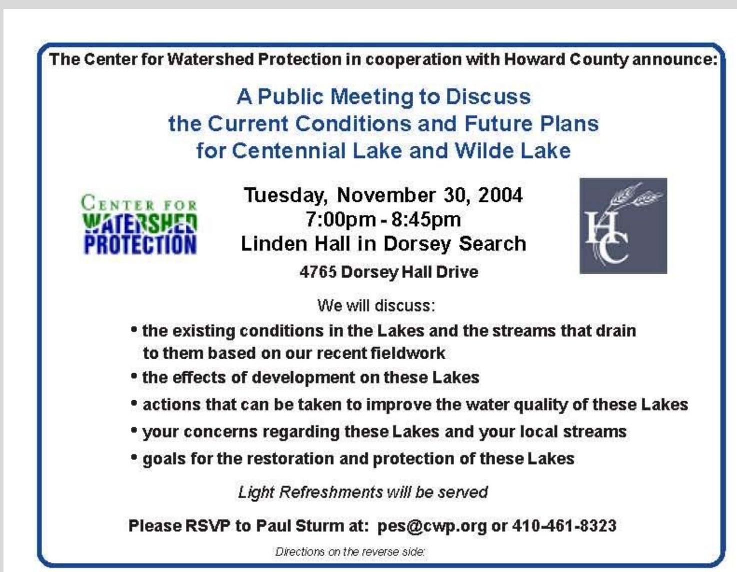
Real World Example: Centennial and Wilde Lakes Watershed Restoration Plan

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.



The Center for Watershed Protection in cooperation with Howard County announce:

A Public Meeting to Discuss
the Current Conditions and Future Plans
for Centennial Lake and Wilde Lake

Tuesday, November 30, 2004
7:00pm - 8:45pm
Linden Hall in Dorsey Search
4765 Dorsey Hall Drive

We will discuss:

- **the existing conditions in the Lakes and the streams that drain to them based on our recent fieldwork**
- **the effects of development on these Lakes**
- **actions that can be taken to improve the water quality of these Lakes**
- **your concerns regarding these Lakes and your local streams**
- **goals for the restoration and protection of these Lakes**

Light Refreshments will be served

Please RSVP to Paul Sturm at: pes@cwp.org or 410-461-8323

Directions on the reverse side.

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

P-18 Stakeholder Involvement

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

P-22 Recommendations

P-24 Implementation Units

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.

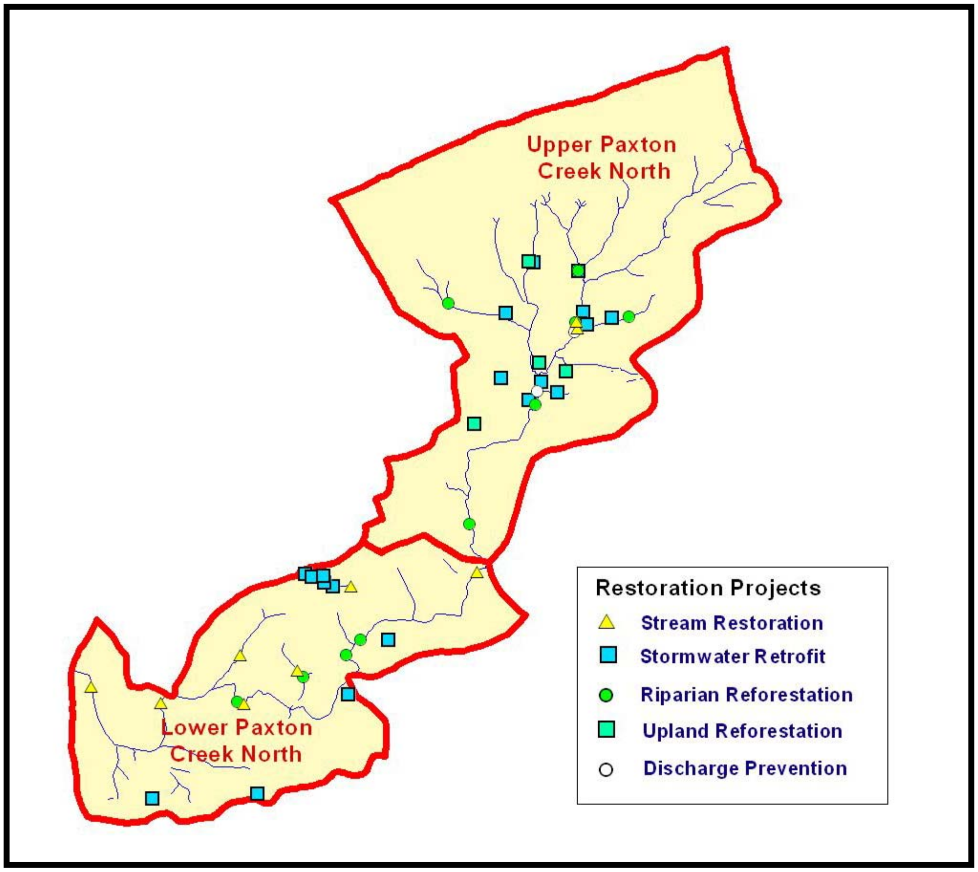


Figure 7.1: Restoration projects in the Paxton Creek North subwatershed, Pennsylvania

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.

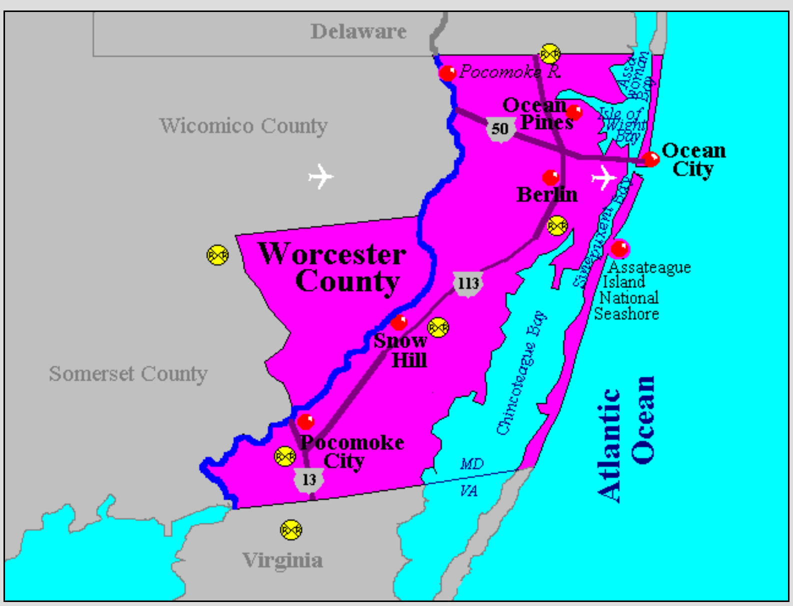


Photo from www.worcestercountyonline.org © 2004 Worcester County Economic Development
Worcester County Department of Comprehensive Planning. 2005.

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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A User's Guide to Watershed Planning in Maryland

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Prepared by:

Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, MD 21043
www.cwp.org

Prepared for:

Maryland Department of Natural Resources
Watershed Services
580 Taylor Avenue
Tawes State Office Building
Annapolis, MD 21401
www.dnr.maryland.gov

A User's Guide to Watershed Planning in Maryland

Prepared by:
Center for Watershed Protection
8390 Main Street, 2nd Floor
Ellicott City, MD 21043
www.cwp.org
www.stormwatercenter.net

Prepared for:
Maryland Department of Natural Resources
Watershed Services
580 Taylor Avenue
Annapolis, MD 21401
Toll Free in Maryland: 1(877) 620-8DNR x8809
Out of State: 410-260-8809
TTY Users call via the MD Relay
www.dnr.maryland.gov

December 2005

Robert L. Ehrlich, Jr., Governor
Michael S. Steele, Lt. Governor
Ronald Franks, Secretary

Foreword

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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:

- Rebecca Winer
- Karen Cappiella
- Tom Schueler
- Tiffany Wright
- Jennifer Tomlinson
- Emily Corwin
- Chris Swann
- Lauren Lasher

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- Tay Harris, Maryland Department of Planning
- Elizabeth Horsey, Maryland Department of Agriculture
- Danielle Lucid, Maryland Department of the Environment
- Catherine Shanks., Maryland Department of Natural Resource
- Ken Sloate Maryland Department of Natural Resources
- Ken Yetman, Maryland Department of Natural Resources

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- Shannon Moore, Frederick County
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- Elizabeth Chaisson, City of Bowie
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- James Garrity, Worcester County
- James George, Maryland Department of the Environment
- Amy Handen, National Park Service
- Lindsay Leiterman, Maryland Department of Natural Resources
- Audra Luscher, Maryland Department of Natural Resources
- Ruth Newell, City of Bowie
- Janis Outen, Maryland Department of the Environment
- Anne Patterson, Maryland Department of Natural Resources
- Nancy Pentz, Baltimore County
- Pat Pudelkewicz, Harford County
- Mark Richmond, Howard County
- Mary Searing, Anne Arundel County
- Keota Silaphone, Worcester County
- Catherine Shanks, Maryland Department of Natural Resources
- Ken Sloate, Maryland Department of Natural Resources
- Martin Sokolich, Talbot County
- Lise Soukoup, City of Rockville
- Steve Stewart, Baltimore County
- Susan Straus, City of Rockville
- Nate Wall, City of Rockville
- Ken Yetman, Maryland Department of Natural Resources

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.

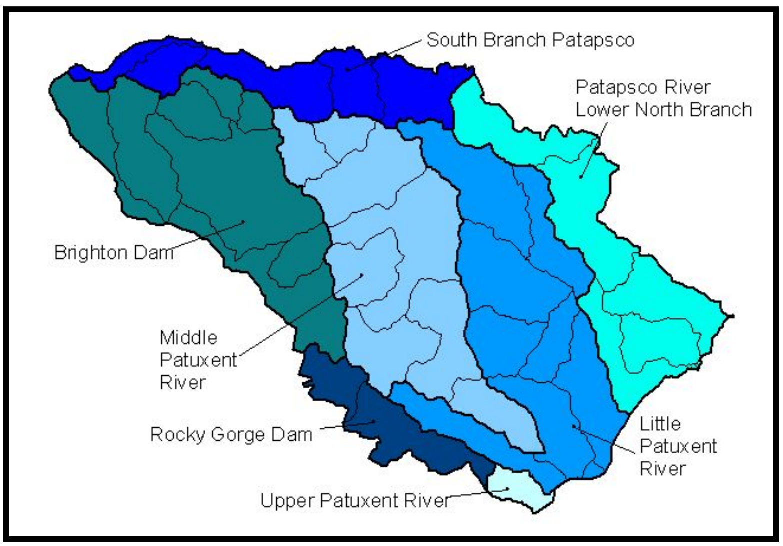


Figure 1.1: Howard County, MD watersheds (labeled) and subwatersheds

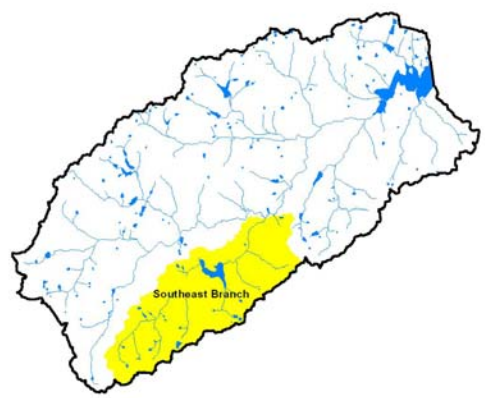
<table>
<tr><th colspan="2">Table 1.2: Geographic Scales of Watershed Planning</th></tr>
<tr><td colspan="2">1. Community – Durham County, NC</td></tr>
<tr><td>Community refers to the entire land area controlled by a single political jurisdiction such as a city, county, village or town. Most communities 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.</td><td>
</td></tr>
<tr><td colspan="2">2. Watershed – Little Lick Watershed</td></tr>
<tr><td>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.</td><td>
</td></tr>
<tr><td colspan="2">3. Subwatershed -- Southeast Branch Subwatershed</td></tr>
<tr><td>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.</td><td>
</td></tr>
</table>

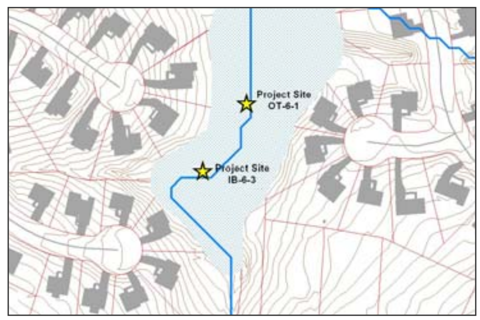
Table 1.2: Geographic Scales of Watershed Planning	
4. Neighborhood -- Lakeridge Corner	
Neighborhoods are an even smaller management unit and are defined as relatively homogenous residential land uses within a subwatershed. Individual neighborhoods have markedly different characteristics and are the locations where protection and restoration projects are implemented. Neighborhoods are also the scale at which community acceptance of these projects is gauged.	
5. Project Site – Sites OT-6-1 and IB-6-3	
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.	

Table 1.3: Using the Subwatershed Scale in Watershed Planning	
Watershed Planning Method	*Rationale for Conducting at the Subwatershed Scale*
Establish a baseline	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.
Classify and rank subwatersheds	In larger watersheds, the most vulnerable or most restorable subwatersheds should be identified in order to focus limited resources and provide rapid results.
Conduct stream and upland assessments	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.
Conduct project investigations	
Plan for indicator monitoring	
Estimate pollutant loads and reductions	Subwatersheds are limited in size where few confounding pollutant sources that can confuse management decisions are present (e.g., agricultural runoff, point sources, etc.).
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.	

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.

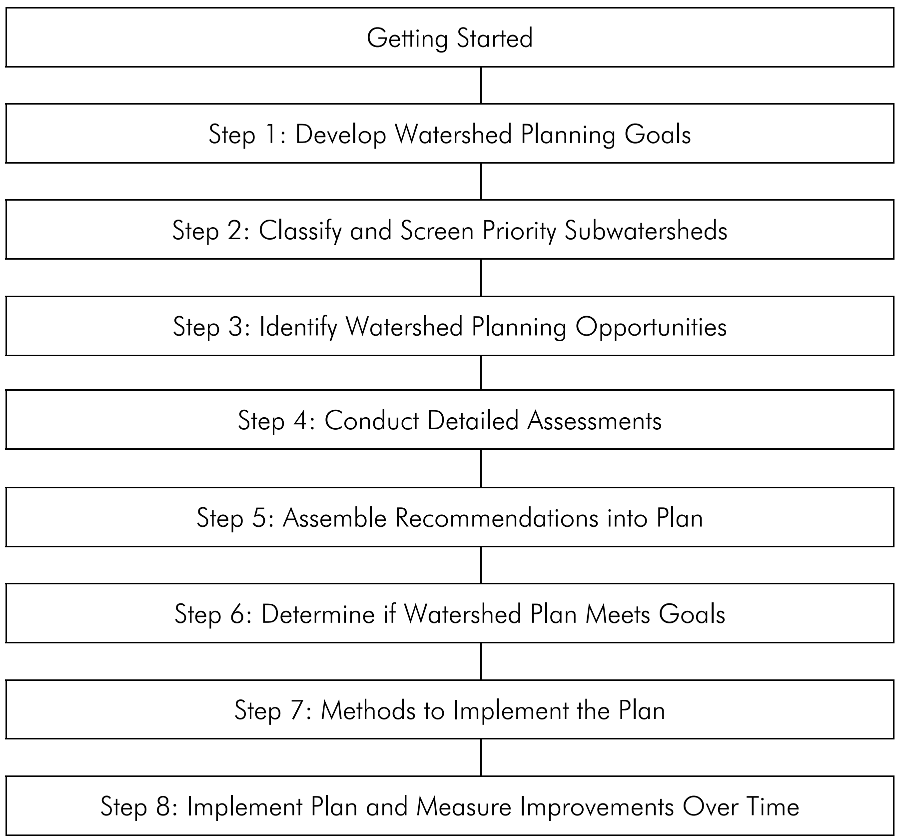


Figure 1.2: The Watershed Planning Process

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

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.

> 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/

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

> 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.

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:

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.

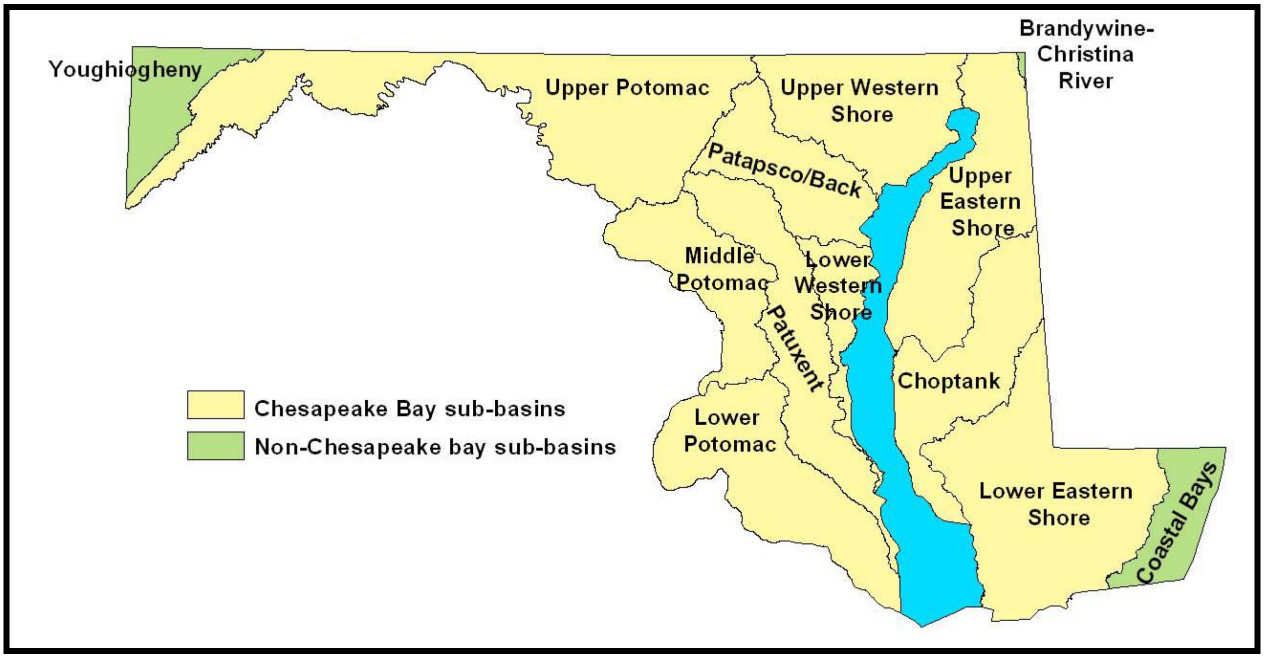


Figure 2.1: Maryland's Major Sub-Basins

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.

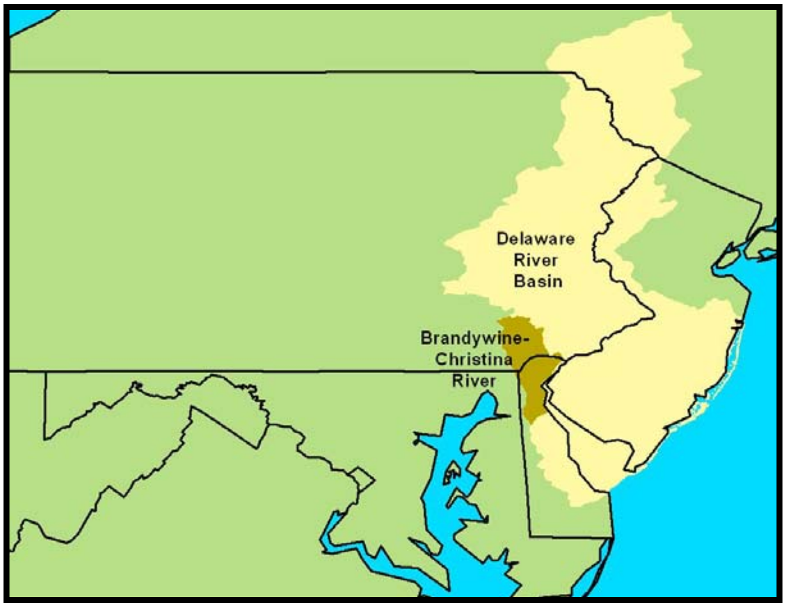


Figure 2.3: Brandywine-Christina Sub-Basin

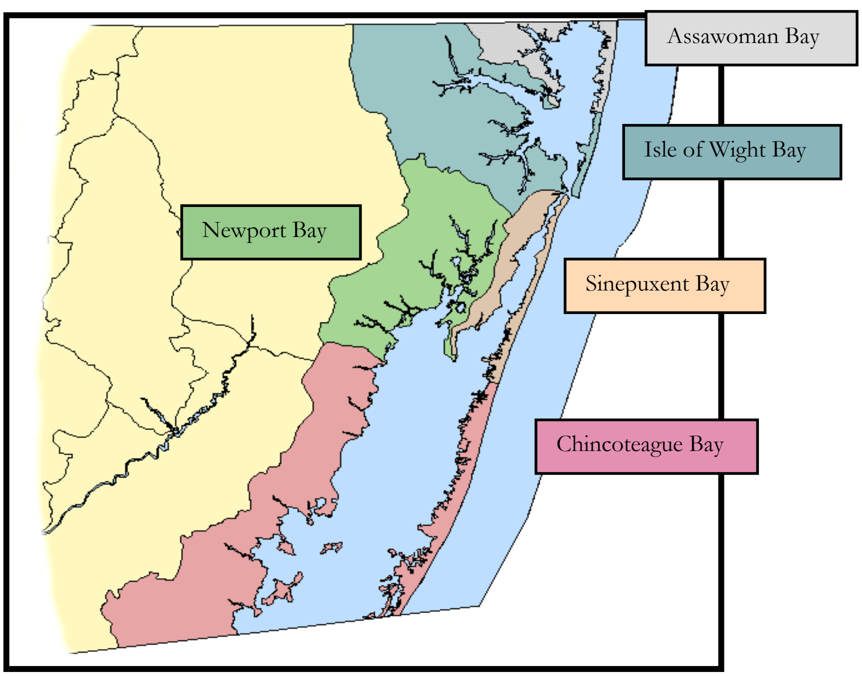


Figure 2.4: Maryland Coastal Bays CCMP Area
(Source: MD DNR, NDa)

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

Unified Local Watershed Planning Principle	Driver: 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

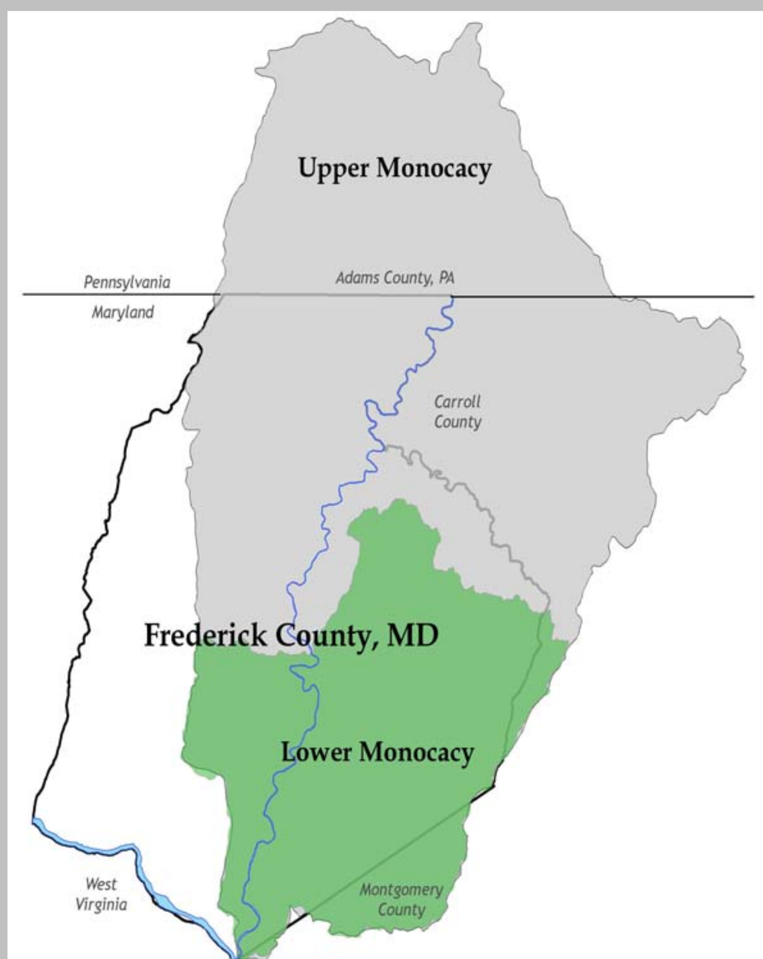
World Example illustrates how a community incorporated these criteria into a watershed plan enabling them to request funding of its recommended implementation projects through 319 funds. Additional information on EPA's watershed planning guidance elements can be found at: www.epa.gov/owow/nps/Section319/319guide03.html.

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

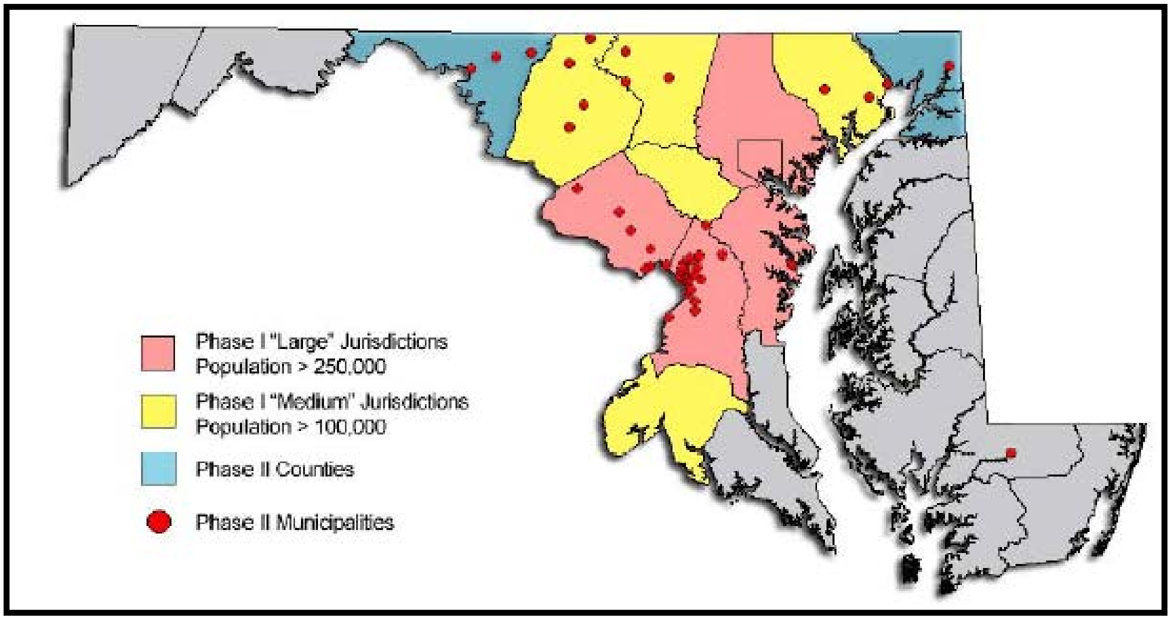


Figure 2.5: Maryland MS4 Phase I and MS4 Phase II Communities (Source: MDE, no date)

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

<u>Maryland Department of Natural Resources Critical Area Act</u>

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/.

<u>Maryland Department of Natural Resources Forest Conservation Act</u>

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://www.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

P-2 Watershed 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

P-3 Existing 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:

- <u>Subwatershed size</u> - The average size of subwatersheds should be 10 square miles or less.

- <u>Subwatershed orientation</u> - 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.

- <u>Jurisdictional boundaries</u> - 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.

- <u>Homogeneous land use</u> - 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.

- <u>Ponds / lakes / reservoir</u> - 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.

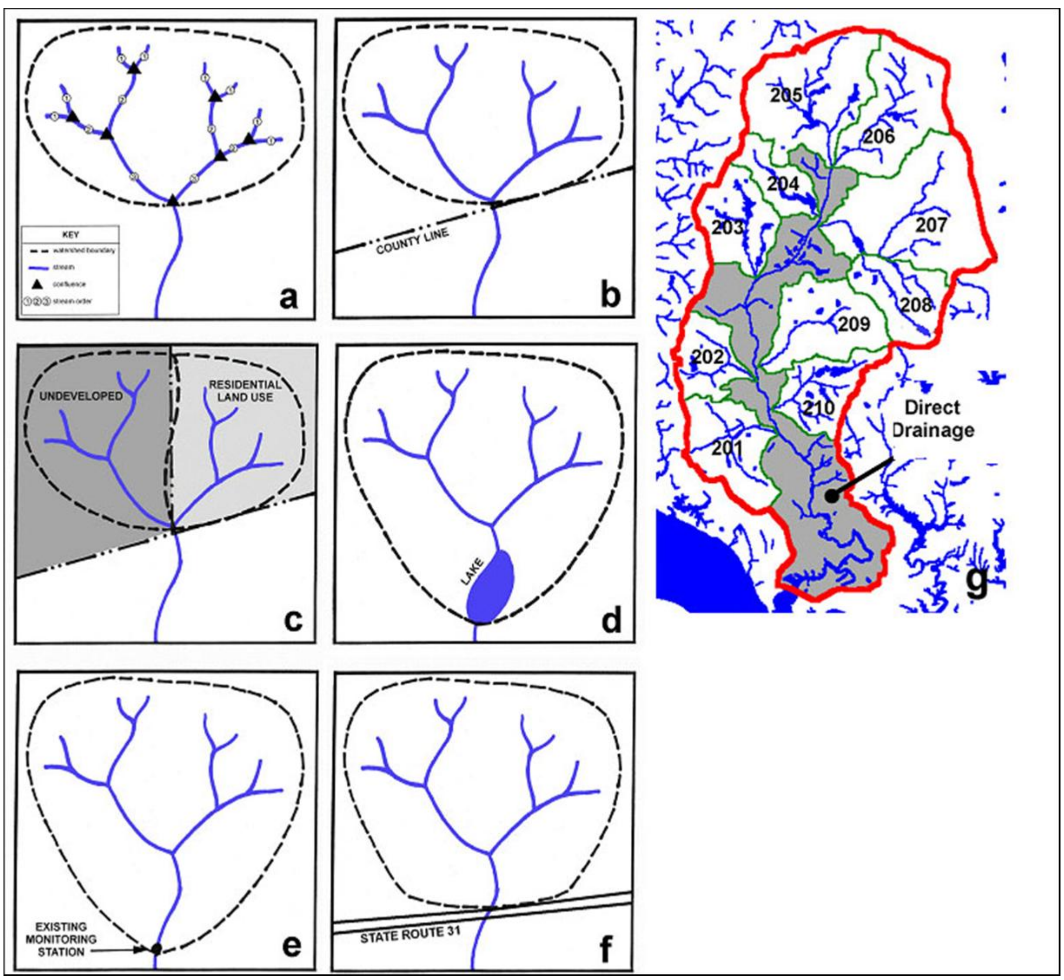


Figure 3.1: Subwatershed Origin Considerations

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.

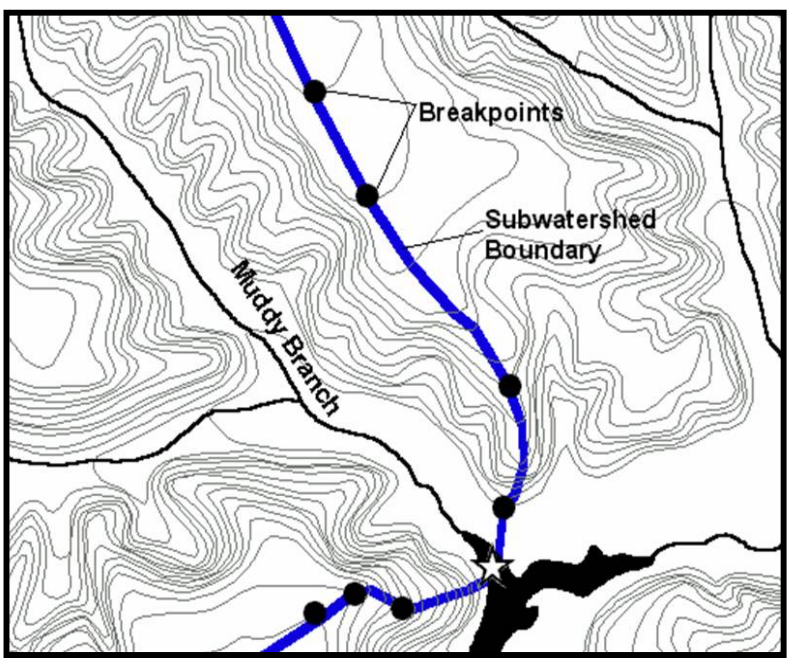


Figure 3.2: Connect breakpoints starting at the origin

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.

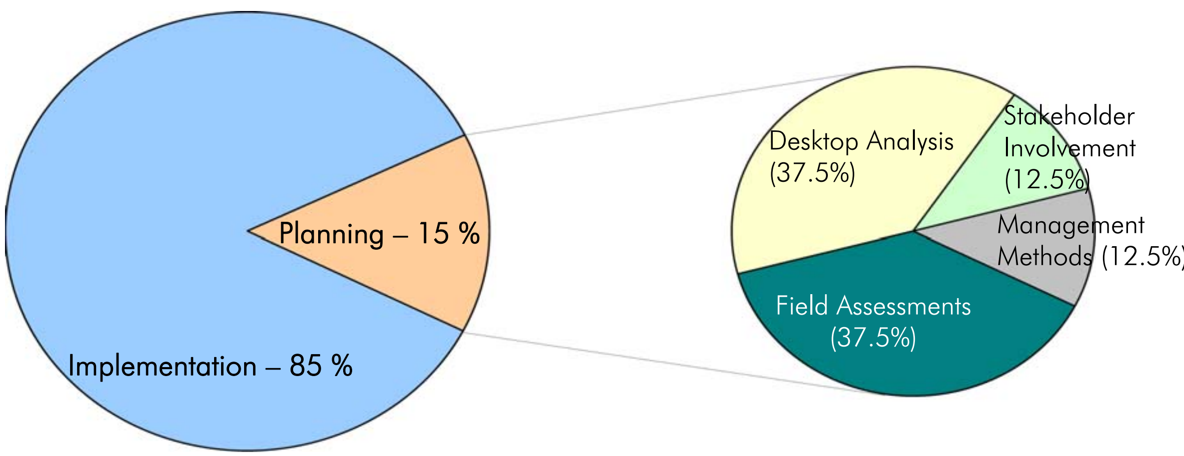


Figure 3.3: Breakdown of watershed planning funding

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.

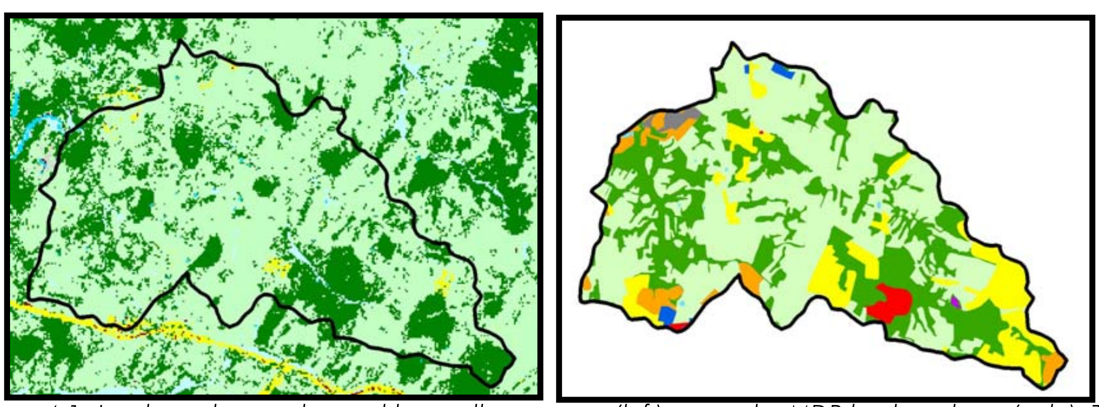


Figure 4.1: Land use data as depicted by satellite imagery (left) versus the MDP land use layer (right). The image on the left shows the watershed land use as primarily forest and agricultural, while the image on the right more accurately depicts the residential and commercial areas that also exist in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

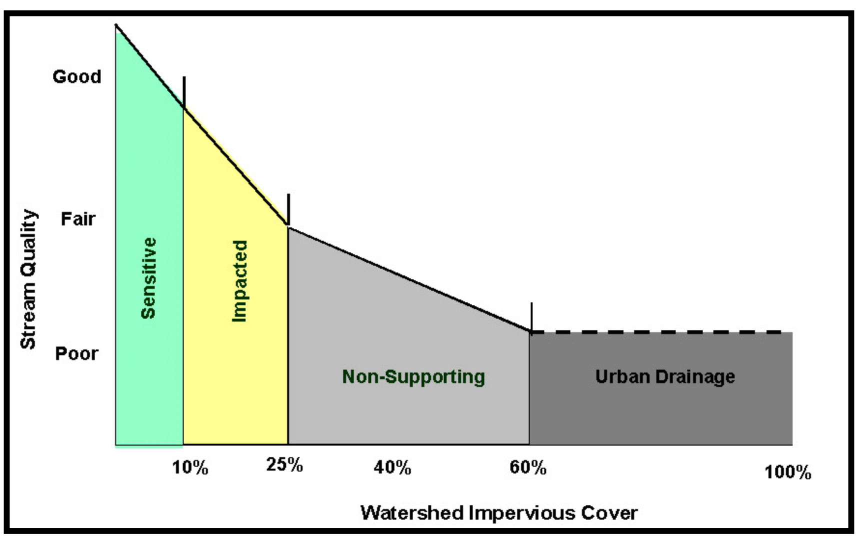


Figure 4.2: Representation of the Impervious Cover Model (Source: CWP, 2003b)

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.

Future impervious cover

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.

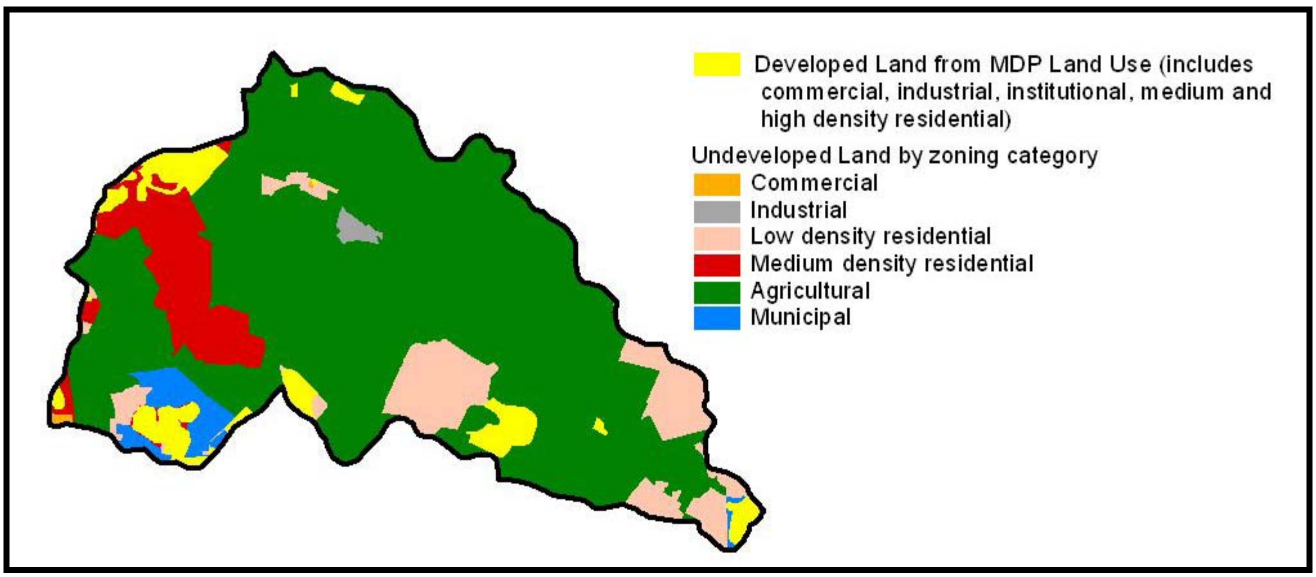


Figure 4.3: Developed and undeveloped land in a subwatershed of the Lower Monocacy watershed

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.

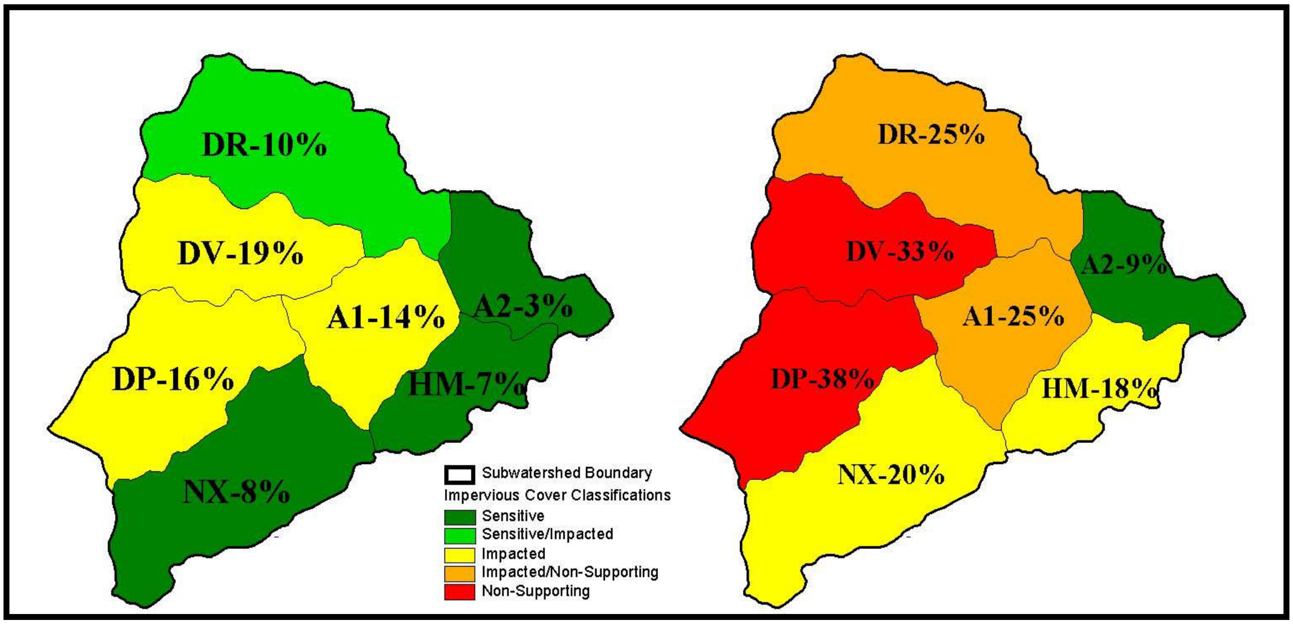


Figure 4.4: Subwatershed classification based on current (left) and future (right) impervious cover estimates for the Appoquinimink watershed in Delaware.

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

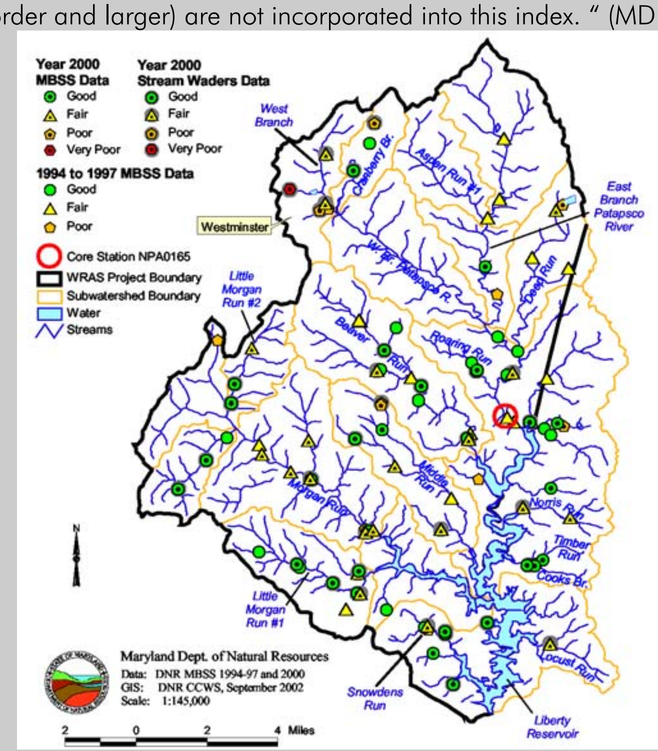
Carroll County, Maryland received federal funding to prepare a Watershed Restoration Action Strategy (WRAS) for its portion of the Liberty Reservoir watershed, which covers 87,040 acres. This drinking water supply watershed was a high state priority for protection and restoration. The remaining 17,762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

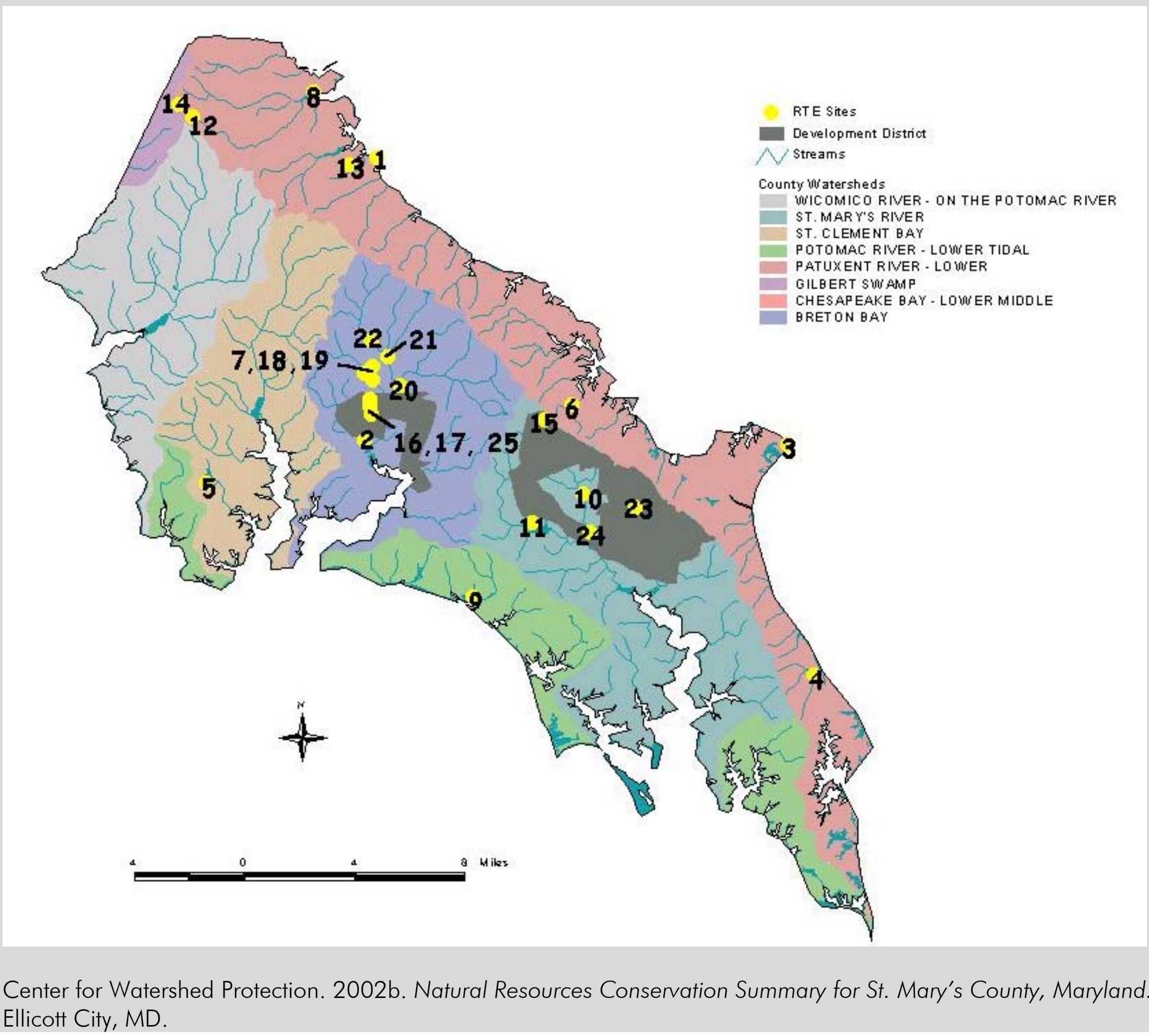
A sensitive areas inventory should also include a detailed assessment of forest cover in the watershed. It is important to know the percent forest cover in a watershed in order to set future goals for maintaining or increasing this cover, and to use in estimating future pollutant loads from different 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

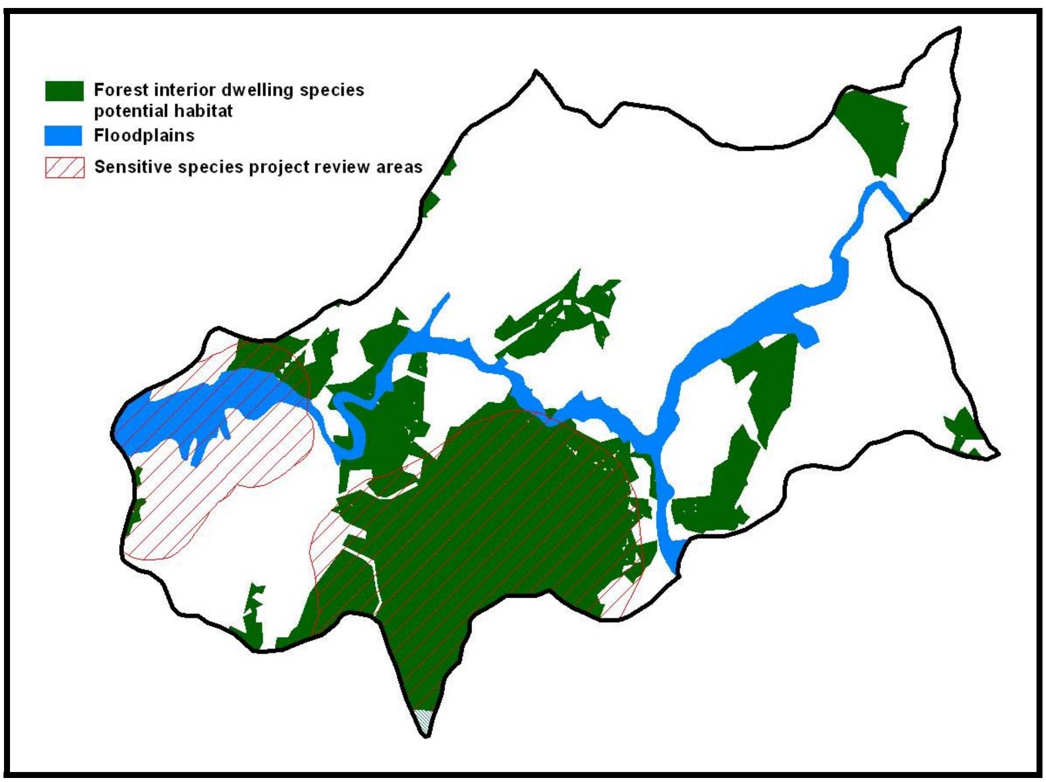


Figure 4.5: Potential protection sites identified for further evaluation in the field

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).

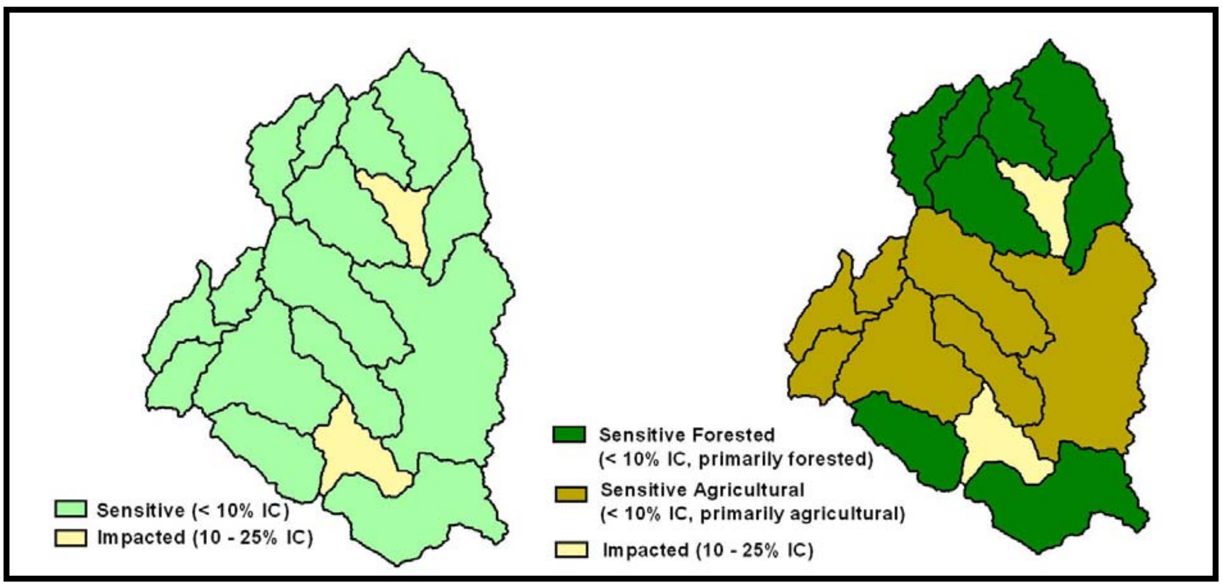


Figure 4.6: Subwatersheds classified using the ICM (left) compared to an expanded classification based on percent forest and agriculture (right).

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.

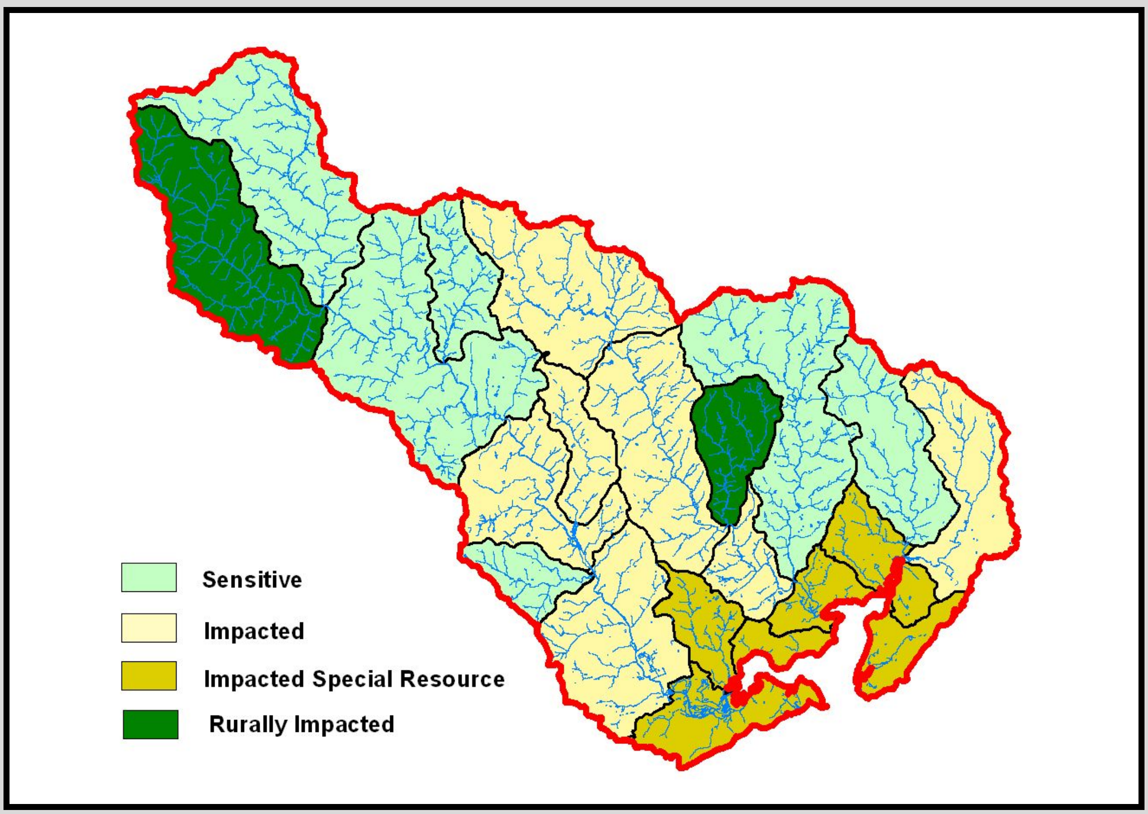
The ranking process refines the subwatershed classification, and is used to identify priority subwatersheds, which are typically the top-ranked subwatersheds in each classification category. Additional information on classifying and ranking subwatersheds is provided in User's Guide Tools 12 and 13. User's 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

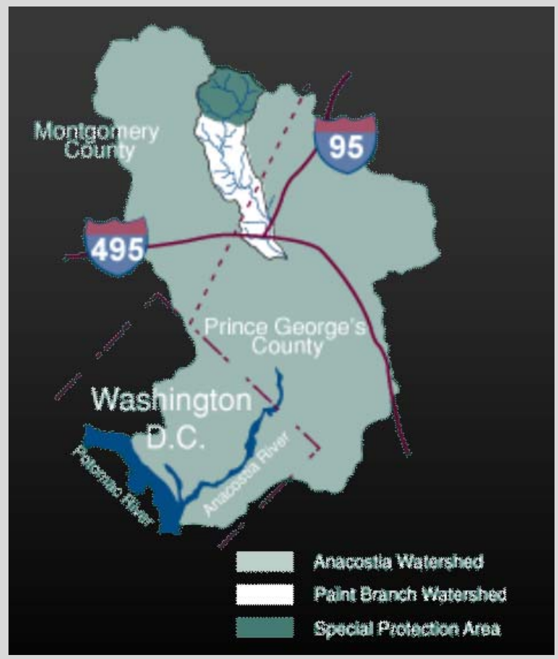
Watershed Protection Tool	*Potential Watershed Plan Recommendation*
Tool 1. Land Use Planning	• Adopt overlay zoning to protect sensitive natural areas • Establish a transfer of development rights (TDR) program
Tool 2. Land Conservation	• Actively pursue forest or wetland conservation
Tool 3. Aquatic 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.

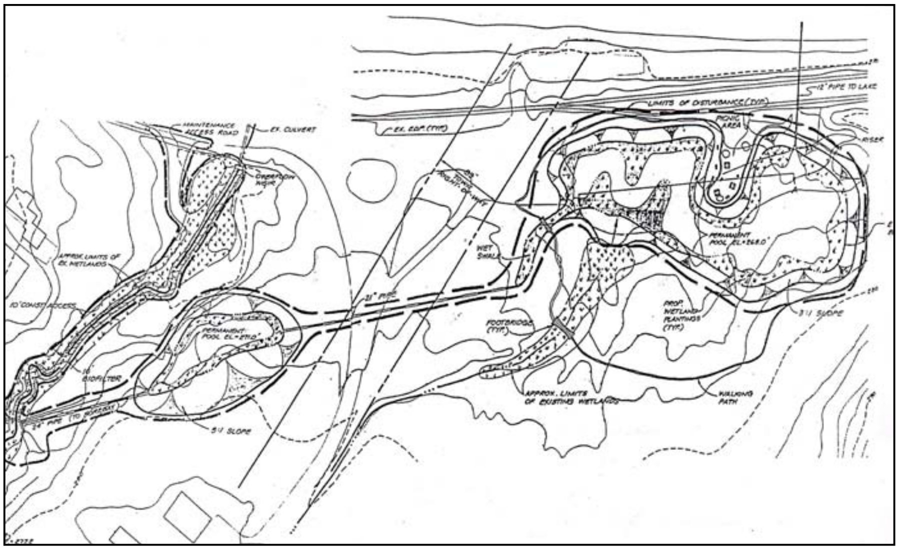


Figure 4.7: Example of a project concept design for a pond retrofit

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

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.

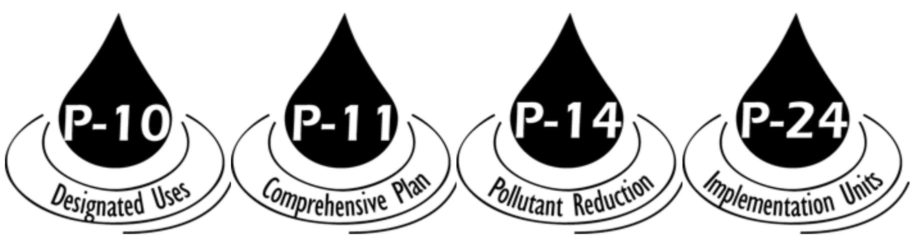
Table 4.11: Example Project Ranking System

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.

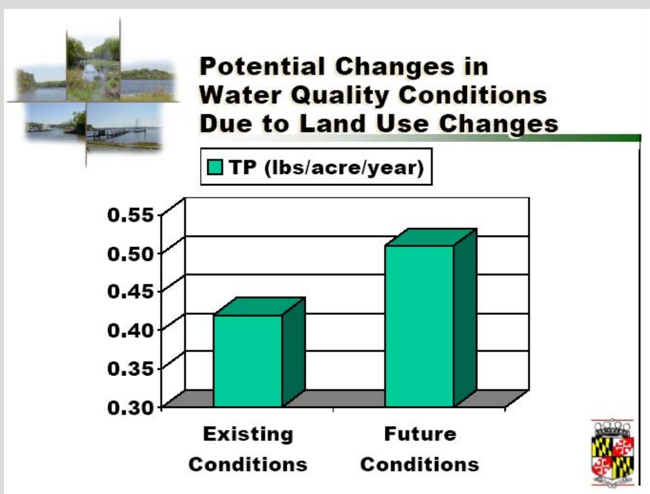
Pollutant loads can also be estimated using the CBP Watershed Model. This model estimates nutrient loads for 10 urban and non-urban land uses for specific stream segments within the Chesapeake Bay Watershed. While the model itself cannot be downloaded, data from model scenarios can be obtained, and a 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

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.

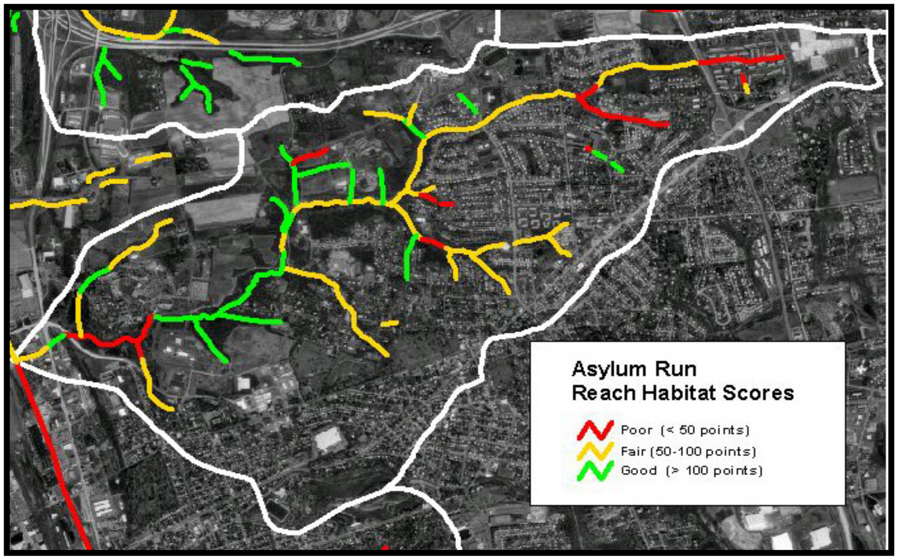


Figure 5.1: Reach Habitat Quality in Asylum Run subwatershed, Pennsylvania

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.

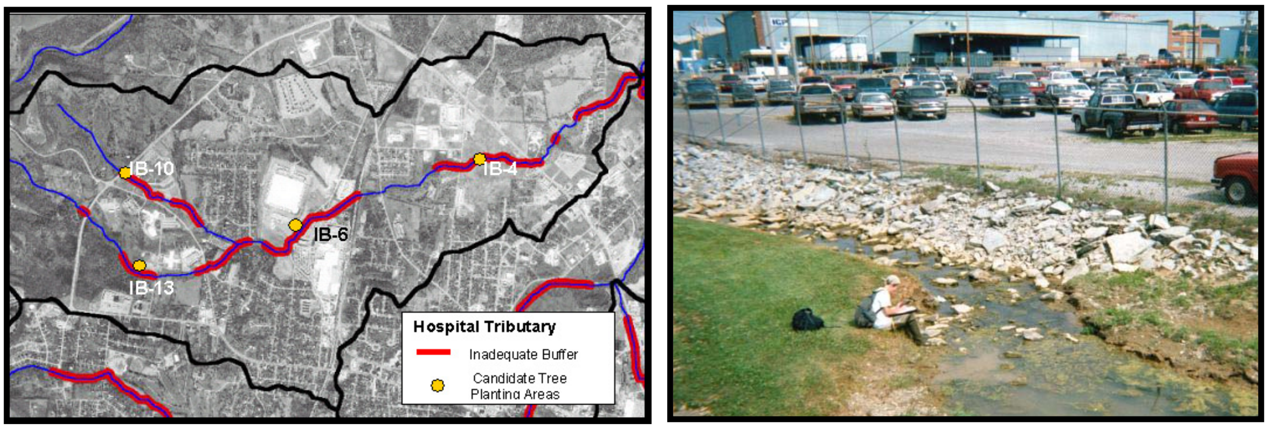


Figure 5.2: Location of impacted buffers and potential reforestation sites in Hospital Tributary subwatershed in Tennessee

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

<u>Neighborhoods</u>

- 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.)

<u>Hotspots</u>

- 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

<u>Pervious Areas</u> (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

<u>Streets and Storm Drains</u>

- 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

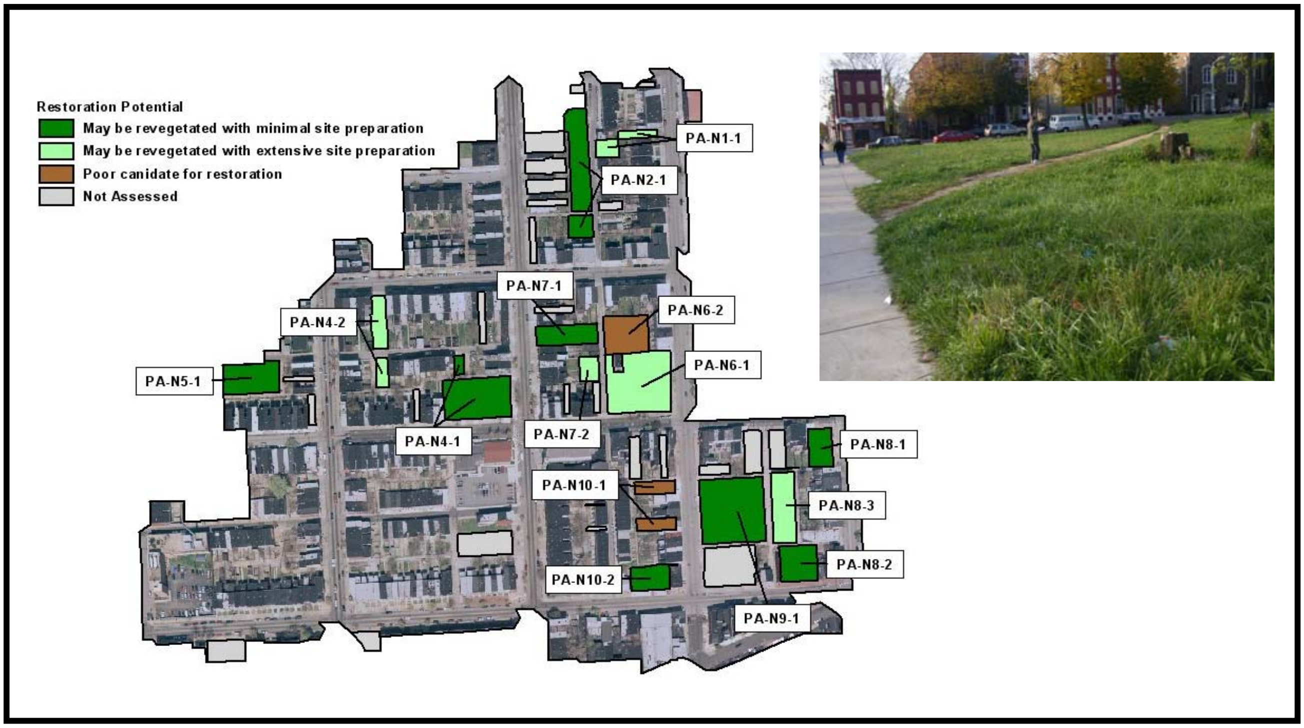


Figure 5.3: Restoration potential of pervious areas identified during the USSR in a subwatershed of Watershed 263 in Baltimore, Maryland

C. Conduct Project Investigations

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. Find Suspect Outfalls in the Subwatershed: 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. Trace Problem Back up the Storm Drain Network: 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.

<u>Contiguous Forest Assessment</u>
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.

<u>Rare, Threatened and Endangered Species Assessment</u>
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.

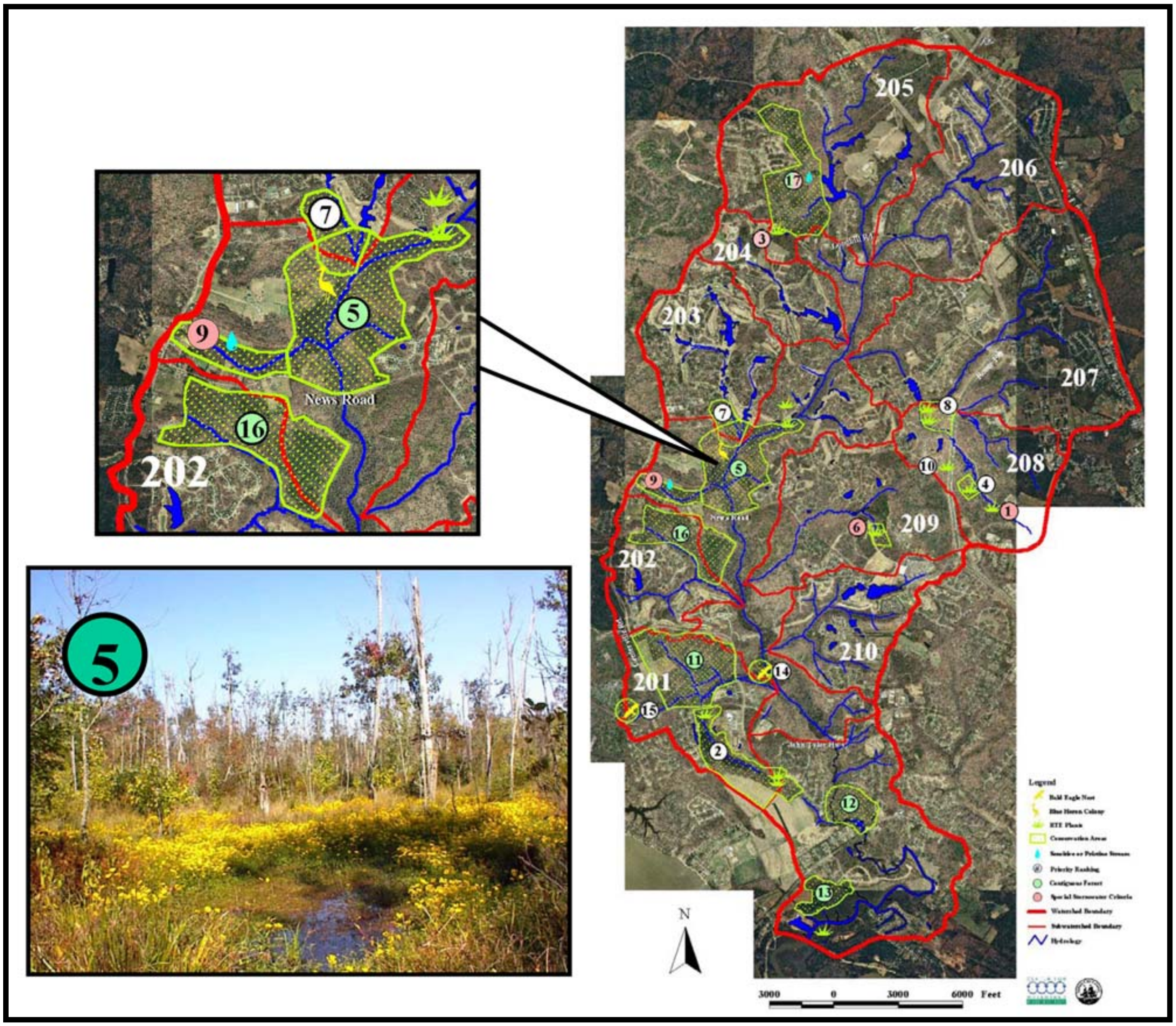


Figure 5.5: Sensitive areas assessment for Powhatan Creek watershed, Virginia

Wetland Assessment

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

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

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

P-18 Stakeholder Involvement

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.

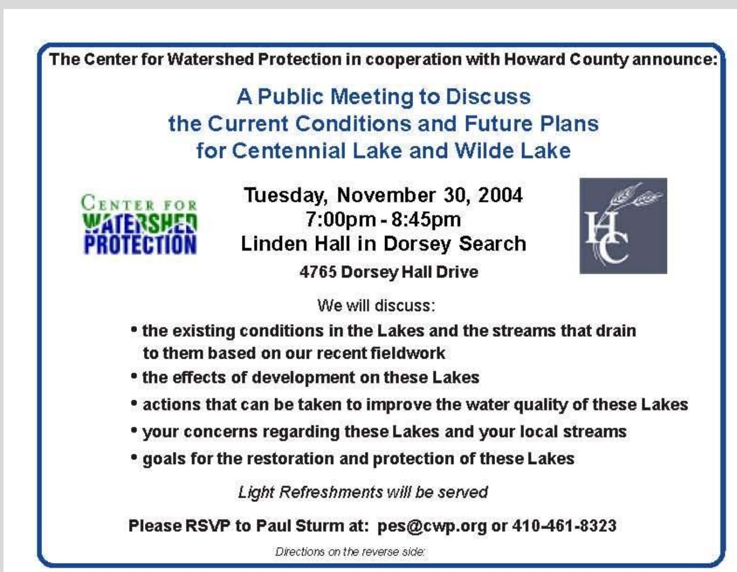
Real World Example: Centennial and Wilde Lakes Watershed Restoration Plan

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.

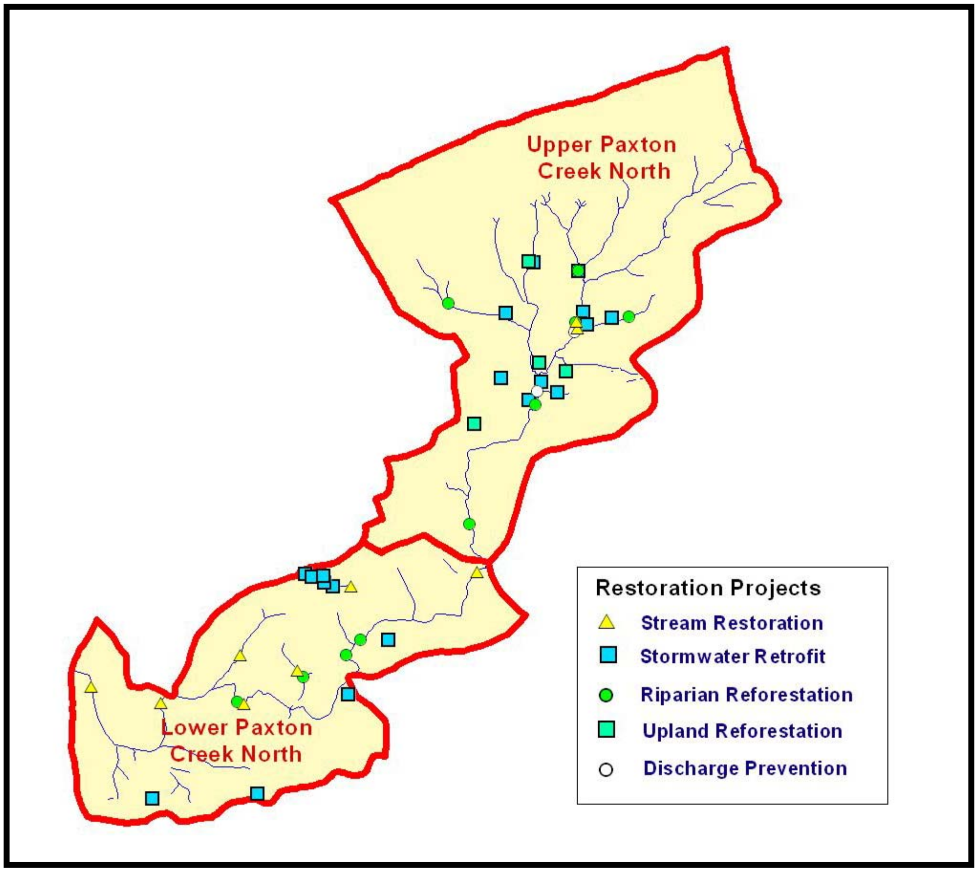


Figure 7.1: Restoration projects in the Paxton Creek North subwatershed, Pennsylvania

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.

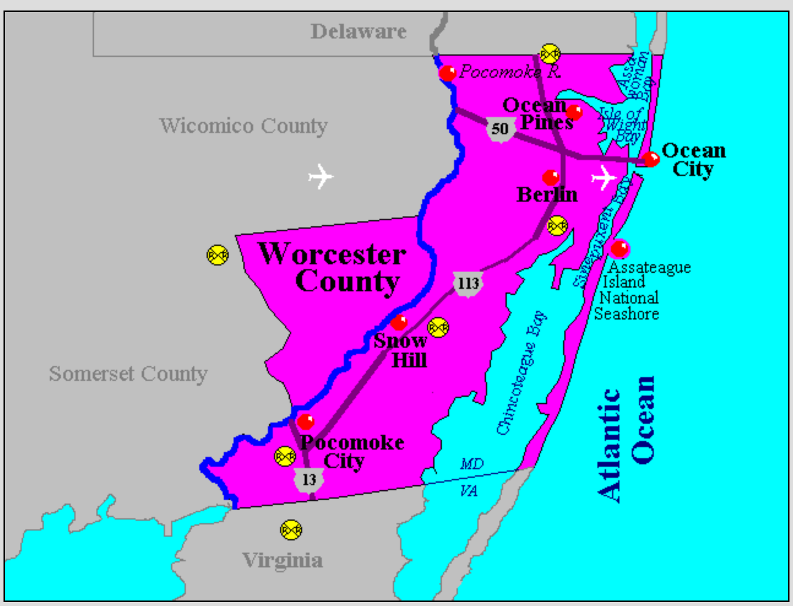


Photo from www.worcestercountyonline.org © 2004 Worcester County Economic Development
Worcester County Department of Comprehensive Planning. 2005.

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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User's Guide Downloadable Tool Directory	
Tool No.	**Title**
1	Maryland Contact and Website List
2	Maryland GIS Resources
3	Maryland Monitoring Resources
4	Funding Resources
5	Relevant 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 Program Benchmarking Tool
10	MDP's Models and Guidelines, Estimating Residential Development Capacity
11	Leaf Out Analysis
12	Watershed Vulnerability Analysis
13	Comparative Subwatershed Analysis
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 Inventory (SRI) Field Sheets • Urban Reforestation Site Assessment (URSA) Field Sheets • Discharge Prevention Investigation (DPI) Field Sheets • Sensitive Areas Assessment Field Sheets
20	Stakeholder Involvement Profile Sheets
21	Stakeholder Education Resources
22	Management Profile Sheets

Tool 1
Maryland Program Contacts and Websites

This tool provides a list of programs that influence the watershed planning process in Maryland and contact information for more information

Maryland Program Contact and Resource List

Program	Contact Name, Agency and Phone	E-mail	Website
Antidegradation Policy	Jim George MDE 410-537-3579	jgeorge@mde.state.md.us	www.dsd.state.md.us/comar/26/26.08.02.04%2D1.htm
Chesapeake 2000 Bay Agreement	Carin Bisland CBP 410-267-5732	bisland.carin@epa.gov	www.chesapeakebay.net/c2k.htm
Coastal Bays Comprehensive Conservation Management Plan (CCMP)	Dave Blazer MCBP 410-213-2297	director@mdcoastalbays.org	• www.mdcoastalbays.org/ • www.dnr.state.md.us/coastalbays/index.html
Environmental Protection Agency's Watershed Plan Guidance Elements	Fred Suffian EPA Region III 215-814-5753	suffian.fred@epa.gov	www.epa/gov/owow/nps/Section319/319guide03.html
National Pollutant Discharge Elimination System Program	Brian Clevenger MDE (410) 537-3543	bclevenger@mde.state.md.us	www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/index.asp
Total Maximum Daily Loads Implementation	Jim George MDE 410-537-3579	jgeorge@mde.state.md.us	www.mde.state.md.us/Programs/WaterPrograms/TMDL/index.asp
Total Maximum Daily Loads Development	David Seaborn MDE 410-537-3572	dseaborn@mde.state.md.us	www.mde.state.md.us/Programs/WaterPrograms/TMDL/index.asp
Maryland Nontidal Wetlands Protection Act of 1989	Amanda Sigillito MDE (410) 537-3768	asigillito@mde.state.md.us	www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/index.asp
Comprehensive Plan Updates	Tay Harris MDP 410-767-4558	tharris@mdp.state.md.us	• www.mdp.state.md.us/planningact/download/mmg9303.htm • www.mdp.state.md.us/mgs/mg20.PDF
Source Water Assessments	John Grace MDE 410-537-3714	jgrace@mde.state.md.us	www.mde.state.md.us/Programs/WaterPrograms/Water_Supply/sourcewaterassessment/index.asp

Program	Contact Name, Agency and Phone	E-mail	Website
Maryland's Tributary Strategy	Jamie Baxter MD DNR (410) 260-8987	jbaxter@dnr.state.md.us	• http://dnr.maryland.gov/bay/tribstrat/index.html. • www.chesapeakebay.net/wqctributarymd.htm
Water and Sewerage Facilities Planning	Larry Fogelson MDP 410-767-4549 George Keller MDE 410-537-3746	lfogelson@mdp.state.md.us gkeller@mde.state.md.us	• www.mde.state.md.us/Programs/MultimediaPrograms/Smart_Growth/SG_Water.asp • www.mdp.state.md.us/water.html
Project Priority Ranking System for Water Quality Financing	Marya Levelev MDE 410-537-3720		• http://www.mde.state.md.us/Programs/WaterPrograms/Water_Quality_Finance/index.asp
Critical Area Act	Ren Serey MD DNR 410-260-3462	rserey@dnr.state.md.us	www.dnr.state.md.us/criticalarea/
Forest Conservation Act	MD DNR		www.dnr.state.md.us/forests/programs/urban/explained.html
Wildlife and Heritage Service	MD DNR		http://www.dnr.state.md.us/wildlife/
Priority Funding Areas	MDP		www.mdp.state.md.us/pfamap.htm
Flood Hazard Mitigation Program	MDE 410-537-3000		www.mde.state.md.us/Programs/WaterPrograms/Flood_Hazard_Mitigation/index.asp
State Scenic and Wild River System	John F. Wilson MD DNR (410) 260-8412	jfwilson@dnr.state.md.us	www.dnr.state.md.us/resourceplanning/scenicrivers.html
MDE: Maryland Department of the Environment MD DNR: Maryland Department of Natural Resources MDP: Maryland Department of Planning CBP: Chesapeake Bay Program MCBP: Maryland Coastal Bays Program EPA: Environmental Protection Agency			

Tool 2
Maryland GIS Resources

This tool provides links to free or low-cost, readily available GIS data useful for watershed planning in Maryland, as well as links to national data available for purchase

GIS Data Resources

Several key sources of free or low-cost, readily available GIS data have been identified for watershed planning in Maryland. These are presented in Table 1 and are grouped into two tiers. The first tier of data resources includes those deemed most useful based on their resolution, state-wide availability, low cost, accessibility, user-friendliness, and relevance to watershed planning. Tier 2 resources are those that have a higher cost, are not specific to Maryland, require a higher level of expertise to use, or contain more obscure layers that are not necessarily useful in every watershed plan. Each resource is briefly described and a web link is provided.

Table 1. GIS Data Resources for Watershed Planning in Maryland

Source	*Name of Resource*	*Description*	*Website*
Tier 1 Resources			
Maryland Department of Natural Resources	Geospatial Data	Download free state-wide data and order additional data at very low cost. See complete list of available data following this table.	http://dnrweb.dnr.state.md.us/gis/data/data.asp
Maryland Department of Planning	GIS Data Download	Download sewer, zip codes, land use/land cover, soils, zoning (general), priority funding areas, census data, congressional and legislative districts	http://www.mdp.state.md.us/zip_downloads_accept.htm
Maryland Department of Planning	MD Property View	Property boundaries, high-resolution aerial photos available for purchase. Ranges from $300 - $700 per county for property boundaries, $10 - $30 per tax map for aerials	http://www.mdp.state.md.us/data/index.htm
Chesapeake Bay Program	FTP Site	Download state-wide hydrography, landcover, political boundaries, transportation and watershed boundaries (HUC 8, HUC 11)	ftp://ftp.chesapeakebay.net/Pub/Geographic/
Chesapeake Bay Program	Resource Lands Assessment	Download Bay-wide GIS data results of CBP model scenarios. Data includes ranking of lands by importance to: Prime Farmland, Ecological Network, Water Quality Protection, Forest Economics, Cultural Assessment and Vulnerability to development	http://www.chesapeakebay.net/rla.htm

Table 1. GIS Data Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
EPA	Watershed Assessments, Tracking and Environmental ResulTS (WATERS)	Download GIS layers of 303(d) listed waters and 305(b) water quality assessments	http://www.epa.gov/waters/data/downloads.html
EPA	Better Assessment Science Integrating point and Nonpoint Sources (BASINS)	Order CD (free) or download software from website. Contains various natural resource data, base map layers, environmental monitoring data (station locations) and point source data (Superfund sites, industrial facilities discharge sites, toxic releases)	http://www.epa.gov/waterscience/basins/b3webdwn.htm
USGS	Seamless Data Distribution	Download high-resolution orthophotos, National Elevation Dataset, National Land Cover Database and various other layers using interactive map.	http://seamless.usgs.gov/website/Seamless/
USGS	USGS Geographic Data Download	Download National Hydrography Dataset, 1:24,000 Digital Line Graphs and national scale Land Use/Land cover, Digital Elevation Models, Digital Line Graphs. Contains info on obtaining other USGS map products.	http://edc.usgs.gov/geodata/
USGS	Earth Explorer	Purchase reasonably priced satellite imagery, aerial photos, Digital Line Graphs, elevation data Digital Raster Graphics.	http://edcsns17.cr.usgs.gov/EarthExplorer/
Geo Community	GIS Data Depot	Download 1:24,000 Digital Elevation Models, DOQs and other data at state or county level. Free or very low cost.	http://data.geocomm.com
Map Mart	USA Data Store	Download or order USGS products at very low cost, also order high resolution aerial photos and other data at reasonable cost.	www.mapmart.com

Table 1. GIS Data Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
Tier 2 Resources			
Maryland Geological Survey	Data Resources	Download layers of shoreline change, sediment distribution, shorelines, county boundaries.	http://www.mgs.md.gov/indexdata.html
Department of Interior	National Atlas	Download various national data layers in the following categories: agriculture, biology, boundaries, climate, environment, geology, history, map reference, people, transportation, water. May be useful for more obscure layers such as extent of invasive species habitat.	http://www.nationalatlas.gov/atlasftp.html
Federal Emergency Management Agency	FEMA Flood Map Store	Digital Q3 flood data available to order for $50 per county.	http://www.msc.fema.gov/ordrinfo.shtml
Natural Resources Conservation Service	State of the Land	Download 8 digit HUC boundaries and various other boundary layers such as counties, federal lands and congressional districts	http://www.nrcs.usda.gov/technical/land/aboutmaps/coverages.html
Natural Resources Conservation Service	State Soil Geographic Database (STATSGO)	Download soil layers for U.S. states. This layer is most useful for counties with no SSURGO data available.	http://www.ncgc.nrcs.usda.gov/products/datasets/statsgo
Natural Resources Conservation Service	Soil Survey Geographic Database (SSURGO)	Download soils layers for counties. Not available for all counties.	http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo
US Census Bureau	Topologically Integrated Geographic Encoding and	Download TIGER/Line files, which include roads, railroads, rivers, lakes, legal boundaries and census statistical boundaries. Requires special conversion tools to use in GIS	http://www.census.gov/geo/www/tiger/index.html

Table 1. GIS Data Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
	Reference System (TIGER)		
US Fish and Wildlife Service	National Wetlands Inventory	Download wetlands data. NWI is available digitally for only 40% of conterminous U.S. and often misses a lot of smaller wetlands.	http://wetlands.fws.gov/downloads.htm
Maryland Historical Trust	Digital Data Products	Order GIS layers of historic properties, historic preservation easements and archaeological sites, fairly low cost.	http://www.marylandhistoricaltrust.net/gis-upd.html
Space Imaging	Ikonos	Purchase high-resolution satellite imagery. Can be very expensive.	www.spaceimaging.com
Towson University	Chesapeake Bay and Mid-Atlantic from Space	Landsat satellite data available for download by county. Requires special software to analyze data. Impervious cover and other base map data will be available soon.	http://chesapeake.towson.edu/data/download/
University of Maryland	Global Land Cover Facility	Landsat and other satellite imagery and products available for download	http://glcf.umiacs.umd.edu/data/

The Maryland DNR has the most complete Maryland-specific collection of GIS data, and is available for free download or on CD for $65 per disk. We recommend starting with this website and then using the other websites to obtain data that is not available through DNR such as recent (less than 5 years old) high-resolution aerial photos. Certain detailed layers such as impervious cover layers, utilities and 2-foot contours will not be available at the state level and must be created or derived from local sources. The data layers available through DNR include:

- Conservation Reserve Enhancement Program (CREP) Eligible Areas
- Critical Area
- Floodplain (100 and 500-year)
- Forest interior dwelling species – potential habitat
- Green Infrastructure
- Greenway

- Maryland's I-Team data
- Natural Heritage Areas
- NERR Project Areas
- Protected Lands
    - Federal lands
    - DNR-owned lands
    - County parks
    - Agricultural land preservation foundation easements and districts
    - Private conservation lands
    - Maryland Environmental Trust easements
    - Forest legacy
    - Rural legacy areas
- Sensitive Species Project Review Areas
- Recent Shoreline
- Submerged Aquatic Vegetation
- Trib Strategy Areas
- Watersheds (1:24,000 scale, developed by MD DNR)
- Wetlands NWI (1:24,000, 1981-1982)
- Wetlands of Special State Concern
- Wetlands DNR (1:12,000, 1988-1995)
- LIDAR elevation data
- Color infared Digital Orthophoto Quarter Quadrangles (DOQQs) (1 meter, 1988-1995)
- Panchromatic digital imagery (1 meter, 1998-2000)
- RESAC impervious cover data*
- Strategic forest lands assessment data*

*Coming Soon: For more information on these layers contact Christine Conn (MD DNR, Ecosystem Analysis Center) at 410-260-8785.

Tool 3
Maryland Monitoring Resources

This tool lists available watershed monitoring data sources that have been identified for watershed planning in Maryland. This includes water quality, flows, biological monitoring, and physical data

Monitoring Data Resources

This tool lists available watershed monitoring data sources that have been identified for watershed planning in Maryland. This includes water quality, flows, biological monitoring, and physical data. These data sources are presented in Table 1 and are grouped into two tiers. The first tier of data resources are those deemed most useful based on their accessibility, coverage area, user-friendliness, and relevance to watershed planning. Tier 2 resources are less comprehensive, have a narrower focus, or provide only narrative data (e.g. impaired segments of a waterbody). Each resource is briefly described and a web link is provided.

Table 1: Monitoring Resources for Watershed Planning in Maryland

Source	*Name of Resource*	*Description*	*Website*
		Tier 1 Resources	
MD DNR	Eyes on the Bay	Includes links to water quality data, (continuous monitoring and fixed station monthly monitoring data), as well as water quality mapping of various rivers.	http://mddnr.chesapeakebay.net/eyesonthebay/index.cfm
MD DNR	Maryland Biological Stream Survey (MBSS) Data Search	Searchable MBSS data by county, stream, site, etc. Includes WQ, habitat, macros, and fish.	http://mddnr.chesapeakebay.net/mbss/search.cfm
MD DNR	Surf Your Watershed	A cooperative effort between MDE and DNR to maintain a catalog of important environmental and programmatic information for MD's 8-digit watersheds.	www.dnr.state.md.us/watersheds/surf
MD DNR	Watershed Restoration Action Strategies	Stream Corridor Assessment survey data of streams with Watershed Restoration Action Strategies.	http://www.dnr.state.md.us/watersheds/surf/proj/wras.html
Chesapeake Bay Program	Living Resources Monitoring	Searchable CBP databases (water quality, toxics, point sources, benthic macroinvertebrate, plankton, SAV) as well as links to other sites described herein.	http://www.chesapeakebay.net/monprgms.htm

Table 1: Monitoring Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
Chesapeake Bay Program	Watershed Model Phase 4.3	Estimates nutrient and sediment delivery to the Chesapeake Bay based upon regional variables. This model is a linked application of five models: airshed, watershed, estuarine hydrodynamic, estuarine hydrodynamic, and living resources models.	http://www.chesapeakebay.net/model.htm
EPA (various sources)	STORET (short for STOrage and RETrieval)	Repository for National water quality, biological, and physical data. If unfamiliar with STORET, the Training Exercise helps with downloading data and importing into Excel. MDE, USGS, and MD DNR data reported here.	http://www.epa.gov/STORET/index.html
USGS	Chesapeake Bay River Input Monitoring Program	Data retrieval of water quality (concentrations), stream flow, and loads (such as TSS, nitrogen, or phosphorous) for select Maryland stations.	http://va.water.usgs.gov/chesbay/RIMP/dataretrieval.html
USGS	National Water Information System (NWIS) Data for Maryland	Data from selected surface-water, ground-water, and water-quality sites in Maryland.	http://waterdata.usgs.gov/md/nwis/nwis
MDE	Maryland 303(d) List Search	Online access and user defined query of the State's 303(d) List.	http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/303d_search/
MDE	Fish and Shellfish Contaminant Monitoring	Information and reports related to chemical levels measured in fish and shellfish tissue. Also contains fish consumption information.	http://www.mde.state.md.us/CitizensInfoCenter/FishandShellfish/index.asp
Tier 2 Resources			
EPA	Nutrient Water Quality Criteria	Database of nutrient water quality. Can run query by state, county and site. Data for Maryland limited to 1990-1996.	http://www.epa.gov/waterscience/criteria/nutrient/database/index.html
EPA	Permit Compliance System	Provides information about NPDES facilities permits and compliance status. Searchable by region.	http://www.epa.gov/enviro/html/pcs/index.html

Table 1: Monitoring Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
MD DNR	Tidal Fish 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. Data presented by River, not by station.	www.dnr.state.md.us/fisheries/juvindex/
National Estuarine Research Reserve System (NERR)	NERR System Wide-Monitoring Program	Water quality and meteorological data for select stations in the Chesapeake Bay watershed.	http://cdmo.baruch.sc.edu/home.html
NOAA, National Marine Fisheries Service	Fishery surveys in the Chesapeake Bay	Searchable databases for the following survey types: winter dredge, juvenile striped bass, and trawl for Maryland sites.	http://noaa.chesapeakebay.net/surveys.htm
USGS	Water quality assessment of the Potomac River Basin	Water quality and spatial data for selected Potomac stations for the years 1992-1996.	http://md.water.usgs.gov/pnawqa/datarpt/
USGS	WaterWatch	Clickable map of stream gauging sits in Maryland; compares current and historical streamflow. Links to other stream flow parameters (flood, high flows, averages) and data summary options (plot or table).	http://water.usgs.gov/cgi-bin/waterwatch?map_type=real&state=MD
Alliance for the Chesapeake Bay	Alliance Citizen Monitoring Database	A database about volunteer-based water monitoring organizations in the Chesapeake Bay includes descriptions of data and how to obtain access to data. Search by Program Name or Geographic extent to get relevant information.	http://www.acb-online.org/project.cfm?vid=217
Susquehanna River Basin Commission	Nutrient and Sediment Data	Hydrologic conditions, nutrient and sediment loads, trends, and data. Includes easily viewed maps of various GIS layers.	http://www.srbc.net/nutrientprogram.htm

Other Useful Resources

US EPA Surf Your Watershed
Provides general information on the health of your watershed, watershed groups, groundwater, and air quality.
http://www.epa.gov/surf/

US EPA National Assessment Database
In the National Assessment Database (NAD), assessed waters are classified as either Fully Supporting, Threatened, or Not Supporting their designated uses. This information is reported in the National Water Quality Inventory Report under Section 305(b) of the Clean Water Act.
http://www.epa.gov/waters/305b/

Maryland Department of the Environment TMDL
Includes everything you need to know about TMDL's in Maryland including regulatory background, definition and how to calculate.
http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/home/index.asp

Maryland 2002 Section 303(d) List
Includes everything you need to know about Maryland's 2002 Integrated 303(d) List as well as the list, sorted by watershed or by impairment (i.e., bacteria, metals, nutrients, etc.).
http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/2002_303d_list.asp

North American Breeding Bird Survey
The BBS is a large-scale survey of North American birds. It is a roadside survey, primarily covering the continental United States and southern Canada. The primary objective of the BBS has been the estimation of population change for songbirds. However, the data have many potential uses, and investigators have used the data to address a variety of research and management objectives. http://www.mbr-pwrc.usgs.gov/bbs/intro04.html

North American Amphibian Monitoring Program
The NAAMP is a collaborative effort among regional partners, such as state natural resource agencies and nonprofit organizations, and the USGS to monitor populations of vocal amphibians. The regional partners recruit and train volunteer observers to collect amphibian population data, following the protocol of the NAAMP. Amphibian population data are collected using a calling survey technique, in which observers identify local amphibian species by their unique vocalizations.
http://www.pwrc.usgs.gov/NAAMP/database/

Tool 4
Maryland Funding Resources

This tool contains resources for financing watershed planning in Maryland and is limited to those resources for which local governments are eligible

Financing for Watershed Planning

The following resources are for financing watershed planning in Maryland and are limited to those resources for which local governments are eligible. Resources include grants, loans, and cost-share agreements and are split into two categories: resources that fund the development of a watershed plan and resources that can be used to implement watershed management plan recommendations, including stormwater retrofits, reforestation projects, pollution prevention, agricultural BMPs, and more. The two resources listed below can be used to fund watershed planning in Maryland.

Chesapeake Bay Small Watershed Grants Program
This grant program, sponsored by the Environmental Protection Agency, awards financial assistance to support communities in developing and implementing watershed management plans, developing the capacity of local governments to enhance local watershed management, and encourage environmentally sensitive development, land conservation, and sound land use planning. Grants awarded for 2004 ranged from $5,000 to $50,000.
For more information:
National Fish & Wildlife Foundation
1120 Connecticut Avenue, Suite 900
Washington, DC 20036
www.nfwf.org

Chesapeake Bay Trust
The Chesapeake Bay Trust offers grants for qualified activities in Maryland that contribute to the restoration of the Chesapeake Bay. The Trust favors partnerships and action-oriented activities, with emphasis on projects that unite business, government and citizen groups in restoration and protection activities. Priority is given to two principal areas: education projects that promote a behavior change toward the Bay, and the performance of restoration activities that utilize volunteers. Specific grants available to local governments include Quarterly Grants, the Targeted Watershed Grants program, and the Living Shoreline Initiative.
Chesapeake Bay Trust
60 West Street, Suite 405
Annapolis, MD 21401
(410) 974-2941
www.chesapeakebaytrust.org

In addition, the US EPA Chesapeake Bay Watershed Implementation Grants program is currently being assembled and will be a major source of funding for watershed planning in Maryland.

Maryland Agricultural Land Preservation Foundation
Established by the Maryland General Assembly in 1977 and is part of the Maryland Department of Agriculture. The Foundation purchases agricultural preservation easements that restrict development on prime farmland and woodland.
http://www.malpf.info/

Maryland's Program Open Space
Program Open Space provides dedicated funds for Maryland's state and local parks and conservation areas.
http://www.dnr.state.md.us/pos.asp

Financing for Watershed Plan Implementation

Table 1 presents a list of resources that can be used to finance implementation of watershed plans in Maryland.

Table 1: Financing Resources for Watershed Plan Implementation in Maryland			
Name of Resource	*Types of Projects Funded*	*Description*	*Website*
Conservation Reserve Enhancement Program	Ag BMPs and conservation	Provides financial incentives to farmers to create wetlands, plant riparian buffers and provide wildlife habitat. Annual incentive payments of $50-$200/acre and up to 87.5% cost-share for most practices.	http://www.dnr.state.md.us/wildlife/milo.asp
Governor Ehrlich's Bay Restoration Fund (MDE)	Infrastructure upgrades	This $5 million fund provides grants of up to 75% for various wastewater treatment and sewer upgrades. As of 2005, funding is only available for sewer replacement/rehab and combined or sanitary sewer overflow corrections	http://www.mde.state.md.us/water/cbwrf/index.asp
Maryland Agricultural Water Quality Cost Share Program (MACS)	Ag BMPs and nutrient management assistance	The MACS program provides farmers with up to 87.5% cost-share grants to install a full range of BMPs on their farms as part of a more comprehensive program to protect watersheds and maintain farm productivity.	http://www.mda.state.md.us/pdf/MDA_MACS_bro_proof4.pdf
MD DNR Rural Legacy Program	Ag land conservation	Provides funding to protect large contiguous tracts of land and other strategic areas from sprawl development, and enhance natural resource, agricultural, forestry and environmental protection; local government must apply to have an area designated a "rural legacy area."	http://www.dnr.state.md.us/rurallegacy/rlprogram/index.html
MD DNR Shore Erosion Control Program	Shoreline erosion control	Grants and loans for structural or non-structural shore erosion control practices; as of 2005, only loans are available; 75% interest-free loans for projects on private and public lands using State special funds	http://www.dnr.state.md.us/forests/programapps/sec.html
MDE 319 Grants	NPS pollution control	As of 2005, 319 money is being directed to specific watersheds, and RFPs will not be announced until at least 2006. Waterways with a high likelihood of being delisted from 303(d) list will take priority when RFPs are released.	http://www.mde.state.md.us
MDE Small Creeks and Estuaries Restoration	Various restoration projects	This cost-share program provides up to 50% in grant funds for the study, approved design, and construction costs or up to 75% with demonstrated need. Projects include stream bank stabilization, wetland creation, and vegetative buffers targeting "seriously degraded" water bodies.	http://www.mde.state.md.us/Programs/WaterPrograms/WQIP/wqip_smallcreeks.asp

Table 1: Financing Resources for Watershed Planning and Implementation in Maryland			
Name of Resource	*Types of Projects Funded*	*Description*	*Website*
MD NRCS Conservation Security Program	Ag conservation	Provides financial and technical assistance to promote conservation on Tribal land and private working lands, including cropland, grassland, prairie land, improved pasture, and range land, as well as forested land that is incidental to agriculture operation.	http://www.md.nrcs.usda.gov/programs/csp/csp.html
MDE Maryland Stormwater Pollution Control Cost-Share Program	Stormwater Retrofits	Grant funding for stormwater management retrofit and conversion projects in urban areas developed prior to 1984; up to 75% of the costs for project design and construction (maximum of $500,000 per project)	http://textonly.mde.state.md.us/Programs/WaterPrograms/WQIP/wqip_stormwater.asp
MDE Water Quality State Revolving Loan Fund (SRF)	Point and NPS pollution control	Provides low or no interest rate loans to local governments for point and non-point source pollution control including wellhead protection, wastewater treatment plant improvements, and brownfield clean-up.	http://textonly.mde.state.md.us/Programs/WaterPrograms/Water_Quality_Finance/Water_Quality_Fund/index.asp
NRCS Environmental Quality Incentives Program (EQIP)	Ag BMPs and conservation	Provides farmers and ranchers with 75% cost share of certain conservation/management practices for up to 3 years.	http://www.nrcs.usda.gov/programs/eqip/
NRCS Wildlife Habitat Incentives Program (WHIP)	Various restoration projects	Provides up to 75 percent cost-share assistance to establish or improve upland, wetland, riparian, and aquatic habitat areas. Limited funds available directly to local governments.	http://www.nrcs.usda.gov/programs/whip/
US Housing and Urban Development (HUD)	Brownfields	HUD administers this competitive grant program to redevelopment brownfields where environmental problems potentially exist. Funding of up to $2 million includes site remediation costs	http://www.hud.gov/offices/cpd/economicdevelopment/programs/bedi/index.cfm

Table 1: Financing Resources for Watershed Planning and Implementation in Maryland			
Name of Resource	*Types of Projects Funded*	*Description*	*Website*
US EPA Brownfields Cleanup Grant and Revolving Loan Fund (RLF)	Brownfields	Maximum cleanup grant is $200k per site (five sites max) and maximum RLF is $1 million. Each requires a 20% cost share.	http://www.epa.gov/swerosps/bf/applicat.htm#pg
US EPA Drinking Water State Revolving Fund	Drinking water protection	A loan program with funds set aside for emphasis on small and disadvantaged communities and programs that encourage pollution prevention as a tool for ensuring safe drinking water	http://www.epa.gov/safewater/dwsrf.html
US EPA Five Star Restoration Program	Various restoration projects	Funds community-based restoration projects that lead to education; funding levels are from $5,000 to $20,000, with $10,000 as the average amount awarded per project	http://www.epa.gov/owow/wetlands/restore/5star/index.html
American Forests Global Re-Leaf Grants	Tree planting	Covers costs associated with the planting of seedlings (e.g., site preparation, seedling purchase, contracting, transportation, shelters, etc.)	http://www.americanforests.org/global_releaf/grants/criteria.php
ESRI and NACo Technology Grants	Mapping	Grants provide GIS software and hardware packages to local governments with two levels of GIS experience - introductory and intermediate.	http://www.esri.com/grants/index.html
National Environmental Education and Training Foundation Competitive Challenge Grants	Education	NEETF grants are available for three areas: health & environment, environmental education, and safe water (community-wide understanding of water - as it relates to human health and community vitality)	http://www.neetf.org
National Fish and Wildlife Foundation Bring Back the Natives	Various restoration projects	Supports direct project-related salaries, contractual services and materials needed for on-the-ground restoration; Requires 2:1 non-federal to federal match; The average grant is about $60,000.	http://www.nfwf.org/programs/grant_apply.htm

Tool 5
Relevant Programs, Requirements and Resources

This tool is a continuation of the listing of drivers, resources and data provided in Chapter 2

Relevant Programs, Requirements and Resources

National Park Service Rivers, Trails and Conservation Assistance Program (RTCA)
The RTCA is a program to further the mission of the NPS by working with community groups and local, State, and federal government agencies to preserve open space, conserve rivers, and develop trails and greenways. RTCA staff can facilitate and bring expertise to the implementation of project(s) recommended in a watershed plan that coincide with the RTCA and NPS mission of outdoor recreation and natural resource conservation. The RTCA program implements the natural resource conservation and outdoor recreation mission of the National Park Service in communities across America. More information can be found at: http://www.nps.gov/rtca/

Maryland's Clean Water Action Plan
The Maryland Clean Water Action Plan (CWAP) charts a course toward fulfilling the original goals of the Clean Water Act. Maryland's 1998 Clean Water Action Plan called for the assessment of all State waters to determine the degree of nonpoint source impairment and to establish restoration priorities. The resulting Unified Watershed Assessment (UWA) looked at all 134 watersheds in the state in terms of both watershed impairments and significant water resource values. The assessment categorized watersheds as either in need of protection, restoration, or, in some instances, both.

The resulting assessment report provides a lot of good baseline data that can be used to characterize the current conditions of a watershed, although some of the data and references to the Watershed Restoration Action Strategy process may be somewhat outdated. The watershed categorizations can be used to highlight and determine which watersheds need attention first. Categorization and baseline data should also be used to set initial goals and set direction of watershed planning. The full assessment report can be found at http://www.dnr.state.md.us/cwap/.

Watershed Protection and Flood Prevention Act
The Watershed Protection and Flood Prevention Act, Public Law 83-566, Stat. 666, (see exhibit 500–1) authorizes the Secretary of Agriculture to cooperate with State and local agencies in planning and carrying out works of improvement for soil conservation and for other purposes. It provides for technical, financial, and credit assistance by the United States Department of Agriculture (USDA) to local organizations representing the people living in small watersheds. It also provides for needed additional treatment and protection of federally owned lands within such watersheds. Unlike other national conservation programs, the Watershed Protection and Flood Prevention Program requires the development of a physically, environmentally, socially, and economically sound plan of improvements scheduled for implementation over a period of years. It uses a project-type approach to accomplish this. Firm commitments are required from local organizations (including States). They must:
• Share the costs of installation,
• Assume operation and maintenance responsibilities (with certain exceptions on Federal land), and
• Meet other requirements as a condition for Public Law 83-566 assistance in carrying out the improvements.

The National Watershed Manual outlines the minimum requirements for administering the Watershed Protection and Flood Prevention Act and is available at:
http://www.nrcs.usda.gov/programs/watershed/NWSM.html

Community Watershed Assessment Handbook
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. The purpose of the handbook is to outline a basic process for assessing a community's current and anticipated future watershed conditions. In addition, the manual offers guidance for using the resulting assessment information as a foundation for future watershed management planning. Available online at:
http://www.chesapeakebay.net/pubs/watershed_assess/

Maryland Surf Your Watershed
The Surf Your Watershed project is a cooperative effort between the Maryland Department of the Environment and the Department of Natural Resources to maintain a catalog of important environmental and programmatic information for Maryland's 8-digit watersheds. MD DNR hopes to begin updating the data in the near future, but there is not currently a long-term plan to keep the information current. Therefore, this may provide useful historical data, which includes parameters such as impervious cover percentages, population densities, forest cover, and wetland loss. Available online: http://www.dnr.state.md.us/watersheds/surf/

Maryland Environmental Trust
The Maryland Environmental Trust (MET) is a statewide local land trust with the goal of preserving of open land, such as farmland, forest land, and significant natural resources through conservation easements. MET also provides assistance to citizen groups in formation and operation of land trusts by offering training. In addition, MET gives grants to environmental education projects and provides a directory of local land trust on their website.

The Maryland Environmental Trust may be valuable partners for protection oriented watershed plans. For more information view their organizational website at:
http://www.dnr.state.md.us/met/.

Maryland's Rural Legacy Program
The Program 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 in order to protect areas vulnerable to sprawl development that can weaken an area's natural resources, thereby jeopardizing the economic value of farming, forestry, recreation and tourism. Additional information is available online at:
http://www.dnr.state.md.us/rurallegacy/

Maryland's Green Print Program
GreenPrint is aimed at protecting the most valuable remaining ecological lands in Maryland. The purpose of the program is threefold:

- Identify, using the most up-to-date computer mapping techniques, the most important unprotected natural lands in the state;
- Link, or connect, these lands through a system of corridors or connectors; and
- Save those lands through targeted acquisitions and easements.

The DNR GreenPrint program is a state land acquisition program. However, DNR may choose to pass funds through to a local government or private land trust. Local partners who wish to suggest a GreenPrint acquisition project should contact the Program Open Space administrator for their region. Maps of greenprint areas identified across the state can be found online at: http://www.dnr.state.md.us/greenways/greenprint/.

Maryland Stormwater Management Regulations

In 1982, the General Assembly passed the "Stormwater Management Act," and shortly thereafter, stormwater management regulations were adopted. Since that time, MDE has revised the requirements for stormwater management and now provides explicit guidance on required measures, incentives and credits, innovative stormwater management practices, and redevelopment criteria. For more information on MDE's extensive stormwater management program and to view the *2000 Maryland Stormwater Design Manual*, see: http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/index.asp

Maryland Erosion and Sediment Control Regulations

Maryland's Erosion Control Law and regulations specify the general provisions for program implementation; provisions for delegation of enforcement authority; requirements for erosion and sediment control ordinances; exemptions from plan approval requirements; requirements for training and certification programs; criteria for plan submittal, review, and approval; procedures for inspection and enforcement; and applicant responsibilities. Clearly defining minimum standards is essential to make erosion and sediment control work. MDE has established minimum criteria for effective erosion and sediment control practices. The 1994 Standards and Specifications for Soil Erosion and Sediment Control are incorporated by reference into State regulations and serve as the official guide for erosion and sediment control principles, methods, and practices. For more information and to view current state standards, see: http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/home/erosion_sediment.asp

Tool 6
Model Scopes

This tool provides two example scopes-of-work to develop a watershed restoration or protection plan

Model Scope of Work
False Creek Watershed Restoration Plan

Background Information
Presented below is a model scope of work to develop a watershed restoration plan for the False Creek Watershed in Phantom County, Maryland. The 28 square mile watershed contains over 62 miles of perennial streams and has been delineated into 6 subwatersheds. The City of Bogusville, a Phase II community, is located in the lower portion of the watershed. A portion of the mainstem below Bogusville is 303(d) listed for sediment and nutrients. About ¾ of the watershed is built-out and consists of urban and suburban development, with the remainder in agriculture and forest in the upper reaches of the watershed. The City of Bogusville has developed this scope of work as part of a grant application submitted to a state-funded program for watershed planning. The City's Stormwater Management Division will be responsible for conducting the assessments and developing the plan. A baseline assessment of the watershed completed by this Division under a previous grant will provide much of the background data for use in developing the restoration plan.

Note to User's Guide Readers:
This model scope of work is based on the following assumptions:
- All of the methods outlined in Getting Started (Chapter 3) have already been completed.
- Establishing a Baseline (Chapter 4) has been completed under a previous grant.
- Classifying and Ranking Subwatersheds has been skipped because it was determined that the grant amount would allow the City to conduct stream and upland assessments of the entire watershed. The City of Bogusville made the decision to focus stormwater retrofit efforts in the Example Run subwatershed because uncontrolled runoff from the City is causing flooding problems in the immediate area and contributing to high sediment and nutrient loading downstream, where a portion of the mainstem is on the 303(d) list.
- Project budget only includes level of effort, not actual dollar amounts as these will vary for every jurisdiction depending on staff salary and benefit amounts, how/if volunteers are utilized, travel reimbursement policies, and any associated indirect costs.

WORKPLAN

Project Title: False Creek Watershed Restoration Plan

Detailed Description of Project:

Goals and Objectives
The overall objective of this project is to develop a watershed restoration plan for the False Creek Watershed, located in Phantom County in western Maryland. The restoration plan will incorporate watershed goals, findings from stream and upland assessments, and specific recommendations for protection and restoration projects, as well as code and programmatic changes. A major goal of the restoration plan is to reduce sediment and nutrient loads in the watershed, and ultimately have streams removed from the 303 (d) list.

Methodology and Approach
The methodology and approach proposed for this project includes six tasks that are described below.

<u>Task 1. Develop Watershed Restoration Goals</u>
Under this task, the City of Bogusville will define clear and measurable goals and objectives to guide the restoration process, and select indicators that will be used to measure progress towards them. A major source of data for setting watershed goals is the False Creek Watershed Baseline Report produced in 2004 by the City of Bogusville. This report summarizes existing watershed data (e.g., land use, historic and current monitoring data, demographics), and defines key problems and impairments in the watershed. Subtasks associated with developing watershed restoration goals are:

> *1.1 Watershed Needs and Capabilities Assessment:* Conduct a review of local restoration capacity and needs, including regulatory drivers for restoration, technical resources, restoration partners, and key stakeholders. The Needs and Capabilities Assessment will be used for this review, and is provided as Attachment A.
>
> *1.2 Conduct Stakeholder Education Meetings:* Facilitate up to two stakeholder meetings to solicit stakeholder involvement in watershed issues and obtain consensus on goals and objectives that guide watershed restoration.

<u>Task 2. Identify Restoration Opportunities</u>
Under this task, the City of Bogusville will conduct stream and upland assessments to identify restoration opportunities in the watershed.

> *2.1 Conduct Stream Assessment:* Five field crews (2 staff for each field crew) will assess the perennial streams in the watershed using the Stream Corridor Assessment (SCA) protocol (Attachment B) for five days. Specific restoration opportunities will be identified, including impacted buffers and stream erosion.
>
> *2.2 Conduct Upland Assessment:* Field crews will also visit and evaluate residential neighborhoods and potential hotspots in the watershed using the Unified Site and Subwatershed Reconnaissance (USSR) protocol (Attachment C). Specific restoration opportunities will be identified, including stormwater outfalls and upland pollution sources. The City of Bogusville will use the Phantom County parcel data to identify and contact key landowners to obtain permission to access their property prior to conducting field work.

<u>Task 3. Conduct Detailed Restoration Assessments</u>
Under this task, the City of Bogusville will utilize a subcontractor evaluate stormwater retrofit potential in the Example Run subwatershed. This subwatershed contains the City of Bogusville and is subject to frequent flooding from uncontrolled stormwater runoff. This subwatershed was chosen as an area of focus because of the immediate flooding problems, and because this runoff was identified as a major contributor to the downstream sediment and nutrient concentrations that have placed a portion of the mainstem on the 303(d) list. The City of Bogusville will use the Retrofit Reconnaissance Inventory (RRI) protocol (Attachment D) to identify and develop concept designs for up to seven potential storage and on-site retrofit opportunities. Prior to conducting the inventory, field crews will identify potential retrofit sites based on land use and storm drain mapping and STPs, and will obtain landowner permission before accessing private property.

Task 4. Develop Watershed Restoration Recommendations

Under this task, the City of Bogusville will develop watershed restoration recommendations for the False Creek Watershed. Watershed restoration recommendations are the most important element of a watershed restoration plan, and generally consist of two parts: 1) protection and restoration projects, and 2) regulatory and programmatic changes. Protection and restoration projects refer to a suite of site-specific projects that either conserves existing watershed resources or corrects specific problems identified through stream and upland assessments. Regulatory and programmatic recommendations are designed to protect watershed resources from future development impacts, and 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 are recommended. Subtasks associated with developing watershed restoration recommendations are:

4.1 Inventory of Potential Projects: Compile data from field assessments to identify the full suite of potential projects.

4.2 Neighborhood Consultation Meetings: Conduct neighborhood consultation with all major landowners and HOAs affected by the proposed restoration projects to get feedback on the proposed projects. Neighborhood consultation can take the form of public meetings or forums, or one-on-one meetings and field trips.

4.3 Rank Projects: Develop a ranking system and rank individual projects based on factors such as pollutant reduction, cost, feasibility, and public acceptance. The ranking system used will reflect overall watershed goals and stakeholder preferences and allow a direct and fair comparison among all proposed projects in the watershed.

4.4 Evaluate Local Programs and Regulations: Conduct an audit of local watershed programs and regulations. The purpose of the audit is to identify specific areas of existing regulations and programs that could be improved to provide better watershed protection. The 8 Tools Audit (Attachment E) will be used for this subtask. Develop recommendations for changes to local regulations and programs based on the results of the 8 Tools Audit and stakeholder input.

Task 5. Determine if Recommendations Meet Watershed Restoration Goals

Under this task, the City of Bogusville will analyze the ability of the proposed protection and restoration projects to meet the watershed restoration goals and objectives defined in Task 1. The primary method used to accomplish this task is the Watershed Treatment Model, a simple spreadsheet model that estimates flow or pollutant reduction associated with implementation of specific restoration projects across an entire watershed or subwatershed. A brief summary of the WTM is provided as Attachment F. The project ranking and recommendations will be revised based on findings from the WTM, if necessary.

Task 6. Develop Watershed Restoration Plan

Under this task, the City of Bogusville will draft a 20 to 30 page restoration plan for the False Creek Watershed that incorporates watershed restoration goals and recommendations made under Tasks 1 and 4, as well as a plan for monitoring restoration success based on indicators identified under Task 1. The recommendations section will include project ranking and priority projects, watershed maps, and regulatory and programmatic recommendations. The restoration plan will also include a proposed schedule and guidance for implementation of all priority projects, including estimated costs, conceptual designs, responsible parties and project partners, funding strategies, and a construction and maintenance schedule. Subtasks associated with developing watershed restoration plan are:

6.1 Draft Watershed Plan: Develop draft watershed restoration plan and submit to funders, major State agencies and Phantom County for review.

6.2 Hold Final Stakeholder Meeting: Present the draft plan at a local public meeting to solicit final comments from stakeholders.

6.3 Finalize the Plan: Revise the draft plan based on public comment and submitted to the Board of Supervisors for adoption. The City of Bogusville will also submit to the Board of Supervisors a request for funding to implement priority projects recommended for the first year.

Project Schedule and Deliverables

Five deliverables are anticipated under this project. These are listed below along with the proposed schedule for completion.

Project Schedule and Deliverables		
Task	**Deliverable**	**Schedule**
1	Completed Needs and Capabilities Assessment	Month 1
	Memo summarizing watershed restoration goals, objectives and indicators	Month 2
2	Memo summarizing results of stream and upland assessments, to include summary tables and maps of proposed projects	Month 4
3	Memo summarizing results of stormwater retrofit inventory, to include summary tables and project concept designs	Month 5
4	Completed 8 Tools Audit	Month 6
	Memo summarizing draft watershed restoration recommendations, project ranking system, and neighborhood consultation methods	Month 6
5	Memo summarizing results of the WTM	Month 8
6	Draft watershed restoration plan	Month 10
	Final watershed restoration plan and funding proposal for implementation of first year projects	Month 12

Project Budget

The table provided below proposes the level of effort in staff hours for each task.

Proposed Level of Effort	
Task	**Effort (hours)**
1. Develop Watershed Restoration Goals	
1.1 Watershed Needs and Capabilities Assessment	100
1.2 Hold Stakeholder Education Meetings	80
2. Identify Restoration Opportunities*	
2.1 Conduct Stream Assessment	484
2.2 Conduct Upland Assessment	168
3. Conduct Detailed Restoration Assessments*	88

Proposed Level of Effort	
Task	**Effort (hours)**
4. Develop Watershed Restoration Recommendations	
4.1 Inventory of Potential Projects	40
4.2 Hold Neighborhood Consultation Meetings	40
4.3 Rank Projects	40
4.4 Evaluate Local Programs and Regulations	100
5. Determine if Recommendations Meet Restoration Goals	120
6. Develop Watershed Restoration Plan	
6.1 Draft Watershed Plan	120
6.2 Hold Stakeholder Meeting	40
6.3 Finalize the Plan	40
* Hours include pre and post processing	

Project Partners

The City of Bogusville has identified several key partners for implementing this scope of work. The Friends of False Creek will provide assistance in coordinating stakeholder meetings and will also recruit volunteers to assist with the stream and upland assessments. A subcontractor, FloodTech, Inc., will conduct the stormwater retrofit inventory and use the WTM to evaluate pollutant reductions. Qualifications for FloodTech, Inc are provided as Attachment H. Finally, the City of Bogusville will work closely with the Maryland DNR, who funded the False Creek Watershed Baseline Report, to solicit feedback on the plan recommendations and implementation schedule.

Next Steps

Watershed restoration planning does not end with the completion of the plan itself. The next steps are to actually implement the plan recommendations according to the schedule outlined in the plan. The City of Bogusville will solicit local funding for implementation of priority projects recommended for the first year of implementation. Additional funding sources, such as Maryland DNR, EPA, and Chesapeake Bay Program will be pursued for implementation of additional projects with project partners identified in the watershed restoration plan. The City of Bogusville will track and evaluate both plan implementation and restoration success by keeping an up-to date inventory of project implementation status and by conducting the long-term monitoring outlined in the watershed restoration plan.

Trout Creek Watershed Plan
Model Scope of Work

Submitted by:
Watershed Consultants, Inc.

The Watershed Consultants, Inc. (WCI) is pleased to provide this proposal for technical services related to the development of a watershed plan for the Trout Creek watershed located in the coastal plain portion of Brook County, MD. This is considered to be the first phase of two phases to develop a comprehensive watershed plan for the Trout Creek Watershed.

Background Information

The Trout Creek watershed is approximately 90 square miles watershed that contains nine subwatersheds and approximately 190 perennial stream miles. The lower half of the watershed is primarily dominated by agriculture (mostly active pastureland) while the upper watershed is a mixture of low to medium density residential development. Additional development in the headwater subwatersheds is anticipated in the near future. The Trout Creek watershed ultimately drains to the Blue Crab River in the southern half of Brook County.

Important natural and historical resources exist in the watershed. While the headwater streams in Trout Creek have not been extensively studied, they lead to tidal areas that have high fish diversity and are estimated to be important nursery grounds for many species of fish and other estuarine organisms. Thus, maintaining the diversity of the aquatic community may be a prime objective of the plan. Preventing sediment deposition in downstream tidal wetlands is also a primary goal, as significant channel erosion and construction has occurred due to some uncontrolled upstream development and rural impacts.

Note to Users Guide Readers:
This model scope of work is based on the following assumptions:

- All of the methods outlined in Getting Started (Chapter 3) have already been completed by the County.
- Steps do not exactly follow those outlined in the Users Guide but have been adapted and modified to fit the characteristics of the watershed and requirements of the plan.
- The County does not have enough staff to complete the watershed plan themselves.
- The amount of funding currently available is not enough to complete detailed assessments in all the subwatersheds.
- Additional funding will be available again in Year 2.
- Project budget only includes level of effort, not actual dollar amounts as these will vary for every jurisdiction depending on staff salary and benefit amounts, how/if volunteers are utilized, travel reimbursement policies, and any associated indirect costs.

Methodology and Approach

The full watershed plan will be done in two phases to accommodate funding availability. The tasks and subtasks outlined below are associated with the first phase of this project. The first phase will encompass a contiguous forest assessment; review data and studies; codes, ordinances and programs at the watershed scale. Field work and other detailed project investigations will be focused on four priority subwatersheds that will be determined through a screening process. The watershed plan developed as a result of this first phase will separate and identify recommendations that require immediate attention and implementation.

The second phase of the plan will be completed once additional funding sources become available and will include the completed field work and set of recommendations for the remaining five subwatersheds. Detailed project investigations conducted under the second phase may include a stream repair inventory (SRI) and a pasture assessment for water resource protection.

Task 1: Develop Watershed Planning Goals

1.1 *Kick-off Meeting:* WCI will meet with Core Team to kick-off the project in Month 1. At a minimum the core team will consist of representatives from the County Department of Public Works, County Department of Planning, County Health Department, Friends of Trout Creek, Brook County Land Trust, Brook County Soil Conservation District, Maryland Department of Natural Resources (MD DNR), Forest Service and WCI. During the kick-off meeting the core team will put together a preliminary stakeholder list, discuss future stakeholder involvement, determine broad goals for watershed plan and discuss potential factors for Task 2. The County will provide WCI with any existing data and studies related to the Trout Creek watershed.

1.2 *Establish a Baseline:* Utilizing the existing data and studies, WCI will summarize watershed conditions, conduct an impervious cover analysis, summarize monitoring data and conduct a sensitive areas analysis. The Baseline Report will include an emphasis on potential sources of sediment to downstream tidal wetlands. Copies of the report will be distributed to the core team.

1.3 *Recruit Stakeholders:* Based on the list put together by the Core Team, WCI will complete a contact database, determine best format for contacting stakeholders and meetings.

Product(s): Baseline Report, Preliminary Subwatershed Management Classifications, Draft Watershed Goals

Task 2: Classify and Screen Priority Subwatersheds

2.1 *Educate Stakeholders:* The first meeting will provide stakeholders with a basic understanding of watershed planning, share the results of the baseline report using maps and picture heavy power point presentation, and get preliminary input from stakeholders on draft goals and potential classification and ranking factors (see Subtask 2.2).

2.2 *Classify and Rank Subwatersheds:* Predicting that most subwatersheds will be classified as "Sensitive" (under 10% impervious cover), WCI will take a closer look at other factors gathered during Baseline Report to determine which subwatersheds are the most vulnerable to future development and rurally impacted.

2.3 *Identify Priority Subwatersheds:* WCI will work with the Core Team to identify an appropriate process for identifying up to four subwatersheds where field assessments will be conducted first. WCI will encourage an emphasis on the headwater subwatersheds to target the uncontrolled stormwater runoff.

Product(s): Screening Factors, Revised Subwatershed Management Classifications, and Priority Subwatersheds

Task 3: Identify Watershed Planning Opportunities

3.1 *Evaluate Watershed Programs and Regulations:* Under this subtask, WCI will conduct an in-depth review of the County's codes, ordinances and programs in the context of the eight tools of watershed protection (Land Use Planning, Land Conservation, Aquatic Buffers, Better Site Design, Erosion and Sediment Control, Stormwater Management, Non-stormwater Discharges, and Watershed Stewardship).

3.2 *Conduct Stream Assessment:* WCI will conduct MD DNR's Stream Corridor Assessment (SCA) survey in the four priority subwatersheds. The SCA is a continuous stream walking method that will be used to systematically assess the range of impacts and potential protection and restoration projects found along the stream corridor. WCI will encourage key stakeholders and the core team to join them in the field. Additionally, the survey will also be used to identify and refine the extent of perennial streams in the County since a stream GIS layer is only available from the State. WCI take five teams of two staff in the field for five days.

Product(s): Program and Regulations Review Memo, Field Assessment Sheets, Map Showing Sites with Corresponding Table, Revised Perennial Stream GIS Layer

Task 4: Conduct Detailed Assessments

4.1 *Conduct Contiguous Forest Assessment*: WCI will conduct a contiguous forest inventory for the Trout Creek watershed to evaluate the contiguousness and quality of each forest tract that meets MD DNR's criteria for Forest Interior Dwelling Species (FIDS) habitat. This data will be used to prioritize contiguous forest tracts for conservation.

4.2 *Conduct Retrofit Reconnaissance Inventory (RRI):* An inventory will be conducted in the four priority subwatershed to identify candidate retrofits projects where stormwater treatment previously does not exist. The inventory will be used to identify and develop concept designs for up to seven potential storage and on-site retrofit opportunities.

4.3 *Hold Neighborhood Consultation Meeting(s):* WCI will hold up to two consultation meetings with landowners to discuss the feasibility of adjacent stormwater retrofit projects. Stakeholder input from this meeting will be factored into the overall prioritization of the retrofit candidate projects.

Product(s): Completed Field Sheets, Field Maps Showing Contiguous Forest Tracts, Stormwater Retrofit Concept Designs, Summary of Consultation Meeting(s)

Task 5: Assemble Recommendations into Plan

5.1 *Compile and Rank Recommendations:* WCI will meet with core team to compile and rank recommendations. Recommendations may be ranked according to pollutant reduction, cost, feasibility, public acceptance and other key implementation factors. Emphasis will be placed on early action recommendations in the four priority subwatersheds.

5.2 *Draft Watershed Plan:* WCI will summarize existing conditions and potential opportunities identified during field work, make priority recommendations, and include maps showing the locations of proposed projects. The plan will also include an implementation planning table that will identify the objective, responsible party, measurable indicator, public involvement, programmatic change, estimated cost and potential funding source and implementation timeframe for each recommendation.

Product(s): Draft Watershed Plan

Task 6: Determine if Watershed Plan Meets Goals

6.1 *Estimate Pollutant Loads and Reductions:* WCI will incorporate priority recommendations into the Watershed Treatment Model to show the relationship of pollutant loads before and after implementation. Results from the WTM will be incorporated into the Draft Plan.

6.2 *Incorporate External Plan Review:* WCI will submit the draft plan to the core team and key state agencies for review. WCI will also present the priority recommendations to the larger stakeholder group and engage them in an activity to gauge overall stakeholder support for the report and individual recommendations.

6.3 *Finalize Watershed Goals, Objectives and Indicators:* WCI will formally finalize watershed goals, objectives and indicators now that appropriate feedback and data have been taken into account. WCI will also check the watershed plan against the goals of any other relevant regulatory drivers to ensure that they align.

Product(s): WTM Results Summary Table

Task 7: Methods to Implement Plan

7.1 *Plan for Indicator Monitoring:* With core team input, WCI will map out a plan for measuring success through indictor monitoring. WCI and the core team will identify the appropriate indicators and existing monitoring stations to tie into.

7.2 *Adopt the Final Plan and Determine an Implementation Strategy:* WCI will finalize the watershed plan. WCI with the core team will also identify a strategy to get the watershed plan adopted, funded and implemented over time. Emphasis will be placed on implementing early-action recommendations identified in the four priority subwatersheds.

Product(s): Final Watershed Plan, Implementation and Monitoring Plan Summary Memo

Schedule
A proposed scheduled for completing Phase I of the Trout Creek Watershed Plan is shown in Table 1.

Table 1. Proposed Schedule for Phase I of the Trout Creek Watershed Plan	
Task	**Schedule**
1: Develop Watershed Planning Goals 1.1 Hold Kick-off Meeting 1.2 Establish a Baseline 1.3 Recruit Stakeholders	Months 1 – 3
2: Classify and Screen Priority Subwatersheds 2.1 Educate Stakeholders 2.2 Classify and Rank Subwatersheds 2.3 Identify Priority Subwatersheds	Months 3 – 6
3: Identify Watershed Planning Opportunities 3.1 Evaluate Watershed Programs and Regulations 3.2 Conduct Stream Assessment	Months 7 – 8
4: Conduct Detailed Assessments 4.1 Conduct Contiguous Forest Assessment 4.2 Conduct Retrofit Reconnaissance Inventory 4.3 Hold Neighborhood Consultation Meetings	Months 8 – 9
5: Assemble Recommendations into Plan 5.1 Compile and Rank Recommendations 5.2 Draft Watershed Plan	Month 10
6: Determine if Watershed Plan Meets Goals 6.1 Estimate Pollutant Loads and Reductions 6.2 Incorporate External Plan Review 6.3 Finalize Watershed Goals, Objectives and Indicators	Month 11
7: Methods to Implement Plan 7.1 Plan for Indicator Monitoring 7.2 Adopt the Final Plan	Month 12

Project Budget
Table 2 provided below proposes the level of effort in staff hours for each task.

Table 2. Proposed Level of Effort	
Task	**Schedule**
1: Develop Watershed Planning Goals 1.1 Hold Kick-off Meeting 1.2 Establish a Baseline 1.3 Recruit Stakeholders	 40 360 16
2: Classify and Screen Priority Subwatersheds 2.4 Educate Stakeholders 2.5 Classify and Rank Subwatersheds 2.6 Identify Priority Subwatersheds	 40 120 80
3: Identify Watershed Planning Opportunities 3.3 Evaluate Watershed Programs and Regulations 3.4 Conduct Stream Assessment	 100 484
4: Conduct Detailed Assessments 4.4 Conduct Contiguous Forest Assessment 4.5 Conduct Retrofit Reconnaissance Inventory 4.6 Hold Neighborhood Consultation Meetings	 64 88 80

Table 2. Proposed Level of Effort	
Task	**Schedule**
5: Assemble Recommendations into Plan	
5.3 Compile and Rank Recommendations	40
5.4 Draft Watershed Plan	120
6: Determine if Watershed Plan Meets Goals	
6.4 Estimate Pollutant Loads and Reductions	120
6.5 Incorporate External Plan Review	80
6.6 Finalize Watershed Goals, Objectives and Indicators	8
7: Methods to Implement Plan	
7.3 Plan for Indicator Monitoring	24
7.4 Adopt the Final Plan	24
*Hours include pre and post processing	

Tool 7
Estimated Costs

This tool provides estimated costs for scoping out the methods necessary to complete a watershed plan and constructing watershed planning practices

Scoping Local Watershed Planning Costs

Rules of Thumb on Budgeting and Estimated Costs

- Project management equals 5-10% of budget
- Office time equals two times field time for assessment tasks
- Design and Contingency rules (20-30% of construction costs)
- Don't forget travel, equipment, printing
- Overhead costs may not be covered by funding sources
- Insert estimated hourly labor cost for each step to determine total cost
- Planning and implementation cost ratio should be close to 15:85
- Estimate $150-$200K for watershed planning costs (<50 sq mile)
- Planning costs will vary based on watershed area, stream miles, number of jurisdictions, number of stakeholders, training, and task complexity

NOTE: ALL COSTS SHOWN HERE ARE WORKING ESTIMATES AND SHOULD BE CHECKED FOR ACCURACY IN YOUR WATERSHED PRIOR TO SCOPING AND BUDGETING

Table 1: Estimated Unit Costs and Staff Effort for Watershed Planning Tasks*

Steps for Watershed Protection Planning	*Unit Applied*	*Level of Effort*
Step 1: Develop Watershed Planning Goals		
Watershed Needs and Capabilities Assessment	Community	60 - 100 hours
Establish Baseline	Watershed	*Varies, see Table 2*
Stakeholder Recruitment and Education	Watershed	16 - 40 hours
Step 2: Classify and Screen Priority Subwatersheds		
Watershed Vulnerability Assessment OR	Watershed	100 - 130 hours
Comparative Subwatershed Assessment	Watershed	120 -150 hours
Identify Priority Watersheds	Community	40 – 80 hours
Step 3: Identify Watershed Planning Opportunities		
Evaluate Local Programs and Regulations	Community	80 – 100 hours
Conduct Stream Corridor and Upland Assessments	Subwatershed	*Varies see, Table 3*
Manage Stakeholder Meetings	Meeting	30 - 50 hours
Refine Watershed Goals	Watershed	16 – 24 hours
Step 4: Conduct Detailed Assessments		
Develop Project Concept Designs	Watershed	*Depends on the number and type of watershed projects investigated, and then carried forward to project design—See Table 4 for unit costs for each type of watershed project*
Conduct Project Investigations	Watershed	
Hold Neighborhood Consultation Meeting	Neighborhood	
Inventory of Potential Projects	Watershed	24 – 40 hours
Step 5: Assemble Recommendations Into Plan		
Rank Individual Projects	Watershed	24 – 40 hours
Draft Watershed Plan	Watershed	100 - 140 hours

Table 1: Estimated Unit Costs and Staff Effort for Watershed Planning Tasks*		
Steps for Watershed Protection Planning	*Unit Applied*	*Level of Effort*
Step 6: Determine if Watershed Plan Meets Goals		
Estimate Pollutant Loads & Reductions	Watershed	120 – 180 hours
Incorporate External Plan Review	Community	60 – 80 hours
Finalize Goals, Objectives and Indicators	Watershed	24 – 40 hours
Step 7: Methods to Implement the Plan		
Adopt the Final Plan	Community	80 – 120 hours
Plan for Indicator Monitoring	Watershed	30 - 50 hours

Notes:
Multiply "Effort" by "Unit Applied" to get an idea of the number of hours necessary to complete method (e.g., 3 stakeholder meeting would be 3 x 40)
Estimates based on average staff efforts across a wide range of watershed conditions.
Estimates are intended for guidance only.
Excludes the costs of getting started (setting up watershed-based GIS, organizing core team etc.)

Table 2: Component Tasks in Preparing Watershed Baseline		
Task	*Unit Applied*	*Effort*
Watershed Characterization	Watershed	80 hours
Land Use Analysis	Watershed	80 hours
Impervious Cover Analysis	Subwatershed	80 - 120 hours
Summarize Existing Monitoring Data*	Watershed	100 - 120 hours
Sensitive Area Analysis*	Watershed	80 - 160 hours

** does not include any field assessment*

Table 3: Rapid Field Assessment Costs			
Method	Unit Applied	Effort	Cost (@ $50/hr)
Stream Corridor Assessment (SCA) or the Unified Stream Assessment (USA)	Stream mile	2 mile/2 staff/day	$12,000 (*for 30 miles*)
RSAT or RBP-Habitat	Station	4 hours * (6 sites/day)	$300/station
RBP-Macroinvertebrates	Station	20 hours* (6 sites/day)	$8,000 for 10 stations
Upland Subwatershed Reconnaissance (USSR)	Square mile	2.5 sq mi/2 staff/day	$20,000 (for 25 sq mi)
Contiguous Forest Assessment	Site	8 hours* (5 sites/day)	$3,000 for 10 stations
Rare, Threatened and Endangered Species Assessment	Site	4 hours* (5 sites/day)	$300/station
Wetlands Assessment	Site	4 hours* (4 sites/day)	$300/station

**Field costs include post processing of data*

Table 4: Unit Costs for Project Assessment and Design						
Restoration Practice	*Unit Applied*	*Candidate Project Investigation hrs*	*Project Concept Design hrs*	*30% Design hrs*	*Additional Work*	
					Neighborhood Consultation Meeting	*Engineering Design Survey*
Storage Retrofit	site	4	8	40	Y	Y
On-site Retrofit	site	0.5	2	n/a	N	N
Stream Repair	survey reach	4	6	24	Y	Y

Table 4: Unit Costs for Project Assessment and Design						
Restoration Practice	*Unit Applied*	*Candidate Project Investigation hrs*	*Project Concept Design hrs*	*30% Design hrs*	*Additional Work*	
					Neighborhood Consultation Meeting	*Engineering Design Survey*
Reforestation	Planting site	2	6	n/a	N	N
Discharge Prevention	problem outfall	1	4	n/a	N	Y
Source Control Plan	subwatershed	20	40	n/a	Y	N
Municipal Operations	subwatershed	20	40	n/a	N	N

Estimated Costs for Constructing Watershed Planning Practices

Table 5: Estimated Costs for Common Rural Management Practices			
Practice	*Type*	*Planning Level Construction Costs*	*Units*
Non-Ag BMPs	*Abandoned mine reclamation*	Varies	Acre
	Forest harvesting BMPs	$8 to $30 per acre/year	Acre
	Structural shoreline control	$350 per linear foot	Linear Foot
	Non-structural shoreline control	$125 per linear foot	Linear Foot
	Marina pumpouts	$12,500 per station	Station
Septic Systems	Septic hookups	$20,000 per connection	Per system
	Septic denitrification	$5,500 per system	
	Septic pumpout	$125 to $325 per system	
Crop BMPs	Nutrient Management Plan	$ 6 acre/year	Per Acre of Treatment
	Conservation Tillage	$17 per acre/year	
	Cover Crops	$20 to $30 per acre/year	
	Conservation Plans	$350 per acre	
	Land Retirement	Varies	
	Reforestation (from crop)	$ 500 to $ 1500 per acre	
	Riparian forest buffers	$ 500 to $1000 per acre	
	Riparian grass buffer	$ 100 to $ 500 per acre	
Animal Waste Management Systems	Livestock AWMS	$ 65,000	Per system
	Poultry AWMS	$ 27,000	
	Barnyard runoff controls	$ 7,200	
Pasture BMPs	Stream fencing/off-stream watering/rotational grazing	$ 150 acre/year	Per acre treated
	Fencing/off-stream watering	$ 100 acre/year	
	Off stream watering only	$ 65 acre/year	
Wetland Restoration	Restoration of prior converted wetlands	$ 1000 to $1000 per acre	
Costs derived from *CBP, 2003, DNR, 2002b, CWP, 1998*. Note State and Federal Cost share money may be available for certain practices.			

Table 6: Estimated Costs for Common Urban Management Practices - DRAFT			
Practice	*Type*	*Planning Level Construction Costs*	*Unit*
Storage Retrofits[1]	Modify existing pond	9.5K (5 to 15 K)	Per impervious acre treated
	Culvert storage	12.5 K (7.5 to 17.5 K)	
	New facility	15.5K (12.5 to 20 K)	
	ROW/conveyance	15.5 (12.5 to 30 K)	
	Parking lot	25K (10 to 40 K)	
On-site Retrofits[1]	Residential	15K (10 to 25 K)	Per impervious acre treated
	Non-Residential	25K (10 to 40 K)	
Stream Cleanup and Repair Practices	Stream cleanup	$100 ($0 to 1000)	Per reach cleaned
	Adopt-a-stream	$500 ($200 to 1000)	Per stream mile per year
	Soft bank stabilization[2]	$50 ($15 to 75)	Per linear foot
	Hard bank stabilization[2]	$100 ($20 to 300)	
	In-stream practices [3]	$45 ($20 to 75)	
	Grade controls[3]	$1,800 each ($1,200 to 3,600)	
	Natural channel design[4]	$250 ($200 to 300)	
	De-channelization[4]	$50 ($100-200)	
	Stream daylighting or parallel pipes[4]	$150 ($50-300)	
	Fish barrier removal	$10,000 ($5,000 to 50,000)	Per barrier
Riparian Reforestation	Soil amendments [5]	$1500 ($500 to 10,000)	Per acre
	Rubble removal	$500 ($200 to 1,000)	
	Invasive plant removal	$250 ($100 to 750)	
	Bare root trees[6]	$1,000 ($575 to 1,500)	
	Container trees[6]	$2,000 ($1,000 to 3,000)	
	Balled & burlapped trees[6]	$5,000 ($2,500 to 7,500)	
Discharge Prevention	Repair illicit connection[7]	$2,500 ($1,000 to 5,000)	Per correction
	Establish citizen hotline[7]	$1,300-$3,300 startup costs $1,500- $4,500 annual cost[8]	Per community
	Discharge inspection	$300 ($220 to 400)	Per facility, see Brown *et al.* (2004)
	Septic inspection	$325 ($250 to 400)	
Pervious Area	Upland reforestation	See Riparian Reforestation	Per acre
	Forest Conservation	$8 to 30 per acre year	
	Conservation Easement	$2500 (500 to 10,000)	
Source Control	Neighborhood stewardship	$15 ($5 to 30)	Per household
	Hotspot prevention plan[8]	$5,000 ($2,500 to 25,000)	Per hotspot
Municipal Operations	Street sweeping	$25 to 45	Curb mile/ year/pass
	Storm drain cleanouts	$250 to 1000	Per catch basin
Other	Development ordinance	$ 15,000 (5,000 to 30,000)	

Table 6: Estimated Costs for Common Urban Management Practices - DRAFT
Costs derived from *CBP, 2003, DNR, 2002, Kitchell and Schueler, 2005. Note: State and Federal Cost share money may be available for certain practices.* *Notes:* [1] Retrofit costs do not include land acquisition or maintenance [2] Bank stabilization includes toe protection, bank shaping and establishment of vegetation [3] Costs for individual in-stream habitat and grade control practices vary, consult Manual 4 [4] Costs for comprehensive stream restoration are highly site specific, depending on materials use and site conditions, and do not include costs for utility relocations, culvert replacement, land acquisition, or permitting [5] Compost and other soil amendments over 25% of total planting area [6] Tree planting costs are variable costs and depend on plant species, tree age, planting method, labor source, and tree protection, and maintenance planning [7] For more detail consult Brown *et al.* (2004) [8] Cost of preparing and implementing pollution prevention plan, including installation of limited structural storm water management practices at the site

Tool 8
Needs and Capabilities Assessment (NCA)

This tool helps communities to quickly organize known programs and resources that can be potentially applied to watershed protection and restoration, as well as identify potential resources that may not have been considered. The information provided within this tool is an excerpt from the Center for Watershed Protection's Methods to Develop Restoration Plans for Small Urban Watersheds

Assessing Your Watershed Needs and Capabilities

Most communities already possess many of the ingredients needed for successful watershed management. With a little thought, you should be able to recognize regulations that mandate watershed restoration or protection, local staff that can provide technical and programmatic assistance, and potential funding sources you can use to build an effective watershed program. The **Needs and Capabilities Assessment (NCA)** is a simple tool to help you quickly organize known programs and resources that can be potentially applied to watershed protection and restoration, as well as identify potential resources you may not have considered.

➲ *Please take a few minutes to complete the following questionnaire for a specific watershed. If your watershed contains multiple jurisdictions/communities, choose the one that has the most area or land use authority in the watershed. The NCA is divided into five sections designed to identify existing resources you can use as support for protection and restoration activities.*

Part 1. Regulatory Forces Driving Watershed Planning
This part examines federal and state "regulatory drivers" that influence watershed management in the region and can possibly provide financial or technical resources for implementation. Such drivers may include regulatory mandates of the Clean Water Act, Safe Drinking Water Act, Endangered Species Act, and regulations such as TMDLs, MS4 NPDES storm water permits, or Source Water Control Plans.

Part 2. Local Agency Capacity
This part is used to discern local program capability for watershed protection, data availability, restoration and protection experience, and funding and mapping resources.

Part 3. Your Local Agency Restoration Rolodex
This part identifies key local agencies and staff to involve in watershed planning in your area. You should get to know these people and programs and integrate them into your protection and restoration efforts.

Part 4. Adding Non-local Government Partners to Your Rolodex
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 your watershed planning and implementation.

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

Part 1. Regulatory Forces Driving Watershed Planning

1.	**Does my community have a Phase I or II EPA NPDES storm water permit?** *If so, local municipalities are required to meet a set control measures to minimize stormwater impacts. These measures include implementing education and outreach, stormwater retrofits, illicit discharge detection and elimination programs, etc that you can leverage for support.*	☐ Yes ☐ No ☐ Don't Know
2.	**Are any waters in your watershed not meeting water quality standards?** *If yes, a TMDL that deals with NPS controls may need to be developed. If not, you may have identified some high quality streams or wetlands that you may want to focus your protection efforts on (i.e. land conservation, better site design, and stringent stormwater criteria)*	☐ Yes ☐ No ☐ Don't Know
3.	**Does your community have combined or sanitary sewer overflows?** *If yes, then your community would certainly benefit from stormwater reduction activities. Alternatively, municipalities may be in the process of sewer separation and outfall modifications that might be linked with your riparian restoration efforts*	☐ Yes ☐ No ☐ Don't Know
4.	**Is your watershed part of a drinking water supply?** *If so, then you are set! Many sole-source drinking water watersheds require a Source Water Protection Plan. Tap in (no pun intended)!*	☐ Yes ☐ No ☐ Don't Know
5.	**Are endangered species present in your watershed?** *If so, watershed activities may be prompted under the ESA (i.e. Pacific salmon, Barton Springs salamander, etc). Think about how your community should adapt its land use planning and stormwater management practices to better protect these species.*	☐ Yes ☐ No ☐ Don't Know
6.	**Is your watershed encompassed within a regional or multi-state watershed agreement, a coastal management program, or a national estuary program?** *If so, look to MOUs and agreements, mitigation ratios, 6217, and NEP program guidance to assist in establishing watershed goals or providing financial or technical support for planning efforts.*	☐ Yes ☐ No ☐ Don't Know
7.	**Are priority wetland mitigation sites located within your watershed?** *Your watershed may have additional restoration potential (with funding!) if designated restoration, creation, or protection areas have been identified in your watershed. Alternatively, if any wetlands have been designated as potential locations for disposal of dredge/fill material, then you should understand which wetland functions you may be losing*	☐ Yes ☐ No ☐ Don't Know
8.	**Is environmental protection or enhancement a strong factor in local land use decisions, redevelopment incentives, or transportation planning?** *If so, consider utilizing local environmental regulations to support your efforts (ie. forest conservation, stormwater utility, wetland mitigation, environmental overlay districts, open space requirements, buffer ordinances, incentive programs).* *If not, then you may have some work to do.*	☐ Yes ☐ No ☐ Don't Know
9.	**Are wetland alterations frequently permitted in your watershed?** *If so, you may want to become intimately familiar with federal 404 wetland protections, 401 WQ certification, and other features of the Clean Water Act designed to help you protect your water resources.*	☐ Yes ☐ No ☐ Don't Know

10.	**Does your state or local community have its own wetland protection regulations?** *If so, you are in luck. Some states/locales have adopted protection standards more stringent than federal requirements. Some provide protection for wetlands that are not currently considered "jurisdictional" by the feds (e.g. isolated wetlands); other require wetland buffers, or employ additional site development criteria to protect wetlands and the areas that drain to them.* *If not, you may consider pursuing adoption of local wetland protection regulations, since federal regulations may not protect all critical wetland resources.*	☐ Yes ☐ No ☐ Don't Know
11.	**Does your watershed have potential recharge areas?** *If so, these areas may be critical for maintaining the quantity and quality of groundwater supplies, wetlands, and other hydrologic features. Many communities have land use planning criteria for recharge areas that you may be able to use.*	☐ Yes ☐ No ☐ Don't Know

➲ **Do you have any untapped regulatory resources in your community?** *(Try listing at least 2)*

1.

2.

Part 2. Local Agency Capacity

12.	**Have any watershed studies, plans or research been conducted in the past ten years?** *Check around, most watersheds have been studied by someone in the past, and the data and mapping can help set a baseline.*	☐ Yes ☐ No ☐ Don't Know
13.	**Does an interagency workgroup exist to coordinate watershed issues?** *If so, infiltrate its inner circle. At a minimum, these folks should be added to your stakeholder tree. If not, this is a perfect role for a local watershed group.*	☐ Yes ☐ No ☐ Don't Know
14.	**Is there a local staff person who acts as a watershed coordinator?** *If so, this person should become your new best friend. Have this person review your stakeholder list.*	☐ Yes ☐ No ☐ Don't Know
15.	**Does an interagency workgroup exist to coordinate wetland restoration and protection efforts?** *Consider as part of a larger watershed workgroup, having a subcommittee dedicated to coordinating wetland mitigation, permitting, protection, tracking, and assessment efforts.*	☐ Yes ☐ No ☐ Don't Know
16.	**Do you know which agencies are responsible for collecting water quality samples and other monitoring data?** *Think about it, folks who collect this data really want it to be used. If you know who has it, not only can they help you understand your watershed, but they can also provide critical assistance in performing or designing monitoring efforts. Add them to your stakeholder list.*	☐ Yes ☐ No ☐ Don't Know

17.	**Do existing public outreach education programs exist?** *If so, you should coordinate efforts. While local programs may have existing materials and resources you can use, you may be in a position to help target those programs to priority neighborhoods or business areas in the watershed.* *If not, why not? This may be a niche for local watershed groups.*	☐ Yes ☐ No ☐ Don't Know
18.	**Do local wetland protection regulations require local engineers to evaluate stormwater impacts on downstream wetlands?** *If so, there may be access to hydrologic data for your watershed. They may be able to assist you in identifying vulnerable wetlands, run models to predict loss of wetland functions, and identify restoration opportunities.*	☐ Yes ☐ No ☐ Don't Know
19.	**Is local engineering staff engaged in storm water retrofitting?** *If so, there may be local capacity to help design, finance, construct, or maintain priority retrofits in your watershed. Additionally, you may be able to generate volunteers or coordinate demonstration programs for local retrofits. Add them to your stakeholder list. If not, watershed groups can provide this service for local governments, particularly those under pending Phase II permits.*	☐ Yes ☐ No ☐ Don't Know
20.	**What local agency owns the largest blocks of land in your watershed?** *You may be surprised to see how much land is publicly owned in your watershed. Get to know these managers because some of the most feasible restoration projects occur on publicly owned land. Consider which protection techniques to apply to surrounding or upstream or neighboring parcels to help maintain the quality of this open space.*	☐ Schools ☐ Parks ☐ Utility ☐ Golf course ☐ Municipality ☐ Don't Know
21.	**Are any green way, wetland mitigation, or waterfront revitalization efforts planned or underway in your watershed?** *If so, these are great opportunities for you to slip in some restoration projects and educate watershed residents on proper buffer and landscape practices.*	☐ Yes ☐ No ☐ Don't Know
22.	**Have any inventories been conducted to evaluate natural area remnants (e.g forests, wetlands, or open space)?** *Some communities have compiled detailed inventories of remaining forest, parks, and wildlife areas—these can be extremely helpful in identifying natural area remnants before going out in the field. Wetland inventories are harder to come by, particularly information on condition, function, and restorability.*	☐ Yes ☐ No ☐ Don't Know
23.	**Does your community have a sense of which remaining natural areas are likely to be threatened by development?** *Development often fragments forests and directly or indirectly alters wetland function. Ask yourself if your community even knows what your forest and wetland functions are or which ones you will likely lose as the watershed develops.*	☐ Yes ☐ No ☐ Don't Know
24.	**Has your community delineated drainage areas to sensitive or high quality wetlands?** *If not, don't worry. Few have, despite the importance of managing surface drainage that is critical for sustaining wetland hydrology.*	☐ Yes ☐ No ☐ Don't Know

25.	**Does your community maintain natural resource maps at the local scale (i.e. wetlands, forest cover, open space, sensitive habitats)?** *GIS has made it easier to refine and update large scale mapping information as local surveys and ground-truthing are conducted. The National Wetlands Inventory, for example, is not detailed enough to identify all wetlands at the small watershed scale, but can be updated using GIS.* *Check to see if your community's development review process includes an update of GIS maps of delineated natural resource areas. The Army Corp of Engineers is currently integrating their 404 permitting process with GIS, which may be a source of mapping data local governments can use for wetlands.*	☐ Yes ☐ No ☐ Don't Know
26.	**Are flood plains mapped and managed based on FEMA requirements?** *In order to get federal flood insurance, many communities have mapped their flood plains and modeled flood prone areas. This fine scale data can be helpful in stream corridor analysis.*	☐ Yes ☐ No ☐ Don't Know
27.	**Does a storm water utility or other dedicated funding mechanism exist for storm water infrastructure maintenance or upgrades?** *A growing number of communities have established a utility to support storm water planning and maintenance, which can be a dedicated source of funding for watershed restoration.*	☐ Yes ☐ No ☐ Don't Know
28.	**Does a wetland mitigation bank exist for your watershed area?** *If so, see what kind of funds are available! You may be surprised at how much money is out there for this, particularly in states with active construction along transportation corridors.* *If you know where opportunities for wetland restoration and protection exist in your watershed (and what the mitigation ratios are), then you can be proactive in soliciting some of these funds.*	☐ Yes ☐ No ☐ Don't Know
29.	**Do capital or operating budgets exist that can be used or leveraged for watershed-related purposes?** *Examine local capital and operating budgets to find line items and program areas that are related to watershed management.*	☐ Yes ☐ No ☐ Don't Know
30.	**Do you understand the procurement pathways for municipal contracting for restoration design and construction?** *Most restoration projects are built using local dollars, so it helps to know* the *municipal contracting process to develop restoration projects.*	☐ Yes ☐ No ☐ Don't Know
31.	**Has the community received any environmental grants available from state or federal agencies in the last two years?** *Check with your state environmental agency(ies) to see what grants are available and what has been previously awarded. EPA also maintains a list of federal grants for watershed and wetland restoration. Review the project reports for previous grants.*	☐ Yes ☐ No ☐ Don't Know

➲ **Is your community watershed capacity lacking in any areas?** *(Try listing at least 2)*

1.

2.

Part 3. Your Local Agency Watershed Rolodex

32.	**Do you know what agency is primarily responsible for mapping & GIS?** *If so, find a contact and take them out to lunch. You might be surprised at how willing these folks can be to help (and how useful their skills are!).*	☐ Yes ☐ No ☐ Don't Know Agency: Name: Phone:
33.	**Do you know what local agency is primarily responsible for conducting stream or wetland assessments?** *These folks can be great sources of information and can probably quickly tell you where sensitive and degraded areas are in the watershed. Consider working with them to collect data you need for watershed planning efforts.*	☐ Yes ☐ No ☐ Don't Know Agency: Name: Phone:
34.	**Do transmission lines cross your watershed?** *If yes, get to know the power and phone companies. These guys can be great financial partners in riparian restoration and stream stabilization projects.*	☐ Yes ☐ No ☐ Don't Know Contacts:
35.	**Do any units handle land stewardship within the local parks agency?** *Most local park agencies have naturalist, biologists and other staff that manage natural areas. Be sure to enlist them to spread the stewardship message and provide support on protection and restoration projects.*	☐ Yes ☐ No ☐ Don't Know Contacts:
36.	**What agency handles street and storm drain maintenance?** *Street sweeping, catch basin cleaning and storm drain maintenance are usually handled by the public works department. These folks play a strong role in restoration through their municipal pollution prevention efforts.*	Agency: Name: Phone: ☐ Don't Know
37.	**Which department handles storm water and flood plain management functions?** *These folks are critical partners in reviewing stormwater plans, as well as constructing storm water retrofit, stream restoration, and wetland enhancement projects.*	Agency: Name: Phone: ☐ Don't Know
38.	**Which agency coordinates emergency spill response?** *Preventing polluted runoff at storm water hotspots is an important element of watershed protection. These people can help identify pollution risks and develop pollution prevention and spill response plans.*	Agency: Name: Phone: ☐ Don't Know
39.	**Which utilities manage the sanitary sewer network and if they are in compliance?** *If yes, get to know them because these folks collect money for cleaning water. Take them to lunch. Sewer lines often run along stream corridors and cross wetland complexes, so these folks will be integral to your efforts.*	Utility: Name: Phone: ☐ Don't Know
40.	**Who is responsible for pollution prevention compliance at municipal operations?** *Good housekeeping for municipal operations is not only a NPDES Phase II requirement, but is also a good way to demonstrate environmentally sensitive practices.*	Agency: Name: Phone: ☐ Don't Know

41.	**Which agency handles household hazardous waste, used oil recycling, composting and other personal stewardship programs?** *Consider integrating watershed education (i.e., downspout disconnection, proper lawn maintenance, pet waste, buffer management) with these existing homeowner stewardship programs.*	Agency: Name: Phone:		☐ Don't Know
42.	**Do you know the unit that plants and maintains trees?** *If not, find them. You probably have a lot of public land in need of reforestation and street trees, and these folks can be a great source for planting materials and equipment.*	☐ Yes Agency: Name: Phone:	☐ No	☐ Don't Know
43.	**Do you know who designs and constructs wetland and stream restoration projects?** *If not, you need to start looking. Successful wetland and stream restoration can be elusive and projects can easily become expensive failures. Experienced contractors as well as designers can be hard to find in small communities.*	☐ Yes Company: Name: Phone:	☐ No	☐ Don't Know
44.	**Do you know the department that handles development review and land use planning?** *Watershed development can negatively impact stream and wetland quality, and there are many stages along the land development process where environmental safeguards can be applied. Get to know local process and find out where your input is most valuable.*	☐ Yes Agency: Name: Phone:	☐ No	☐ Don't Know
45.	**Do you know who reviews/establishes stormwater management or drainage criteria?** *If you want to protect sensitive resources, you may need to convince this person to require more stringent design criteria, performance monitoring, and proper maintenance.*	☐ Yes Agency: Name: Phone:	☐ No	☐ Don't Know
46.	**Do you know what agency reviews/establishes grading requirements or oversees erosion and sediment control implementation?** *Site construction can be one of the most critical phases of the development cycle in terms of impacts to streams, wetlands, and other receiving waters. ESC often fails due to improper practice installation and maintenance, so you may want to encourage enhanced enforcement in sensitive areas (i.e. upstream of sensitive wetlands). Since many developing communities don't have the staff to keep up with ESC inspections, watchdog watershed groups can make a huge difference*	☐ Yes Agency: Name: Phone	☐ No	☐ Don't Know
47.	**Do you know who enforces local protection of natural resources, such as trees and forests, open space, wetlands, and their buffers?** *Hmmm. Good question…*	☐ Yes Agency: Name: Phone:	☐ No	☐ Don't Know
48.	**Do you know who tracks septic system installation and maintenance?** *If so, congratulations. Very few communities have a good grasp on how many septics are in their watershed, much less how well they are maintained until there is a significant problem.*	☐ Yes Agency: Name: Phone:	☐ No	☐ Don't Know

➲ **Who in the local government is missing from your rolodex?** *(Try listing at least 2)*

1.

2.

Part 4. Adding Non-Local Government Partners to Your Rolodex

49.	**Is there a recognized watershed group in your watershed?** *Watershed groups can be a great resource for local governments because they can often mobilize volunteers, receive grants, and—when trained—perform watershed assessment and planning functions.*	☐ Yes ☐ No ☐ Don't Know Group: Name: Phone:
50.	**Do any colleges or universities exist within 30 miles of your watershed?** *If so, consider all the free academic research and graduate student labor you can direct towards your watershed. You may also be able to tap into the scientific community (e. g., Society of Wetland Scientists), student environmental groups, or use library resources.*	☐ Yes ☐ No ☐ Don't Know University: Name: Phone:
51.	**Are local civic associations in your rolodex?** *Garden clubs, scout troops, church and youth groups, neighborhood association, etc are a terrific source for volunteers. Get these folks engaged in riparian plantings and rain barrel programs at a minimum.*	☐ Yes ☐ No ☐ Don't Know Group: Name: Phone:
52.	**Do any regional organizations have resources or expertise to lend to the watershed effort?** *Think outside the box. Do you have any non-profits in your area that can contribute to the watershed effort? Think about councils of governments, soil and water conservation districts, extension agencies, and "friends of" groups.*	☐ Yes ☐ No ☐ Don't Know Group: Name: Phone:
53.	**Are there any national organizations that might have an interest in your watershed?** *What about Ducks Unlimited, Trout Unlimited, or the Nature Conservancy—these groups are great advocates for wetland and habitat protection!*	☐ Yes ☐ No ☐ Don't Know Organization: Name: Phone:
54.	**Do developable areas still exist in your watershed?** *If so, get to know your local homebuilders association. Let them take you out* to *lunch. Open space design can be mutually beneficial to builders and environmentalists. In some cases, additional conservation and restoration or opportunities may present themselves. If not, keep your eye open for storm water retrofit, wetland restoration, and land reclamation opportunities. Opportunities for improving storm water treatment may also be found during redevelopment.*	☐ Yes ☐ No ☐ Don't Know Group/Company: Name: Phone:
55.	**Are there large tracts of state, federal or institutional land present in the watershed?** *If so, these landowners should be invited to participate in the planning effort. If there are large tracts of privately held land, landowner interviews will be critical to generating support for conservation easements and land stewardship.*	☐ Yes ☐ No ☐ Don't Know Name: Phone:

56.	**Do any land trusts exist in the area?** *Protection of remaining wetlands, contiguous forests, steep slopes and special habitats is integral to overall watershed management. If the local government does not have the capacity to manage conservation easements, consider a land trust as a viable legal alternative.*	☐ Yes ☐ No ☐ Don't Know Group: Name: Phone:
57.	**Do any state or federal agencies have gauges or monitoring stations in the watershed?** *Unlike local or academic monitoring, the USGS and many state agencies have the ability to provide long-term monitoring. If monitoring stations exist, take advantage of the information to establish baseline conditions and track watershed changes over time. If not, consider building a case for gauge installation.*	☐ Yes ☐ No ☐ Don't Know Agency: Name: Phone:
58.	**Do you know any private-sector environmental consultants?** *These folks may be tapped for conducting functional wetland assessments, updating local GIS databases, or identifying protection and restoration opportunities.*	☐ Yes ☐ No ☐ Don't Know Company: Name: *Phone*:
59.	**Do you know who covers the environmental beat?** *Get to know one or two local reporters who you can call to cover watershed-related issues and events.*	☐ Yes ☐ No ☐ Don't Know Paper/News: Name: *Phone*:
60.	**Are any GIS mapping layers available from non-local sources?** *Don't assume that the data is not available just because your local government does not have a well-developed or accessible system. A variety of internet sites (www.datadepot.com, USGS, etc) where you can download data for a small fee.*	☐ Yes ☐ No ☐ Don't Know
61.	**Do you know who is in charge of 404 permitting for jurisdictional wetlands in your watershed?** *The Army Corp of Engineers is generally responsible for granting permits and approving wetland delineations for federally protected wetlands. The EPA has veto authority over the ACoE decisions. Interested states can assume authority over the Section 404 permitting program—a small number have done so to date.* *Another thing you should consider is the working relationship between local reviewers and federal permitters…*	☐ Yes ☐ No ☐ Don't Know Agency: Name: Phone:
62.	**Are there any roadway construction projects in your watershed?** *State DOTs are some of the worst wetland offenders out there. As a result, they often generate huge pots of money for wetland mitigation projects!*	☐ Yes ☐ No ☐ Don't Know Name: Phone:

➲ **Who else is missing from your rolodex?** *(Try listing at least 2)*

1.

2.

Part 5. Community Attitudes

63.	**What are the primary water resource concerns in the community?** *Be aware that the public may not share the same watershed concerns that you do. Successful planning requires input from diverse interests and the integration of seemingly disparate objectives within watershed goals (flooding, air quality, economic growth, historic preservation, etc).*	☐ Yes ☐ No ☐ Don't Know
64.	**Is your local watershed a popular recreational destination?** *If so, that's great news because there is no better way to generate public support for watershed activities than to link them to recreational amenities. Enlist hiking, biking, canoeing, duck hunting, and other recreational groups to your cause. If not, maybe you can work towards that goal.*	☐ Yes ☐ No ☐ Don't Know
65.	**Is the general public's basic level of watershed awareness relatively high in your watershed?** *If so, you should patent your secret formula!* *If not, don't be discouraged, not many communities can boast such a well-rounded populace. Stakeholder involvement must be targeted at many levels ranging from local government staff to neighborhoods to individual homeowners. Each step in watershed planning should contain a public component designed to engage and inform your local community.*	☐ Yes ☐ No ☐ Don't Know
66.	**Are elected officials or senior agency staff aware of the term *watershed management*?** *If framed in the right way, watershed management can be politically popular because it provides services to constituents in the neighborhoods and public areas.*	☐ Yes ☐ No ☐ Don't Know
67.	**Has the local press/media covered your watershed in the past 3 months?** *If not, why not? These people are always looking for community feel good stories, so give them something to write about. Call up your local reporters and have them come out with you in the field or advertise a big event. This is a great way to begin educating the public and giving recognition to supportive local officials and staff.*	☐ Yes ☐ No ☐ Don't Know
68.	**Are wetlands viewed as an amenity or mosquito pits?** *Hopefully your community recognizes the many benefits wetlands provide, if not, wetland protection may be difficult. You'll want to start making a list of the specific services your wetlands provide (shellfish, drinking water filters, nutrient processing, flood prevention, etc)—particularly the economic benefits—and start educating!*	☐ Amenity ☐ Nuisance ☐ Don't Know

Comments/Notes:

Tool 9
Smart Watershed Benchmarking Tool

This tool is a detailed scorecard that assesses the degree to which a municipality is complying with fourteen "smart watershed" principles that create the foundation for a coherent strategy to restore urban watersheds

Coming Soon!

Tool 10
Development Capacity Analysis

The following document, produced by MDP, provides a methodology for estimating the total amount of development that may be built in an area under a certain set of assumptions, including applicable land use laws and policies(e.g., zoning), environmental constraints, etc.

Estimating Residential Development Capacity

A Guidebook
for Analysis and Implementation in Maryland

MARYLAND

MDP

Maryland Department of Planning

LINCOLN INSTITUTE OF LAND POLICY

National Center for Smart Growth Research and Education, University of Maryland

August 2005

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I. Introduction and Guidebook Purpose

One of the fundamental questions facing land use planners is whether there is sufficient development capacity to accommodate future residential needs. Until recently, only a few Maryland jurisdictions were doing a thorough job estimating whether they had sufficient land and redevelopment opportunities to accommodate new growth.

That, however, has begun to change. Sparked by the work of a gubernatorial task force, the state of Maryland and its local jurisdictions have signed a Memorandum of Understanding that, for the first time, stipulated that local governments voluntarily measure their future development capacity. The compact also requires the state government to provide local jurisdictions with the technical assistance needed to complete the job. This breakthrough was prompted in part by the passage of Smart Growth legislation eight years ago and the vigorous promotion for the last several years by Maryland homebuilder groups, the Chesapeake Bay Foundation and 1000 Friends of Maryland.

Under this agreement, local governments in Maryland are now committed to conduct and include a development capacity (i.e. build-out) analysis when they update their comprehensive plans. [The 1992 Planning Act requires local governments to update their comprehensive plans every six years. All non-charter counties and municipalities are required to submit them to the Maryland Department of Planning for review. Charter counties are not required to do so, but most usually do.]

This change could place Maryland in the ranks of states such as Washington and Oregon that are considered leaders in performing this important, but often ignored, planning function.

The purpose of this Guidebook is to help local governments in Maryland conduct a development capacity analysis for their jurisdictions. Some local governments will do their own analysis; others will use the Maryland Department of Planning's (MDP) analysis or a modified version thereof.

The Guidebook is primarily designed for local government planners and relies heavily on the Task Force's final report, which can be downloaded from MDP's website at http://www.mdp.state.md.us/develop_cap.htm. This Guidebook provides overall guidance for data, methodology, and analysis reporting as well as step-by-step examples. The Task Force's report was fairly specific in many cases regarding various aspects of the analysis. This is reflected in these guidelines.

II. Defining Development Capacity Analysis

A Development Capacity Analysis, sometimes referred to as a “build-out analysis” or “buildable lot inventory,” 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 and policies (e.g., zoning), environmental constraints, etc. While this kind of analysis is most often associated with an estimate of capacity for new residential development, there is also value in estimating a jurisdiction’s capacity to meet commercial and industrial needs, recreational needs or other land use goals. For now, Maryland’s program focuses only on residential capacity.

Local governments should perform regular capacity analyses because it is integral to good long-range planning. It is important to have an estimate of the development supply (location, size, density type, etc.) in order to assure a jurisdiction is adequately planning for future growth.

III. Best Practices in Development Capacity Analysis

The planning technique of estimating future development capacity is not new, although only a handful of states are aggressive in their efforts to do so. Here are summaries of how two states, Washington and Oregon, and one city in Colorado (Fort Collins) handle this issue.

A. Washington State

Washington State adopted its Growth Management Act in 1990 as a response to statewide concerns about unmanaged growth, but did not add its “Buildable Lands Program” until May 1997. The Buildable Lands Program provides mechanisms for measuring the supply of residential, commercial, and industrial land to meet growing needs within urban growth boundaries. This tool requires jurisdictions to measure and respond to gaps between projected growth (targets) and current development patterns (actuals). The program addresses two key questions: Do local governments have enough suitable land to accommodate expected growth for 20 years? And, are urban densities being achieved in urban growth areas?

The Buildable Lands Program was introduced in the fastest growing counties of western Washington (Clark, King, Pierce, Snohomish, and Thurston) and the 97 towns within their boundaries. Affected jurisdictions are required to gather data on an annual basis and evaluate the data every five years (2002, 2007). The collected data and evaluation of development activity (actuals) is compared to the projections found in local comprehensive plans. Where gaps exist, local jurisdictions are required to introduce measures designed to bridge this gap (such as expanding the growth boundary).

The first report in 2002[1] showed adequate capacity to meet growth demands except for in a few cities. The report also highlighted trends in urban density and residential development such as the increase in urban residential densities throughout the six counties. The report demonstrated the greater effectiveness of growth management policies in achieving the state's growth management goals.

Although the results have been positive, state funding for the program was eliminated in 2002. The requirements are still in place, which presents a challenge to affected jurisdictions that struggle with the high cost of data collection. The next evaluation period is in 2007.

B. Oregon

Oregon's Urban Growth Boundary (UGB) law includes a provision to ensure that "a local government shall demonstrate that its comprehensive plan or regional plan provides sufficient buildable lands within the urban growth boundary established pursuant to statewide planning goals to accommodate estimated housing needs for 20 years."[2]

This statute, designed to ensure a sufficient supply of land within UGBs, demands an inventory of the buildable lands within the UGB as well as a determination of housing capacity, including a breakdown of types and densities. This law requires that local authorities take steps to address their housing demand over the next 20 years (through actions such as the expansion of the growth boundary or an amendment to the comprehensive land use plan)

C. Fort Collins, Colorado

In 1997, the city of Fort Collins, Colorado, adopted a long-term comprehensive planning tool or procedure called the Buildable Land Inventory Project. The program was started to manage the growth and development of the city by maintaining an inventory of vacant and buildable land inside the urban growth area.

The city of Fort Collins uses GIS data to track "vacant land absorption." This has proven to be a valuable tool for policy makers in making decisions about the growth of the city. By monitoring the city's growth, city leaders discovered that build-out was occurring at a rate faster than expected (when compared to the 1997 city plan).[3]

Fort Collins' planners say one of their biggest challenges has been to create a seamless process of data analysis using data sets that are not easily comparable.

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[1] State of Washington Department of Community, Trade and Economic Development. June 2003. *Buildable Lands Program: 2002 Evaluation Report – A Summary of Findings*. Available at: http://cted.wa.gov/_CTED/documents/ID_917_Publications.pdf
[2] Oregon Department of Land Conservation and Development. 2003. *ORS 197.296: Buildable Land Factors*. Available at www.orcities.org/webdocs/ORS/ORS197.296-298.html
[3] Carpenter, Katy and Timothy Wilder. 2004. City of Fort Collins: *BLIP – Buildable Land Inventory Project*. Available at: http://gis.esri.com/library/userconf/proc04/docs/pap1751.pdf

IV. Development Capacity Analysis in Maryland

A. Capacity Analysis Requirement under the Smart Growth Law

Analysis of development capacity is required under Maryland's Smart Growth law. The 1997 Priority Funding Areas (PFAs) Act states, "The designation by a County of a Priority Funding Area under this section shall be based on:

i. An analysis of the capacity of land areas available for development, including infill and redevelopment; and

ii. An analysis of the land area needed to satisfy demand for development at densities consistent with the Master Plan."[4]

Despite this requirement, the performance and quality of capacity analyses by local jurisdictions in Maryland has been inconsistent. The Maryland Department of Planning, by contrast, has consistently applied its capacity analysis tool, which contributed to the decision to establish the task force.

B. The Development Capacity Task Force

To assure that capacity analyses are conducted in a uniform way, local governments, Maryland's development industry, and environmental interests have been discussing the issue for at least the past four years. The goal was to decide whether legislation is necessary to require buildable lot inventories or build-out analyses at the local government level.

In October 2003, Governor Robert L. Ehrlich, Jr., sought to resolve this impasse by creating the Development Capacity Task Force as part of his Priority Places Executive Order 01.01.2003.33. The Task Force, in turn, conducted pilot land capacity analyses in five counties and five municipalities.[5] Maryland Planning Secretary Audrey E. Scott chaired the Task Force, which included members representing county and municipal governments, homebuilders, the environmental community, economic development interests, academia, advocates for historic preservation, and the planning community. Key issues addressed by the task force included:

i. What is the need for development capacity information?

ii. What are the growth trends and their implications for development capacity?

iii. Who conducts capacity analysis?

iv. What method and data are used?

v. What is the role and purpose of the analysis?

vi. Will the analysis be required in local government comprehensive plan updates or will it be a suggested addition?

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[4] Senate Bill 389, Chapter 759, Acts of 1997, page 11, lines 9-15. Available at: http://www.mdp.state.md.us/fundingact.htm.

[5] The 10 pilot jurisdictions included the municipalities of Chestertown, Havre de Grace, Salisbury, Frederick and Hagerstown and the counties of Harford, Montgomery, Anne Arundel, Worcester and St. Mary's.

To help implement its recommendations, the Task Force drafted a local government Memorandum of Understanding (MOU) and a gubernatorial Executive Order (see Appendix E of the Task Force Report for the complete documents). The MOU, signed by the Maryland Municipal League and the Maryland Association of Counties, commits local governments to conduct development capacity analyses. Jurisdictions may conduct their own analysis (per the Final Report's guidance) or work with MDP to complete the analysis. The Executive Order, commits MDP to continue its work with local governments to conduct local development capacity analyses. It also directs MDP to enhance its data and method over time.

As part of MDP's required routine review of comprehensive plan updates, the Executive Order directs MDP to specifically look for the local development capacity analysis. MDP is directed to comment negatively on a plan if a local government has not included a capacity analysis (its own or MDP's). In addition, MDP is directed to attach its own analysis for any county that fails to submit one on its own. This is expected to be unlikely because MDP has offered to assist local governments perform their analysis or even do it for the local government if necessary. These implementation steps are to be evaluated after two years (in approximately August 2006). If local governments fail to integrate development capacity analyses into their planning by then, the Task Force may consider legislation to require the analyses.

C. MDP's Role in Technical Assistance

MDP has been conducting development capacity analyses across the State for many years. This work has been conducted as part of local government technical assistance, Smart Growth/Priority Places implementation, watershed analyses, and other programmatic responsibilities within the agency. MDP's analysis relies heavily on the cooperation of and input from local government. When local governments and MDP work together, conducting a development capacity analysis is not an overly burdensome task. To be successful, however, MDP and local governments must share data, agree on key inputs and assumptions, and jointly review analysis outputs.

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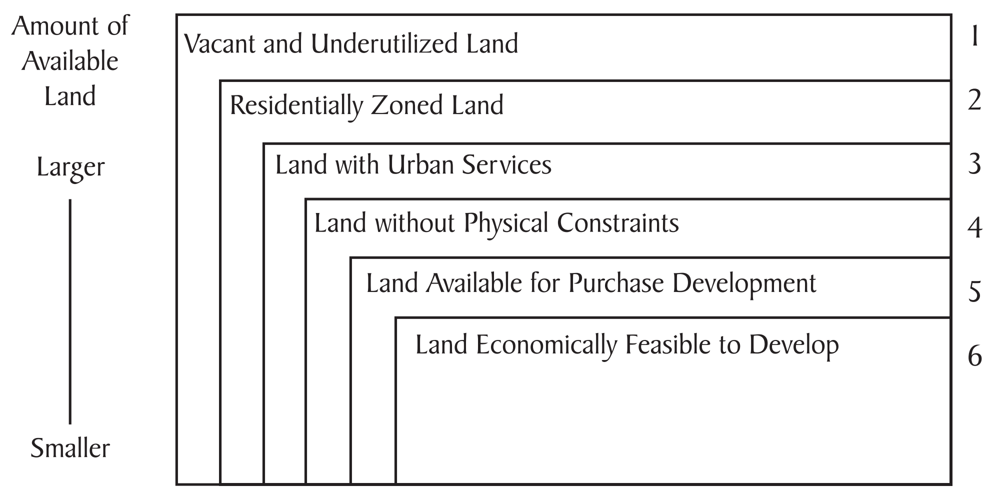
[6] Kaiser, Edward J. David R. Godschalk, and S. Stuart Chapin, 1995. *Urban Land Use Planning*. Urbana and Chicago: University of Illinois Press.

V. Conducting Development Capacity Analysis in Maryland

A. Definition of Development Capacity

Development capacity is the ability of land to accommodate greater development. According to Edward J. Kaiser, "In its simplest meaning, developable land is vacant or underused land, without severe physical constraints, which is planned or zoned for more intense use and has access to the urban services necessary to support development."[6] To illustrate this point, we use the Levels of Developability graph from Kaiser.

Table 1: ***Levels of Developability***[7]



B. What are the Key Steps in Calculating a Capacity Analysis?

The first step in creating a comprehensive local land monitoring system is to assess future development capacity. The five steps involved in conducting such an assessment are:

- i. Identify vacant land and those lands that cannot be developed due to environmental constraints.
- ii. Subtract land needed for urban public services.
- iii. Add land that can be redeveloped or developed at greater intensity through infill.
- iv. Identify land with public services.
- v. Estimating development capacity.

While Table 2 demonstrates how to calculate these basic steps, the text below details how local government officials and staff can anticipate and address potential hurdles or complexities within each step.

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[7] Kaiser et al. 1995. Page 198.
[8] Kaiser et al. 1995.

1. Identifying Vacant Land

Vacant land can be identified in a variety of ways: through field inspection, tax assessment records, and remote sensing[8]. It is important to realize that all methods have significant limitations, yet it is possible to find the right combination to fit one's needs.

Field inspections, for all but the smallest of urban areas, are prohibitively expensive. Sampling could reduce the cost, but leads only to summary measures or a synthetic database, neither of which produce a desired level of accuracy.

Identifying parcels classified as vacant in the assessor's records, and aggregating their land areas, is perhaps the least costly method of developing a vacant land inventory. Such simple aggregation, however, can lead to gross errors. Often in the past, the parcel size and use designation in the assessor's files were wrong, but the data has consistently improved, especially in the areas of interest for capacity analysis. Further, the assessor will generally classify a parcel as vacant only if the parcel is completely vacant. A ten-acre parcel, for example, with a single-family structure may be classified as developed even if local zoning allows, for example, six units per acre. Thus alternative methods must be used to identify parcels that are partially vacant.

Interpretation of remotely sensed data, such as aerial photographs, is an increasingly popular approach to augment or spot-check a jurisdiction's analysis, especially for rural areas. Constraints imposed by the resolution of the images, however, continue to limit its use in urban areas. Remote sensing allows a clear distinction between vacant and developed parcels, but a determination of development type or the extent of constraints on developed land is more difficult.[9]

In practice, a combination of methods is probably optimal. Metro, the regional government in the Portland, Oregon, metropolitan area, for example, uses air photo interpretation in combination with tax-lot maps and information about land characteristics and public utilities, all registered to common coordinates through GIS, to identify parcels that are fully vacant and those that are partially vacant. Even with this approach, however, specific rules must be adopted concerning how large the vacant segment of a partially developed parcel must be in order to classify that part as vacant land[10], and field inspection (either random or systematic) must be used to clean the database.

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[9] Hopkins, L.D. and G.J. Knaap. 2000. An Inventory Approach to Land Supply Monitoring and it's Implications for Database Design. In *Monitoring Urban Land Supply with GIS*, edited by A. Vernez-Moudon and M. Hubner. New York, NY: John Wiley and Sons.
[10] Hall, C. 2001, Identifying Vacant Land, in Gerrit J. Knaap, *Land Market Monitoring for Smart Urban Growth*, Cambridge, MA: Lincoln Institute of Land Policy.

2. Identifying Environmental Constraints

Not all vacant land is developable. It may be constrained — either partially or absolutely — by a combination of governmental and private industry factors related to environmental conditions.

Almost all land is developable given enough demand, enough money, and the absence of policy restrictions. Even land covered with water can be developed: for example, San Francisco Bay Area development has occurred by filling parts of the Bay. Other developments float on the Bay. Thus, dividing vacant land into two mutually exclusive categories of "buildable (developable)" and "unbuildable (nondevelopable)" is a judgment informed by a simultaneous consideration of land characteristics, market economics, and public policy. It is only when policy is applied to measurable environmental conditions that a constraint becomes absolute. Of course, as knowledge, science, public opinion and politics change over time, policies – and their effect on whether land is developable – also change over time.

Typical environmental characteristics that render land as "unbuildable" are: if it is located in a floodplain, sloped more than some amount (usually 15 % to 25 %, depending on the use), in a wetland or riparian buffer, or particularly subject to natural hazards such as earthquakes, mud slides, or storm damage.[11] Jurisdictions with GIS capabilities can build and analyze overlay maps electronically to identify unbuildable land due to environmental constraints. To perform this function effectively, it is important for jurisdictions to build a team within an agency or department that includes environmental professionals, planners, and municipal lawyers to determine the limitations unique to your community.

3. Identifying Potential for Redevelopment and Infill

As many communities experience everyday, growth can occur as infill development on land that is already developed (adding more development on unused remainders of developed land) or as redevelopment (replacing existing development with new development).[12] Interest in urban infill and redevelopment has grown rapidly in the 1990s and, in fact, is a central goal of Smart Growth efforts in many jurisdictions. A number of sites, for example, have observed that as development pressure has increased, so has the potential for infill or redevelopment. Until this shift, the development of vacant land at the urban periphery (i.e., suburban development, now often referred to as green field development) had been the dominant means of accommodating urban growth.

Now, redevelopment of blighted urban land (or brownfields) or other underutilized urban parcels has become perhaps the most salient feature of Smart Growth strategies. But communities are finding that the techniques needed to estimate how much growth can be accommodated through such mechanisms are only now being

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[11] Metro. 1997. *Urban Growth Report,* final draft. Portland: Metro;

[12] Redevelopment usually yields a net increase in developed space (housing units, commercial or industrial square footage) to accommodate growth but it need not.

developed. So far, consistent empirical work on rates of redevelopment, parameters that are essential to forecasting land consumption, are very limited.

In practice, however, redevelopment potential has, up to now, been gauged largely by using data on land value and assessed improvements. For parcels less than one acre, for example, Oregon's Metro compared improvement values to the improvement values of surrounding properties. Metro considered properties as "redevelopable" if the improvement value of the parcel was 50 % to 70 % of the mean improvement value of surrounding properties. ECONorthwest[13] arrayed all developed land in a matrix with the ratio of improvement to land value on one axis, and parcel size on the other, and then made judgments based on plan designation about the percentage of land in each category that might redevelop over a 20-year horizon.

To estimate infill potential, Metro determined the percent of building permits that had been issued over the last five years for parcels not included in the list of vacant land acreage. These permits Metro classified as "refill." Based on this method, Metro estimated that about 25 % of future housing units could be accommodated on land currently classified as developed.[14] Though Metro's approach seems reasonable, it is not clear that past rates of refill are a good indicator of future development patterns, especially as the capacity to accommodate infill and redevelopment becomes exhausted.

What is clear, however, is that to the extent that infill and redevelopment are strategies individual communities wish to pursue, those communities must develop a methodology to estimate as accurately as possible how much of their future growth can thus be accommodated.

4. Identifying Serviced Land

Although managing the supply of developable land is a major component of urban growth management, municipal ordinances often require developers to provide or pay for adequate urban services through a variety of exactions and impact fees. For land to be developable consistent with smart growth goals, it must be ripe for infill or redevelopment or, if it is a green field property, it must be vacant, unconstrained by physical factors or policy restrictions, and provided with urban services.

Identifying the supply of land with access to services requires both an articulation of service standards and the attribution of service capacity to land area. The articulation of service standards is necessary for any community that wishes to implement any type of policy that requires new infrastructure to come on line concurrent with new development. (Note that such fees and exactions on developers are generally used to pay for municipal services on new green field development and generally apply to larger scale developments. These fees and exactions generally do not apply to typical

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[13] ECONorthwest, 1999. Regional Economic and Housing Analysis, Linn-Benton County, Albany OR: Cascade West Council of Governments.
[14] Metro (1997)
[15] FAC 9J-5.0055(2)

infill development projects. Thus, such fees and exactions may not act as a barrier to urban infill, but only to suburban green field development.) Florida administrative code, for example, requires local governments to establish service standards for roads, sanitary, sewer, solid waste, drainage, potable water, parks and recreation, mass transit, and public transit.[15] Levels of service standards vary extensively in degree of complexity, but all represent some ratio of the demand for service to the capacity of service available.

The ability of a community to determine if specific parcels of land are provided with services is equally complex and varies by the type of service being provided[16]. The general service area of an elementary school or fire station, which is essentially defined by its accessibility, is approximately round, assuming that transportation costs within the service area are uniform (which, unfortunately, is only approximately true even without taking into account the effects of hills or water bodies in the service area). The service areas around roads and sewer systems can be even trickier to determine because they depend on the route or network of roads or sewer lines, their capacity at different points along the routes or lines, and varying demand at different times.

In practice, communities have addressed this problem in a number of different ways. Montgomery County, Maryland, for example, has an extensive planning information system designed to implement its Adequate Public Facilities Ordinance. The County is divided into areas in which policy and service capacities are monitored for each. When the capacity of a given service reaches a critically low level in the policy area, development can be delayed until sufficient service capacity is provided.[17]

Similar procedures are used in many Florida jurisdictions[18]. In Oregon, where growth management policies require an adequate supply of buildable (but not serviced) land, the supply of urban services is treated in various ways. Metro's recent analysis of lands available for future UGB expansion (1998) identified the cost of providing services to various locations when considering how much and where to expand the UGB. Lower cost locations were ranked as stronger candidates for expansion.

5. Identifying Development Capacity

Once the net supply of serviced land has been determined, it is necessary to identify how much development capacity the land provides. Definitions of development capacity vary. Development capacity, for example, can be based on the capacity of ecological or public facility systems. Examples provided by Kaiser et al (1995) include those based on the evacuation capacity of a causeway in Sanibel, Florida, and the pollution-assimilation capacity of Lake Tahoe. As those examples make clear, however, the carrying capacity of natural and man-made systems are often not fixed but can be increased through infrastructure investments.[19]

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[16] Frank, James E and Mary Kay Falconer. 1991. The Measurement of Infrastructure Capacity: Theory, Data Structure, and *Analytics, Computers, Environment, and Urban Systems.* 14(4): 283-297.
[17] Godschalk, David R. and Stephan Baxter. 2000. *Montgomery County, MD: A Pioneer in Land Supply Monitoring from 1985 to 1998.* In *Monitoring Urban Land Supply with GIS*, edited by A. Vernez-Moudon and M. Hubner. New York, NY: John Wiley and Sons.
[18] FAC 9J-5.0055(2)
[19] Kaiser et al. (1995)

In situations where development capacity is not clearly constrained by natural systems, a first step in estimating capacity involves identifying land needed for urban infrastructure such as streets, water and wastewater facilities, schools, parks, churches, and other public and semi-public facilities. Net developable land is the land that is available for development after subtracting land needed for these forms of infrastructure.

Estimating land needed for infrastructure can be done using simple or complex methods. Simple methods involve the application of simple ratios—e.g., 15 acres of parkland per 1000 estimated population growth, or 25 % of developed land for streets. More complex methods take into account the size and configuration of parcels, the age distribution of the population, and the existing capacity of public and semi-public facilities.[20]

After subtracting out land needed for infrastructure, development capacity is typically estimated by type of land use using a technique called a build-out analysis[21]. For residential development, the standard approach is to disaggregate land supply by zoning classification (or plan designation) and to identify the maximum number of housing units allowed by zoning.

Though simple in concept, the standard approach has technical complications. Many of the technical issues concern the precise housing and employment densities that are allowed for each zoning classification. For some residential zoning categories, maximum density is quite clear: e.g., R5 allows 5 units per acres. For others (e.g., planned unit developments and mixed use urban centers), maximum housing and employment densities are often permitted within certain ranges and are therefore, for the purpose of calculating development capacity, considered ambiguous.

To further complicate this picture, zoned densities are often not attained by builders due to political decisions, opposition from nearby residents, or other factors. To account for this reality, Portland's Metro[22] incorporated what they called an "underbuild" factor as part of its capacity calculations. Specifically, Metro assumed that development will take place at only 80 % of maximum capacity allowed by zoning (MDP uses 75%). The use of such factors may provide a more realistic assessment of future development densities, but it confuses measures of development capacity with elements of a development forecast.[23] If, for example, development has historically taken place at 50% of true development capacity, and measures of capacity are adjusted by a 50% "underbuild" factor, then policy makers will be inclined to provide twice as much capacity and facilities to offset the perpetual underutilization of true capacity.

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[20] White, Mark S. 1996. *Adequate Public Facilities Ordinances and Transportation Management*. Planning Advisory Service Report Number 465. Chicago: American Planning Association.
[21] Knaap, Gerrit J. 1998. *Toward Model Statutes for the Land-Use Element: An Assessment of Current Requirements and Practice, in Modernizing State Planning Statutes*, PAS Report #480/81. Chicago: American Planning Association.
[22] Metro (1997)
[23] Knaap, Gerrit J. 1998. *Letter to Lydia Neill*, in Peer Review Report. Portland: Metro Growth Management Services Department.

Table 2: ***Sample Summary Table Used for Capacity Reporting***[24]
Other examples are available in the appendix.

Result	Process	Acres	Number of Parcels	Capacity
Total Acres in Parcels and Lots				
	Subtract land zoned for nonresidential use(commercial, industrial)			
Residentially Zoned Acres				
	Subtract tax exempt land(tax exempt code)			
	• Subtract protected lands and environmentally sensitive parcels (ag easements, wetlands, HOA land, etc.)			
	• Subtract other parcels without capacity (built out areas, etc.)			
Acres and Parcels with Capacity	Total capacity			
Capacity Inside PFA				
Capacity Outside PFA				
I. Subsets of the Analysis of Interest (these are not additive)				
Acres and Parcels with capacity associated with Underdeveloped land.	Improved Parcels (>$10,000), less than 5 acres.			
Acres and Parcels Associated with Small parcels.	Parcels <2 acres in size (improved or unimproved)			
Acres and parcels associated with larger, undeveloped parcels.	Includes unimproved parcels, greater than 2 acres with capacity and improved parcels greater than 5 acres with capacity.			

[24] Maryland Development Capacity Task Force, Final Report, July 2004

C. What Information and Data are Needed to Complete a Capacity Analysis?

The following is a list of minimum requirements for data that should be included in a development capacity analysis: (1) parcel data; (2) zoning maps and estimates of zoning yield; (3) lands protected or encumbered with environmental constraints; (4) local water and sewer plans; and, (5) information based on specific local planning expertise.

Requirements	Specifications	Notes
(1) Parcel Data	• MDP generates annual updates of MdProperty View, a geo-referenced database for every piece of land in Maryland. • MDP has a "GIS Data Partnership" through which a jurisdiction supplies MDP with planning datasets, such as zoning, master water and sewer plan maps, and protected lands in exchange for licenses of MdProperty View or FINDER	• Where jurisdictions have superior parcel data, such as a parcel polygon GIS file, they are encouraged to use it in their development capacity analysis.
(2) Zoning Maps and Estimates of Zoning Yield	• Maps of zoning districts (a guide to where future development is allowed). • Maximum density allowed in each zoning category. •Expected zoning yield.	• Zoning yield is one of the most important inputs into a capacity analysis. It is the actual average density of development associated with a specific zoning district in a specific jurisdiction. It is often less than the allowable density of a zoning district, since it accounts for land that is needed to build roads, on-site environmental features (steep slope, wetlands, etc.), market conditions, or other considerations when development projects are actually approved. • Local governments should examine factors that prevent developments from obtaining a zoning yield of 100% of allowable density per zoning district. • Estimating yields for mixed-use and PUD-type zones are necessary. Jurisdictions may want to consider several estimates of yields and other inputs to the analysis. This approach can be used to produce a range of capacity estimates given certain conditions, or even by approaching the analysis based on two or more possible development scenarios.
(3) Protected Land and Lands with Environmental Constraint	Environmentally constrained lands should be factored into the analysis, such as:	• Capacity analyses should take into consideration lands with any of the features mentioned in (3), but some of these features may not be present in every analysis.

Requirements	Specifications	Notes
	• Protected lands (land preservation easements, parks, homeowner association lands, historic preservation easements, etc.) • The “Critical Area” along the shoreline of the Chesapeake Bay and its tidal tributaries; areas surrounding drinking water reservoirs; streams and their buffers. • Floodplains • Historic, cultural, or archeological areas; • Steep slopes; and • Other areas as deemed appropriate and measurable.	• Some constrained lands may only be partially constrained (i.e. floodplains). A clear method for dealing with this issue should be included in a capacity analysis.
(4) Local Water and Sewer Plans	• Maps of existing and planned sewer and water service areas as well as areas where sewer and water is not planned. • Descriptions of each sewer and water service category (i.e. time frames for when new service is expected to be available)	• Zoning yields can be adjusted based on master water and sewer plan areas (i.e. if sewer exists or is planned, allowable density is generally higher).
(5) Local Planning Expertise	• Examples of local modifications include: • Small area plans or sector plans (TOD areas, mixed use centers, etc.) may provide ancillary information about how an area will develop over time. Such plans often articulate a more elaborate picture of future growth than zoning. • General policies and procedures within the jurisdiction that may have an impact on capacity analysis (subdivision requirements, anomalies of water and sewer plans or zoning categories, etc.). • Trends and market impacts on realized density within the local jurisdiction (i.e., the market may not support the same densities that may be in a zoning district). • Knowledge of data weaknesses, customized situations, etc. • Other information about zones or issues that my affect future development, such as infrastructure issues.	• Often in local jurisdictions there are plans, policies or trends that are not captured in empirical GIS data (listed in (5) but are nonetheless valuable to any capacity analysis. This local planning expertise should be integrated into analysis by adjusting key inputs, such as zoning yield, sewer service assumptions, protected lands status, etc.

VI. Where and When to Present Findings

A. *Frequency of Development Capacity Analysis*

At a minimum, development capacity analysis should be included each time a local government updates its comprehensive plan and should be part of planning in general at the local level. Local governments are encouraged to do a capacity analysis even if they have recently adopted a new comprehensive plan to prevent a local government from waiting years to complete a capacity study.

B. *Capacity Analysis in Comprehensive Plans*

The capacity analysis should be included in the local government's comprehensive plan. This could be done in the form of:

1. A chapter in the plan, including all of the suggested elements of a capacity analysis.
2. An appendix to the plan, including all of the suggested elements of a capacity analysis.
3. A table within the plan, that refers to an external report that includes all of the suggested elements of a capacity analysis.
4. A reference within the plan to an external report that includes all of the suggested elements of a capacity analysis.

If the analysis is not presented in the comprehensive plan directly, an explanation of how capacity analysis was used in the local planning process is recommended.

C. *Annual Report*[25]

Jurisdictions should issue an annual development report that highlights key development trends in and out of the PFAs. MDP can assist jurisdictions develop this annual report. At a minimum these reports should include the following items:

1. Approved development plans and recorded lots inside and outside of the Priority Funding Area (PFA);
2. Estimates of the jurisdiction's capacity for additional infill development, development of underdeveloped parcels, and redevelopment;
3. Actual development yields per zoning district (gross and net); and
4. Jurisdictions should make their zoning, sewer service areas, protected lands and related data available for capacity and other analyses. Jurisdictions should make available development review pipeline information, such as approved development plans, recorded lots, number of units, type, etc.

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[25] Many of the reports listed in this section have long been required under Article 66B, Maryland's state planning enabling legislation.

Appendix A:

Example of Development Capacity Calculation for Chestertown[26]

Result	Process	Acres	Number of Parcels	Capacity
Total Acres in Parcels and Lots		1,405 acres	1,674	
	Subtract land zoned for nonresidential use (commercial, industrial)	384 acres	285	
Residential or Mixed Use Zoned Acres		1,021 acres	1,389	
	Subtract tax exempt land (tax exempt code)	216 acres	101	
	Subtract protected lands and environmentally sensitive parcels (ag easements, wetlands, HOA land, etc.)	8 acres	13	
	Subtract already built-out areas	428 acres	1,181	
Acres and parcels with Capacity	Total citywide capacity	369 acres	94	1,185
Capacity Inside PFA		369 acres	94	1,185
Capacity Outside PFA				
Subsets of the Analysis of Interest (these are not additive)				
Acres and parcels associated with underdeveloped parcels	Improved parcels (>$10,000), less than 5 acres	15 acres	12	31
Acres and parcels associated with small parcels	Parcels <2 acres in size (improved or unimproved)	54 acres	82	103
Acres and parcels associated with larger, undeveloped lands (includes mixed use)	Includes unimproved parcels, greater than 2 acres with capacity and improved parcels greater than 5 acres with capacity.	311 acres	10	1,070

[26] Maryland Development Capacity Task Force, Final Report, July 2004

Appendix B: Example of Development Capacity Calculation for Harford County[27]

Result	Process	Acres	Number of Parcels	Capacity
Total Acres in Parcels and Lots		314,959 acres	86,617	
	Subtract land zoned for nonresidential use (commercial, industrial)	12,110 acres	3,119	
Residential or Mixed Use Zoned Acres		302,849 acres	83,498	
	Subtract tax exempt land (tax exempt code)	97,321 acres	1,375	
	Subtract protected lands and environmentally sensitive parcels (ag easements, wetlands, HOA land, etc.)	50,162 acres	2,647	
	Subtract other parcels without capacity (built-out areas, etc.)	54,468 acres	71,061	
Acres and parcels with Capacity	Total capacity	106,270 acres	8,498	33,859
Capacity Inside PFA		9,324 acres	3,074	22,131 ***
Capacity Outside PFA		96,946 acres	5,424	11,728
Subsets of the Analysis of Interest (these are not additive)				
Acres and parcels with capacity associated with underdeveloped parcels	Improved parcels (>$10,000), less than 5 acres	1,435 acres	864	1,585
Acres and parcels associated with small parcels	Parcels <2 acres in size (improved or unimproved)	2,750 acres	4,004	4,530
Acres and parcels associated with larger, undeveloped parcels	Includes unimproved parcels, greater than 2 acres with capacity and improved parcels greater than 5 acres with capacity.	102,680 acres	4,214	28,528

*** Note: MDP is working with Harford County to correct a few problem parcels that will result in a reduction of between 2,000 and 3,000 units of capacity.

[27] Knaap, Gerrit J. 2004. *Monitoring Land and Housing Markets: An Essential Toll for Smart Growth.* Report for National Center for Housing and the Environment.

Appendix C:
Example of Buildable Acres for Metropolitan Portland[28]

Gross vacant acres (excludes 1998 UGB amendments)	45,800
Less: Environmentally constrained land	(8,200)
Gross vacant buildable acres	37.600
Less: Federal, state, county, city-owned lots	(1,900)
Less: Acres of platted single-family lots	(2,900)
Less: Streets	(5,400)
Less: Schools	(1,100)
Less: Parks	(3,700)
Less: Places of worship	(700)
Net vacant buildable acres	21,900

[28] Hall, Carol, 2001. Identifying Vacant Land, in Gerrit J. Knaap, *Land Market Monitoring for Smart Urban Growth.* Cambridge, MA: Lincoln Institute of Land Policy. Page 65.

Appendix D:

Example of Development Capacity Worksheet for Washington State[29]

	Urban Comprehensive Plan Designations										
	Residential					Employment					
	Housing Type/Density Categories				Sub-total	Employment Sector/ Designation Categories				Sub-total	Totals
A. Total gross acres of vacant, partially-used, and underutilized land.											
B. Total area above considered unbuildable due to critical areas, zoning, right-of-way, and public use requirements.											
C. Total net buildable area of vacant, partially-used and underutilized land (A-B).											
D. Total net buildable area of land without adequate water/waste water infrastructure during remaining portion of planning period.											
E. Total net buildable area of land with adequate water/waste water infrastructure during remaining portion of planning period (C-D).											
F. Total net buildable area of land required for future public facilities and public purpose lands.											
G. Total net buildable area of land not required for future public facilities (E-F).											
H. Total net buildable area of land assumed not to be available for development during remaining portion of planning period.											
I. Total net buildable area of land assumed to be available and suitable for development during remaining portion of planning period (G-H).											

[29] *Buildable Lands Program Guidelines*. Washington State Community, Trade, and Economic Development Report.

Local Government Memorandum of Understanding Regarding Residential Development Capacity Inventories

August 19, 2004

(1) The Maryland Department of Planning (MDP) and local governments, (county and municipal), including their respective representative organizations the Maryland Association of Counties (MACo) and the Maryland Municipal League (MML), and the other members of the Development Capacity Task Force understand the importance and usefulness of land capacity inventories as a beneficial land-use planning tool. Recent efforts by MDP and selected local governments to establish capacity inventories have resulted in a renewed State and local government planning partnership to address this complex land-use planning tool. MDP's continued support, including technical assistance, is essential to maintaining this partnership and to further the interest of county and municipal governments to implement the capacity inventory planning tool.

(2) MDP, MACo, and MML shall continue to work with county and municipal governments to encourage the creation of land capacity inventories and their inclusion in comprehensive plans and for Priority Funding Area changes. County and municipal governments will also further the other recommendations of the Governor's Development Capacity Task Force (DCTF). MACo and MML will continue to encourage local governments to share needed land-use information and work with MDP in creating capacity inventory inventories.

(3) The commitment to the creation of land capacity inventories and their inclusion in comprehensive plans and for Priority Funding Area changes by local governments is contingent on MDP providing support as needed, including technical assistance, which is consistent with a recommendation of the Maryland Smart Growth Policy Collaborative that instructed "the Administration to provide funding to State and local governments to develop land capacity inventories."

(4) In developing the capacity inventories, MACo and MML will encourage local planning departments to use the analysis developed by MDP and used throughout the work of the DCTF that estimates development capacity in and out of Priority Funding Areas. However, it is expected that the inventory will be customized and enhanced according to best practices by local jurisdictions to the extent feasible, based on the availability of resources. Jurisdictions that currently have their own capacity inventories will share them with MDP.

(5) For the purpose of reporting key development trends and to aid in the production and tracking of development capacity, local governments will develop annual development reports. As recommended in the Task Force Report, these annual reports should provide information on zoning yields, rates of infill and redevelopment, environmental constraints, and development trends.

(6) MDP shall consult with the Maryland State Builders Association, MACo, and MML to develop a proposed schedule for conducting its capacity analysis with the local governments. Key considerations in the development of this schedule include a jurisdiction's comprehensive planning cycle and its growth pressure. A local jurisdiction shall be notified of the estimated date of the commencement of the inventory analysis in collaboration with MDP.

(7) Two years after the execution of this MOU, MDP will survey the progress of local government land capacity analyses for consistency with the Governor's Development Capacity Task Force recommendations and the Governor's Executive Order. This time period anticipates the uncertain fiscal realities facing both the State and local governments and also provides them sufficient time to demonstrate commitment towards developing this land-use planning tool. If this survey of progress is determined to be unacceptable, MML and MACo will work with the Administration and the members of the original Development Capacity Task Force to draft mutually agreeable legislation to remedy this lack of progress. Members of the Task Force will not introduce legislation related to development capacity until this time.

(8) For the purpose of continuing progress in developing capacity analyses, representatives of MML and MACo will meet quarterly with MDP, the Homebuilders, and other members of the Task Force to track progress, exchange information, and share lessons learned. These meetings will also help to track the progress of creating the capacity inventories per paragraph (7) above.

(9) This MOU is contingent on the Governor signing the corresponding Executive Order that was also drafted by the Task Force, or a version that closely resembles this draft. The Draft Executive Order is intended to insure that State and local resources are deployed in a cooperative and coordinated way to implement the recommendations of the Task Force. It specifies that MDP shall provide technical assistance (e.g., data, analysis, examples, guidance) to local governments for the purpose of including the results of development capacity analysis in comprehensive plan updates and for Priority Funding Area changes.

Local Government Organization Signatories

Maryland Association of Counties
County Executive James M. Harkins, Harford County, President

Maryland Municipal League
Mayor Barrie P. Tilghman, City of Salisbury, President

Development Capacity Task Force Members

State of Maryland, Task Force Chair
Secretary Audrey E. Scott – Maryland Department of Planning

Municipal Representative
Ms. Dianne Klair – Manager, Community Development and Planning, City of Havre de Grace

County Representative
Mr. Arnold "Pat" Keller – Planning Director, Baltimore County

Homebuilders Representative
Mr. Frank Hertsch – President, Morris & Ritchie Associates, Inc.

Academic Representative
Dr. Gerrit Knaap – Executive Director, National Center for Smart Growth Research and Education, University of Maryland

Environmental Representative
Mr. George Maurer - Senior Planner, Chesapeake Bay Foundation

Planning Community Representative
Mr. Dirk Geratz – President, Maryland Chapter – American Planning Association

Economic Development Representative
Mr. John Savich – Director of Economic Development, St. Mary's County

Historic Preservation Representative
Mr. Tyler Gearhart – Executive Director, Preservation Maryland

EXECUTIVE ORDER
01.01.2004.43

Residential Development Capacity Implementation

WHEREAS, Executive Order 01.01.2003.33 created the Development Capacity Task Force to study local residential development capacity inventories and develop recommendations to enhance land-use planning consistent with the Administration's Priority Places Strategy;

WHEREAS, The Task Force has issued its final report on the Development Capacity Study to the Governor, but should continue to exist to consult with the Department of Planning on capacity inventory issues;

WHEREAS, The Maryland Department of Planning and local governments (county and municipal), including their respective representative organizations, the Maryland Association of Counties, and the Maryland Municipal League, as well as other members of the Task Force, understand the importance and usefulness of land capacity inventories as a beneficial land-use planning tool;

WHEREAS, Recent efforts by the Maryland Department of Planning and selected local governments to establish capacity inventories have resulted in a renewed State and local government planning partnership; and

WHEREAS, The Maryland Department of Planning's continued support, including technical assistance, is essential to maintain this partnership and to further the interest of county and municipal governments to implement the capacity inventory planning tool.

NOW, THEREFORE, I, ROBERT L. EHRLICH, JR., GOVERNOR OF THE STATE OF MARYLAND, BY VIRTUE OF THE AUTHORITY VESTED IN ME BY THE CONSTITUTION AND LAWS OF MARYLAND, HEREBY PROCLAIM THE FOLLOWING ORDER, EFFECTIVE IMMEDIATELY.

A. The Development Capacity Task Force, created in Executive Order 01.01.2003.33, shall continue to function as an advisory body to the Department of Planning. The Task Force shall dissolve four years after the effective date of this Executive Order.

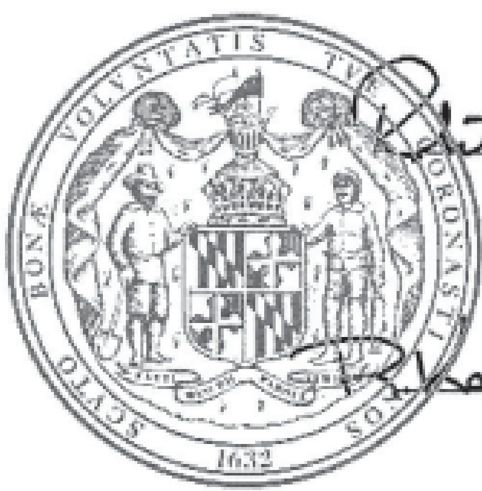
B. The Maryland Department of Planning shall:
    1. Provide technical assistance (e.g., data, analysis, examples, guidance) to local governments for the purpose of creating guidelines for development capacity analysis, to be included in the results of development capacity analyses in comprehensive plan updates and for Priority Funding Area changes.
    2. Consult with the Development Capacity Task Force to develop a proposed schedule for conducting its capacity analysis with local governments, and notify local governments of the proposed schedule.
    3. Review comprehensive plans with the expectation that results of development capacity analyses are included and are a factor in the plans' policies.

4. Meet quarterly with the Development Capacity Task Force to track the progress of developing capacity analyses, exchange information, and share lessons learned.

C. Reporting.

1. For the purpose of reporting key development trends and to aid in the production and tracking of development capacity, the Maryland Department of Planning will request that local governments generate annual development reports to be submitted to the Department, which should include information on zoning yields, rates of infill and redevelopment, environmental constraints, and developments trends.
2. The Task Force has prepared a Local Government Development Capacity Inventory Memorandum of Understanding, that constitutes an agreement between the State and local governments to implement the Task Force's recommendations by, among other things, providing information on development trends and by conducting their own development capacity analysis, with State assistance if necessary, and including them in their comprehensive plans.
3. Two years after the execution of the Local Government Development Capacity Inventory Memorandum of Understanding, the Department will survey the progress of local government land capacity inventories for consistency with the Development Capacity Task Force's recommendations and this Executive Order. If this survey of progress is determined to be unacceptable, the Department will consult with the Development Capacity Task Force to identify potential legislative remedies.

GIVEN Under My Hand and the Great Seal of the State of Maryland, in the City of Annapolis, this 19th Day of August 2004.



Robert L. Ehrlich, Jr.
Governor

Attest:

R. Karl Aumann
Secretary of State

VII. Acknowledgement

Funding for the development of this guidebook was provided by the Lincoln Institute of Land Policy. A nonprofit and tax-exempt educational institution established in 1974 to study and teach land policy, including land economics and land taxation. The Institute, based in Cambridge, Mass., is supported primarily by the Lincoln Foundation, which was established in 1947 by the Cleveland industrialist John C. Lincoln. The Institute's goals are to integrate theory and practice to better shape land policy and to share understanding about the multidisciplinary forces that influence public policy.

Maryland Department of Planning
301 West Preston Street, Suite 1101
Baltimore, Maryland 21201

www.mdp.state.md.us

LINCOLN INSTITUTE OF LAND POLICY

Tool 11
Urban Forestry Planning and the Leaf Out Analysis

This tool provides a chapter from the Center for Watershed Protection's Urban Watershed Forestry Manual, Part 1, which guides the watershed planner or forester through a six-step method for increasing forest cover in a watershed, defining watershed-based forest covers goals, and identifying priority sites for protection, restoration and reforestation

CHAPTER 2: PLANNING METHOD FOR INCREASING FOREST COVER IN THE WATERSHED

This chapter guides the watershed planner or forester through a six-step method for increasing forest cover in the watershed that includes defining watershed-based forest cover goals and identifying priority sites for protection, restoration and reforestation (Figure 8). These methods are only one component of the larger urban watershed restoration process, and should be coordinated with other restoration practices outlined in Schueler (2004). For example, the baseline and sentinel monitoring of watershed conditions recommended in Schueler (2004) are essential to evaluate the effect of increasing forest cover through urban watershed forestry techniques.

Figure 8 presents the six-step method for increasing watershed forest cover, which is explained in detail in this chapter.

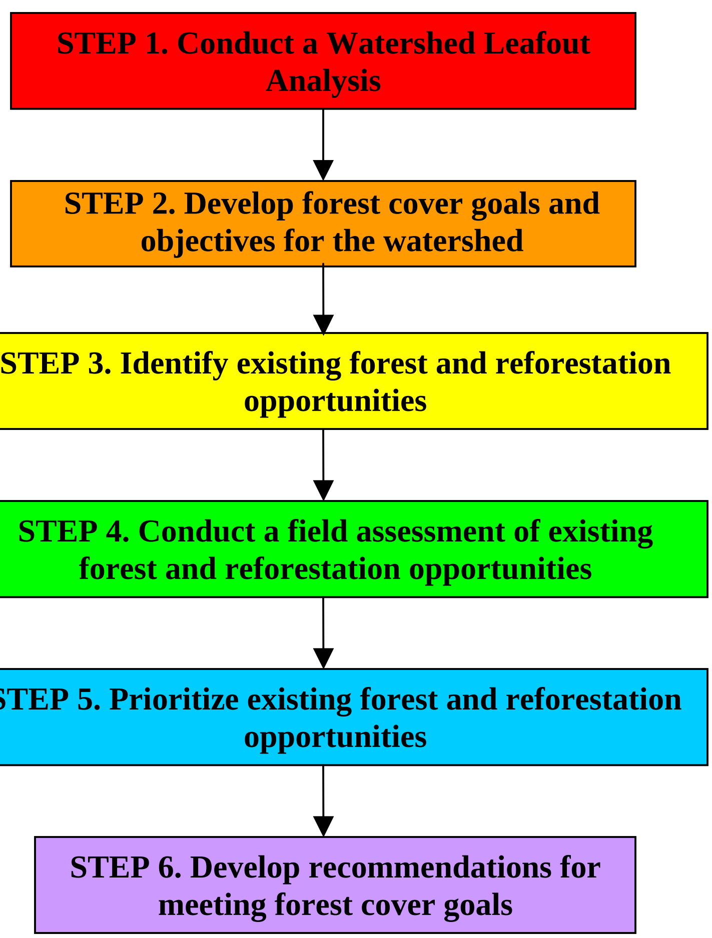


Figure 8. Six-step process for increasing forest cover in the watershed

The six-step method described here focuses on *planning* to increase forest cover in the watershed. Detailed guidance on *implementation* of techniques to increase forest cover is outside the scope of this manual; however, specific references are made throughout to direct the reader to the best implementation resources. This method is based on the assumption that a municipal or community program has mapping and other resources and the ability to conduct the method.

The method is typically conducted across an entire watershed or subwatershed, but could easily be applied to a different scale, such as a small urban catchment or an entire metropolitan area. In addition, the actual implementation of several of the steps occurs at the individual parcel scale (e.g., evaluating reforestation sites, implementing reforestation projects). The use of Geographic Information Systems (GIS) is required for the method and the resolution of data should be appropriate for the scale of analysis (see text box on following page).

Step 1: Conduct a Watershed "Leafout Analysis"

Watersheds are constantly gaining and losing forest cover at the same time due to the clearing of forests for land development, homeowner landscaping, abandonment of farm land or open space, reforestation or other activities. The first step entails an inventory of existing and future watershed land cover to systematically account for forest losses and gains. The method described here is referred to as the "Leafout Analysis" because it is similar to a buildout analysis, which predicts future impervious cover with development based on zoning categories. The Leafout Analysis focuses on future forest cover rather than impervious cover. This analysis can be used to identify and evaluate the location, distribution, average size, future use and ownership of forest fragments and reforestation sites. This information can then be used to determine which types of projects (protection, restoration or reforestation) and what types of lands (public, private, residential turf, parks) will yield the greatest return in terms of increasing forest cover in the watershed. This step requires the use of GIS (see text box on following page).

The substeps of the Leafout Analysis include the following and are described in detail below:

Step 1.1 Estimate the Distribution of Current Land Cover in the Watershed
Step 1.2 Identify Protected and Unprotected Lands in the Watershed
Step 1.3 Determine Whether Parcels are Developed or Undeveloped
Step 1.4 Determine Allowable Zoning on Undeveloped Land
Step 1.5 Summarize Watershed Data
Step 1.6 Acquire Forest Cover Coefficients
Step 1.7 Estimate Future Forest Cover in the Watershed

USING GEOGRAPHIC INFORMATION SYSTEMS FOR THE LEAFOUT ANALYSIS

A Geographic Information System (GIS) is a computer-based tool for mapping and analyzing all sorts of geographically referenced (spatial) data. GIS is a common tool for local governments to manage property data, map natural resources, plan future transportation corridors and provide efficient emergency response. Maintaining a GIS can require extensive resources for data collection, staff training, hardware and software acquisition and more.

The inventory of current and future land cover described in this section requires the use of GIS; therefore, some basic understanding of GIS is helpful to navigate this section. Since a wide variety of GIS software is available, the steps described in this section refer only to general procedures rather than software-specific manipulations. The data layers created in this analysis have applicability and utility across a wide variety of local departments and analyses. The minimum GIS layers required for the inventory of land cover in the watershed are listed below. Many of these layers are available for free download from websites such as the Maryland State Geographic Committee's Technology Toolbox: www.msgic.state.md.us. De la Cretaz (2003) provides some guidance on compiling and analyzing watershed GIS data and Appendix B provides a list of additional data resources.

- Watershed and subwatershed boundaries (delineation methods available at the Storm water Manager's Resource Center: www.stormwatercenter.net)
- Open water and wetlands
- Topography
- Land cover (e.g, impervious, forest, turf)
- Protected lands (e.g., conservation easements)
- Parcel boundaries
- Land use (e.g., schools, parks)
- Zoning
- Natural resources (e.g., stream buffers, steep slopes, floodplains)
- Monitoring data (e.g., water quality, habitat, biological)
- Cultural, recreational or historical sites
- Storm water treatment practices and other drainage features

Step 1.1 Estimate the Distribution of Current Land Cover in the Watershed

The first step is to create or acquire a GIS layer of current land cover in the watershed that distinguishes between three cover types: impervious cover, forest cover and non-forest vegetative cover. Open water and non-forested wetlands are not included in the land cover analysis.

- *Impervious cover* is defined as any surface that does not allow water to infiltrate and typically includes roads, buildings, parking lots, driveways, sidewalks and decks.

- *Forest cover* includes all land that is primarily covered by trees and shrubs, although the actual classification of forest cover can vary greatly with the data source (see text box on page 2). The ideal forest cover layer in this scenario is actually urban tree canopy, which includes the canopy of individual trees, groups of trees and forests.

- *Non-forest vegetative cover* can include turf, bare ground, landscaping, meadow and crops. In urban watersheds, the majority of non-forest vegetation is usually turf. Since it is difficult to distinguish between these cover types from aerial photos, and because all of these cover types are potential reforestation candidates, any land cover that is not forest or impervious is considered turf for the purposes of this analysis.

Depending on current GIS data, staff expertise and resources available, there are three options for obtaining a current land cover layer:

1. Use existing local or regional land cover GIS layers (see Appendix B for potential sources)
2. Derive land cover from high-resolution imagery using GIS and remote sensing techniques
3. Use GIS to digitize land cover from recent aerial photos

If recent land cover maps of an appropriate scale and resolution are not available, one option is to acquire high-resolution satellite or aerial imagery and use remote sensing software to interpret and classify the images into the three land cover categories. Existing imagery that may be used includes USGS digital orthoquads and IKONOS satellite imagery. Minimum standards for measuring urban tree canopy include a resolution of 1 meter and imagery that is no more than 3 years old (CBP, 2004). Two techniques that utilize image classification to derive forest cover are the Baltimore Strategic Urban Forests Assessment and American Forests CITYgreen.

In the CITYgreen analysis, high resolution satellite and aerial imagery is used to create a tree canopy layer for input into the CITYgreen software. American Forests has developed a method of classifying the imagery to create this ‘green data’ layer. This layer is used to calculate the benefits of the canopy in terms of runoff reduction, air quality, carbon storage and energy savings. For more information about CITYgreen, see www.americanforests.org.

The Baltimore Strategic Urban Forests Assessment (SUFA) was modified from the Maryland DNR Strategic Forest Lands Assessment (SFLA) (MD DNR, 2003) for application to an urban area. The SUFA method involved acquiring high resolution satellite imagery of the study area and using remote sensing software and techniques to interpret the image by creating ‘masks’ of the tree canopy cover, non-tree vegetation and impervious surfaces within the jurisdiction. These masks were then overlaid with local land use, zoning and resource management data to create an ‘opportunity mask’ of potential planting sites prioritized based on local need. For a detailed description of the methods used, see Irani and Galvin (2002) or the SFLA website at http://www.dnr.state.md.us/forests/download/sfla_report.pdf.

A third option for deriving land cover is to acquire aerial photos and directly digitize land cover layers from these photos (see Appendix B for sources of aerial photos). This method can be time-consuming but may be more affordable than using satellite imagery, particularly if some of the land cover layers already exist in GIS format.

Once the GIS layer of current land cover has been acquired or developed, the area of each cover type in the watershed should be quantified (see Figure 9).

Step 1.2 Identify Protected and Unprotected Lands in the Watershed

The next step is to create or acquire a GIS layer of protected and unprotected lands, in both public and private ownership. Protected lands are defined as land protected from future development through the application of conservation easements or by local regulations that protect specific natural resources. The types of protected land vary in each watershed, but may include wetlands, floodplains, stream corridors or buffers, steep slopes, hydric or erodible soils, parkland, land in conservation easements, karst features, and historic or cultural sites. Protected lands can be digitized from paper maps or from aerial photos if they do not currently exist in GIS format. The final GIS layer should indicate which lands are protected. All remaining lands are designated as unprotected (see Figure 9).

Step 1.3 Determine Whether Parcels are Developed or Undeveloped

The next step is to create or acquire a GIS layer of developed and undeveloped parcels in the watershed to identify which parcels have already been developed, or ‘built-out’ to the maximum extent allowed by zoning (Figure 9). The development status (e.g., ‘developed’ or ‘undeveloped’) of a parcel may be readily available in the associated data table of a good parcel boundary GIS layer. Ideally, this layer will contain ownership data to be used later to prioritize sites based on ownership and to contact landowners about potential projects. If this is not the case, estimates of the development status of each parcel can be made by initially classifying all parcels containing buildings as developed. Aerial photos and local knowledge of the area can be used to verify this classification. Parcel boundaries can be digitized from paper maps if they do not currently exist in GIS format.

Alternatively, state planning agencies or the municipal department that handles land development permits may have a composite set of parcel maps in a digital format or a database of developed and undeveloped parcels (e.g., property tax maps) that can be linked to a GIS layer. One example is the Maryland PropertyView Database available from the State Planning Department: http://www.mdp.state.md.us/data/index.htm

Step 1.4 Determine Allowable Zoning on Undeveloped Land

Most local planning and zoning departments maintain a GIS and/or paper map of zoning categories. A zoning map dictates the allowable land uses and development densities within the community and provides a snapshot of what landuse will look like with future buildout. If a GIS layer of zoning does not exist, one can be digitized from the paper zoning map. If the watershed spans more than one community, zoning information from each community must be acquired and combined (see Figure 9).

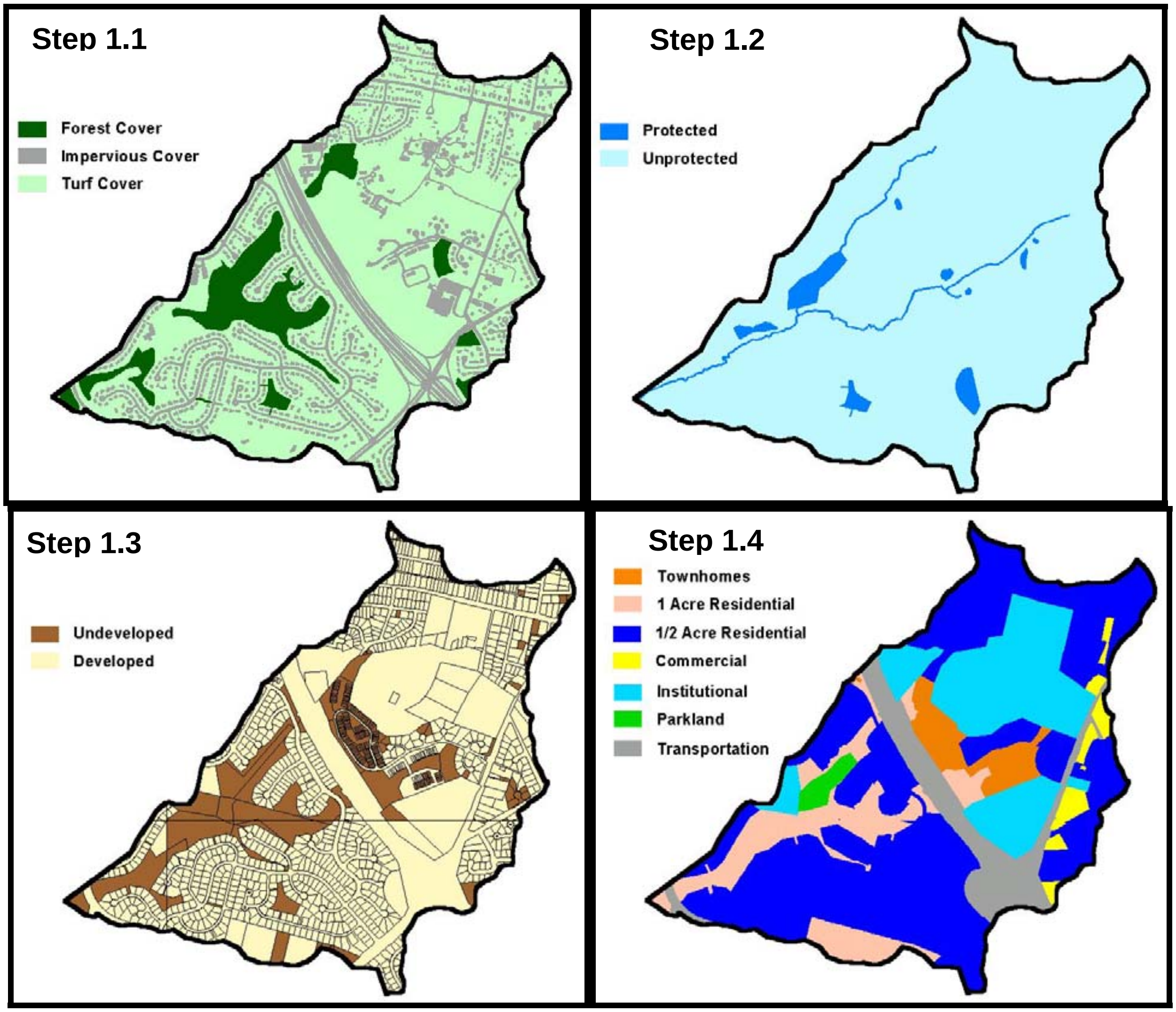


Figure 9. Example maps created as a result of the Leafout Analysis: Current Land Cover (upper left), Protected Lands (upper right), Development Status (lower left) and Zoning (lower right).

Step 1.5 Summarize Watershed Data

In this step, the data collected in the first four steps is used to develop a summary table that provides the necessary variables for estimating future forest cover (Table 4). This can be done using GIS by merging the four layers created in Steps 1.1 through 1.4 and querying the resulting data table. The variables highlighted in Table 4 will be plugged into a worksheet designed to estimate future forest cover in Step 1.7.

Table 4. Summary of Watershed Data						
Zoning Category	**Current Impervious Cover (acres)**	**Current Forest Cover (acres)**		**Current Turf Cover (acres)**		
				Developed		**Undeveloped**
		Protected OR Developed	**Buildable* (unprotected and undeveloped)**	**Public**	**Private**	
Agriculture	100	1000	50	0	3000	50
Open urban land	150	2000	100	4000	0	0
2 acre residential	500	500	200	0	4000	1000
1 acre residential	1000	500	2000	0	2000	500
½ acre residential	1000	500	3000	0	1500	1000
¼ acre residential	2000	500	1000	0	1000	500
1/8 acre residential	2000	0	50	0	150	100
Townhomes	4000	0	500	0	100	400
Multifamily	3000	0	100	0	100	0
Institutional	1000	0	500	3000	500	0
Light industrial	5000	0	500	0	50	100
Commercial	5000	0	2000	0	500	500
Total	24,750	5000	10,000	7000	2950	4150

Each of the variables quantified in this step serves some function in estimating future forest cover:

- The *total amount of impervious cover* in the watershed will limit the potential for future forest cover (unless impervious cover is removed in order to reforest).

- *Forested land that is either protected or already developed* is assumed to remain forest with future watershed development.

- *Forested land that is both unprotected and undeveloped* is considered 'buildable,' and some proportion of that forest will be cleared during future development (Step 1.6 will estimate that proportion).

- *Developed turf* probably provides the best opportunities for reforestation, especially public lands because of ownership. However, only some proportion of public turf will actually be available for reforestation. Privately-owned developed turf is likely to be home lawns or commercial/industrial land and has the potential to greatly increase forest cover with reforestation, but will require extensive education, outreach and incentives to be effective.

- *Undeveloped turf* may also provide some opportunity for reforestation; however, this should always be done in conjunction with protection measures to ensure long-term sustainability of the forest.

Step 1.6 Acquire Forest Cover Coefficients

Forest cover coefficients represent the fraction of developed land that is forest. These coefficients are applied to specific zoning categories to estimate the amount of future forest cover on all buildable land in the watershed. Currently, little data exists for forest cover or turf cover coefficients. However, some data is available that represents the fraction of developed land that is impervious. The methods used to derive these impervious cover coefficients may be used to estimate forest cover and turf cover coefficients.

Impervious cover coefficients for 12 urban and suburban land uses are available from Cappiella and Brown (2001) and are presented in Table 5. These coefficients were derived from recently developed urban-suburban areas in the Chesapeake Bay region and are applicable to areas with similar types of development. Where possible, local or regional estimates of impervious cover should be used. If none are available, communities should derive their own from local data (see Cappiella and Brown, 2001 for methods). Communities should also derive their own forest and turf cover coefficients by analyzing limits of disturbance on site plans or by analyzing turf cover or forest cover at the parcel scale as a subsample of actual development sites. Appendix C and Cappiella and Brown (2001) provide detailed methods for deriving land cover coefficients.

Impervious, forest, and turf cover coefficients are provided in Table 5 for three forest conservation scenarios. The forest and turf cover coefficients are examples only and are loosely based on a number of assumptions and data sources described below. Additional data sources that may be used to develop land cover coefficients are provided in Appendix D.

Table 5. Example Land Cover Coefficients for Three Forest Conservation Scenarios

Zoning Category	Impervious Cover (%)[4]	Turf Cover (%)[5]			Forest Cover (%)[5]		
		NFC[1]	IFC[2]	DFC[3]	NFC[1]	IFC[2]	DFC[3]
Agriculture	0.02	0.93	0.83	0.78	0.05	0.15	0.20
Open urban land	0.09	0.86	0.76	0.41	0.05	0.15	0.50
2 acre residential	0.11	0.84	0.74	0.39	0.05	0.15	0.50
1 acre residential	0.14	0.81	0.71	0.36	0.05	0.15	0.50
½ acre residential	0.21	0.74	0.64	0.54	0.05	0.15	0.25
¼ acre residential	0.28	0.67	0.57	0.47	0.05	0.15	0.25
⅛ acre residential	0.33	0.62	0.52	0.47	0.05	0.15	0.20
Townhomes	0.41	0.54	0.44	0.39	0.05	0.15	0.20
Multifamily	0.44	0.51	0.41	0.36	0.05	0.15	0.20
Institutional	0.34	0.61	0.51	0.46	0.05	0.15	0.20
Light industrial	0.53	0.42	0.32	0.32	0.05	0.15	0.15
Commercial	0.72	0.23	0.13	0.13	0.05	0.15	0.15

[1]NFC = clearing can proceed anywhere at the site except protected wetlands.
[2]IFC = some site areas cannot be cleared because of steep slopes, wetland buffers, stream buffers, floodplains or other local clearing restrictions.
[3]DFC = additional site areas cannot be cleared because of explicit forest conservation or afforestation requirements at the site (e.g., Maryland Forest Conservation Law).
[4]Impervious cover coefficients from Cappiella and Brown (2001).
[5]Turf cover and forest cover coefficients are example values only.

The forest cover coefficients presented in Table 5 are representative of three tiers of local forest conservation regulations: No Forest Conservation (NFC), Indirect Forest Conservation (IFC) and Direct Forest Conservation (DFC).

The *No Forest Conservation* scenario applies to communities that have no forest conservation or other natural resource conservation regulations that apply during land development. Under NFC, the entire site can be graded, except for state or federally delineated wetlands. For the forest cover coefficients presented in Table 5, the assumption was made that a minor fraction of forest cover (5%) may be retained during construction.

The *Indirect Forest Conservation* scenario applies to communities that have some additional regulations that prevent clearing on portions of a development site containing stream buffers, steep slopes, floodplains or other sensitive natural area. These areas often contain forest fragments, and therefore indirectly contribute to forest conservation, although they may represent a very small fraction of the site. The amount of forest conserved will vary depending on how much of the site is currently forested AND located within floodplains, steep slopes, stream buffers, etc. For the forest cover coefficients presented in Table 5, the assumption was made that approximately 15% of any given site would be preserved as forest.

The *Direct Forest Conservation* scenario applies to communities with defined forest conservation or afforestation requirements at the development site, in addition to the environmental criteria listed under the Indirect Forest Conservation scenario. The forest cover coefficients presented in Table 5 were primarily based on the Maryland Forest Conservation Act criteria, which require a certain percentage of a development site to be preserved as forest or reforested during development.

The turf cover coefficients presented in Table 5 reflect the remaining land after impervious cover and forest cover are subtracted from the total land area.

Figure 10 illustrates the three tiers of forest conservation regulations. Prior to development, the parcel shown in Figure 9 had 45% forest cover (dark green). With development under the NFC scenario, only a small portion of forest on the site was preserved, with a net forest cover of 10%. Under the IFC scenario, a stream buffer ordinance that restricts disturbance of native vegetation within 100 feet of all streams resulted in the developer conserving additional forest along the stream that runs through the property. The net forest cover for this scenario was 25%. Under the DFC scenario, a forest conservation ordinance that required preservation of 40% of the site as forest resulted in a net forest cover of 40% and total forest loss of only 5%.

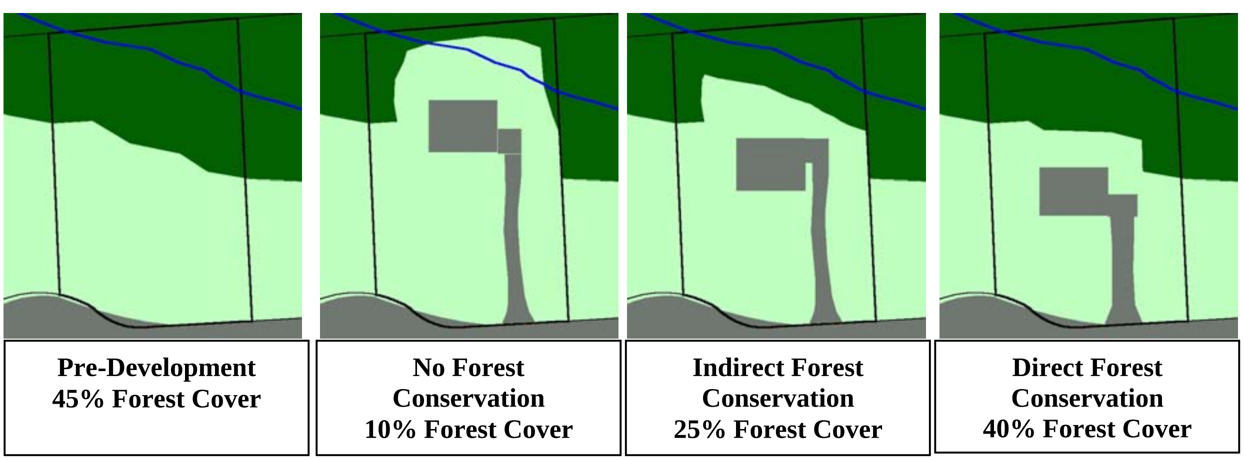


Figure 10. Effect of forest conservation regulations at the development site

Most communities fall into one of these three tiers of forest conservation and should select the appropriate forest cover coefficients depending on the prevailing regulations in their community. As illustrated in Table 5, land cover coefficients vary with the zoning category and the forest conservation scenario; however, one variable not reflected in this table is the prior landuse of the site. Land in agricultural use will have less forest cover to start with compared to a forested parcel so will likely have lower forest cover coefficients. In addition, forest cover coefficients that are derived for older developments may tend to be higher than for more recently developed areas because trees have been planted or allowed to grow up over time. This variability and the current lack of data on forest and turf cover coefficients points to the derivation of land cover coefficients as a major data gap in this analysis and area for future research.

Forest cover coefficients will be used in Step 1.7 to estimate future forest cover on buildable lands in the watershed. The default values shown in Table 5, or data provided in Appendix D may be used until detailed studies are conducted to derive additional data.

Step 1.7 Estimate Future Forest Cover in the Watershed

The final step in the Leafout Analysis is to estimate future forest cover in the watershed under full buildout conditions. This initial estimate of future forest cover is intended to quantify forest cover under a worst-case or 'do-nothing' approach and does not account for any future or planned forest conservation or reforestation efforts or regulations. Step 2, Develop Forest Cover Goals and Objectives, models the effect of various forest protection and reforestation techniques on future forest cover.

The text box below summarizes the assumptions used in estimating future forest cover. These assumptions should be modified when more detail is available regarding future development patterns in a particular watershed. The worksheet on the following page should be used to estimate future forest cover in the watershed under a worst-case scenario (e.g., no additional reforestation or conservation efforts). Data summarized in Table 4 (Step 1.5) and the forest cover coefficients acquired in Step 1.6 should be used to fill in the blanks in the worksheet.

ASSUMPTIONS USED IN ESTIMATING FUTURE FOREST COVER IN THE WATERSHED

1. All developed land will remain in its current land cover.
2. All protected land will remain in its current land cover.
3. All impervious cover will remain impervious (e.g., no removal of pavement).
4. All land that is unprotected AND undeveloped is considered "buildable" and is subject to future development under allowable zoning.
5. Full buildout of the watershed will occur based on allowable zoning (e.g., no re-zoning).
6. Future land cover of all buildable land can be estimated by applying the appropriate land cover coefficients for each zoning category.
7. The land cover coefficients chosen should reflect the current status of forest conservation regulations in the watershed.

Leafout Analysis Worksheet for Estimating Future Forest Cover in the Watershed Under Worst-Case Scenario (e.g., no additional reforestation or conservation efforts)

Area of Current Protected or Developed Forest: *From Table 4. All protected or developed forest will remain forest.*	*5000*	(acres)
	+	
Area of Forest Protected *See table below. Default value is zero.*	*0*	(acres)
	+	
Area of Forest Conserved During Development *See table below. Use forest cover coefficients that represent the current forest conservation requirements in your watershed.*	*2780*	(acres)
	+	
Area Reforested *Default value is zero.*	*0*	(acres)
	=	
Area Future Forest Cover	*7780*	(acres)

Zoning Category	Buildable Forest (acres)		Priority Forest Protected (acres)		Buildable Forest Remaining (acres)		Forest Cover Coefficient (%)		Forest Conserved During Development (acres)
Agriculture	*50*	-	*0*	=	*50*	*	*50*	=	*25*
Open urban land	*100*	-	*0*	=	*100*	*	*50*	=	*50*
2 acre residential	*200*	-	*0*	=	*200*	*	*50*	=	*100*
1 acre residential	*2000*	-	*0*	=	*2000*	*	*50*	=	*1000*
½ acre residential	*3000*	-	*0*	=	*3000*	*	*25*	=	*750*
¼ acre residential	*1000*	-	*0*	=	*1000*	*	*25*	=	*250*
1/8 acre residential	*50*	-	*0*	=	*50*	*	*20*	=	*10*
Townhomes	*500*	-	*0*	=	*500*	*	*20*	=	*100*
Multifamily	*100*	-	*0*	=	*100*	*	*20*	=	*20*
Institutional	*500*	-	*0*	=	*500*	*	*20*	=	*100*
Light industrial	*500*	-	*0*	=	*500*	*	*15*	=	*75*
Commercial	*2000*	-	*0*	=	*2000*	*	*15*	=	*300*
Total	*10,000*		*0*						*2780*

Summary Results

Current Forest Cover *From Table 4.*	*15,000*	(acres)		
	-			
Future Forest Cover *From above.*	*7780*	(acres)		
	=			
Future Forest Loss	*7220*	(acres)	*48*	(%)

The worksheet result gives an estimate of future forest loss (%) in the watershed with no additional forest conservation or reforestation efforts. In the example shown, 48% of existing forest in the watershed is lost to development.

The USDA Forest Service Northeastern Research Station is developing a new tool to project future forest canopy cover that may facilitate the Leafout Analysis. The tool involves a GIS-integrated management decision program that is a component of the Urban Forest Effects (UFORE) Model. This tool is called UFORE Future Effects and is designed to project future canopy cover over a 30-year period based on estimated growth and mortality rates. More information about UFORE is available at http://www.fs.fed.us/ne/syracuse/Tools/UFORE.htm and http://www.ufore.org/

Step 2: Develop Forest Cover Goals and Objectives

The second step is to develop overall goals for increasing forest cover in both the watershed and the community, and to identify specific objectives for attaining these goals. Forest cover goals should be specific, measurable and realistic, and have an associated timeline for attainment.

Step 2.1 Set Numerical Targets for Forest Cover

A numerical target for forest cover should be defined first for the entire community, and then for each individual watershed within the community. American Forests recommends 40% cover for most metropolitan areas, and a number of communities have already adopted this as a goal (see Appendix E). Across the U.S., tree canopy cover in urban and metropolitan areas currently falls below this standard, averaging 27% and 33%, respectively (Dwyer and Nowak, 2000).

A recent Chesapeake Bay Program directive encourages communities to adopt canopy goals (see text box below) and recommends that goals should: represent an increase in overall tree cover, be set for a 10-year horizon, and establish targets for percent increase in forest cover at specified intervals (CBP, 2004). Goals should also take into account current forest cover, current and planned development patterns and regulations, and resources available for reforestation and protection efforts. The Urban Forest Effects (UFORE) website provides data on current canopy cover for 21 U.S. cities that may be used as a starting point for developing community forest cover targets: www.fs.fed.us/ne/syracuse/Data/data/htmT.
Because most metropolitan areas contain multiple watersheds that often have varying land use and development patterns, a numerical target should be defined for each individual watershed, based on community-wide targets but taking into account specific watershed protection or restoration goals and using the results of the Leafout Analysis. It may not be realistic for some watersheds to meet the community-wide forest cover goal, while other watersheds may surpass them. To date, few communities have adopted numerical targets for forest cover at the watershed scale. However, some data indicates that watershed forest cover of at least 45 to 65% is most beneficial in terms of stream health (see Appendix E). These studies provide a starting point for setting watershed-wide forest cover goals. Table 6 provides some example forest cover goals for four watershed scenarios.

Table 6. Example Forest Cover Goals for Four Watershed Scenarios

Watershed Type	Impervious Cover %	Forest Cover Goal	Benefits of Forest Cover
Suburban/Forested	< 25	60% minimum with 70% riparian forest cover	• Maintain aquatic ecosystem • Improve filtering capacity • Wildlife habitat • Stream protection
Suburban/Agricultural	< 25	40-50% minimum	• Maintain aquatic ecosystem • Improve filtering capacity • Wildlife habitat • Stream protection
Urban-Suburban	26 to 60	25-40% minimum	• Storm water runoff reduction • Reduce urban heat island • Wildlife habitat • Increase aesthetic value • Provide recreational opportunities
Urban	> 60	15-25% minimum	• Reduce urban heat island • Storm water runoff reduction • Public health and air quality • Community livability

The forest cover goals presented in Table 6 are examples only and should be refined based on individual watershed characteristics, modeling or literature review to directly address storm water, air quality or other outcomes. Current forest cover should be used as a starting point for goal setting. Current watershed impervious cover may also help determine the maximum limit of forest cover that it is possible to achieve without removal of impervious surfaces. Numerical forest cover targets should be revisited periodically and revised if necessary. Cost estimates for implementing forest conservation and reforestation objectives are necessary for communities to determine what is a realistic forest cover increase to achieve given a specific timeframe and budget. Two examples are presented in the text box on the following page.

QUANTIFYING REALISTIC FOREST COVER GOALS

A study of the urban forest in Syracuse, NY found that the current forest cover in the city was 26.6% for the 25.1 square mile area. A specific recommendation was made in the city's Urban Forest Management Plan to increase overall canopy cover to 30%. Assuming that existing forest cover was maintained, this **increase of 3.4%** could be implemented over **25 years** by planting 1,360 new trees each year (Nowak and O'Connor, 2001). Annual costs for implementation are estimated at $272,000 (based on cost of $200 per tree for planting and maintenance from Connecticut Climate Change, 2004).

A similar study by the North East State Foresters Association (Luley and Bond, 2002) used a model to determine that a **10% increase in canopy cover** was realistic for the New York City metropolitan region (a 1950 square mile area) to achieve over a **30-year time period**. This increase would bring the total tree canopy cover up to 41%. To achieve this goal, more than 1 million trees would need to be planted each year at an annual cost of $212 million (using the above cost estimate).

Step 2.2 Define Priority Objectives to Meet Goals

Forest cover goals for a watershed should represent an increase in the existing percentage of forest cover. The specific objectives utilized to meet forest cover goals may vary with each watershed and should be based on the data derived from the Leafout Analysis (e.g., current impervious cover, area of protected forest, area of buildable forest, proportion of public and private developed turf). Table 7 provides guidance on identifying priority objectives to meet forest cover goals in specific types of watersheds.

Table 7. Linking the Leafout Analysis with Forest Cover Goals and Priority Objectives

Urban Watershed Forestry Objective	Characteristics of Watersheds Where Objective is Prioritized
A. Protect Priority Forests	Significant proportion of buildable forest, significant forest lost to development in leafout analysis scenario, large tracts of forest owned by single landowners
B. Prevent Forest Loss During Development/Redevelopment	Significant proportion of buildable forest, significant forest lost to development in leafout analysis scenario, current forest cover regulations do not directly or indirectly protect forests
C. Maintain Existing Forest Canopy	Highly developed watershed with little or no buildable forest remaining, majority of forest is on developed land
D. Enhance Forest Remnants	Significant protected forest exists, little remaining buildable forest
E. Plant Trees During Development/Redevelopment	Significant proportion of buildable land, current conservation regulations do not provide much protection of trees (and is not feasible or acceptable to change) or most of buildable land is turf (prior ag land)
F. Reforest Public Land	Significant proportion of public turf
G. Reforest Private Land	Significant proportion of private turf, private turf is held by a few large landowners, or private turf is held by many small landowners, but represents the best opportunity for increasing forest cover (e.g., very little forest exists to protect, little buildable forest left, little public turf)

Step 2.3 Evaluate Effect of Objectives on Future Forest Cover

The Leafout Analysis provides a baseline estimate of future land cover under a worst case or "do nothing" scenario. Based on priority forest cover objectives, alternative scenarios can be evaluated to determine their impact on future forest cover. The worksheet on the following page illustrates an example scenario in which future forest loss was reduced from a 48% loss to a 7% gain in watershed forest cover.

Leafout Analysis Worksheet for Estimating Future Forest Cover in the Watershed - Forest Conservation/Reforestation Scenario

Area of Current Protected or Developed Forest:	5000	(acres)
From Table 4. Protected or developed forest will remain forest.	+	
Area of Forest Protected	2000	(acres)
See table below. Select area to protect as part of an urban watershed forestry program.	+	
Area of Forest Conserved During Development	5000	(acres)
See table below. Use forest cover coefficients that represent the amount of forest conserved at a site with adoption of forest conservation or afforestation requirements.	+	
Area Reforested	4000	(acres)
Select area to reforest as part of an urban watershed forestry program.	=	
Area Future Forest Cover	16,000	(acres)

Zoning Category	Buildable Forest (acres)		Priority Forest Protected (acres)		Buildable Forest Remaining (acres)		Forest Cover Coefficient (%)		Forest Conserved During Development (acres)
Agriculture	50	-	500	=	50	*	50	=	25
Open urban land	100	-	500	=	100	*	50	=	50
2 acre residential	200	-	50	=	200	*	50	=	100
1 acre residential	2000	-	250	=	2000	*	50	=	1000
½ acre residential	3000	-	0	=	3000	*	50	=	1500
¼ acre residential	1000	-	0	=	1000	*	50	=	500
⅛ acre residential	50	-	0	=	50	*	50	=	25
Townhomes	500	-	0	=	500	*	50	=	250
Multifamily	100	-	0	=	100	*	50	=	50
Institutional	500	-	500	=	500	*	50	=	250
Light industrial	500	-	0	=	500	*	50	=	250
Commercial	2000	-	200	=	2000	*	50	=	1000
Total	10,000		2000						5000

Summary Results

Current Forest Cover	15,000	(acres)		
From Table 4.				
Future Forest Cover	16,000	(acres)		
From above.				
Future Forest Increase	1,000	(acres)	7	(%)

Figure 11 illustrates the effect of these objectives on future forest cover compared with future forest cover with no protection or reforestation efforts.

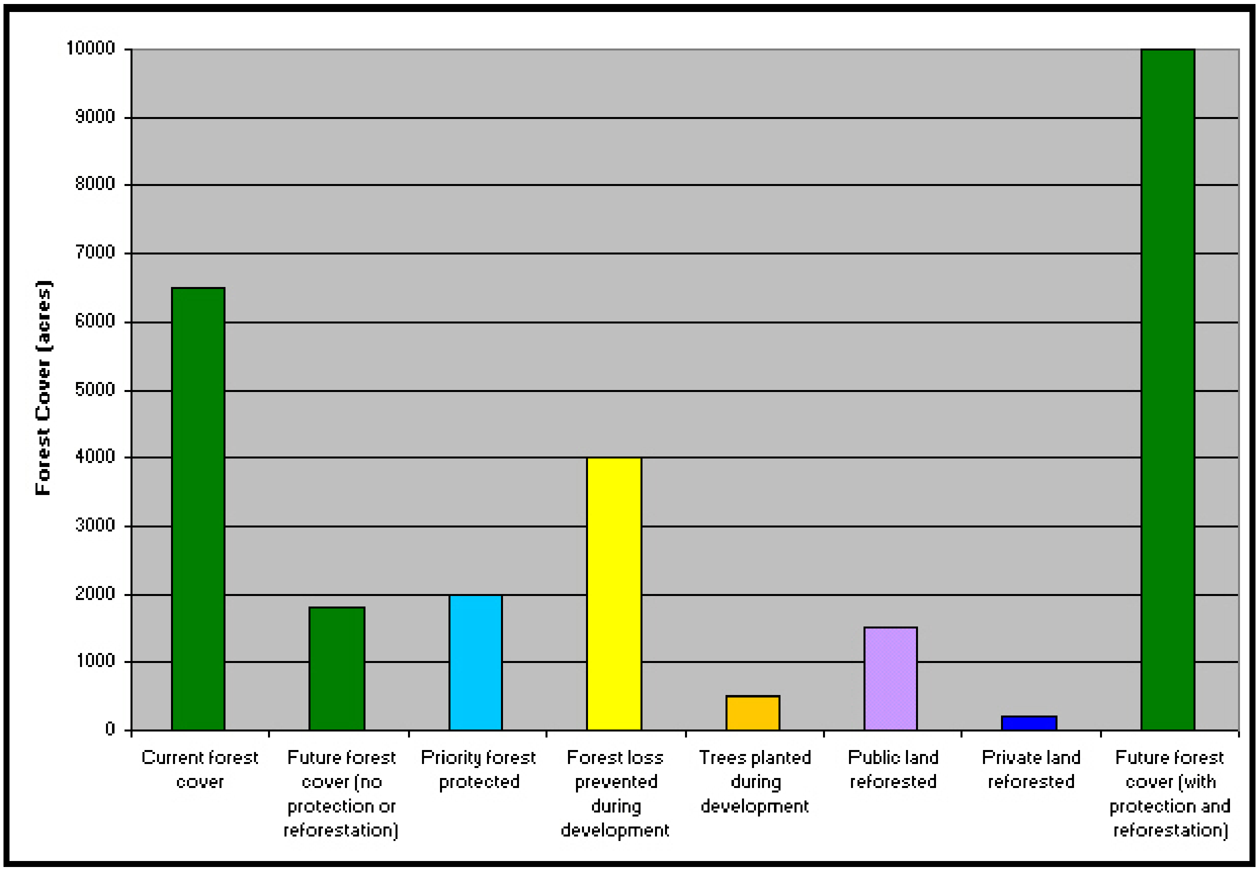


Figure 11. The effect of forest conservation and reforestation on future forest cover

Step 3: Identify Existing Forest and Reforestation Opportunities

Once numerical targets for protection of existing forest and reforestation are identified, the next step involves locating the best sites in the watershed for these activities. In this step, priority forest and reforestation sites are selected for further evaluation in the field based on the inventory of current land cover in the watershed. However, due to factors such as budget and land ownership, it is not desirable or feasible to pursue each and every forested site for protection, or each and every open area for reforestation. Using the information generated through the inventory of current and future land cover, as well as some additional land use and land owner information, a select number of sites can be identified through the use of a GIS. Table 8 identifies what are typically the best opportunities for each of the seven urban watershed forestry objectives.

Table 8. Types of Land Best Pursued for Urban Watershed Forestry Objectives	
Urban Watershed Forestry Objective	**Best Opportunities**
A. Protect Priority Forests	Large tracts of contiguous, unprotected forest
B. Prevent Forest Loss During Development/Redevelopment	Forest on parcels to be developed
C. Maintain Existing Forest Canopy	Forest on parcels that are already developed
D. Restore Forest Remnants	Protected forests
E. Plant Trees During Development/Redevelopment	Turf areas on parcels to be developed, including streetside planting areas, storm water treatment practices, property lines
F. Reforest Public Land	Turf areas on public-owned parcels that are already developed (e.g., parks, schools, stream buffers, STPs, rights-of-way) or undeveloped turf areas (provided reforestation is done in conjunction with protection measures)
G. Reforest Private Land	Turf areas on private-owned parcels that are already developed (e.g, home lawns, stream buffers, institutional and commercial land)

GIS layers created in Step 1 (current land cover, protection status, development status, zoning and future land cover) are combined with the following layers in this step:

- Property boundaries/land owner information
- Public lands (e.g., schools, parks, rights-of-way)
- Storm water treatment practices
- Vacant land
- Aerial photos
- Natural resource data (e.g., streams, wetlands, floodplains, critical habitats, karst features, steep slopes, erodible soils, monitoring data)
- Cultural, recreational or historical areas

Step 3.1 Identify Existing Forests for Further Assessment

To identify existing forests for further assessment, a watershed map that also identifies forested land that may be lost to future development (e.g., unprotected and undeveloped land) should be analyzed (Figure 12). It may also be useful to overlay other GIS layers on the map that define constraints on site selection, such as: land ownership, transportation corridor or utility restrictions, prior site use (e.g., potential for soil or groundwater contamination) and natural, cultural and historical resources.

Forests selected for further evaluation are assessed in the field to determine whether they are good candidates for protection or restoration and to select appropriate protection or restoration techniques. In highly urban watersheds where few remaining forests exist, it may not be necessary to whittle down the forested sites to a more manageable number. Criteria for selecting forested parcels for further evaluation include the following:

- Currently unprotected
- Publicly owned or willing land owner
- Contiguous forest greater than a specified acreage (set by municipality, dependent on average size of forest fragments)
- Strategic location in watershed (e.g, adjacent to existing forest parcel, reforestation site or protected land, connects or has the potential to connect two existing contiguous forest parcels, has significant natural, historic, cultural or recreational value)

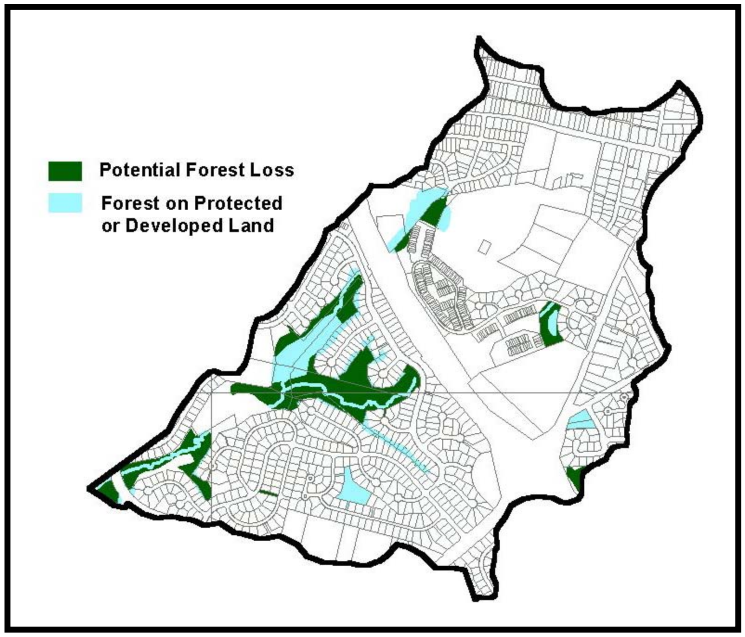


Figure 12. Potential Forest Loss

Each community should tailor these criteria for selecting forest parcels to take into account the specific characteristics of their watersheds. The possibility of expanding forested areas or linking them to the stream corridor or other remnants should always be considered when selecting priority forest sites. Owners of large forested tracts may be contacted at this stage to gauge their interest in forest conservation efforts, and to get permission to evaluate their land further.

Step 3.2 Identify Reforestation Opportunities for Further Assessment

To select reforestation sites for further assessment, a map that displays the existing non-forest vegetative cover in the watershed should be analyzed along with property boundaries, vacant lands, public lands, storm water treatment practices, and natural cultural and historical resource information.

Sites with turf cover typically present the best reforestation opportunities because they do not involve extensive removal of vegetation or impervious cover. If the GIS layer of land cover does not distinguish between turf and other types of non-forest vegetation, aerial photos may be used to verify which parcels contain turf. Turf cover typically represents the largest portion of non-forest vegetative cover and can comprise up to 80% of urban pervious cover (CWP, 2000b). Figure 13 shows the distribution of turf cover at the state level across various land uses (composite of MTC, 1996; VASS, 1998 and PTC, 1989).

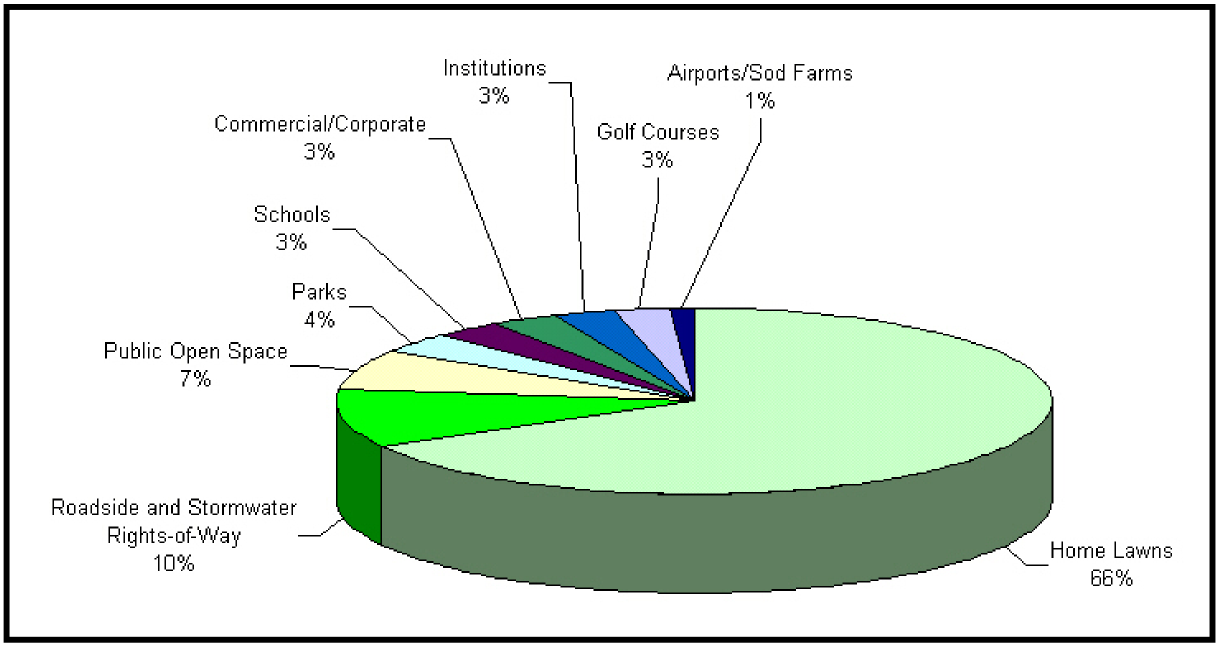


Figure 13. Distribution of turf cover at the state level (composite of MTC, 1996; VASS, 1998 and PTC, 1989)

As can be seen, home lawns constitute the largest single share of turf cover (about 67%). Public land such as rights-of-way, open space, parks and schools constitute about a quarter of the total turf cover. This distribution will vary from watershed to watershed, but home lawns and public land are typically the major components.

While reforesting home lawns may yield the largest increase in watershed forest cover, this can be difficult to accomplish because of the sheer number of landowners involved and potentially small number of homeowners who are willing to convert their turf to forest. If home lawns do comprise a significant portion of turf cover in the watershed, an education program geared towards homeowners about the benefits of planting trees, combined with a community tree planting or cost share program, may be the most effective tool for increasing forest cover on residential lots (GFC, 2001). The same approach may be used for private institutions, commercial land and multifamily housing complexes, which may also have large turf areas that can be reforested. Figure 14 illustrates that while private turf may present opportunities for extensive reforestation, the land is typically in the hands of multiple owners.

Public lands are attractive from the standpoint of reforestation because of their large size and ownership. These include highway cloverleafs and buffers, parks, schools, storm water dry ponds and utility corridors. Vacant lands and stream corridors provide additional opportunities to reforest the watershed. Criteria for selecting reforestation opportunities for further evaluation include the following:

- Turf cover
- Developed or vacant land

- Publicly owned (e.g., highway cloverleafs, highway buffers, parks, schools, storm water dry ponds, utility corridors)
- Strategic location in watershed (e.g, stream corridor, adjacent to existing forest parcel, reforestation site or protected land, connects or has the potential to connect two contiguous forest parcels, has significant natural, historic, cultural or recreational value)

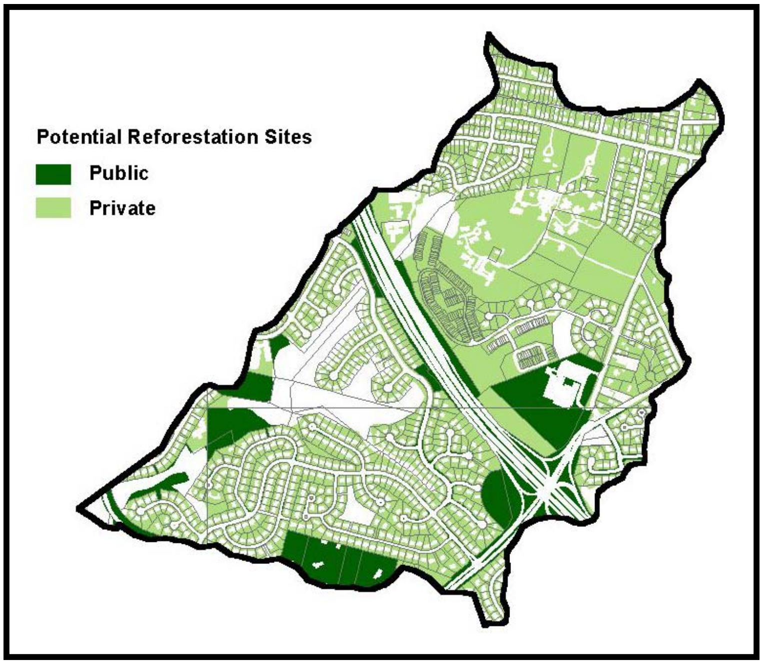


Figure 14. Reforestation potential

Each community should tailor these criteria to select reforestation opportunities that take into account the specific characteristics of their watersheds. For example, a community with a very large number of sites that meet the above criteria may elect to only evaluate turf parcels larger than two acres. The possibility of expanding existing forested areas or linking two forest fragments should always be considered when selecting priority reforestation sites.

Step 4: Conduct a Field Assessment of Existing Forest and Reforestation Opportunities

The next step is to select existing individual forest and/or potential reforestation sites for further evaluation in the field to verify their existence and use, determine if they are good candidates for protection, restoration or reforestation, and to collect some basic screening information to rank the sites.

Step 4.1 Conduct a Field Assessment of Existing Forest Fragments

Many methods exist for evaluating the quality of existing forests; however, few are specifically tailored to urban forests. Several forest assessment methods are summarized in Table 9, which address at least some of the potential impacts of development on forests. The priority forests selected in Step 3 should be assessed using one of these methods or an equivalent. The choice of which method to use and how many forested parcels to initially evaluate in the field will ultimately be driven by staff, budget, resources and the level of detail desired.

Table 9. Summary of Forest Assessment Methods			
Forest Assessment Method	**Applicability**	Description	**Source**
Unified Subwatershed and Site Reconnaissance (USSR)	Urban upland forests	The Pervious Area Assessment form of the USSR is used to collect basic information about existing forest remnants	Wright, *et al.* (2004)
Woodland Buffer Habitat Assessment	Riparian forest	Evaluates the value of riparian forest for wildlife habitat	Hanssen (2003)
Upland Contiguous Forest Assessment	Upland forests	Designed to evaluate large parcels of contiguous forest to determine which are priorities for conservation	CWP (unpublished)
Maryland's Green Infrastructure Assessment	Regional application	Evaluates hubs and corridors in terms of ecological significance for the purpose of land acquisition	Weber (2003)
Maryland Forest Conservation Act Stand Assessment	Parcel scale	Evaluates forest stands on an individual development site to identify conservation areas	Greenfeld, *et al.* (1991)

Each method collects similar types of information at forest fragments to evaluate the quality of the forest, identify potential restoration opportunities, and rank each site in terms of conservation priorities. These forest characteristics are presented in Table 10.

Table 10. Forest Characteristics Evaluated in Field Assessments	
Characteristic	**Description**
Basic site information	Landowner and use, parcel size, location, protection and development status
Surrounding landuses	Observe adjacent forest or open areas and evaluate potential for connection with these nearby fragments
Dominant species	Dominant tree species or forest association
Forest age	Indicated by successional stage or size class of dominant trees
Vertical structure	Presence of different vertical layers of vegetation such as ground cover, understory, mid-story and canopy trees. Measure of habitat complexity.
Canopy density & condition	Percentage of forest covered by tree canopy, Canopy condition and health.
Herbaceous vegetation	Density and species or herbaceous vegetation, presence of duff layer
Understory vegetation	Density and species of understory vegetation
Invasive species	Density, extent and species of invasive plant species
Indicator or rare, threatened, or endangered (RTE) species	Species and specific location. Indicator species are intolerant of a decline in habitat quality and are therefore indicators of high quality habitat
Evidence of disturbance	Clearing, trash dumping, erosion, pollution, overbrowsing
Presence of food, water, cover and habitat	Includes streams, wetlands, snags and cavity trees, large woody debris, conifers, mast species, vernal pools, leaf litter

Basic site information and surrounding land uses are evaluated to assess the feasibility of protecting or restoring the site and to use in ranking the site in terms of its potential to connect other forest fragments or habitat corridors. The remaining characteristics provide an overall indicator of the ecological significance or value of the forest. Most forest assessment methods will include a system for interpreting data collected in the field that results in an actual score or classification of the forest in terms of ecological value.

Step 4.2 Conduct a Field Assessment of Potential Reforestation Sites

Most potential reforestation sites are public or private turf. Turf areas should be assessed in the field to verify their condition, evaluate the feasibility of reforestation, and collect information to prioritize candidate sites. If desired, additional information may be collected at this time to use in developing a reforestation plan for the sites (e.g, detailed soil characteristics). Table 11 summarizes three assessment methods for evaluating urban reforestation sites. Additional information on evaluating plant sites is provided in Part 3: Urban Tree Planting Guide, and in Reynolds and Ossenbruggen (1991) and WFC (1993).

Table 11. Summary of Reforestation Site Assessment Methods

Reforestation Site Assessment Method	Applicability	*Description*	Source
Unified Subwatershed and Site Reconnaissance (USSR)	Urban upland pervious areas	The Pervious Area Assessment form of the USSR is used to collect basic information about potential planting sites	Wright *et al.* (2004)
Unified Stream Assessment	Urban riparian areas with inadequate stream buffer	The Inadequate Buffer form is used to collect basic information about potential planting sites with < 25 foot forested stream buffer	Kitchell and Schueler (2004)
Site Assessment for Urban Tree Planting	Urban planting sites	Detailed site assessment for urban tree planting to use in selecting species and developing a planting plan	Bassuk *et al.* (2003)

The types of information collected with each assessment method vary with the purpose of the assessment and location(s) in which they apply (upland or riparian). Table 12 provides a summary of the three types of information typically collected during a reforestation site assessment: feasibility factors, ranking factors and factors to use in creating a reforestation plan.

Table 12. Factors Evaluated in Field Assessment of Reforestation Sites

Factor Type	Description
Feasibility	Landowner and use, site access, potential soil contamination, lack of sun or water, severe and widespread invasive species or overbrowsing, conflicts with infrastructure
Ranking	Size and dimensions of planting area, location in watershed, surrounding landuse, potential for connection to nearby forest or protected land, presence of nearby streams, wetlands, RTE species or other sensitive resource
Reforestation Planning	Current vegetative cover, invasive species, trash dumping, soil pH, soil texture, soil compaction, soil drainage, soil salinity, soil depth, distance to water table, light exposure, heat exposure, wind exposure, slope, and potential for damage from vandalism, automobiles, deer, lawnmowers, etc.

The feasibility and ranking factors collected will be used in to prioritize sizes for reforestation (Step 5) and the reforestation planning factors collected will be used to determine exactly what to plant, where to plant and when to plan at the site (Step 6).

Step 5: Prioritize Existing Forest and Reforestation Opportunities

The next step is to prioritize the candidate sites identified in Step 4 for protection, enhancement and reforestation. The ranking system should take into account the forest cover goals for the watershed, as well as any larger watershed protection or restoration goals that have been defined. The ranking system should also be driven by the resources available for implementing watershed forestry projects, and will be based on results of both the inventory of watershed land cover and the field assessments. Therefore, some factors may be weighted more heavily that others. While the exact ranking system should be defined by the user, some important ranking factors to include are presented in Table 13.

Table 13. Common Ranking Factors to Prioritize Parcels for Protection, Enhancement or Reforestation

Ranking Factor	Description
Feasibility Ranking Factors	
Land ownership	Prioritize public land then private land with willing landowners
Access to site	Project may be infeasible if access to site is not adequate for any necessary foot traffic, vehicles or heavy equipment.
Prohibitive site characteristics	Certain site characteristics may make a project infeasible, such as potentially contaminated soils or insufficient sunlight for plant growth
Environmental Ranking Factors	
Continuity (if forest)	Prioritize sites with uninterrupted cover
Connectivity	Prioritize sites that link or have the potential to link adjacent forest, reforestation sites or protected lands
Contiguity	Prioritize sites with greater than a specified acreage
Ecological significance	Prioritize sites with high habitat scores, high fish and bug Index of Biotic Integrity (IBI) scores, mature vegetation, RTE species, or other sensitive natural resources, or streams identified as restoration priorities
Location in watershed	Prioritize sites located in riparian areas, wetlands, floodplains, steep slopes, erodible soils, recharge areas or other locations important to watershed hydrology and water quality.
Community Ranking Factors	
Recreational value	Prioritize sites with recreational value
Community acceptance	Prioritize sites that received community support and have a potential base of volunteers to help with tree planting or maintenance (this may entail a public meeting to get community input on projects)
Historic or cultural value	Prioritize sites with significant cultural or historical value
Difficulty Ranking Factors	
Cost	Prioritize sites with the lowest cost per acre
Level of effort	Prioritize sites that require minimal site preparation (soil amendments, removal of invasive species) over those requiring extensive site preparation

Separate prioritization methods may be developed to rank forested sites and reforestation sites. Several examples of detailed prioritization methods for protection, enhancement and reforestation projects are summarized in Table 14.

Table 14. Summary of Prioritization Methods for Protection, Enhancement and Reforestation

Prioritization Method	Applicability	Description	Source
Maryland's Green Infrastructure Assessment	Regional application	Prioritizes hubs and corridors for land acquisition based on ecological significance	Weber (2003)
Urban Riparian Restoration Project	Urban riparian areas	3-tiered ranking system for prioritizing riparian sites for reforestation	Virginia Department of Forestry (1993)
Watershed Analysis Extension for ArcView	Watershed scale	Provides tools for quantitatively ranking land in a watershed by estimated surface water quality impact	de la Cretaz, *et al*. (2003)
Chesapeake Bay Resource Lands Assessment	May be applicable at a variety of scales	GIS-based methods for identifying forests in the Chesapeake Bay watershed that are important for protecting water quality and watershed integrity	Painton-Orndorff, *et al*. (2004)
Forest Areas of Local Importance	County or regional application	GIS-based decision tool to identify critical forest areas for protection	NEGRDC (2004)
Urban Forest Effect (UFORE Model	Site level	GIS-based tool for selecting the best locations to plant trees to improve air quality and building energy conservation	USDA Forest Service (2004)

Step 6: Develop Recommendations for Meeting Forest Cover Goals

The last step is to integrate forest cover goals for the watershed in the context of a watershed plan. This plan should include specific recommendations for implementing protection, enhancement and reforestation techniques at priority sites.

Watershed planning is a unique forest protection tool in that it takes a landscape-level approach to conserving forests based on natural features rather than focusing on jurisdictional boundaries or an individual development site. A watershed plan should ideally be created for every watershed within a jurisdiction that seeks to maintain or increase forest cover and incorporates specific recommendations for how to do this. CWP (1998b) and Schueler (2004) provide detailed guidance on how to create watershed protection plans and subwatershed restoration plans.

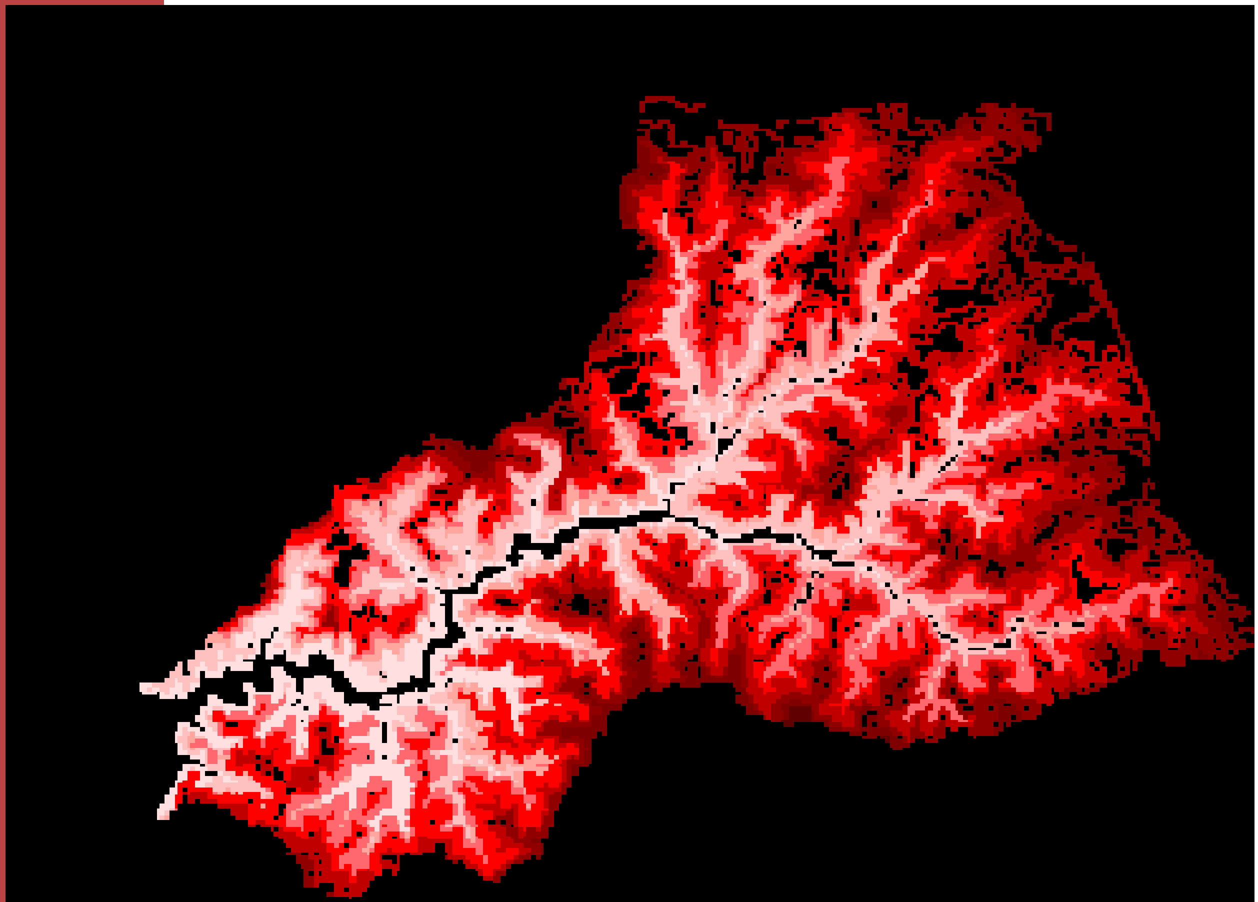
A watershed plan should incorporate the forest cover goals developed in Step 2 as well as the priority objectives identified and any related numerical targets. The watershed plan should also include priority sites identified for protection, restoration and reforestation. Detailed information should be provided for the top priority sites, including the following:

- Specific techniques recommended for protection, enhancement or reforestation
- Cost estimates for implementation and maintenance
- Potential funders, partners and other entities who will be involved in project implementation and/or long-term maintenance (e.g., watershed organizations, homeowners associations or HOAs)
- Implementation schedule

This step will involve some decision-making as to what types of protection, enhancement or reforestation techniques to use at each priority site. Protection, enhancement and reforestation techniques are described in detail in Chapter 3.

Tool 12
Watershed Vulnerability Analysis

The Watershed Vulnerability Analysis technical release outlines a basic eight-step process for creating a rapid watershed plan and provides guidance on delineating subwatersheds, estimating current and future impervious cover, and identifying factors that would alter the initial classification of individual subwatersheds



Watershed Vulnerability Analysis

Jennifer Zielinski
Center for Watershed Protection
8391 Main Street
Ellicott City, MD 21043
www.cwp.org
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1.0 Introduction

In 1998, the Center for Watershed Protection published the *Rapid Watershed Planning Handbook* which presents a rapid, eight point program for developing effective watershed plans, and details various methodologies used in watershed planning, such as impervious cover measurement and estimation, subwatershed mapping, cost projections, and rapid monitoring techniques. Since then, the Center has worked in over a dozen small watersheds across the country to protect trout, salmon, wetlands, drinking water, habitat quality, lakes, swimming beaches, and other important water resources. The *Watershed Vulnerability Analysis* was created primarily as a rapid planning tool for application to larger watersheds, but also contains a refinement of the techniques used in *Rapid* to delineate subwatersheds, estimate current and future impervious cover (and hence likely impacts to the subwatersheds), as well as providing guidance on factors that would alter the initial classification or diagnosis of individual subwatersheds. Examples of application of the vulnerability analysis include instances where more than 15 or 20 subwatersheds exist in a watershed or jurisdiction and it is necessary to group and prioritize subwatersheds for implementation and protection.

This technical release outlines the basic process for performing a rapid Watershed Vulnerability Analysis and serves as an update to the *Handbook.* The analysis compares subwatershed quality across the watershed and yields four primary outcomes of interest to the watershed manager. These are:

(A) A defensible rationale for classifying subwatersheds. Typically, these classifications are used to develop specific management criteria for each subwatershed class within the framework of an overall watershed overlay district.

(B) An effective framework to organize and integrate mapping and monitoring data that are currently being collected in the subwatershed assessments to make final classifications.

(C) A rapid forecast of which specific subwatersheds are most vulnerable to future watershed growth and warrant immediate subwatershed planning efforts.

(D) A priority ranking identifying subwatersheds that merit prompt restoration actions.

The basic watershed vulnerability analysis presented here follows an eight-step process (Figure 1). Considerable judgment and discretion needs to be exercised in most steps; we have attempted to outline the key choices to be made in these areas. Section 3 of this document goes over each step in detail.

2.0 Analysis Terminology

It is critical that the reader recognize and understand the terminology used throughout this document. Two concepts in particular merit special attention - watershed scale and subwatershed classification. Watershed scale refers to the size of the land unit selected for assessment and management. Subwatershed classification refers to the assessment and management category assigned to a subwatershed to guide planning decisions and efforts.

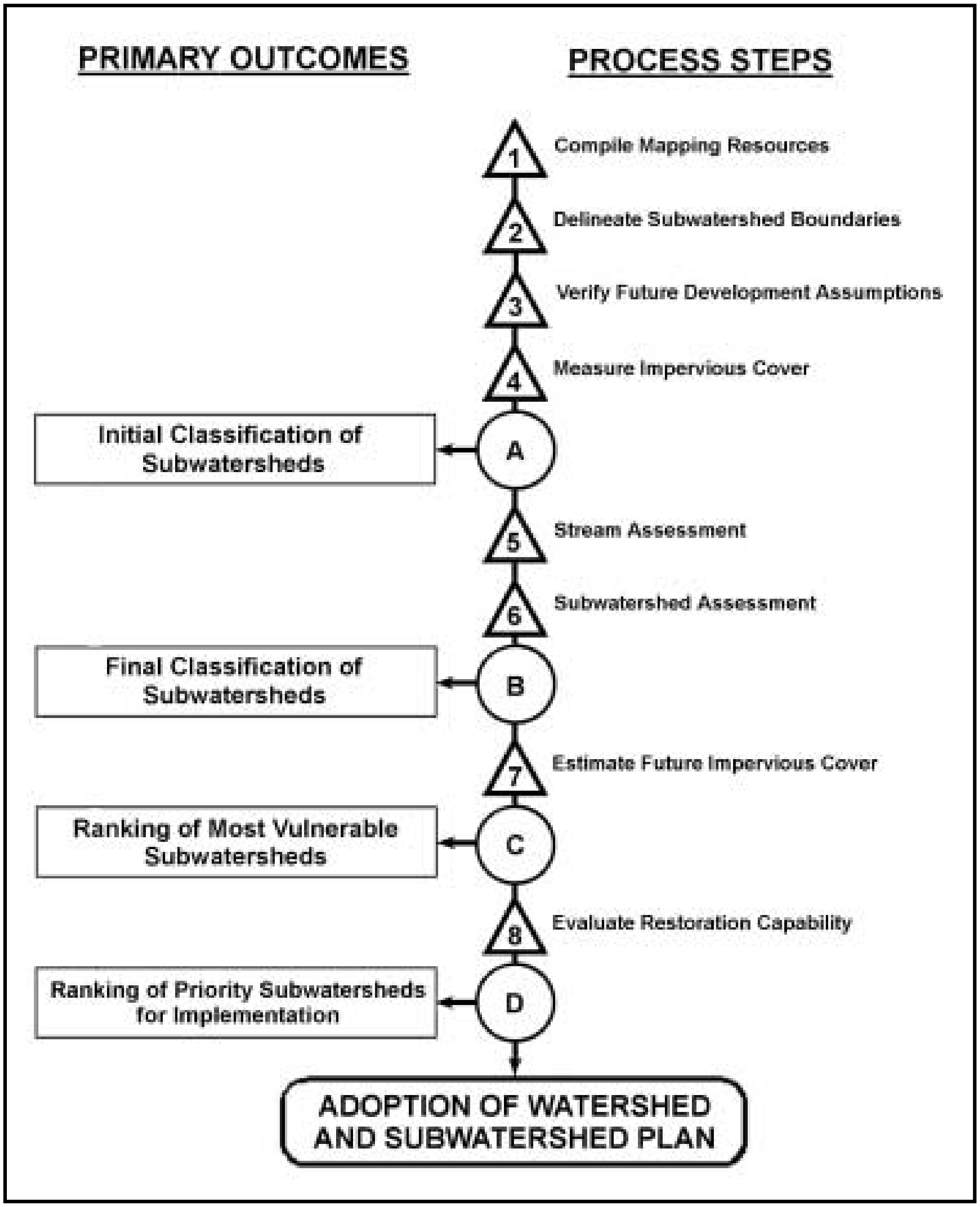

Figure 1: Process for Conducting a Watershed Vulnerability Analysis

2.1 Watershed Scale for Assessment and Management

When conducting a watershed vulnerability analysis, the first thing to consider is how the watershed is configured. The drainage area to a particular water resource can contain several management units (Figure 2). These management units vary in size, and often require different levels of assessment and planning activities (Table 1).

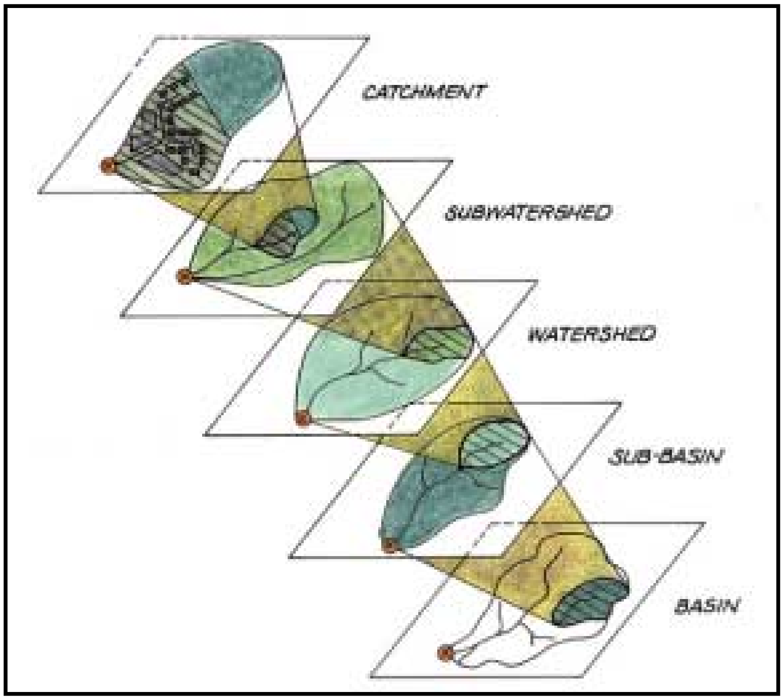

Figure 2: Units for Watershed Assessment and Management

The watershed vulnerability analysis focuses on the watershed and the subwatershed management units. Typically, the analysis is conducted for an entire watershed. However, smaller units - the subwatersheds - must be considered individually during both the assessment phase as well as the planning stage.

The subwatershed-scale is preferred for assessment studies, stream classification, and management planning for several reasons. First, the influence of impervious cover on hydrology, water quality, and biodiversity is readily apparent at the subwatershed level. Second, subwatersheds are small enough that there is less chance for confounding pollutant sources (e.g., agricultural runoff, point sources, etc.) to confuse management decisions. Third, subwatersheds boundaries tend to be within just a few political jurisdictions where it is easier to establish a clear regulatory authority and incorporate the stakeholders into the management process. Lastly, the size of a subwatershed allows monitoring, mapping, and other watershed assessment steps in a rapid time frame. A subwatershed plan can generally be completed within 12 to 18 months and still allow ample time for goal development, agency coordination, and stakeholder involvement.

Table 1: Description of the Various Watershed Management Units

Watershed Management Unit	Typical Area (square miles)	Influence of Impervious Cover	Sample Management Measures
Catchment	0.05 to 0.5	very strong	stormwater management and site design
Subwatershed	0.5 to 30	strong	stream classification and management
Watershed	30 to 100	moderate	watershed-based zoning
Sub-basin	100 to 1,000	weak	basin planning
Basin	1,000 to 10,000	very weak	basin planning

2.2 Subwatershed Classification

Research has shown that the amount of imperviousness in a watershed can be used to estimate the current and future quality of subwatersheds. The research generally indicates that certain zones of stream quality exist, most notably at about 10% impervious cover, where the most sensitive stream elements are lost from the system. A second threshold appears to exist at around 25 to 30% impervious cover, where most indicators of stream quality consistently shift to a poor condition (e.g., diminished aquatic diversity, water quality, and habitat scores).

Using the findings of this research, the Center for Watershed Protection developed a simple Impervious Cover Model (Figure 3) that can be used to categorize subwatersheds into specific management units that have unique characteristics. The model classifies subwatersheds into one of three categories, based on the percentage of impervious cover: sensitive, impacted, and non-supporting (Table 2).

The subwatershed categories set forth by the Impervious Cover Model, as well as the other categories described in Table 2, can be used to determine the current and future quality of a subwatershed. The methodology discussed in this document describes how to determine the current impervious cover of a subwatershed, and how to project the future impervious cover of a subwatershed under build-out conditions. Each of the subwatershed categories has an associated suite of tools for assessment and management that can be customized for the specific subwatershed conditions and goals.

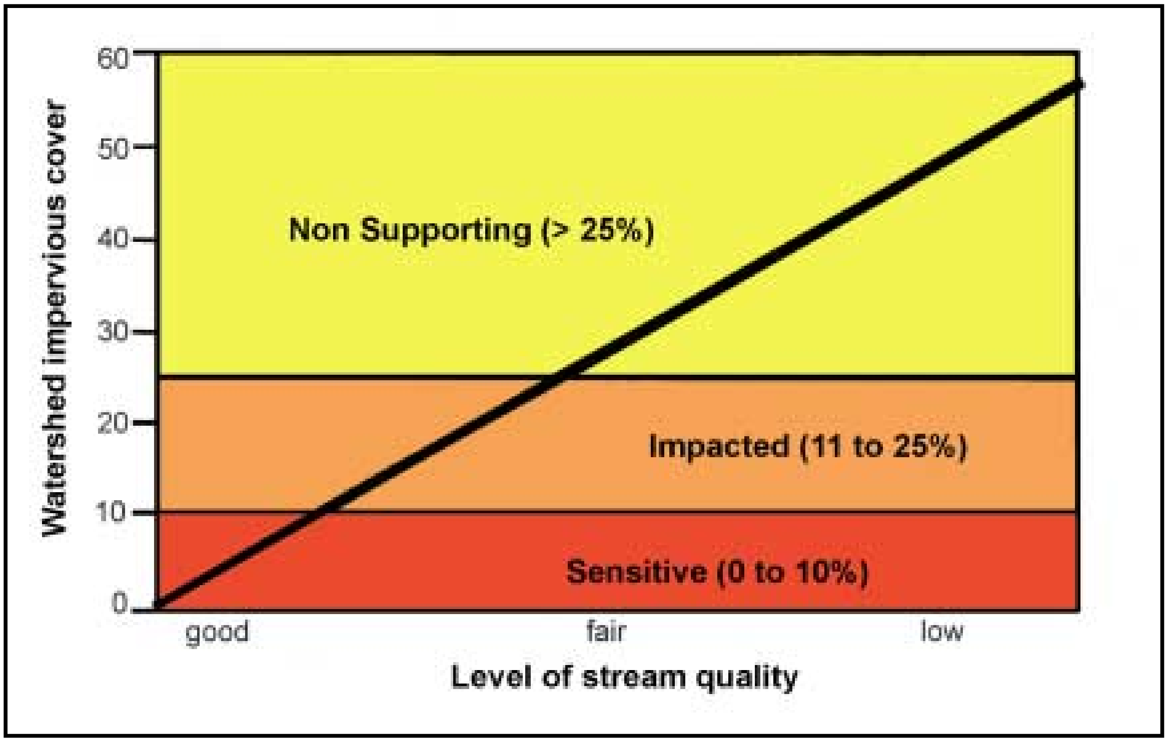

Figure 3: The Impervious Cover Model

It is important to keep in mind that there are some limitations to using the Impervious Cover Model. The model generally should only be applied to 3rd order streams and smaller because most of the supporting research has been conducted at this scale. Additionally, much of the research was done in the Pacific Northwest and Mid-Atlantic ecoregions, though supporting data does exist for the Northeast, Upper Midwest, and Southeast. The Impervious Cover Model is intended to predict potential rather than actual stream quality, so an individual stream may depart from the model for various reasons. Lastly, further research is needed regarding the influence of stormwater treatment practices, pervious areas, and riparian forest cover, as well as the threshold between impacted and non-supporting streams.

For this watershed vulnerability analysis, the primary purpose of using the impervious cover model is to develop a baseline that benchmarks the current and future quality of subwatersheds. Once these benchmarks are established, planning and management practices to protect or restore the subwatersheds can be established.

Table 2: Subwatershed Assessment, Planning, and Management Categories

Subwatershed Category	Description
Categories Derived from the Impervious Cover Model	
Sensitive Stream	Subwatershed typically has impervious cover of zero to 10 percent. Streams 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. Since impervious cover is so low, they do not experience frequent flooding and other hydrological changes that accompany urbanization.
Impacted Stream	Subwatershed typically has impervious cover ranging from 11 to 25%, and shows clear signs of degradation due to watershed urbanization. Greater storm flows begin to alter the stream geometry. Both erosion and channel widening are evident in alluvial streams. Stream banks become unstable, and physical habitat in the stream declines noticeably. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with the most sensitive fish and aquatic insects disappearing from the stream.
Non-Supporting Stream	Subwatershed impervious cover exceeds 25%. Streams in this category essentially become a conduit for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel is often highly unstable, and stream reaches can experience severe widening, down-cutting and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated, and the stream substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Water quality is consistently rated as fair to poor, and water contact recreation is no longer possible due to the presence of high bacterial levels. The biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish.
Additional Categories Applicable to Various Types of Receiving Waters	
Urban Lake	Subwatershed drains to a natural or man-made lake that is subject to degradation (watershed to lake area ratio of 200 to 1 or less).
Water Supply Reservoir	Reservoir managed to provide a pure raw drinking water supply and/or to store drinking water pending advanced treatment.
Coastal / Estuarine Waters	Subwatershed drains to an estuary or near-shore ocean.
Aquifer Protection	Subwatershed where surface water has a strong interaction with groundwater, and where groundwater is the primary source of drinking water.
Overlay Category Applicable to Other Seven Subwatershed Categories	
Restorable Subwatershed	Subwatershed classified as sensitive, impacted or non-supporting that has sufficient retrofit potential to make a meaningful improvement in the hydrologic regime and pollutant loading of the stream.

2.3 Determine Appropriate Subwatershed Classification System

Table 2 presents watershed categories that may be used as a basis for developing a local subwatershed classification system. Figure 4 presents an example of a local eight-tier classification scheme for subwatersheds within a planning area.

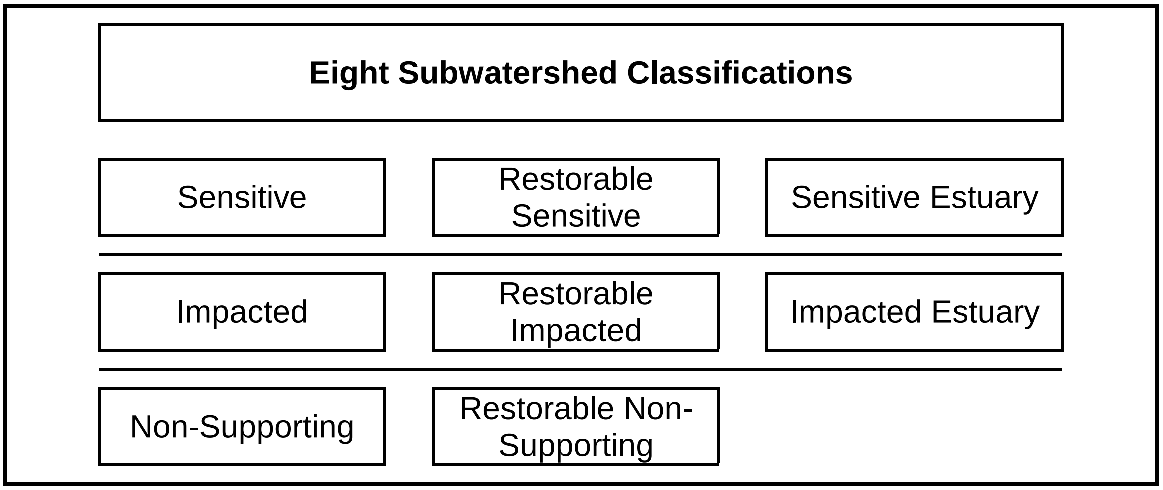

Figure 4: Example of a Local Eight-Tier Subwatershed Classification Scheme

3.0 Method for Conducting a Watershed Vulnerability Analysis

The watershed vulnerability analysis follows an eight-step process that is described below (Figure 1). Most steps require judgment and discretion, so a good familiarity with the subwatersheds is essential.

Step 1: Compile mapping resources.

The purpose of this step is to acquire the mapping resources needed to derive key subwatershed management variables that will be evaluated in succeeding steps. In our experience, we have found that the following variables are worthy of being derived in any subwatershed:

Essential Variables
- Subwatershed area
- Existing impervious cover
- Land use, by zoning category
- Future impervious cover, based on land use plans
- Downstream water resources (e.g., 3rd order stream draining to a water supply reservoir)

Helpful Variables
- Stream mileage
- Percent of stream mileage in forested condition
- Existing forest cover
- Existing jurisdictional wetlands
- Amount of developable land remaining
- Road crossings
- NPDES discharge points
- Existing and planned sanitary sewers

Mapping layers that play an essential role in determining the above variables, as well as auxiliary layers that may be useful, are outlined in Table 3.

Table 3: Essential and Auxiliary Mapping Layers Used During a Watershed Vulnerability Analysis.

Essential Mapping Layers
• topography • hydrology • impervious cover (roads, sidewalks, buildings, parking lots, etc.) • current land use (typically zoning) • future land use (zoning or master plan) • aerial photos (typically digital ortho-photographs)
Auxiliary Mapping Layers
• existing and planned buffers, riparian cover • floodplains • significant environmental features (wetlands, contiguous forest tracts, steep slopes, etc.) • major stormwater management facilities • strategic monitoring stations • land ownership (public, private) • stormwater retrofit sites • drinking water supplies (wells and reservoirs) • soils and geologic features • lands identified for acquisition or conservation easement • stormwater hot spots (site with significant pollutant loading potential) • hazardous waste sites • historical sites • wells

Step 2: Delineate the subwatershed boundaries.

From an operational standpoint, subwatersheds are often defined as the total land area draining to the point just below the confluence of two second-order "blueline" streams[1]. In reality, watershed managers may need to exercise some discretion in drawing actual subwatershed boundaries. Several practical issues should be evaluated during subwatershed delineation. These issues are illustrated in detail in Figure 5, and should be carefully considered when delineating subwatersheds.

1. Subwatershed size. If the previous definition is used, the average size of subwatersheds typically range from 1 to 10 square miles in size. In some planning and study areas, this may produce an unacceptably large number of potential subwatersheds to study. In these cases, subwatersheds should generally be defined as the total land area draining to the point just below

[1]"Blueline" streams refers to the bluelines used to depict perennial streams on USGS 7.5 Minute Quadrangle maps.

the confluence of third-order “blueline” streams (Figure 5a). In general, it is advisable to keep subwatershed area relatively uniform across the study area.

2. Subwatershed orientation. In general, our convention has been to define subwatersheds along the prime axis of the main stream or river present, and then number them in clockwise fashion around the watershed.

3. Jurisdictional boundaries. Wherever possible, subwatershed boundaries should be drawn so that they are wholly contained within a single political jurisdiction (city, county, township etc.; Figure 5b). This greatly simplifies the planning and management process.

4. Homogeneous land use. To the greatest extent possible, subwatershed 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 watershed (e.g., undeveloped on one side, commercial development on the other) it may be advisable to split them into two subwatersheds (Figure 5c).

5. Ponds / lakes / reservoirs. Where feasible, subwatershed boundaries should be extended downward to the discharge point of any pond, lake, or reservoir present on the primary streams of the subwatershed (Figure 5d). The transition of running water to standing water in a subwatershed usually creates a sharp discontinuity in the nature and quality of aquatic resources.

6. Existing monitoring stations. Subwatershed boundaries should always be extended to include the location of any existing monitoring stations (Figure 5e). In addition, it is good practice to fix the subwatershed at major road crossings or bridges in the stream segment (Figure 5f), since these areas often coincide with stream access and possible monitoring stations.

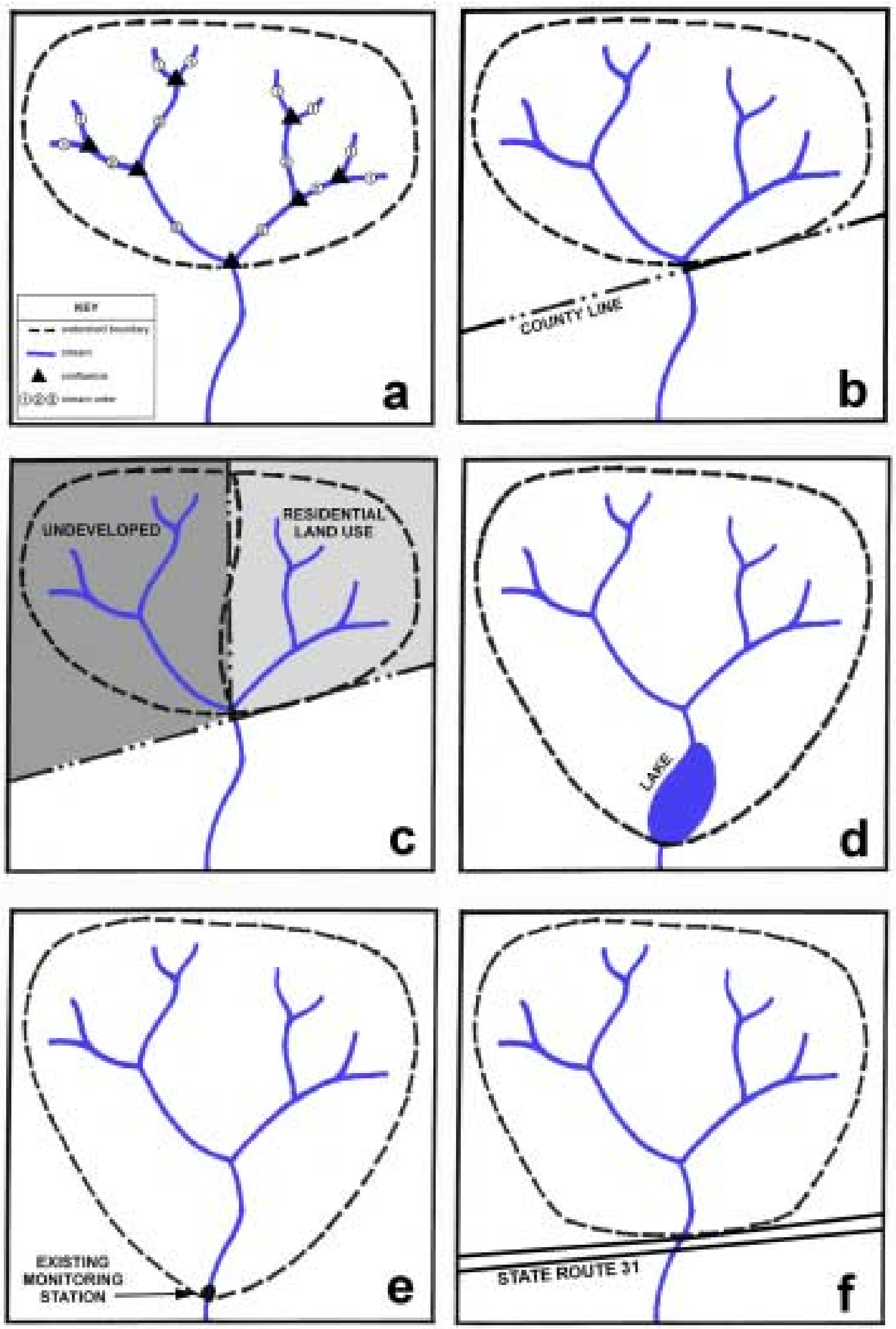

Figure 5: Subwatershed Delineation Considerations

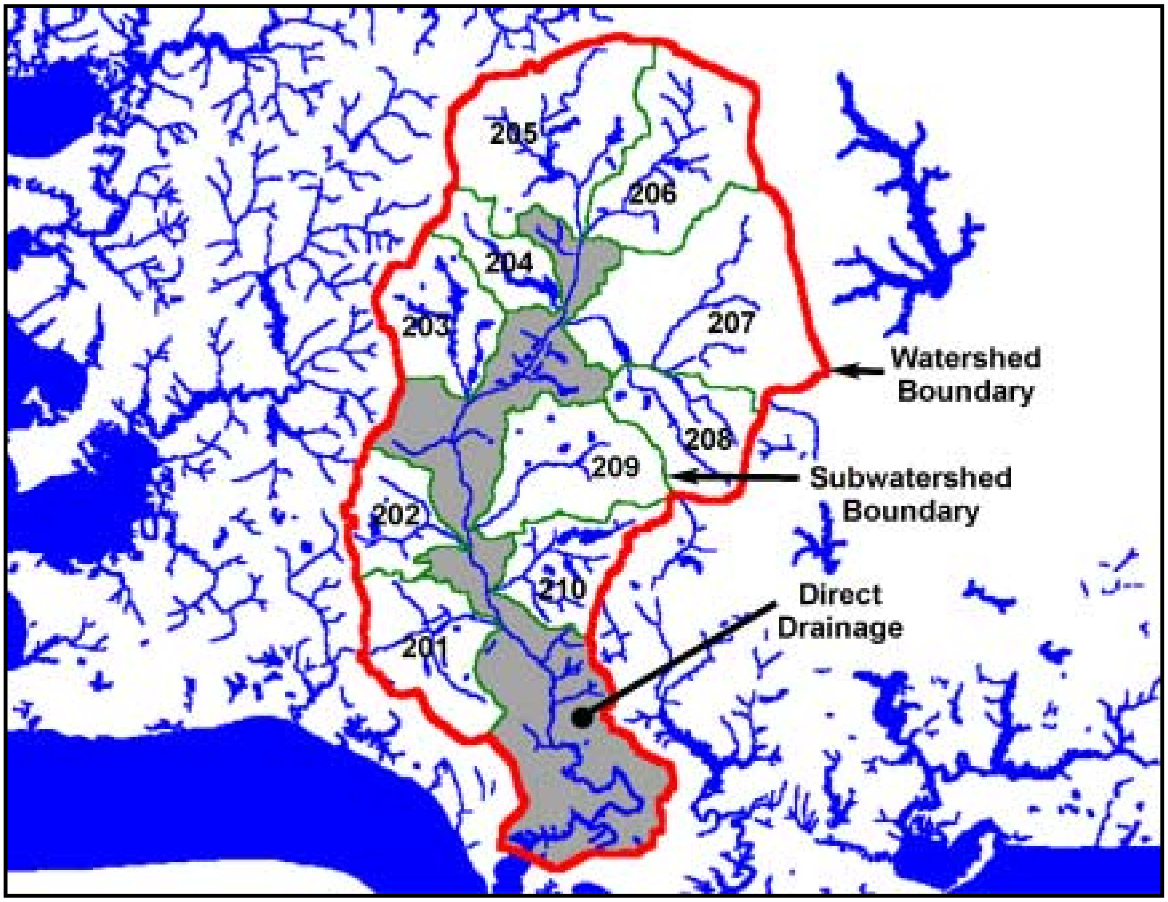

Figure 6: Subwatershed and Direct Drainage (shaded) Delineation for the Powhatan Creek Watershed in James City County, Virginia

7. Direct drainage. A recurring problem when delineating subwatersheds within a larger watershed context is the direct drainage. This happens when first or second order streams drain directly into a fourth or higher order mainstem of a stream. This results in small wedges of watershed area along the mainstem that are too small to be defined as subwatersheds, but still need to be accounted for. Our convention is to accumulate direct drainage along both sides of the mainstem, and then group it together into a composite subwatershed when the combined direct drainage area exceeds about ten square miles in size (Figure 6). Also, the amount of direct drainage can be minimized by extending the downstream point of the primary stream segment of a subwatershed all the way to the confluence with the next higher order stream.

Step 3: Verify current and future development assumptions.

Before estimating current impervious cover (Step 4) and future impervious cover (Step 7), it is useful to verify current and projected land use information. Often, additional land use information beyond mapping resources is required to accurately predict the current and future impervious cover within a subwatershed. This information may be acquired through the local planning department, watershed stakeholders, regional councils, department of public works or parks, citizen associations, land trusts, developers and property owners, farmers, utility companies, and business interests. Key pieces of information that should be gathered at this stage include:

- Development plans that are "in the pipeline" and will be completed prior to the watershed planning process
- Plans for municipally owned properties, such as schools, sports complexes, and parks
- Properties with conservation easements
- Plans for large tracts held by individual landowners
- Current and planned transportation corridors
- "Holding zones"[2] within current zoning
- Open space plans

In many cases, current land use and impervious cover can be directly estimated from low altitude aerial photography and associated planimetric data (e.g., roads, parking lots, building footprints, etc.), at reasonable cost. However, in rapidly developing subwatersheds, the under-estimation of current impervious cover is a common problem. The local planning department should be consulted to ensure that GIS coverages used in determining impervious cover accurately depict current land use (Figure 7). In some cases, field verification of land use may be necessary. In addition development plans that are in the plan approval stage and will be completed prior to the watershed planning process should be accounted for.

The technique most commonly used to estimate future impervious cover - zoning build-out analysis - has the potential to over-estimate impervious cover. For example, zoning build-out analysis assumes that all development shown on a zoning map will ultimately be constructed, and then multiplies each zoned area by average impervious cover for that particular zoned land use. Zoning, however, often reflects a best case scenario in terms of projected economic growth. Consequently, much of the potential development shown on zoning maps may not be built because of local economic conditions or lack of infrastructure. Thus, zoning build-out analysis can overestimate impervious cover, at least for the first several decades.

[2]"Holding zones" refer to zoned areas (typically agriculture or rural residential) that do not correspond to jurisdictional master planning. These areas may be designated growth areas, but the re-zoning process is not initiated until development plans are submitted.

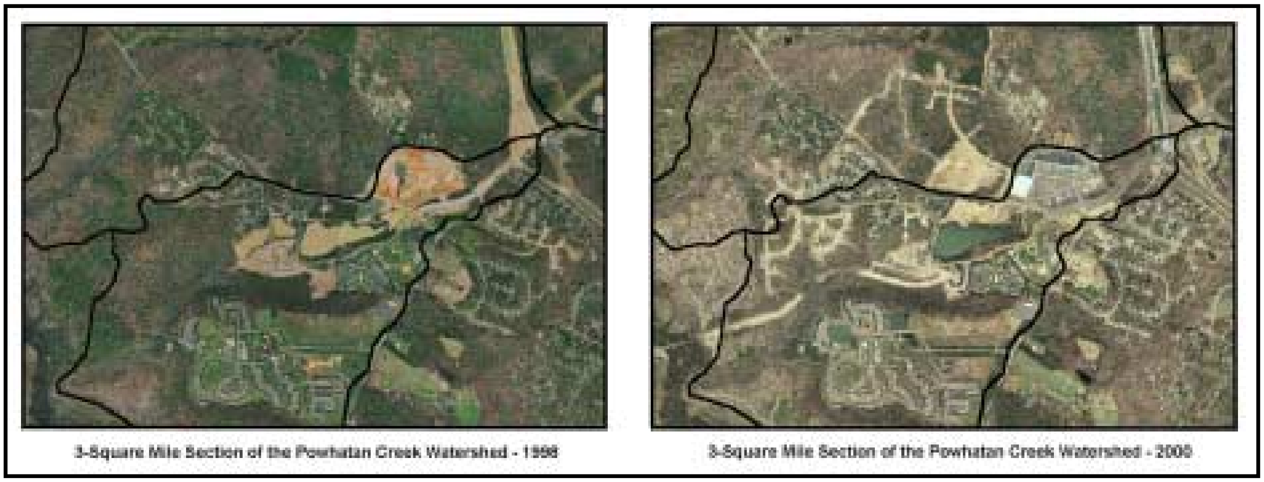

Figure 7: Land use may change rapidly, as depicted in these aerial photographs of a three-square mile area of a developing watershed.

The local government should be consulted regarding development plans for municipally owned properties, current and planned transportation corridors, holding zones within local zoning, open space acquisition plans, and planned modifications to current codes and ordinances pertaining to site design. These factors may modify either what is considered "developable" land, or they may modify land use - impervious cover relationships. Information regarding properties currently covered by conservation easements should be gathered from the local government, land trusts, and citizen and watershed organization, as this will also modify the amount of developable land. Finally, future plans for large tracts, such as farms or contiguous forest, can be obtained from individual landowners or government.

Step 4: Estimate the current impervious cover in the subwatersheds.

There are several techniques to measure impervious cover at the subwatershed level. Deciding which technique is best for a subwatershed depends largely on the resources and data available for the measurement. One of the most commonly used and most accurate techniques is direct measurement. This technique directly measures each of the individual components of impervious cover. These components may include parking lots, buildings, roads, driveways, and sidewalks (Figure 8). One of the most efficient ways to make these measurements is to use GIS. GIS coverages that are necessary to calculate impervious cover include digital planimetric data for each impervious component. Digital ortho-photographs are useful for double checking the accuracy of the planimetric data. Input from stakeholders or local planners may also help to identify discrepancies if GIS coverages are slightly dated.

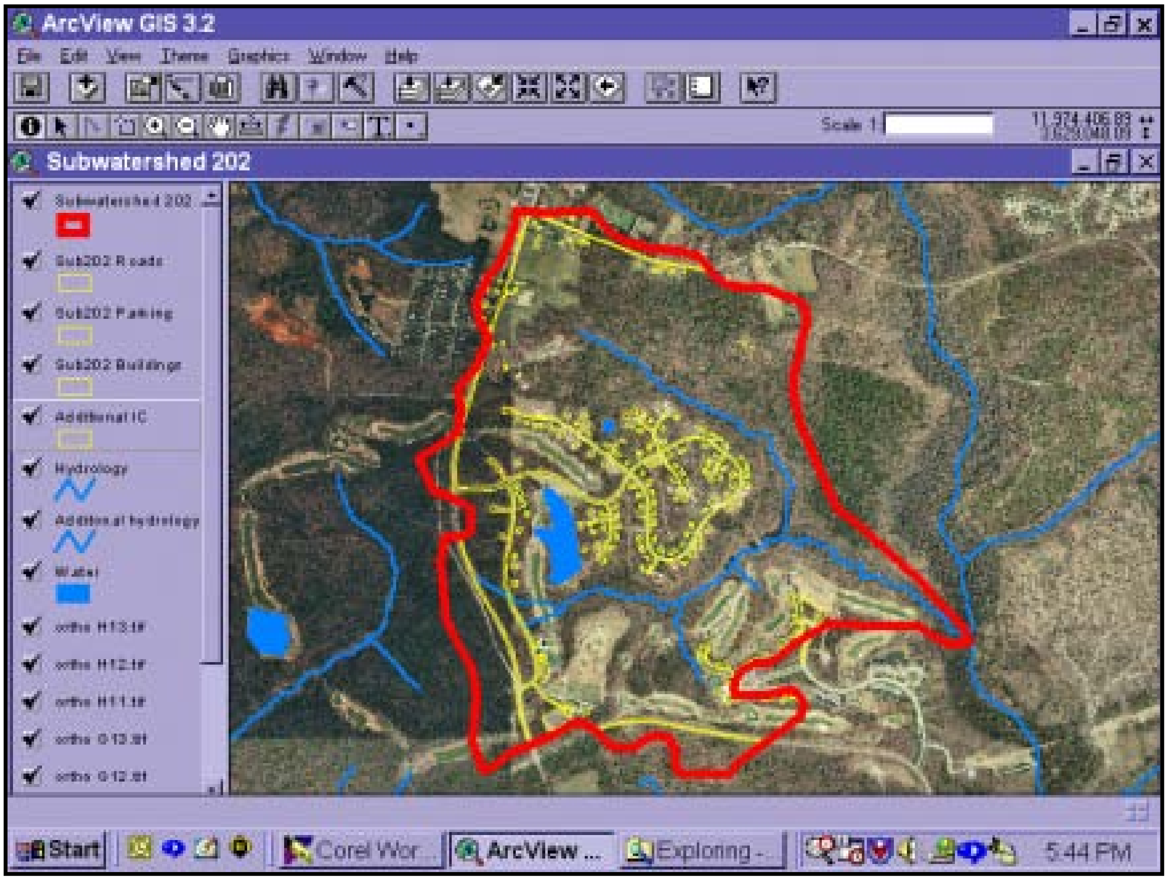

Figure 8: Impervious Components of a Subwatershed

The area of each impervious component can be directly calculated from the GIS coverages. However, there are some features in an urban landscape that are not always delineated in GIS coverages. These features may include driveways, sidewalks, tennis courts, swimming pools, decks, and sheds. Where these data are missing, estimates can be made based on existing data. For example, if driveways are not included in the planimetric data, their area can be estimated based on average residential density and the number of houses in the subwatershed. A study conducted by Cappiella and Brown (2001) made direct measurements of all the components of impervious cover. Using their data, (Table 4) an estimate of the impervious cover associated with driveways can be made.

Table 4: Average Driveway Areas in the Chesapeake Bay Region

Residential Density (lot size in acres)	Average Driveway Area (sq. ft.)
2	3,212
1	2,073
1/2	1,152
1/4	652
1/8	432

Source: Cappiella and Brown, 2001

In summary, impervious area is directly calculated from available GIS coverages, adjustments are made to account for impervious areas not identified within the GIS system, and the total impervious area is divided by the subwatershed area to determine the impervious cover fraction.

PRIMARY OUTCOME A – INITIAL CLASSIFICATION OF SUBWATERSHEDS

Once the first four steps are complete and the current impervious cover has been determined, an initial classification of the subwatersheds can be made. At this initial stage, a subwatershed may be preliminarily classified as a sensitive, impacted, or non-supporting subwatershed draining to an urban lake, water supply reservoir, coastal / estuarine waters, or aquifer. Using the example of a local eight-tier subwatershed classification scheme presented in Figure 4, a subwatershed may be classified within five of the eight proposed categories:

- Sensitive - subwatershed with less than 10% imperviousness
- Sensitive Estuary - subwatershed with less than 10% imperviousness draining to an estuary
- Impacted - subwatershed with 11 to 25% imperviousness
- Impacted Estuary - subwatershed with 11 to 25% imperviousness draining to an estuary
- Non-Supporting - subwatershed with greater than 25% imperviousness

Steps 5 and 6 of the analysis will refine the subwatershed classification, and also allow for the determination of whether or not a subwatershed is restorable.

Step 5: Conduct a stream corridor assessment.

Impervious cover is not a perfect indicator of existing stream quality. Field data can provide important insight to the subwatershed classification process, particularly when a subwatershed is on the borderline between one classification and another. We routinely examine ten criteria to decide whether a borderline stream should be classified as sensitive, impacted, or non-supporting. If stream assessment monitoring reveals that the stream meets at least five criteria, it is classified as Sensitive, even if it has slightly more than 10% impervious cover in its subwatershed. Similarly, if a subwatershed meets one to five of these criteria, it is provisionally classified as Restorable Sensitive, even if the subwatershed has less than ten percent impervious cover.

The ten criteria are:

1. Reported presence of rare, threatened or endangered species in the aquatic community (e.g., freshwater mussels, fish, crayfish or amphibians).

2. Confirmed spawning of sensitive fish species.

3. Fair/good, good, or good to excellent macroinvertebrate scores.

4. More than 65% of Ephemeroptera, Plecoptera, and Tricoptera (EPT) species present in macroinvertebrate scores.

5. No barriers impede movement of fish between the subwatershed and the mainstem.

6. Stream channels show little evidence of historic alteration (ditching, enclosure, tile drainage or channelization).

7. Water quality monitoring indicates no standards violations during dry weather.

8. Stream and floodplain remain connected and regularly interact.

9. Subwatershed drains to a downstream surface water supply.

10. Stream channels are generally stable, as determined by the Rosgen level III analysis or a similar geomorphic analysis; stream habitat scores should rate at least fair-to-good.

Step 6: Conduct a subwatershed scale assessment.

A series of landscape-level criteria are evaluated to make a final determination about the subwatershed classification and priority rank. This is referred to as a subwatershed scale assessment. We typically examine ten criteria to decide borderline subwatershed classifications. If the subwatershed assessment reveals that the stream meets at least five of these criteria, it is classified as Sensitive, even if it has slightly more than 10% impervious cover in its subwatershed. Similarly, if a subwatershed meets more than three criteria, it is classified as Restorable Sensitive, Restorable Impacted, or Restorable Non-Supporting, based on its imperviousness.

The ten criteria are:

1. Subwatershed contains documented rare, threatened and endangered plant or animal populations.

2. Wetlands, floodplains and/or beaver complexes make up more than ten percent of subwatershed area.

3. Inventoried conservation areas[3] comprise more than ten percent of watershed area.

4. More than 50% of the riparian corridor has forest cover, and is either publicly owned or regulated.

5. Large contiguous forest tracts remain in the watershed, and more than 40% of watershed is in forest cover.

6. Significant fraction of subwatershed is in public ownership and management.

7. Stream buffers form a continuous network throughout subwatershed.

8. Subwatershed is connected to the watershed through a wide, undisturbed corridor that allows for wildlife access.

9. Farming, ranching and livestock operations in the watershed utilize best management practices.

10. Prior development in the subwatershed has utilized stormwater practices for both quality and quantity control.

[3]Conservation areas may include critical habitat for plant and animal communities, such as freshwater wetlands, large forest tracts, springs, spawning areas, habitat for rare, threatened, or endangered (RTE) species, and native vegetation areas; the aquatic corridor, including floodplains, stream channels, springs and seeps, steep slopes, and riparian forests; undeveloped areas responsible for maintaining the pre-development hydrologic response of a subwatershed, such as forest, meadow, prairie, and wetlands; or cultural and historic areas, such as archaeological sites, trails, parklands, scenic views, water access, and recreational areas.

PRIMARY OUTCOME B – FINAL CLASSIFICATION OF SUBWATERSHEDS

The final classification of the subwatersheds, based on information garnered in the stream corridor and subwatershed scale assessments, may now be determined. In addition, the overlay category of "restorable" may not be applied. Using the example of a local eight-tier subwatershed classification scheme presented in Figure 4, a subwatershed may be classified within any of the eight proposed categories:

- Sensitive
- Restorable Sensitive
- Sensitive Estuary
- Impacted
- Restorable Impacted
- Impacted Estuary
- Non-Supporting
- Restorable Non-Supporting

Step 7: Estimate the future impervious cover in the subwatersheds.

A simple procedure for predicting future impervious cover can be applied using established land use-impervious cover relationships, the most recent comprehensive plan, and parcel and zoning information which can often be obtained from GIS coverages. The methodology, described in more detail below, assumes future impervious cover estimates represent the maximum level of development that is expected in the subwatersheds.

Step 1. Identify undeveloped parcels by their zoning category in each subwatershed (Figure 9).

Step 2. Subtract unbuildable land (floodplains, wetlands, steep slopes, conservation areas, etc.) from the parcel area (Figure 9).

Step 3. Multiply each undeveloped parcel by an average impervious cover for the associated zoning category (Table 5).

Step 4. Calculate the area of planned highways and arterial roads and add this number to the sum of the impervious area for all land uses in the subwatershed.

Step 5. Add new impervious area to current impervious area to yield the total future impervious area.

Step 6. Divide the total future impervious area by the total area of the subwatershed to get an impervious cover fraction, and multiply by 100 to get an impervious percent.

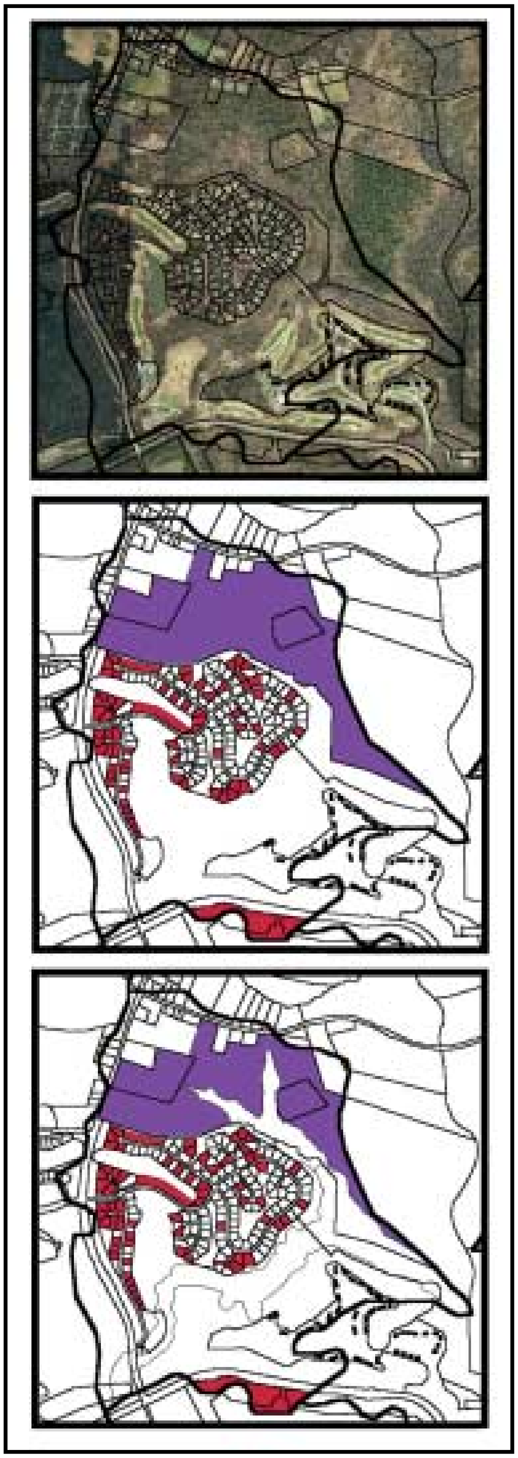

Figure 9: The top panel depicts lots and parcels, the middle panel depicts buildable lots and parcels (shaded); and the bottom panel subtracts unbuildable areas (eliminated from shaded areas).

Table 5: Impervious Cover Estimates for the Chesapeake Bay Region

Land Use Category	Sample Number (N)	Mean Impervious Cover
Agriculture	8	**1.9%**
Open Urban Land	11	**8.6%**
2 Acre Lot Residential	12	**10.6%**
1 Acre Lot Residential	23	**14.3%**
½ Acre Lot Residential	20	**21.2%**
1/4 Acre Lot Residential	23	**27.8%**
1/8 Acre Lot Residential	10	**32.6%**
Townhome Residential	20	**40.9%**
Multifamily Residential	18	**44.4%**
Institutional	30	**34.4%**
Light Industrial	20	**53.4%**
Commercial	23	**72.2%**

Source: Cappiella and Brown, 2001

The determination of future impervious cover has assumed build-out conditions with the current level of environmental protection. The future impervious cover may now be used to project the future quality of the subwatershed. As under Primary Outcome A, a subwatershed may be classified as a sensitive, impacted, or non-supporting subwatershed draining to an urban lake, water supply reservoir, coastal / estuarine waters, or aquifer. Using the example of a local eight-tier subwatershed classification scheme presented in Figure 4, a subwatershed may be classified within five of the eight proposed categories:

- Sensitive - subwatershed with less than 10% projected imperviousness
- Sensitive Estuary - subwatershed with less than 10% projected imperviousness draining to an estuary
- Impacted - subwatershed with 11 to 25% projected imperviousness
- Impacted Estuary - subwatershed with 11 to 25% projected imperviousness draining to an estuary
- Non-Supporting - subwatershed with greater than 25% imperviousness

It is important to note that the overlay category of Restorable cannot be used to classify the future quality of a subwatershed since the only information available to us to determine the future quality of the subwatershed is the build-out impervious cover. A subwatershed's restorability is determined through the Stream Corridor Assessment (Step 5) and the Subwatershed Scale Assessment (Step 6).

PRIMARY OUTCOME C – DETERMINATION OF MOST VULNERABLE SUBWATERSHEDS

Once the current and future subwatershed classifications are determined, the subwatersheds that are most vulnerable to changes in land use can be identified. The primary questions to consider when determining the vulnerability of subwatersheds are:

1. Does the subwatershed drain to a highly valued water resource, such as a water supply reservoir or an estuary that support shellfish beds?
2. Will the subwatershed classification change? (e.g., shift from sensitive to impacted)
3. Does the subwatershed classification come close to changing? (e.g., future impervious cover is projected at 10%)
4. What is the absolute change in impervious cover? (e.g., a subwatershed that shifts from 5% to 14% may be more vulnerable than a subwatershed that shifts from 6% to 12%)

Step 8: Evaluate the restoration capability.

The last step in the watershed vulnerability analysis is a priority ranking that identifies subwatersheds that merit prompt restoration actions.

The rank of a subwatershed is relative to the other subwatersheds in the study area. The following criteria are used in determining the priority for subwatershed planning and implementation:

1. Subwatershed vulnerability, as determined under Primary Outcome C.

2. Designated use of the receiving water within the subwatershed.

3. The presence of significant aquatic endangered species habitat (presence = higher planning priority).

4. Fraction of land considered significant conservation areas (larger fraction = higher planning priority).

5. Fraction of the subwatershed that is developable (larger fraction = higher planning priority).

6. Development pressure within the subwatershed, as determined by local master plans, proximity to major transportation corridors, access to supporting infrastructure, and rate of population growth (more development pressure = higher planning priority).
7. Fraction of land publicly owned, thereby reducing land acquisition fees for conservation areas, riparian corridor protection, or stormwater retrofitting (larger fraction = higher planning priority).

8. Presence of a local watershed organization or significant community and stakeholder commitment to a subwatershed planning process (presence = higher planning priority).

9. Availability of financial and staffing resources for plan implementation (availability = higher planning priority).

PRIMARY OUTCOME D – RANKING OF PRIORITY SUBWATERSHEDS FOR IMPLEMENTATION

The primary outcome of the watershed vulnerability analysis is the ranking of priority subwatersheds for planning and implementation.

There is, however, one final consideration in determining the final schedule for subwatershed plan implementation. Since the subwatershed plans are likely to be developed and implemented on a rotating basis, the first set of plans developed should include a plan for a subwatershed within each of the subwatershed classifications selected for the overall planning area. While individual subwatersheds often have unique management goals, the tools used within a subwatershed management category will eventually be the same. As such, the development of a subwatershed plan for each of the classifications will serve as templates for future subwatershed plans. In addition, planning, protection, or restoration tools developed in the first round of subwatershed plans may be applied to all subwatersheds in the study area as an interim measure until resources are available to develop and implement the remaining subwatershed plans. Discretion, of course, should be used if this approach is taken so that a particularly sensitive subwatershed not selected for the first round of subwatershed plans is not sacrificed.

References

Cappiella, K. and K. Brown. 2001. *Impervious Cover and Land Use in the Chesapeake Bay Watershed*. Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection. 1998. Rapid Watershed Planning Handbook. Center for Watershed Protection. Ellicott City, MD.

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Tool 13
Comparative Subwatershed Analysis (CSA)

This tool contains information on the Comparative Subwatershed Analysis that helps screen subwatersheds within a community to find the ones with the greatest restoration potential. A brief description of the subwatershed "metrics" used to provide a general indication of restoration potential is also included. The information provided within this tool is an excerpt from Schueler and Kitchell, 2005.

D-2	Desktop Analysis **Comparative Subwatershed Analysis**	CSA

Purpose

The CSA screens subwatersheds within a community to find the ones with the greatest restoration potential. The CSA involves a simple spreadsheet analysis of selected subwatershed "metrics" that provide a general indication of their restoration potential. Metrics are derived by analyzing available GIS layers and other subwatershed data sources. Subwatersheds with the highest aggregate score become priorities of subsequent field investigations for actual restoration potential.

Scale	Value
Community- or Watershed-wide	Helpful

Analysis Method

Four tasks are involved in conducting a Comparative Subwatershed Analysis:

1. Delineate subwatersheds and review available metric data
2. Choose and compute metrics that best describe restoration potential
3. Develop weighting and scoring rules to assign points to each metric
4. Compute aggregate scores and develop initial subwatershed ranking

Mapping Needs

The CSA requires an extensive analysis of existing mapping layers and other data, as shown in Table 8. The basic trick is to develop a subwatershed-specific attribute table for each layer, and then compute a single numeric subwatershed metric for that indicator.

Other Data Needs

Summary subwatershed metrics can also be derived from the existing data analysis (EDA) and from stakeholder input (see Table 9).

Product

The priority list is supported by a short report that documents how the metrics were derived, scored and weighted. A watershed map that shows the locations of priority subwatersheds is also produced.

Time Frame / Level of Effort

A CSA can normally be completed in three or four weeks of staff time, if GIS data layers are available.

Where Cited

Appendix D of this manual provides extensive guidance on preparing a CSA.

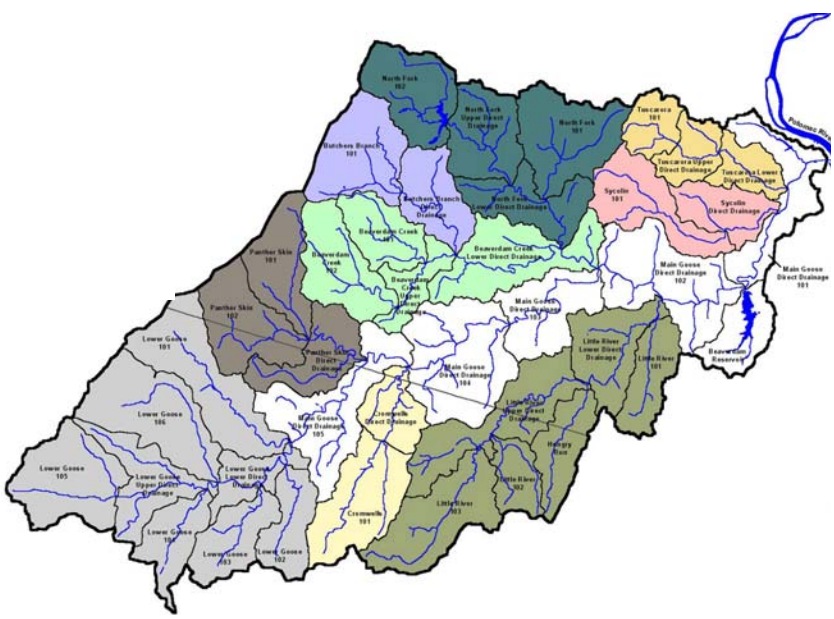
Tips for Conducting a Comparative Subwatershed Analysis

- The quality of the CSA often depends on good subwatershed delineations. While delineation is more of an art than a science, it is a good idea to try to define subwatersheds that are roughly the same size and have a relatively homogenous character.
- An excellent slideshow on subwatershed delineation techniques can be accessed online at: http://www.stormwatercenter.net/Slideshows/delineating_boundaries_files/frame.htm.
- The CSA is the first real test of your watershed-based GIS, so expect a lot of headaches with data compatibility.

D-2	Desktop Analysis **Comparative Subwatershed Analysis**	**CSA**

Tips for Conducting a Comparative Subwatershed Analysis

- Remember - the purpose of a CSA is to get started on the subwatershed restoration process, so don't get bogged down selecting too many metrics or wasting a lot of time deriving exact or precise values for each one. The goal is to get a relative sense of the variation among subwatersheds, not an absolute one.
- While the CSA relies heavily on GIS analysis, it also requires a lot of thoughtful decisions on how to compile, organize, interpret and rank non-GIS subwatershed data. It's not a simple "plug and play" GIS exercise. Non-GIS screening factors, both technical and non-technical, can be very important to calculate.
- It is often a good idea to give stakeholders a role in choosing subwatershed metrics and assigning their relative weight.
- While 27 different subwatershed metrics are presented in Appendix D, try to limit your choices to a manageable number – perhaps a dozen or so that can be quickly created from existing GIS data layers and subwatershed data sources.
- If your watershed is lightly developed but may be subject to land development in the future, you may want to modify the CSA to analyze future watershed vulnerability. Techniques for conducting a watershed vulnerability analysis are described in Zielinski (2001).
- It is a good idea to check individual subwatershed metric scores to see if there are any "deal-killers," which occurs when a subwatershed has a high total score but has a low or zero score on an individual metric, which might preclude or restrict restoration efforts.



A desktop subwatershed analysis was critical to finding the key subwatershed to work on first in this 380 square mile Virginia watershed

Appendix D: A Review of Subwatershed Metrics

This appendix describes the range of possible upland and stream corridor metrics that can be employed in a Comparative Subwatershed Analysis (CSA- See Chapter 2). The rationale behind each metric is explained, in terms of how it influences restoration potential and the feasibility of different types of restoration practices. Guidance is offered on the units to measure each metric, and how to derive it from available mapping and other data sources. An overall summary of subwatershed metrics is provided in Table D1.

Review of Upland Metrics

1. Current Impervious Cover (% of subwatershed)

Impervious Cover (IC) is a powerful predictor of stream impairment and overall subwatershed restoration potential (see discussion on Impervious Cover Model in Manual 1, and CWP, 2003). Generally, subwatersheds with lower IC have greater overall restoration potential. Low IC normally indicates a greater range of potential candidate sites for retrofit, stream repair, reforestation and source control practices. IC is not a reliable indicator of the feasibility of discharge prevention practices. Subwatershed IC can be directly derived from GIS land cover layers, or indirectly estimated based on GIS land use layers using standard land use/impervious cover coefficients (See Cappiella and Brown, 2001).

2. Current Forest Cover (% of subwatershed)

Total subwatershed forest cover (FC) has a strong positive influence on stream quality. Generally, subwatersheds with a high percentage of FC possess better stream quality.

From the standpoint of restoration feasibility, however, low levels of subwatershed FC often indicates more potential sites for upland reforestation practices, and indirectly, retrofit, stream repair and riparian reforestation practices, as well. A GIS can depict forest in terms of either forest canopy or forest cover. Forest canopy is a direct measure of the total subwatershed area covered by tree canopy, whereas forest cover is a more indirect measure (sum of the polygons in which trees are the dominant land cover). Consequently, forest canopy is usually greater than forest cover. Forest cover can usually be derived from standard land cover layers, whereas forest canopy may require further analysis of high-resolution aerial photos or satellite imagery. If forest cover is not accurately shown on the GIS, it should be directly estimated from aerial photos. (Cappiella et al., 2005a)

3. Density of Storm Water Ponds (Ponds/square mile)

This metric is a general index of the extent of current storm water treatment and future retrofit potential within a subwatershed. In general, a high pond density indicates strong restoration potential, since there are many potential candidate sites for storage retrofits and upland reforestation practices. Not every community tracks storm water ponds in their GIS, so it may be necessary to check with the local storm water management authority and inspect files to derive subwatershed pond density.

Table D1: Summary of Subwatershed Metrics		
Subwatershed Metric	*Indicates higher restoration potential when:*	*And suggests that the following restoration practices may be feasible:*
1. Current Impervious Cover (% IC)	Current impervious cover is low Less than 10% = 10 pts, 11 to 25% = 7 pts, 26 to 40% = 5 pts, 41 to 60% = 3 pts, >60% = 1 pt	Low IC suggests a range of possible sites for all practices, but particularly storage retrofits and stream repairs
2. Subwatershed Forest Cover (% FC)	Forest Cover and IC are both low Less than 10% = 10 pts, 11 to 25% = 7 pts, 26 to 40% = 5 pts, 41 to 60% = 3 pts, >60% = 1 pt	Low FC suggests widespread potential for upland and riparian reforestation
3. Storm Water Pond Density (ponds/mi^2)	Pond density is high Award one point for each pond per square mile	Existing pond sites are good candidates for storage retrofits, reforestation of pond buffers, and downstream repairs
4.Subwatershed Development Potential (% developable)	No more development is expected Deduct one point for each 5% of subwatershed area subject to future development	Stable conditions improve the feasibility of all practices, particularly for stream repairs and storage retrofits
5. Publicly-Owned Land (% of subwatershed)	Public land ownership is high Award one point for each 2.5% of subwatershed in public ownership	Provides a wide range of potential sites for all restoration practices
6. Detached Residential Land (% of subwatershed)	Detached residential land is high Award one point for each 10% of subwatershed in public ownership	Suggests strong feasibility for neighborhood source control, on-site retrofits and upland forestry
7. Age of Subwatershed Development (decades from buildout)	At least three decades have passed since buildout Award maximum points for these older subwatersheds	Stable conditions improve the feasibility of all practices, particularly for stream repairs and storage retrofits
8. Industrial Land (% of subwatershed)	Industrial land is high Award one point for each 2% of subwatershed classified as industrial	Suggests strong potential to implement source control, discharge prevention and on-site retrofits
9. Storm Water Hotspot Density (potential hotspots/mi^2)	Hotspot density is high Award two pts for each hotspot per square mile	Suggests strong potential to implement source control, discharge prevention and on-site retrofits
10. Age of Sewer System (decades)	Aging sewers systems cause water quality problems Add one point for each decade since the sewer system was constructed	Discharge prevention and enhanced municipal operations (e.g., SSO controls)
11. Sum of Forest, Wetlands and Parks (% of subwatershed)	Sum of all three is high Award one point for each 2% of subwatershed area in the three uses	Upland and riparian reforestation, natural area restoration, stream repairs and some storage retrofits
12. Citizen Concern (index)	Citizen concern is high Award points based on stakeholder assessment of subwatershed concern	Suggests strong support for full range of restoration practices

Table D1: Summary of Subwatershed Metrics		
Subwatershed Metric	*Indicates higher restoration potential when:*	*And suggests that the following restoration practices may be feasible:*
14. Subwatershed Stream Density (stream miles/mi^2)	Stream density is high Deduct one point for each 5% reduction in stream density from local average	Greater feasibility of all corridor practices: storage retrofits, stream repair, riparian management and discharge prevention
15. Stream Corridor Forest Cover (% forested)	Corridor forest cover is low Deduct one point for each 10% reduction in forest cover	Suggests feasibility of riparian reforestation and wider range of sites for storage retrofit and stream repairs
16. Available Stream Corridor Area (acres /stream mile)	Open corridor acreage is high Add one point for each two acres per stream mile available	Suggests feasibility of riparian reforestation and wider range of sites for storage retrofit and stream repairs
17. Road Crossings (crossings/stream mile)	Headwater crossings are numerous Add point for each one crossing/stream mile	Storage retrofits, stream repairs and culvert modifications, stream adoption. *NOTE: Use Metric 20 to assess fish barriers*
18. Storm Water Outfall Density (outfalls/stream mile)	Stormwater outfall density is high Add one point for each ten mapped outfalls/stream mile	Potential sites for storage retrofits and probable risk of illicit discharges
19. RBA Composite Scores (varies)	RBA score is higher/lower than predicted by ICM Add points based on input from monitoring experts	Indicates need for all restoration practices, including stream repair
20. Connection to Downstream Waters (open/impeded)	Downstream connection are open Deduct one point for each major crossing/stream mile	Indicates overall feasibility of fishery recovery and potential need for fish barrier removal and stream repair
21. Public Ownership of Corridor (% of corridor)	Public corridor ownership is high Add one point for each 10% of the stream corridor in public ownership	Greater feasibility of all corridor practices: storage retrofits, stream repair, riparian management and discharge prevention
22. Violations of WQ Standards (Violations/yr)	Standards are frequently exceeded Add points based on number of annual violations	Suggests need to focus on pollutant reduction through discharge prevention, source control and retrofits
23. Fishery Status (Varies)	F-IBI score is higher/lower than predicted by ICM Add points based on input from fishery experts	Suggests potential to recover fish community through stream repairs, retrofits and riparian reforestation
24. Corridor Recreational Value (index)	Recreational use or value is high Add points based on stakeholder input or measured uses	Suggests strong support for full range of restoration practices
25. Water Quality Regulatory Status	Subwatershed or receiving water has special mgmt designation Add points based on input from regulatory experts	Suggests regulatory need to focus on pollutant reduction through discharge prevention, source control and retrofits
26. Severity of Flooding Problems (index)	Flooding problems are severe Add points based on flooding measures (see text)	Suggests need to focus on flood reduction via storage retrofits and riparian management
27. Severity of Streambank Erosion (index)	Streambank erosion is severe Add points based on bank erosion scores (see text)	Suggests need to focus on bank stabilization through storage retrofits and stream repairs

4. Subwatershed Development Potential (% of subwatershed)

Many urban subwatersheds are not yet fully built out, so it is important to project the amount of incremental IC that could still be built in the future. In general, subwatersheds that still have considerable development potential have poor prospects for restoration, since new development will generate more storm water impacts that could offset any improvements due to restoration practices. In addition, extensive subwatershed development potential negatively affects the feasibility of storm water retrofit, stream repair and upland forestry practices. Subwatershed development potential is derived through analysis of zoning maps and development forecasts. First, the remaining amount of developable land in the subwatershed is estimated. Next, the corresponding IC associated with the future development is calculated using land use/IC coefficients. Desktop methods to determine subwatershed development potential and predict future changes in subwatershed IC are presented in Cappiella *et al* (2005a).

5. Publicly-Owned Land (% of subwatershed)

This metric is important because publicly owned lands are the preferred location for most restoration practices. Subwatersheds with a high percentage of publicly owned land tend to have greater restoration potential because they offer a greater number and range of potential sites to systematically install storage retrofit, stream repair, and upland forestry practices. Public land is operationally defined as the aggregate of local, state, federal and tribal parcels above a minimum threshold size (e.g., 2 acres). Public owned land is relatively easy to derive from GIS land use layers, particularly if tax or parcel data are available to confirm ownership.

6. Detached Residential Land (% of subwatershed)

The proportion of a subwatershed in detached residential land use is a useful metric since neighborhoods can be significant source of pollutants as well as a potential location for on-site retrofits. In general, subwatersheds with a high percentage of residential land have greater restoration potential. Residential land is a strong indicator of the feasibility of on-site retrofit, pollution source control and upland forestry practices. The amount of residential land in a subwatershed is easily computed from GIS land use and zoning layers, or by visible inspection of maps.

7. Age of Subwatershed Development (+ or - decades from buildout)

This metric expresses the age of subwatershed development as the number of decades before or after buildout. Buildout is defined as the point at which major development ceases, and a subwatershed attains its maximum degree of impervious cover (beyond minor redevelopment). The age of development is an important subwatershed metric, since it provides useful clues about the potential for storm water retrofits, illicit discharges, and forest loss. In addition, the age of subwatershed development is a critical feasibility factor for stream repair practices since streams may take several decades to fully adjust to upstream development. In general, older subwatersheds (30 + years) have greater restoration potential than younger ones. In reality, most subwatersheds are a complex mosaic of structures built in many different eras, making it impossible to derive an exact estimate of the average age of development. A rough estimate, however, is all that is usually needed, and this can be inferred from plat or parcel data, or through a simple drive-by survey of the subwatershed (see NSA in Manual 11).

8. Industrial Land (% of subwatershed)

The fraction of a subwatershed devoted to industrial land can be an indirect indicator of the potential risk of illicit discharges and density of storm water hotspots that may warrant further investigation. In general, the greater the percentage of industrial land, the higher the risk for storm water pollution, illicit discharges, and other water quality problems. Subwatersheds with a lot of industrial land have greater restoration potential, since many of industrial operations are already regulated, which makes implementation of storm water retrofit, discharge prevention and source control practices easier. The industrial land metric can be easily derived from GIS land use layers.

9. Hotspot Density (Potential hotspots/square mile)

This metric measures the number of commercial, industrial, institutional, municipal and transport-related operations in the subwatershed with the potential to be storm water hotspots. Subwatersheds with a greater hotspot density are expected to generate higher storm water pollution loads, and are targets for pollution source controls, discharge prevention and on-site retrofit practices. Potential hotspots are located by analyzing business databases that classify subwatershed business operations by their Standard Industrial Code (SIC). Certain SIC classifications are strongly associated with hotspot potential, which are listed in Appendix A of Manual 8 *Pollution Source Control Practices*. Communities that are regulated under the EPA NPDES municipal storm water permit program may already have geospatial data on hotspot locations.

10. Condition of Sewer System (Average age in decades)

The average age of the sewer system can reveal clues about the potential risk of illicit discharges, sanitary sewer overflows and other sewage discharges to the stream network. In general, subwatersheds with aging sewers have a greater risk of water quality problems, and may be good targets for discharge prevention practices and/or improved municipal operations. The average age of sewers is hard to define precisely since most are complex systems built (and upgraded) during different eras. If a community has detailed sewer infrastructure information on its GIS, it may be possible to extract sewer age from attribute tables. Alternatively, sewer age can be inferred from the age of subwatershed development, estimated by interviewing old timers in the local sewer authority, or examining maintenance records to look for clusters of sewage spill or overflow problems.

11. Sum of Forest, Parks and Wetlands (% of subwatershed)

This metric evaluates the aggregate land area in a subwatershed devoted to natural area remnants. Operationally, the metric is defined as the sum of subwatershed area in forest, wetland and park cover and is usually quite easy to calculate when these GIS layers are available. Subwatersheds that possess extensive natural area remnants normally have greater restoration potential, since they often enhance stream quality and offer possible sites for further natural area restoration, reforestation and wetland enhancements.

12. Citizen Concern (Index of concern)

Citizen concern is an important metric, as the public often expresses variable levels of subwatershed concern that ultimately affects the degree of stewardship and support for restoration efforts. The degree of citizen concern in each subwatershed can be hard to measure, but may be gleaned based on patterns of past stakeholder interest, volunteer activity, complaints or hotline reports. In other cases, citizen concern can be qualitatively measured simply by asking stakeholders.

13. Community Organization (Presence/absence)

Another non-technical metric is whether a watershed, neighborhood, civic, community or recreational group is active in the subwatershed. If such groups are active, they often strongly increase restoration potential since they can directly participate in restoration and stewardship activities. Determining the degree of community organization is usually subjective and is best made by talking with stakeholders that understand the community.

Review of Stream Corridor Metrics

14. Subwatershed Stream Density (Stream miles/square mile)

This metric indicates how much of the urban stream network in a subwatershed has been enclosed or eliminated in the past. High stream density generally indicates greater restoration potential since it suggests that more potentially suitable reaches are available to locate stream repair, reforestation and retrofit practices. Stream density is relatively easy to derive by adding the cumulative perennial stream mileage shown on GIS hydrology layers and dividing it by the total subwatershed area. Stream density is normally compared to a maximum regional reference value, which is obtained from an undeveloped subwatershed with an unaltered stream network.

15. Stream Corridor Forest Cover (% of corridor with forest cover)

This metric is an index of the potential area available for riparian reforestation or floodplain wetland restoration. Subwatersheds with high corridor forest cover are normally expected to have better stream quality. Paradoxically, subwatersheds with a low corridor forest cover usually have greater restoration potential, since they offer more opportunities for reforestation, better stream access, and require less clearing of existing mature forests during the construction of restoration practices. The stream corridor can be operationally defined as a zone extending 100 feet in either direction from the centerline of perennial streams in a subwatershed. The resulting shapefile is then analyzed to compute the cumulative area of forest cover or canopy cover within the corridor zone. If forest cover is not currently available from the GIS, it can be digitized or visually estimated from recent aerial photos. Note: Since this metric is similar to metric 16, the team should choose one or the other, but not both.

16. Available Area in the Stream Corridor (Open acres/stream mile)

This metric is the reciprocal of stream corridor forest cover, and measures how much open land is available within the defined stream corridor. It is expressed as the total acres of open corridor per stream mile. In general, subwatersheds that have more open area available within the stream corridor have a greater restoration potential since they offer a greater range of potential sites for storage retrofits, stream repair and riparian reforestation practices. "Open" areas are determined by evaluating land cover within the stream corridor zone (e.g., 100 feet on either side of perennial streams), and is defined either as white space (no structures) or as grass cover, depending on what GIS layers are available. A maximum open acreage of 25 acres per stream mile is possible using the 100 feet on each side of the stream. Given that this metric is similar to the preceding metric (No. 15), the team should choose one or the other, but not both.

17. Road Crossings (Crossings/stream mile)

This metric is an index of the amount of stream interruption within a subwatershed and reveals clues about potential retrofit and stream repair opportunities. Road crossings are also an indirect measure of potential fish barriers that may preclude fishery recovery, although fish barriers are explicitly considered using another metric (No. 20). Headwater crossings are a preferred measure of potential sites for storage retrofit and stream repair practices, and are defined as any crossings of a first or second order stream. The crossing metric is easily determined by superimposing GIS stream and road layers or by visually counting crossings shown on aerial photographs.

18. Density of Storm Water Outfalls (Mapped outfalls/stream mile)

The density of mapped storm water outfalls within a subwatershed reveals important information about storm water impacts, illicit discharge risks and threats to infrastructure. In addition, outfall density is a useful subwatershed indicator of overall retrofit feasibility since every outfall represents a possible storage retrofit site. Most communities regulated under the municipal NPDES storm water permit are required to maintain a GIS or paper map of their storm drain system. Outfall density can be easily computed from these maps as the total number of points where perennial streams and storm drains intersect in a subwatershed.

19. Rapid Baseline Assessment (RBA) Composite Scores (Various units)

Various metrics can be derived from physical, water quality or biological indicator sampling conducted during a rapid baseline assessment (RBA-- see Section 2.2). Most of the rapid assessment methods compute an overall or average score that represent conditions within the subwatershed (e.g., excellent, good, fair, poor). RBA should always be used in a CSA, although it can sometimes be hard to interpret in the context of restoration (e.g., does a "poor" score suggest that restoration is achievable, or desirable or hopeless?). It is usually a good idea to evaluate RBA data in the context of indicator predictions for the four urban stream classifications of the ICM model (See Manual 1, Appendix A). Subwatersheds that possess "outlier" indicator scores merit special attention (e.g., indicator scores are poor when they are expected to be good, or are good when they are expected to be poor).

20. Connection to Downstream Waters (Open, impeded or unknown)

This metric assesses all major crossings located between a subwatershed and its downstream receiving water (e.g., river, lake or estuary) to determine whether aquatic life can freely move back and forth. Subwatersheds that are open to migration and/or re-colonization are assumed to have greater potential to restore fisheries and aquatic diversity, compared to subwatersheds where movement is partially or fully impeded. The connection metric is scored as open, impeded, or unknown, based on a visual inspection of crossings, dams and other barriers observed on maps or aerial photographs.

21. Stream Corridor in Public Ownership (% of corridor)

It is much easier to install restoration practices on publicly controlled land in the stream corridor, such as parks, greenways and floodplains, compared to private land. Consequently, subwatersheds that have a high percentage of public corridor ownership are normally thought to have greater restoration potential. The metric is computed by analyzing parcel ownership data within the defined stream corridor zone (e.g., 100 feet on either side of perennial streams).

22. Violations of Water Quality Standards (Violations/year)

If a community has historically sampled water quality at the subwatershed level, the resulting data can be transformed into summary metrics that examine the relative frequency with which water quality standards are violated (e.g., bacteria, dissolved oxygen, turbidity, and nutrients). Water quality metrics are often computed during the Existing Data Analysis (EDA—Section 1.2) or by evaluating the State 303(d) list. Subwatersheds that experience frequent violations have a greater need for practices that can reduce pollutants to meet water quality standards, such as storm water retrofit, discharge prevention and pollution source control practices. This metric is similar is some respects to Metric 25, so the team should choose one or the other, but not both.

23. Fisheries Data (Various units)

Some communities may possess data on current or historical fish populations, barriers or habitat quality. If subwatershed-specific fishery data is discovered during the Existing Data Analysis, it should always be incorporated into the CSA. In most cases, subwatersheds that rank as having good or fair fish populations have better prospects for restoration than subwatersheds that are designated as poor.

24. Stream Corridor Recreational Value (Index)

Stream corridors differ greatly in their recreational use and public access. In general, subwatersheds where stream corridors are utilized for trails, bike paths, greenways or parks tend to attract greater public support for restoration and enhancement. By contrast, corridors that are privately owned or have poor or restricted public access tend to get much less attention. Generally, high recreational use indicates greater potential support for restoration, although some intense recreational uses may actually preclude use of parts of the corridor for reforestation, retrofit and stream repair practices. The recreational value of the subwatershed stream corridor can be subjectively determined and expressed in terms of a comparative index.

25. Water Quality Regulatory Status (Index)

The receiving waters of a subwatershed may be designated for special protection, have a unique water resource management use, or be subject to mandatory pollutant reductions if water quality standards are not being met (e.g., a Total Maximum Daily Load or TMDL). Each community has a different combination of natural resource, water use and water quality designations. The core team should first check to see if the water body is listed on the State 303(d) list for non-attainment (this may have already been done in the Needs and Capabilities Assessment- Section 1.1). A metric should be developed if significant differences exist in the regulatory status of subwatersheds (or the receiving waters they discharge to). The regulatory metric is usually expressed as a relative index number. This metric is similar is some respects to Metric 22, so the team should choose one or the other, but not both.

26. Severity of Flooding Problems (Index)

Flooding problems are often a major restoration driver in a CSA. The severity of flooding problems among subwatersheds can be measured in a number of ways, including the number of past drainage complaints, past FEMA modeling of flood risks, number of structures within the 100-year floodplain, and damage claims to private property and/or public infrastructure. In general, the more severe the flooding problems, the greater the restoration potential, which usually means that storage retrofits and improved riparian management practices are needed to solve the problem.

27. Severity of Streambank Erosion (Index)

The comparative severity of streambank erosion problems is seldom known until USA or other stream surveys are conducted in subsequent steps of the planning process. However, if a community has conducted geomorphic assessments or tracked drainage/erosion complaints in the past, they may wish to convert this data into a streambank erosion severity metric. In general, the more severe the erosion problems, the greater the restoration potential, which usually means that bank stabilization and storage retrofits are needed to address the problems.

Tool 14
Watershed Protection Program Audit

This tool provides an example audit designed to identify regulatory and programmatic tools and gaps in your watershed protection planning strategy and is organized by the Center for Watershed Protection's Eight Tools of Watershed Protection. These tools roughly correspond to the stages of the development cycle from initial land use planning, site design, and construction

Assessing Your Watershed Protection Programs and Regulations

The Eight Tools Audit is designed to identify regulatory and programmatic tools and gaps in your watershed protection arsenal. The self-assessment is organized by the eight categories of protection tools available in most communities. These tools roughly correspond to the stages of the development cycle from initial land use planning, site design, and construction through home ownership. As a result, a watershed manager will generally need to apply some form of all eight tools in every watershed to provide comprehensive watershed protection. The eight tools include:

- *Land Use Planning*—identify which regulatory measures and/or planning techniques are in use in your community to manage growth, redirect development where appropriate, and protect sensitive areas (i.e., zoning, overlay districts, growth boundaries).

- *Land Conservation*—outline programs or efforts to conserve undeveloped, sensitive areas or areas of particular historical or cultural value (i.e., PDR, land trusts, agricultural preservation, tax incentives).

- *Aquatic Buffers*—evaluate criteria for the protection, restoration, creation, or reforestation of stream, wetland, and urban lake buffers (i.e, width, vegetative standards, incentives).

- *Better Site Design*—assess flexibility of local codes and ordinances to reduce impervious cover, integrate stormwater management, and conserve natural areas in the design of new and redevelopment projects.

- *Erosion and Sediment Control*—examine criteria for the use of erosion prevention, sediment control, and dewatering practices at all new development and redevelopment sites.

- *Stormwater Management*—assess criteria for design of structural practices in new development, redevelopment, or the existing landscape to help mitigate the impacts of stormwater runoff on receiving waters.

- *Non-stormwater discharges*—evaluate operations and maintenance programs for locating, quantifying, and controlling non-stormwater pollutant sources in the watershed.

- *Watershed Stewardship Program*—identify extent of existing stormwater and watershed education or outreach programs; restoration efforts, and monitoring activities.

➲ Please complete the following self-assessment for your watershed, preferably a watershed of 100 sq miles or less in size. If you represent a watershed with multiple jurisdictions, then choose one (maybe the one with the most area in the watershed) to base your answers on.

Background

Your Name: ______________________________

Jurisdiction: ______________________________

Department/Group: ______________________________

Address: ______________________________

____

Phone: ____________________ Fax: ____________________

Email: ____________________

1.	What is the form of government in your community?	☐ City ☐ County ☐ Township ☐ Other
3.	What is the approximate area of your community?	Square miles
4.	What is the approximate population of your community?	
5.	What is the approximate percentage of each of the following land uses in your community?	☐ Ultra-Urban:________% ☐ Urban:____________% ☐ Suburban:__________% ☐ Rural:_____________% ☐ Undeveloped:_______%
6.	Is your community growing?	☐ Quickly and facing a lot of development pressure ☐ Slowly, facing moderate development pressure ☐ Not at all, this isn't really a concern
7.	The best description of my community's stormwater drainage system is:	☐ Storm drains (usually pipes leading to a receiving stream) ☐ Open channels or ditches ☐ Combination of storm drains and open channels ☐ Combined sewers (stormwater and wastewater flow in the same pipe) ☐ Don't know

8.	What is the primary method your community uses to treat wastewater (check all that apply)?	☐ Wastewater treatment plants ☐ Individual septic systems ☐ Community septic systems ☐ Straight pipes ☐ Other
9.	Do you know the department that is primarily responsible for mapping and GIS?	☐Yes ☐No ☐Don't know
10.	What are the primary concerns driving local watershed protection in your community *(check all that apply and describe the most import)?*	☐ Maintain stream quality ☐ Sustain fishery (trout, salmon, warm-water) ☐ Protect lake quality (eutrophication) ☐ Protect quality of drinking water sources ☐ Protect coastal waters ☐ Protect groundwater and maintain recharge ☐ Conserve wetlands and/or forests ☐ Maintain rural character (i.e. farm conservation) ☐ (other) ☐ (other)
11.	What is your community's prior local experience in watershed planning in the last five years?	☐ Watershed plans completed ☐ Some internal planning and studies ☐ None
12.	What is the regulatory status of your watershed?	☐ Not meeting water quality standards, subject to TMDL ☐ Designated as special waters, under antidegradation ☐ Don't know
13.	What are the approximate acres of wetlands in your community?	
14.	Have you lost, or do you foresee losing many isolated wetlands?	☐Yes ☐No ☐Don't know
15.	Does your community have watershed-based GIS data layers?	☐ Watershed GIS system is operational ☐ Community has GIS, but it is not watershed-based ☐ Only have paper maps
16.	What is your community's political receptivity to watershed planning?	☐ Elected officials support or even champion watershed plans ☐ Agency staff are supportive ☐ Have not heard of watershed planning ☐ Unsure and wary of watershed planning ☐ Hostile toward idea of watershed planning
17.	What is your community's awareness about watersheds?	☐ High degree of concern about watershed issues ☐ Mixed level of concern, some awareness ☐ Low level of concern and awareness

18.	What are some of your community's other issues relating to watersheds?	☐ Growth vs. no growth ☐ Farmland conservation ☐ Protection of rural character ☐ Desire for greenways, parks, or recreation ☐ Newcomers vs. old timers
19.	What are the key pollutants of concern in your watershed?	☐ Nutrients ☐ Heavy metals ☐ Sediment ☐ Bacteria ☐ Others: ☐ Don't know
20.	What are the key habitat impairments in your watershed?	☐ Stream degradation ☐ Wetland disturbance ☐ Fish barriers ☐ Rare and endangered species ☐ Riparian condition ☐ Others: ☐ Don't know

Tool #1. Land Use Planning

What land use planning techniques does your community employ that can be used to maintain or limit future impervious cover, redirect development where appropriate, and protect sensitive areas? Watershed recommendations that build upon existing planning techniques (i.e. overlay districts, PDR, zoning) are often easier to implement than untested tools.

Who is the local agency in charge of land use planning?
List agency(ies) and contact information:

1.1	Does your community have a comprehensive plan?	☐Yes ☐No ☐Don't know
	If so when was it last revised?	☐Don't know
	How often do you typically update your comprehensive plan? *Comprehensive plans reflect the vision your community has for itself that will guide development decisions over the next 10-20 years. If your plan is scheduled to be updated, this will be the opportune time to make sure watershed management goals are incorporated.*	☐ Every 5 years ☐ Every 10 years ☐ We don't ☐ Other: ☐ Don't know
1.2	Does your comprehensive plan address the most important watershed or water resource goals for your community? If so, which goals and how? *Flood control, water quality, groundwater protection, and instream habitat are common water resource goals that should be incorporated into the comprehensive planning process. Check your plan to see if these goals are clearly outlined. Your watershed plan should specifically target goals of the comprehensive plan.*	☐Yes ☐No ☐Don't know

		Yes	No	Don't know
	Does your plan evaluate and take into account impacts of future land use on water resources? In what way? *Check to see if long-term transportation and development planning jives with water resource goals. If not, then you may have identified a serious gap in your comprehensive planning process and may have to apply additional protection tools in those areas.*	☐Yes	☐No	☐Don't know
1.3	Does your community have zoning authority?	☐Yes	☐No	☐Don't know
	If yes, please list the different zoning districts that are included in your zoning (include abbreviation): *Zoning is the local authority to regulate the type and density of future land use. If your jurisdiction has land use authority, then there are many opportunities to provide incentives and establish development criteria to protect water resources.* *In addition, zoning information helps you predict future buildout conditions and impervious cover estimates for your watershed.*			
1.4	Do you have access to zoning maps for the other jurisdictions in your watershed? *Inevitably, when multiple jurisdictions exist within a watershed, some have digital zoning information and others do not. It's hard to estimate future impervious cover without all the zoning information for the watershed.*	☐Yes	☐No	☐Don't know

1.5	Have you used land use, zoning, and other techniques to estimate current and future impervious cover in your (sub)watersheds? *Percent impervious cover is a quick and easy indicator of water resource conditions (CWP 1998, 2003). A lot of communities have estimated current impervious cover, but few have estimate future imperviousness!*	☐Yes ☐No ☐Don't know ☐Not applicable
1.6.	Does your community employ any of the following planning tools to direct growth, manage impervious cover, and protect natural resources *(check those that apply)*? Other techniques? *If so, great! Let's figure out how to maximize water resource protection using them.*	☐Overlay districts[1] ☐Watershed-based zoning[2] ☐Purchase or Transfer of development rights[3] ☐Limiting infrastructure extension[4] ☐Infill / community redevelopment[5] ☐Agricultural zoning/ preservation ☐Compensatory wetland mitigation ☐Non of the above ☐Don't know
1.7	Are there local regulations governing the preservation of wetlands during development? If so, describe key elements: ➲*If so, please attach copy of regulation:*	☐Yes, we refer to state/ federal regs ☐Yes, we have our own ordinance ☐No ☐Don't know
	If so, do you have a local wetlands permitting procedure (vs. it is all federal or state level)?	☐Yes ☐No ☐Don't know
	Does your wetland ordinance mandate specific assessment and delineation techniques?	☐Yes ☐No ☐Don't know ☐Not applicable

[1] *A local zoning jurisdiction that is overlaid on a property's existing zoning. Superimposes additional regulations or specific development criteria within specific areas.*
[2] *An alternative zoning technique, whereby the intensity of development within a watershed or subwatershed is at least partially based on the ultimate percentage of impervious cover and the desired level of stream protection.*
[3] *Transfers potential development from a designated "sending area" to a designated "receiving area"*
[4] *A conscious decision is made to limit or deny extending infrastructure, such as public sewer, water, or roads, to designated areas to avoid increased development in these areas*
[5] *Encourages new development and redevelopment within existing developed areas*

	Do you require functional assessment of wetlands in addition to delineation in non-mitigation permitting? Which functional assessment protocol do you use?	☐Yes ☐No ☐Don't know
1.8	Are floodplains mapped and managed based on FEMA requirements?	☐Yes ☐No ☐Don't know ☐Not applicable
	Are there additional local development restrictions within floodplains? Describe: ➲*If so, please attach copy of requirements:*	☐Yes ☐No ☐Don't know ☐Not applicable
1.9	Are there development restrictions pertaining to stream channel modification? If yes, describe key components of restrictions ➲*If so, please attach copy of requirements:*	☐Yes ☐No ☐Don't know ☐Not applicable
1.10	Does your community have a reservoir protection ordinance or other special water quality area protection ordinance? If yes, describe: ➲*If so, please attach copy of ordinance:*	☐Yes ☐No ☐Don't know ☐ We have no special areas
1.11	Are there development restrictions pertaining to steep slopes? If yes, describe key components of restrictions *(what constitutes a steep slope?):* ➲*If so, please attach copy of requirements:*	☐Yes ☐No ☐Don't know ☐Not applicable

1.12	Does your community have a recharge or groundwater protection ordinance? If so, describe key elements? ➲*If so, please attach copy of requirements:*	☐Yes ☐No ☐Don't know ☐Not applicable
1.13	Do you have a wetland protection ordinance outlining more stringent development criteria, higher mitigation ratios, or other protection incentives? If so, describe key elements? ➲*If so, please attach copy of requirements:*	☐Yes ☐No ☐Don't know ☐Not applicable

➲:Summarize existing regulatory or programmatic **land use planning tools** currently available to apply towards watershed protection:

Summarize gaps in land use planning tool box:

Notes:

Tool #2. Land Conservation

Take a look at what programs or efforts exist within (or nearby) your community to conserve undeveloped, sensitive areas or areas of particular historical or cultural value.

Who is the local agency involved in conserving land?
List agency(ies) and contact information:

2.1 Do you know the locations of rare, threatened, or endangered species are in your watershed?

☐Yes ☐No ☐Don't know

2.2 Have critical habitat areas for plant and animal species been mapped in your community?

☐Yes ☐No ☐Don't know

2.3 Have potential groundwater recharge areas and wetland drainage areas been mapped in your watershed?

☐Yes ☐No ☐Don't know

These areas are critical for maintaining hydrologic watershed functions and should not be overlooked by conservationists.

2.4 Do locations of RTE species and sensitive areas trigger additional review by local planners prior to site plan approval?

☐Yes ☐No ☐Don't know

In some cases, the location of sensitive habitats that may be impacted by a particular development may not be known by plan review staff, thereby limiting the level of protection that could potentially be afforded these areas.

2.5 Other than what is required by state and federal laws, is the preservation of critical habitat areas for plant and animal species:

☐Required
☐Encouraged
☐Neither
☐Don't know
☐Other:

If applicable, describe key components of the program (*i.e. regulations, incentives, enforcement):*

➲*If so, please attach copy of requirements:*

2.6	Are there any local requirements for forest conservation? If so, what are they? ➲*If so, please attach copy of ordinance(s).*	☐Yes ☐No ☐Don't know
2.7	Is the preservation of active agricultural areas: If required or encouraged, describe the key components of your program: ➲*If so, please attach copy of ordinance(s). Often, ag preservation can be a leading driver for growth management. Consider prioritizing preservation areas with water recharge, buffer protection, and wildlife corridors goals.*	☐ Required ☐ Encouraged ☐ Too late ☐ None of the above ☐ Don't know
2.8	Other than what is required by state and federal laws, is the preservation of cultural or historical areas: If required or encouraged, describe the key components of your program: ➲*If so, please attach copy of ordinance(s)These sites are often adjacent to or within natural resource protection areas.*	☐Required ☐Encouraged ☐Neither ☐Other: ☐Don't know
2.9	Is the preservation of forests, fields, and wetlands for hunting, fishing, hiking, or other active recreation:	☐Required ☐Encouraged ☐Neither ☐Other: ☐Don't know
2.10	Does your community permit or encourage any of the following techniques to conserve land?	☐ Conservation easements ☐ Land acquisition programs ☐ Purchase of development rights (PDRs) ☐ Landowner stewardship programs ☐ Other ☐ None of the above
2.11	Can the local government administer conservation easements?	☐Yes ☐No ☐Don't know

If so, please describe key components of the program:

	Are maintenance, ownership responsibilities, and enforcement part of the program?	☐Yes ☐No ☐Don't know
2.12	Do any local or regional private land trusts that accept conservation easements exist in the watershed or larger basin? If so, who?: *List group and contact information:*	☐Yes ☐No ☐Don't know
2.13	Have you identified conservation opportunities in the watershed *(i.e. wetlands, forests, recharge areas, etc)*? ➲*Can you get a map of these locations?*	☐Yes ☐No ☐Don't know
2.14	Have you determined which potential conservation areas are most vulnerable to development impacts?	☐Yes ☐No ☐Don't know
2.15	Have you established a process for prioritizing conservation opportunities? If so, describe your ranking factors *(i.e, connectivity; contiguousness; RTE species; :willing land owner):* ➲*You should check program ranking criteria to make sure they include factors that meet watershed protection goals and objectives.*	☐Yes ☐No ☐Don't know
2.16	Is there state or local funding source available for purchasing easements or acquiring land?	☐Yes ☐No ☐Don't know

2.17	If there is a wetland mitigation or compensation program, what is the mitigation ratio for acquisition/conservation? *Depending on your local guidelines, you may be able to use mitigation requirements to acquire sensitive wetlands and their drainage areas.*	☐Not applicable	☐Don't know

➲:Summarize existing regulatory or programmatic **land conservation tools** currently available to apply towards watershed protection:

Summarize gaps in land conservation tool box:

Notes:

Tool #3. Aquatic Buffers

Evaluate your community's ability to protect and restore vegetated riparian, wetland, and shoreline buffers.

Who is the local agency in charge of enforcing buffer requirements?
List agency(ies) and contact information:

3.1	Are stream, wetland, or shoreline buffers required in your community? *(check all that apply)*	☐ Yes, on perennial streams ☐ Yes, on intermittent streams ☐ Yes, on ephemeral streams ☐ Yes, on ephemeral streams ☐ Yes, on most wetlands ☐ Yes, on all wetlands (isolated) ☐ Yes, on shorelines (lakes) ☐ Yes, other: ☐ No ☐ Don't know
	If so, is there a local buffer ordinance? ➲*If so, please attach a copy of your regulations, supporting guidance, enforcement, maintenance information, etc.*	☐ Yes, we refer to the state regs ☐ Yes, we have developed our own ordinance ☐ No ☐ Don't know
	If so, when was it last updated? *If your buffer ordinance has not been updated within the last 5 years, you should evaluate how successful it has been, and how it can be improved (i.e. remove ambiguity, include plant lists, better protection for sensitive streams)*	☐Don't know
3.2	Are buffers part of an overlay district?	☐Yes ☐No ☐Don't know
3.3	If required, what is the minimum required buffer width *(in feet)*? ➲*In general, a minimum base width of at least 100 feet is recommended to provide adequate stream habitat and water quality protection. Much larger widths are recommended for wildlife protection and view corridors. See if you can track down the rationale behind your established widths.*	☐Don't know

	Are width criteria higher for high quality streams, wetlands, reservoirs, or other sensitive aquatic resources?	☐Yes ☐No ☐Don't know
	Widths are commonly measured from *(check all those that apply):*	☐ Centerline of stream ☐ Stream bank ☐ Edge of 100-year floodplain ☐ Edge of wetland drainage area ☐ Top of adjacent steep slope ☐ High tide/water line ☐ Other: ☐ Don't know
	Can widths be expanded to connect wetlands with their critical upland habitats?	☐Yes ☐No ☐Don't know
	Does your community provide flexibility with a variable width buffer system (buffer averaging)? *This can be difficult to administer, however, flexible systems can provide additional protection to highly sensitive areas in exchange for minimal buffer application in "high traffic" portions of a site.*	☐Yes ☐No ☐Don't know
3.4	Are buffers excluded from private property boundaries in new residential subdivisions or commercial development? *If buffers are outside of property lines, then there is often less hassle with enforcement (i.e. homeowners requesting permission to build sheds, cut trees).*	☐Yes ☐No ☐Don't know
3.5	Are methods for determining where buffers are applied/delineated detailed in your buffer ordinance? *Is it a stream or is it a ditch? Your ordinance should alleviate the*	☐Yes ☐No ☐Don't know
3.6	Does your community rely on mapping data (USGS "blue line" streams or NWI) for applying buffer regulations, or are field verifications also used?	☐Yes ☐No ☐Don't know
3.7	Are buffer delineations visibly demarcated on: *Boundaries should be well defined during each stage of the development process from initial plan review to post-construction. This can prevent encroachment during construction and by homeowners.*	☐ Pre-construction plan (site plans) ☐ Construction plans ☐ As built/final plans ☐ Homeowners plat ☐ Other: ☐ None of the above: ☐ Don't know
3.8	Is a physical demarcation (flagging or fencing) of buffers required on site during construction to prevent encroachment?	☐Yes ☐No ☐Don't know

	If so, can site inspectors enforce buffer criteria with stop work orders or fines?	☐Yes ☐No ☐Don't know
3.9	Are excluded uses/activities within the buffer clearly established in your buffer ordinance *(impervious cover, underground storage tanks, structures, etc)?* ➲*If so, please attach a copy of excluded uses.*	☐Yes ☐No ☐Don't know
	What uses/activities are exempt from buffer criteria?	☐ Utilities ☐ Road crossings ☐ Agriculture/Livestock ☐ Logging ☐ Nature trails ☐ Other: ☐ None of the above ☐ Don't know
	Are septic drain fields allowed within the buffer? If not, what is the setback requirement?	☐Yes ☐No ☐Don't know ☐Don't know
3.10	Are there specific vegetative targets outlined in ordinance (i.e. native plants)? If so, please describe: ➲*Buffers should have an ultimate vegetative target for a predevelopment native riparian plant community. Do you have a native plants list, if not, consider tracking one down from your local or state natural resources department. You'll want to reference this list in your ordinance for long-term management and restoration projects.*	☐Yes ☐No ☐Don't know
3.11	Are selective clearing and other management procedures outlined in the buffer ordinance *(3-zoned buffer, mowing restrictions, tree pruning guidance, etc)?* If so, please describe: *Urban stream buffers can be designed with a three- zone buffer where each zone performs a different function, and has a different width, vegetative target and management scheme.*	☐Yes ☐No ☐Don't know

3.12 Do third parties or homeowners associations have the ability to manage buffers in your community? ☐Yes ☐No ☐Don't know

If not, consider giving them the authority to manage invasive plants, pick up trash, and report encroachment.

3.13 Are any of the following criteria established in buffer ordinance to limit the impacts of stream buffer crossing?

☐ Crossing and clearing width must be minimized
☐ Crossing angle is perpendicular to stream
☐ Frequency of crossings is minimized
☐ Creation of fish barriers is prohibited
☐ All features designed to handle 100-year floods
☐ Hydrological alteration must be minimized
☐ Other
☐ None of the Above

Ideally a stream buffer network should be maintained as an unbroken corridor, however this is not always possible. When crossings are necessary, such as roads, bridges, utilities, etc construction methods should be used that will minimize the impact.

3.14 Can stormwater management facilities be located in the buffer? ☐Yes ☐No ☐Don't know

3.15 Can buffers be used for sheet flow stormwater management? ☐Yes ☐No ☐Don't know

3.16 Are any of the following stream buffer management measures required in your community? *(check those that apply)*

☐ Permanent signage marking the buffer boundary
☐ Periodic buffer walks to check for encroachment
☐ Non-compliance enforcement measures
☐ Landowner education on benefits/responsibilities
☐Other:
☐None of the above
☐Don't know

Future integrity of the buffer system requires a long-term management strategy, including a strong education and enforcement program.

3.17 Do you have a GIS mapping layer that identifies good and inadequate buffer areas in your watershed? ☐Yes ☐No ☐Don't know

3.18 Is there a funding mechanism or program for buffer reforestation/restoration for both rural and urban areas?

☐Yes
☐ Rural only
☐ Urban only
☐ No
☐Don't know

3.19	Is there a comprehensive invasive plant control strategy for local buffers? If so, who manages the program?	☐Yes ☐No ☐Don't know
3.20	Does your community provide any of the following voluntary and regulatory incentives to encourage buffer protection above and beyond what is required? If so, please describe:	☐ Buffer averaging ☐ Conservation easements ☐ Property tax reduction ☐ Subsidies ☐ Stormwater credits ☐ Cost-share programs ☐Other: ☐None of the above ☐Don't know

➲:Summarize existing regulatory or programmatic **buffer tools** currently available to apply towards watershed protection:

Summarize gaps in buffer tool box:

Notes:

Tool #4. Better Site Design (BSD)

Residential and commercial site design that reduces impervious cover, protects existing natural areas, and treats stormwater on site. Review development codes and ordinances that encourage or hinder this type of environmentally-sensitive design.

Who is the local agency in charge of updating development regulations and reviewing site plans?
List agency(ies) and contact information:

4.1	Are there zoning or subdivision codes that outline criteria for new residential and commercial development? ➲*If so, please compile relevant sections from your zoning ordinance, road codes, forest conservation, or other regulations guiding site design for new development.*	☐Yes ☐No ☐Don't know
4.2	If so, when were they last revised? ➲*If development codes have not been revised in the last five years, consider doing a quick self-assessment to see if your codes impede environmentally sensitive development (many antiquated codes never considered protecting water resources when they were originally crafted)! We recommend completing the* ***Codes and Ordinances Worksheet*** *(COW) to quickly assess your community's ability to implement BSD.*	☐Don't know
4.3	Are open space *(conservation design, cluster, low impact, etc*) developments a common form of development in your community? ➲*If not, then again, we encourage you to take the COW to identify gaps and barriers in your codes to encourage/allow this type of development.*	☐Yes ☐No ☐Don't know

➲The Codes and Ordinances Worksheet (COW) is a 66-question, 100-point self-assessment used to systematically evaluate your community's development codes based on Better Site Design benchmarks. The COW is organized into 3 parts: codes related to streets and parking lots; requirements for lot geometry; and standards for natural area protection. We recommend using the COW to identify barriers to implementing BSD in your community. An electronic version of the COW can be found at www.cwp.org or www.buildersforthebay.net

4.4	Do developers have to go through additional review, obtain variances, or sell their fist born son in order to get an open space design approved? *If so, consider making this kind of development by-right in order to encourage BSD application.*	☐Yes	☐No	☐Don't know
4.5	Is there an overlay district or a "red-flag" system that triggers additional level of plan review in sensitive areas?	☐Yes	☐No	☐Don't know
4.6	Do local regulations require open space or conservation design near sensitive streams and wetlands; drinking water reservoirs; recharge areas; special habitats, or other natural resources? If so, please describe: *If you a site adjacent to a sensitive area is going to be developed, then develop it in a way that will minimize the environmental impact.*	☐Yes	☐No	☐Don't know
4.7	Does your community have authority over local road design *Some communities do not have authority over how roads are designed in new developments; often the authority rests with state DOT.*	☐Yes	☐No	☐Don't know
	If so, do your local street standards allow for narrower roads and open channel drainage? *The COW establishes benchmarks for road, ROWs, and cul-de-sac design based on community averages from around the country.*	☐Yes	☐No	☐Don't know
4.8	Do local parking lots commonly exceed minimum parking ratios and generate excess, unused impervious surface? *The COW establishes benchmarks for establishing parking ratios, stall dimensions, and parking design flexibility based on what other communities are doing around the country.*	☐Yes	☐No	☐Don't know
4.9	Are homeowner agreements in place to maintain low impact development practices such as rain gardens? *As we move towards low impact development practices, it is important to account for the long-term management and maintenance of many backyard stormwater practices.*	☐Yes	☐No	☐Don't know
4.10	Are open space protection and management criteria specified for new subdivisions and parking lots? *Effective open space protection requires explicit criteria such as percentage of site, contiguousness, long-term management; stormwater integration; and canopy coverage targets.*	☐Yes	☐No	☐Don't know
4.11	Are there guidelines for on-site afforestation or reforestation? *Look for opportunities to not only protect existing tress, but to plant new trees during the development process, particularly in watersheds where agricultural fields are being converted to residential neighborhoods.*	☐Yes	☐No	☐Don't know

Tool #5. Erosion and Sediment Control (ESC)

Take a look at local practices and procedures to prevent erosion and control sediment on construction sites. The clearing of vegetation and the exposure of sediment during the construction process can be one of the most critical periods of the development cycle. ESC often fails due to improper practice installation and maintenance by contractors, and lack of inspection and enforcement by local authorities.

5.1 Who is the local agency in charge of revising and enforcing ESC regulations?
List agency and contact information:

5.2 Is there a local erosion and sediment control ordinance?

➲*If erosion and sediment control is required, please attach a copy of your regulations.*

- ☐ Yes, we refer to the state regs
- ☐ Yes, we have developed our own ordinance
- ☐ No
- ☐ Don't know

If so, when was it last revised?

If more than 5 years, consider revising.

5.3 What is the minimum disturbance area requirement for erosion and sediment control plans?

Phase II requirements cover disturbances greater than 1 acre, however some communities are requiring ESC for less than 1 acre in highly sensitive watersheds (i.e. drinking water).

- ☐ All disturbances
- ☐ greater than 1 acre
- ☐ greater than 2 acres
- ☐ greater than 5 acres
- ☐ within a special resource area
- ☐ Other:
- ☐ Don't know

5.4 Are ESC plans reviewed during the site plan review process?

☐Yes ☐No ☐Don't know

Check to make sure ESC plans are being reviewed in the context of the overall site development process. The process should be set up to trigger red flags in sensitive areas that may require more inspections or advanced ESC.

5.5 Are ESC criteria more stringent in areas draining to sensitive wetlands, trout streams, reservoirs, or other resource protection area?

☐Yes ☐No ☐Don't know

If yes, how so?

This is a good link with land use planning tools…if you have overlay districts established for sensitive areas, you may be able to apply more stringent ESC criteria for development within them.

5.6	Are there clearing and grading requirements or incentives to encourage phased clearing and site fingerprinting? If so, describe: *If not, consider instituting! Research shows that lots with mature trees are worth more to homebuyers than non-treed lots. Research also indicates that pervious areas compacted by bulldozers and grading equipment acts a lot like impervious cover.*	☐Yes ☐No ☐Don't know
5.7	Are there specific ESC requirements for logging operations? ➲*If so, attach copy of guidance manual and/or regulations.*	☐Yes ☐No ☐Don't know ☐not applicable
5.8	Is there guidance available for ESC on hillside roads? ➲*If so, attach copy of guidance manual and/or regulations.*	☐Yes ☐No ☐Don't know ☐not applicable
5.9	Are inspection frequency and enforcement requirements specified in the ESC ordinance? *If not, this should be spelled out to avoid confusion and provide predictability.*	☐Yes ☐No ☐Don't know
	If so, what is the required inspection frequency for construction sites? If after rainfall event, describe storm event (0.5 in, 1 in):	☐ Once every 7 days ☐ Once every 7 days or after rainfall event ☐ Once every 14 days and after rainfall event ☐ Other: ☐ Don't know
	If so, please describe the enforcement measures:	
5.10	How often does the average construction site actually get inspected?	☐ Only when there is a complaint ☐ Less than required ☐ Per regulations ☐ More often than required ☐ Don't know
5.11	Are inspections more frequent in areas draining to sensitive wetlands, trout streams, reservoirs, or other resource areas?	☐Yes ☐No ☐Don't know

5.12	Who conducts inspections of construction sites for compliance with erosion and sediment control requirements?	☐ Not Applicable ☐ County / municipal inspector ☐ Third-party inspector (e.g. private engineer) ☐ Other:
5.13	If government responsibility, how many FTE are dedicated to ESC inspection and enforcement? *No one ever has enough staff! If your watershed is expected to develop at a rapid pace, you may need to increase inspection capacity.*	☐ <0.5 ☐ 0.5-1 ☐ 1.5-3 ☐ >3 ☐ Don't Know
5.14	Describe background/training level for ESC inspectors (state certification, 1 day course, etc):	
5.15	Does your community sponsor erosion and sediment control training for: *If not, you should consider providing a course not just for inspectors, but also for the folks designing, installing, and maintaining the practices...*	☐ Developers ☐ Contractors ☐ Engineers ☐ Inspectors ☐ None of the above ☐ Not Applicable
5.16	Do training programs cover local buffer, wetland, steep slope, open space, and tree protection regulations? *Trainers should take this opportunity to remind contractors and inspectors of the water resources ESC is meant to protect. Make sure trainers understand how ESC practices relate to other protection tools.*	☐ Yes ☐ No ☐ Don't know
5.17	Are ESC enforcement mechanisms (e.g. fines, stop work orders, etc.) generally considered effective deterrents? *Be honest here, if you think enhanced enforcement is needed in your community...*	☐ Yes ☐ No ☐ Don't know ☐ Not applicable
5.18	Do monies collected from fines go back into ESC program? ➲*See if you can find out how many enforcement actions were taken last year and how much $ generally collected from permits and fines.*	☐ Yes ☐ No ☐ Don't know
5.19	Does your community have a guidance manual on erosion and sediment control practices? ➲*If your community has developed guidance and/or requirements, please attach a copy.*	☐ Yes, we refer the development community to a state document ☐ Yes, we have our own guidance ☐ No ☐ Don't know ☐ Not applicable
	If so, when was it last revised? *If it has been 5 years, consider updating the manual to keep up with new technologies!*	

5.16 Check all erosion and sediment control practices that your community commonly uses. Circle the ones that do not appear in your ESC guidance manual.

Phasing and Procedures:
- ☐ Construction sequencing
- ☐ Construction phasing
- ☐ Non-disturbance of open space (visible flagging)
- ☐ Non-disturbance of stream/ wetland buffers
- ☐ Limited grading in wetland drainage areas
- ☐ Construction during dry season
- ☐ Stockpile stabilization
- ☐ Exit tire wash
- ☐ Wash station (cement trucks)

Erosion Prevention
- ☐ Surface roughening (tracking)
- ☐ Stair-step grading
- ☐ Temporary seeding and mulching
- ☐ Erosion blankets (biodegradeable)
- ☐ Turf reinforcement mats (synthetic)
- ☐ Permanent seeding and mulching
- ☐ Rip rap channels
- ☐ Outlet protection
- ☐ Dust control
- ☐ Polyacrylamide (PAM)

Runoff Controls
- ☐ Pipe slope drains to bypass erodible soils
- ☐ Construction dewatering operations
- ☐ Dikes / berms as conveyance to ESC structures
- ☐ Silt ditch
- ☐ Temporary stream crossings

Sediment Control
- ☐ Sediment basin
- ☐ Multipurpose basin
- ☐ Sediment traps (dam)
- ☐ Silt fence
- ☐ Rock check dams
- ☐ Sediment tube check dams
- ☐ Stabilized construction entrance
- ☐ Filter fabric inlet protection
- ☐ Straw bales
- ☐ Block and gravel inlet and curb inlet protection
- ☐ Prefabricated inlet protection
- ☐ Sand / gravel bag barrier

Others:

➲:Summarize existing regulatory or programmatic **ESC** tools currently available to apply towards watershed protection:

Summarize gaps in ESC tool box:

Notes:

Tool #6. Storm Water Management (SMW)

Take a look at the stormwater program in your community to see how structural practices are incorporated into new development, redevelopment, or the existing landscape to help mitigate the impacts of urbanization and stormwater runoff on receiving waters.

6.1 Who is the local agency in charge of revising and enforcing SMW regulations?
List agency and contact information:

6.2 Does your community have a Phase I or Phase II NPDES stormwater permit?

If so, your community's stormwater program is expected to meet certain minimum measures, most of which fit nicely with watershed planning efforts…

- ☐ Phase I
- ☐ Phase II
- ☐ No
- ☐ Don't Know

If applicable, which components of the program (minimum measures) does your community do well?

Which could use some beefing up?

6.3 Is there a local stormwater ordinance?

➲*If stormwater is required on new development sites, please attach a copy of your regulation and additional guidance.*

- ☐ Yes, we refer to the state regs
- ☐ Yes, we have developed our own ordinance
- ☐ No
- ☐ Don't know

If so, when was it last revised?

If it's been a while, you may want to update it to reflect new guidance manuals, refined treatment criteria, and enforcement action, or stormwater utility considerations .

6.4 What are the design criteria for stormwater practices?

☐ Control peak discharge rate (flood control): ______________________________

☐ Treat stormwater runoff for water quality: ______________________________

☐ Recharge (by means of infiltration practices, etc.): ______________________________

☐ Protect downstream channels: ______________________________

☐ Other: ______________________________

Are design criteria more stringent in areas draining to sensitive wetlands, trout streams, reservoirs, recharge areas, sensitive watersheds, or other resource areas? ☐ Yes ☐ No ☐ Don't know

6.5 If yes, describe criteria:

6.6 Do stormwater regulations include hydroperiod standards for downstream wetland? ☐ Yes ☐ No ☐ Don't know

Fluctuations in water level due to changes in hydrology resulting from urbanization can significantly impact wetlands.

6.7 Describe any exemptions to stormwater requirements?

6.8 Does your community provide guidance or set forth requirements on the types of stormwater practices that may be constructed?

➲*If your community has developed guidance and/or requirements, please attach a copy.*

☐ Yes, we refer the development community to a state document
☐ Yes, we have our own guidance
☐ No
☐ Don't know

If so, when was it last updated?

If it's been over 5 years, you will need to update your guidance manual at a minimum in order to incorporate new practice designs and maintenance techniques.

6.9	What are the top three stormwater practices typically installed in your community? *If dry ponds make your list, then may not begetting as much water quality benefit as you could (i.e. you will have plenty of retrofit opportunities…)*	
6.10	Is a stormwater plan or other documentation required during the site plan review process?	☐Yes ☐No ☐Don't know
6.11	Does your community inspect stormwater practices during their construction? *Proper construction/installation of stormwater practices is critical. Frequent inspection is important, particularly when ESC basins are being converted to post-construction stormwater ponds as downstream impacts are frequently observed during this transition.*	☐Yes ☐No ☐Don't know
6.12	Is an as-built or record drawing of the stormwater practice required after construction? *It is important to keep track of the actual location of underground infrastructure, final design, and maintenance plan for all newly constructed practices.*	☐Yes ☐No ☐Don't know
6.13	Are stormwater practices inspected for maintenance upkeep or structural integrity on a regular basis?	☐Yes ☐No ☐Don't know
6.14	How frequently are stormwater practices inspected?	☐ Don't Know ☐ More than once a year ☐ Once a year ☐ Every two years ☐ In response to complaints ☐ Never ☐ Other:
6.15	Are inspections and maintenance more frequent in areas draining to sensitive wetlands, trout streams, reservoirs, recharge areas, or other resource areas?	☐Yes ☐No ☐Don't know

6.16	Who is typically responsible for maintaining stormwater practices? *If third party is responsible (not local gov), it is important that local government provide guidance on, enforce, and maintain record of proper maintenance activities.*	☐ Private owner ☐ Builder ☐ Homeowner's association ☐ Permitting agency ☐ Other ☐ Don't know ☐ Not applicable
6.17	Is there a maintenance agreement or covenant between the permitting agency and the private owner, builder, or homeowner's association in charge of maintenance?	☐Yes ☐No ☐Don't know
6.18	Are there penalties for not complying with the maintenance agreement or other applicable regulations applying to maintenance? If yes, please describe penalties.	☐Yes ☐No ☐Don't know
6.19	Are penalties more severe in areas draining to sensitive wetlands, trout streams, reservoirs, recharge areas, or other resource areas?	☐Yes ☐No ☐Don't know ☐Not applicable
6.20	Does your community track STP locations, basic design information (type, drainage area), and maintenance records using GIS?	☐Yes ☐No ☐Don't know
6.21	Are stormwater wetlands allowable forms of urban wetland mitigation in your community? If so, what is the mitigation ratio?	☐Yes ☐No ☐Don't know
6.22	Can natural wetlands be used for stormwater treatment?	☐Yes ☐No ☐Don't know
6.23	Are direct discharges of untreated stormwater to wetlands prohibited?	☐Yes ☐No ☐Don't know
6.24	Constrictions on wetland outlets?	

➲:Summarize existing regulatory or programmatic **SWM tools** currently available to apply towards watershed protection:

Summarize gaps in SWM tool box:

Notes:

Tool #7. Non-Storm Water Discharges

Locating, quantifying, and controlling non-stormwater pollutant sources in the watershed (i.e. septics, sewer, illicit connections). Operation and maintenance practices that prevent or reduce pollutants entering the municipal or natural drainage system.

Who is the local agency(ies) or utility in charge of wastewater regulations and illicit discharges?

List agency contact information:

List utility contact information:

7.1	How does your community manage sanitary wastes *(check all that apply)*?	☐ Septic systems ☐ Aeration systems ☐ Package treatment plants ☐ Centralized wastewater treatment plants ☐ Other: ☐ Don't Know
7.2	Does your community have combined storm/ sewer system? *If you have combined systems, your community should be in the process of phasing these out.*	☐Yes ☐No ☐Don't know
7.3	Do you use created wetlands for wastewater treatment?	☐Yes ☐No ☐Don't know
7.4	Do the sanitary sewer trunk mains follow (check all that apply): *Often gravity driven, sewer networks typically run along stream corridors. If this is the case, you will want to field assess pipe conditions, particularly at manhole stacks and along pipe joints exposed at stream crossings.*	☐ Shortest distance ☐ Stream valley ☐ Other ☐ Don't Know ☐ Not Applicable
7.5	Does your local sewer authority promptly respond and fix sanitary sewer overflow? *Response within in 24 hours is considered prompt.*	☐Yes ☐No ☐Don't know ☐Not applicable
7.6	Do you allow innovative wetland treatment for septic systems?	☐Yes ☐No ☐Don't know

7.7	Does your community have regulations pertaining to septic system maintenance? *Some communities, particularly in drinking water watersheds require inspection annually or every 2-3 years.*	☐Yes ☐No ☐Don't know ☐Not applicable
7.8	Does your community conduct inspections of privately owned septic systems? Describe program *(who, frequency, enforcement measures, etc):* *If not, find out how your community keeps track of on-site systems. Some communities have programs that provide free septic inspections for homeowners.*	☐Yes ☐No ☐Don't know ☐Not applicable
7.9	Does your community prohibit septic systems in sensitive wetland drainages or aquatic buffers?	☐Yes ☐No ☐Don't know ☐Not applicable
7.10	Does your community have GIS tracking system for septic locations, inspection, and maintenance records?	☐Yes ☐No ☐Don't know ☐Not applicable
7.11	Are there regulations regarding runoff from confined animal feeding lots? *CAFOs are considered point source discharges.*	☐Yes ☐No ☐Don't know ☐Not applicable
7.12	Do you know the locations of all known hazmats (i.e. land fills, super fund sites, underground storage tanks) in your watershed?	☐Yes ☐No ☐Don't know
7.13	Is there a program to detect and remove illicit connections and discharges? If so, describe key elements of program *(agency, hotline, procedures, etc):* *You'll want to make sure your community has the legal authority to detect and repair illicit connections on private property.*	☐Yes ☐No ☐Don't know ☐Not applicable

➲:Summarize existing regulatory or programmatic **non-storm water tools** currently available to apply towards watershed protection:

Summarize gaps in non-storm water tool box:

Notes:

Tool #8. Watershed Stewardship Programs

Stewardship includes watershed education, restoration, and monitoring activities. Take a look at the education or outreach programs targeted towards fostering human behavior that prevents or reduces stormwater impacts and pollution generation over a range of land uses and activities. Many types of stewardship efforts can be applied towards meeting NPDES Phase II requirements.

Who is the local agency(ies) in charge of watershed and stormwater education, monitoring, and restoration?

List agency and contact information for education:

List agency and contact information for monitoring:

List agency and contact information for restoration:

8.1	Does your community administer or support education or outreach programs targeted towards *(check those that apply)?* *These programs don't have to be specific to watershed or stormwater. You'll want to keep these programs and the folks that implement them in mind as you develop stakeholder lists and recommendations as part of your watershed protection efforts.*	☐ Residents ☐ Commercial sector ☐ Industrial sector ☐ Municipal employees ☐ Other: ☐Don't know ☐None of the above
	If so, does this program include/provide watershed related education materials? *If not, does it make sense to integrate stormwater education into any of the existing programs? Or do you think you'll have to create a new program?*	☐Yes ☐No ☐Don't know ☐Not applicable

If so, please check the topics/ activities promoted by the program?

Raising Awareness
- ☐ Streamwalks
- ☐ Storm Drain Stenciling
- ☐ Canoe Trips
- ☐ Watershed Map for Distribution
- ☐ Watershed Boundary Signage
- ☐ Stream Buffer Signage
- ☐ Other:

Training
- ☐ Build Your Own Rainbarrel
- ☐ Water Quality/ Macroinvertebrate monitoring
- ☐ Stream Assessment
- ☐ Other:

Homeowner Stewardship
- ☐ Water Conservation
- ☐ Lawn Fertilization
- ☐ Integrated Pest Management (IPM)
- ☐ Lawn Conversion/Lawnscaping
- ☐ Pet Waste Management
- ☐ Car Washing
- ☐ Automotive Maintenance
- ☐ Septic System Maintenance
- ☐ Other:

Activities
- ☐ Stream Clean-up
- ☐ Stream Buffer Planting
- ☐ Building a rain garden
- ☐ Other:

8.2 How many watershed stakeholder meetings have been conducted in the last year in your community?

- ☐ 0
- ☐ 1-3
- ☐ More than 3
- ☐ Don't know

8.3 Is there a recognized watershed group in your community?

☐Yes ☐No ☐Don't know
☐Not applicable

If so, list contact:

Watershed groups can be a great provider/administrator of education and outreach programs, restoration activities, and volunteer monitoring.

If so, does the watershed group play a role in (check all that apply):

- ☐ Watershed education
- ☐ Watershed assessment and Monitoring
- ☐ Watch dog (discharges, ESC, etc)
- ☐ Watershed planning
- ☐ Managing Conservation Areas
- ☐ Replanting Stream Buffers
- ☐ Stream Clean-up
- ☐ Stormwater Facilities maintenance
- ☐ Stormwater retrofitting
- ☐ Septic Systems inspections/maintenance
- ☐ Other
- ☐ None of the above
- ☐ Don't know

8.4	Does the community provide grants or technical assistance to watershed groups to perform these services? If so, list grant/assistance program:	☐Yes	☐No	☐Don't know
8.5	Are there any stream stewardship or volunteer monitoring programs within your community (i.e Adopt-a-stream, Adopt-a-wetland)? If so, describe:	☐Yes	☐No	☐Don't know
8.6	Are there any stream or wetland restoration programs or projects within your community? If so, list contact and key elements of program:	☐Yes	☐No	☐Don't know
8.7	Have you identified priority areas for wetland protection, restoration, or creation in the watershed? *If you know where these places are, then you can proactively seek mitigation funds for implementation.*	☐Yes	☐No	☐Don't know
8.8	Have you conducted a residential behavior survey to determine homeowner activities and attitudes effecting water quality? *This in addition to a quick drive thru of the neighborhoods in the watershed will help you target your educational message. You can also use a survey to establish baseline conditions.*	☐Yes	☐No	☐Don't know
8.9	Does your community have any restrictions on pet waste management?	☐Yes	☐No	☐Don't know

8.10	Does your community actively enforce dumping restrictions in wetland buffers and other conservation areas?	☐Yes	☐No	☐Don't know
8.11	Do you have restrictions or guidance on proper application/use of fertilizers and pesticides on public lands?	☐Yes	☐No	☐Don't know
8.12	Are there any landowner stewardship programs offered by your community?	☐Yes	☐No	☐Don't know

8.13 Does your community require or encourage any of the following techniques to protect stream quality in agricultural areas *(check those that apply)?*

☐ Conservation tillage
☐ Nutrient management plans
☐ Manure application
☐ Rotational Grazing *(rotating livestock between several small paddocks rather than allowing continuous grazing of one large pasture)*
☐ Off-stream Water Sources *(alternative water sources that can reduce livestock time in stream; most effective when used in conjunction with exclusionary fencing)*
☐ Buffer reforestation
☐ Exclusionary Fencing *(fencing that prevents of limits livestock from entering riparian areas and stream channels)*
☐ Other:

☐ Don't know
☐ Not applicable

What types of technical assistance or cost share/incentive programs are available to farmers?

8.14 Are the following practices encouraged on vineyards?

☐ Integrated pest management (IPM)
☐ Buffer strips
☐ Erosion prevention (terracing, diversion, ditches, no-till cropping, etc.)
☐ Fertilizer reduction based on petiole analysis and/or soil testing
☐ Other

☐ Not applicable
☐ Don't know

	What types of technical assistance or cost share/incentive programs are available to grape growers?	
8.15	Are there any educational programs geared at golf courses for the following?	☐ Buffers ☐ Water use ☐ Runoff management ☐ Pesticide application ☐ Fertilizer reduction ☐ Spray irrigation ☐ Other ☐ Don't know ☐ Not applicable
	What types of technical assistance or cost share/incentive programs are available to golf course managers?	
8.16	Does your community have an emergency spill response plan? *This is important particularly in drinking water watersheds where transportation corridors drain to reservoirs or where groundwater can be easily contaminated.*	☐Yes ☐No ☐Don't know
8.17	Is there a local household hazardous waste collection program?	☐Yes ☐No ☐Don't know
8.18	Do you allow untreated discharge of road salts/sand to wetlands or other waterbodies?	☐Yes ☐No ☐Don't know
8.19	Is local mosquito control program integrated with wetland management?	☐Yes ☐No ☐Don't know
8.20	Does your community operate an environmental hotline for illicit discharges, dumping, wetland filling, ESC failure, etc? If so, list contact information:	☐Yes ☐No ☐Don't know

8.21	Have all municipal yards submitted a pollution prevention plan? ➲*:Attach copy of basic municipal PPP.*	☐Yes ☐No ☐Don't know
8.22	Does your community provide training on pollution prevention for (check those that apply):	☐ Municipal employees ☐ Contractors ☐ Commercial ☐ Business ☐ Industrial ☐ Recycle Centers ☐ Other: ☐ None of the above ☐ Don't know
8.23	Describe the type of watershed monitoring do you conduct? *(Type--WQ, bugs, wetland function, flow, performance monitoring,--Frequency, who conducts, etc)* ➲*:Attach copies of baseline data or summary monitoring reports.*	☐ Don't know
8.24	Who and how often is watershed-monitoring data compiled and reported? *Data on watershed trends, performance monitoring, and project tracking should be reported annually.*	☐ Don't know
8.25	Do local agencies provide training, guidance, and supplies to volunteers for monitoring?	☐Yes ☐No ☐Don't know

➲:Summarize existing regulatory or programmatic **stewardship tools** currently available to apply towards watershed protection:

Summarize gaps in stewardship tool box:

Notes:

Tool 15
Modeling Resources

This tool contains a review of two different types of modeling resources: watershed models that local governments should be aware of in order to access the data or utilize results from the models, and watershed models that are available to local governments to use in modeling different watershed scenarios

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Watershed Models with Useful Data

Important watershed models to know about include the Chesapeake Bay Program Watershed Model and the Scenario Builder, which are described below.

Chesapeake Bay Program Watershed Model

The Chesapeake Bay Program has developed a Watershed Model to estimate existing conditions and processes in the Chesapeake Bay and its contributing watershed areas. The most recent version of the Watershed Model, Phase 4.3 divides the 64,000 square mile Chesapeake Bay watershed into 94 segments for model analysis. The Watershed Model is a linked application of five models: an airshed model, watershed model, estuarine hydrodynamic model, estuarine water quality model, and a living resources model. The airshed model predicts atmospheric nutrient deposition to the Chesapeake Bay and its contributing watersheds, the results of which are input into the watershed model and estuarine water quality model. The watershed model uses the Hydrologic Simulation Program-Fortran (HSPF) and estimates the flow, nutrient and sediment loads into the Bay, the results of which are input into the estuarine water quality model. The hydrodynamic and water quality estuarine models predict water movement in the Bay and the fate of nutrients and sediments once they enter the Bay. The Living Resources Model, is under development, and will eventually simulate the influence nutrient and sediment loads entering the Bay have on aquatic animals and plants, including the consideration of complex food-chain and predator-prey relationships. The Watershed Model is currently managed by the CBP and model Phase 5.0 is under development by the CBP Model Subcommittee. Phase 4.3 model results for various land use management scenarios and regions are available from the CBP website, at http://www.chesapeakebay.net/restrtn.htm. When complete, the Phase 5.0 Watershed Model will divide the basin into 500 model segments, enabling finer scale applications, including possible use for State TMDL development.

Chesapeake Bay Program Scenario Builder

The scenario builder enables Tributary Teams to assess various agricultural, urban and Chesapeake Bay BMP implementation scenarios necessary to achieve tributary basin cap load allocations. The model estimates annual implementation costs, and can be used as a predictor for results of the more complex Chesapeake Bay Model. Model and supporting documentation, along with a Maryland specific Scenario Builder version, are available at:
http://www.chesapeakebay.net/info/wqcriteriatech/tributary_tools.cfm#ScenarioBuilder

Available Watershed Models

This section includes a list of watershed models that can assist watershed planners in a watershed (or subwatershed) treatment analysis by estimating water quality and quantity parameters for various land management scenarios. Two types of models are included in the review: spreadsheet loading models (Watershed Treatment Model and Simple Method) and simulation models. Generally speaking, the spreadsheet models have less input data and require less effort and cost to perform than simulation models. Both types of models return information that can be useful to evaluate watershed restoration goals and develop TMDLs.

The models listed in this section are those deemed most useful to watershed planning in Maryland and generally meet the following criteria:

- Apply at the watershed scale
- Estimate either water quality and/or quantity
- Are easy to obtain and apply
- Are commonly used in the watershed planning process

This listing is not intended to be comprehensive. For a more comprehensive summary of available simulation models for watershed loading, receiving waters, and ecological functions, the *Compendium of Tools for Watershed Assessment and TMDL Development* (Shoemaker, *et al.*, 1997) is an excellent resource document. Figure 1 is an overview of all the models reviewed in Shoemaker, *et al.* (1997), many of which are included in this review. The figure shows how models have been separated into three categories, simple, mid-range, and detailed, based upon model complexity. Table 1 provides a summary of modeling resources for watershed planning in Maryland, including description and web link and are presented in order from simple models to more complex models.

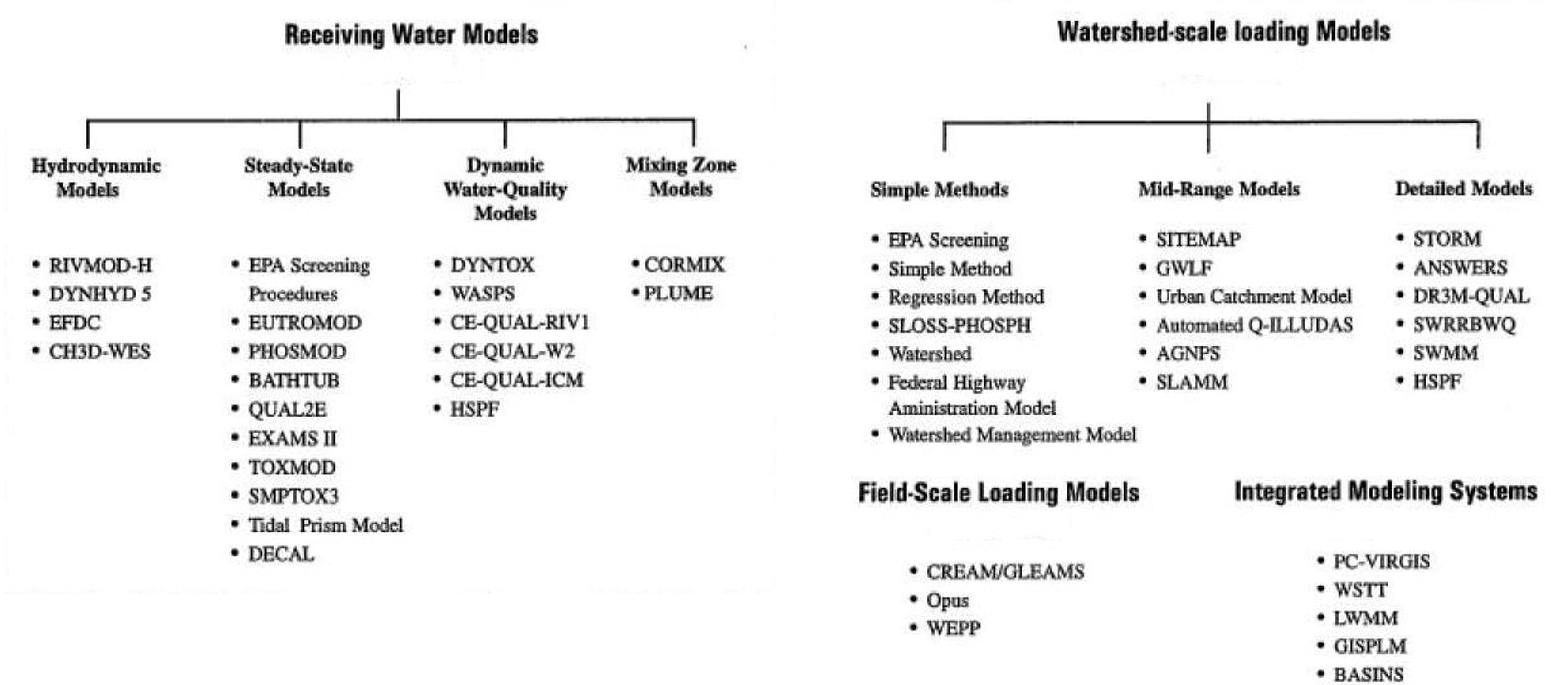


Figure 1: Overview of watershed loading and receiving water models described in the Compendium of Tools for Watershed Assessment and TMDL Development (Shoemaker et al.*, 1997)*

Table 1: Modeling Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
Metropolitan Washington Council of Government (MW-COG)	Simple Method	A spreadsheet model appropriate for small watersheds (<640 acres) that is used to estimate stormwater pollutant loads. Appropriate for evaluating pollutant loads based on various land use and impervious cover scenarios.	Model and support documentation free to download at: http://www.stormwatercenter.net/
Center for Watershed Protection	Watershed Treatment Model (WTM)	A simple tool for the rapid assessment and quantification of various watershed treatment options. WTM allows watershed managers to evaluate multiple treatment options based upon pollutant sources in urban and developing areas.	Model and support documentation free to download at: http://www.stormwatercenter.net/monitoring%20and%20assessment/watershed_treatment_model.htm
U.S. Army Corps of Engineers Hydraulic Engineering Center (HEC)	HEC-RAS, River Assessment System and HEC-HMS, Hydrologic Modeling System	Storm event surface runoff and hydraulic calculations based upon watershed land use and channel characteristics, designed for flood management assessments and channel design. Not capable of water quality calculations.	Model and support documentation free to download at: http://www.hec.usace.army.mil/
Cornell University	GWLF, Generalized Watershed Loading Functions	Estimates stream flow, sediment and nutrient (phosphorus and nitrogen) loads from urban and agricultural land uses. The model can also be used to evaluate basin-wide management strategies.	Distributed by the Cornell University Department of Agriculture and Biological Engineering: Ithaca, NY 14853 - (607) 255-2802
William W. Walker Jr.	P8, Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds	Continuous or single event simulation of hydrology and water quality, that relies on NRCS curve number methods. Good capability to deal with structural stormwater treatment, but not designed to assess soluble pollutants.	Model and support documentation free to download at: http://wwwalker.net/p8/
United States Department of Agriculture	AGNPS, Agricultural Non-Point Source Pollution Model	Quantitatively estimates point and non-point source pollution from agricultural watersheds for various land use and land conservation scenarios.	Model and support documentation free to download at: http://www.ars.usda.gov/Research/docs.htm?docid=5199

Table 1: Modeling Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
University of Maryland	GIShydro2000	GIShydro2000 is a GIS-based software program for performing hydrologic analysis. It consists of a database of hydrologic layers and an ArcView™ application with customized modeling tools. Some Features Include: • Complete database of DEM, land use, and soils data for Maryland drainage area. • Watershed and channel delineation. • Watershed statistics (drainage area, RCN, tc, more). • Peak discharge estimates from USGS regional regression equations (with confidence intervals). • Interface to TR-20 for subdivision, parameter calculation, rating tables, and channel routing.	For more info: http://www.gishydro.umd.edu/
PV & Associates	SLAMM, Source Loading and Management Model	Uses small storm hydrology to evaluate non-point source pollution from urban areas. Has the ability to evaluate a range of source areas and control alternatives to estimate outfall discharges, emphasizing particulate and dissolved pollutant concentrations.	For purchasing information, see: http://winslamm.com/
NOAA Coastal Services Center	N-SPECT, Non-Point Source Pollution and Erosion Comparison Tool	GIS based model that allows coastal watershed managers to predict the impact of land use conversions on stream and river water quality. The model specifically evaluates changes in surface water runoff, non-point source pollution, and erosion.	Model and support documentation free to download at: http://www.csc.noaa.gov/crs/cwq/nspect.html
U.S. Environmental Protection Agency	SWMM, Stormwater Management Model, Version 5	An urban rainfall-runoff model capable of estimating runoff quality and quantity on a watershed scale. Commonly used to design sewer and stormwater facilities and evaluate BMP effectiveness. Requires training and experience to achieve proficiency.	Model and support documentation free to download at: http://www.epa.gov/ednnrmrl/swmm/
United States Geological Survey	HSPF, Hydrologic Simulation Program – Fortran	Continuous simulation of watershed hydrology, with an emphasis on watershed land use. HSPF can be used for TMDL development and to estimate water quantity and quality in response to watershed planning alternatives. Requires training and experience to achieve proficiency.	Model and support documentation free to download at: http://water.usgs.gov/software/hspf.html

Table 1: Modeling Resources for Watershed Planning in Maryland			
Source	*Name of Resource*	*Description*	*Website*
United States Geological Survey	DR3M-QUAL: Multi-Event Urban Runoff Quality Model	Continuous or single event simulation of surface runoff and water quality designed for the subwatershed scale.	Model and support documentation free to download at: http://water.usgs.gov/software/surface_water.html
Systech Engineering, Inc.	WARMF, Watershed Analysis Risk Management Framework	GIS based model that estimates multiple water quality parameters to support TMDL calculations and includes a stakeholder decision-making support system.	For more info: http://www.systechengineering.com/warmf.htm

References cited: Shoemaker, L., M. Lahlou, M. Bryer, D. Kumar, K. Kratt. May 1997. Compendium of Tools for Watershed Assessment and TMDL Development. United States Environmental Protection Agency, Washington, D.C.

Tool 16
Watershed Treatment Model

The Watershed Treatment Model (WTM) is a simple spreadsheet-based approach that evaluates loads from a wide range of pollutant sources, and allows the user to adjust these loads to evaluate multiple alternatives for watershed treatment. For more details on the WTM, see Caraco, 2001.

Tool 17
Continuous Stream Walk Assessment Methods
Field Sheets

This tool contains the field sheets to conduct the Center for Watershed Protection's Unified Stream Assessment (USA)and the Maryland Department of Natural Resource's Stream Corridor Assessment (SCA). Both are continuous stream walk methods that systematically evaluate conditions and identify restoration opportunities within the stream corridor. For more details on USA and guidance for completing the field forms, see Kitchell and Schueler, 2004.

Unified Stream Assessment
(USA)

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID (*Condition-#*): **OT-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____		**GPS:** (*Unit ID*)

BANK: ☐LT ☐RT ☐ Head **FLOW:** ☐ None ☐ Trickle ☐ Moderate ☐ Substantial ☐ Other:	**TYPE:** ☐ Closed pipe	**MATERIAL:** ☐ Concrete ☐Metal ☐ PVC/Plastic ☐Brick ☐ Other:	**SHAPE:** ☐ Single ☐ Circular ☐ Double ☐ Elliptical ☐ Triple ☐ Other:	**DIMENSIONS:** Diameter:_____(in)	**SUBMERGED:** ☐ No ☐ Partially ☐ Fully
	☐ Open channel	☐ Concrete ☐ Earthen ☐ Other:	☐ Trapezoid ☐ Parabolic ☐ Other:	Depth: _____(in) Width (Top):_____(in) " (Bottom):_____(in)	*NOT APPLICABLE*

CONDITION: ☐ None ☐ Chip/Cracked ☐ Peeling Paint ☐ Corrosion ☐ Other:	**ODOR:** ☐ NO ☐Gas ☐ Sewage ☐Rancid/Sour ☐ Sulfide ☐ Other:	**DEPOSITS/STAINS:** ☐ None ☐Oily ☐ Flow Line ☐ Paint ☐Other:	**VEGGIE DENSITY:** ☐ None ☐ Normal ☐ Inhibited ☐ Excessive ☐ Other:	**PIPE BENTHIC GROWTH:** ☐ None ☐ Brown ☐ Orange ☐ Green ☐ Other: **POOL QUALITY:** ☐ No pool ☐ Good ☐Odors ☐Colors ☐Oils ☐ Suds ☐ Algae ☐ Floatables ☐ Other:

FOR FLOWING ONLY	**COLOR:**	☐ Clear ☐ Brown ☐ Grey ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:
	TURBIDITY:	☐ None ☐ Slight Cloudiness ☐ Cloudy ☐ Opaque
	FLOATABLES:	☐ None ☐ Sewage (toilet paper, etc.) ☐ Petroleum (oil sheen) ☐ Other:
OTHER CONCERNS:	☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation ☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other:	

POTENTIAL RESTORATION CANDIDATE ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization
☐ no ☐ Storm water retrofit ☐ Other:

If yes for daylighting:
Length of vegetative cover from outfall: ___________ft Type of existing vegetation:_____________________ Slope: ___________°

If yes for stormwater:
Is stormwater currently controlled? Land Use description:________________________________
☐ Yes ☐ No ☐ Not investigated Area available:

OUTFALL SEVERITY: (*circle #*)	Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream.	Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized.	Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems.
	5 4	3 2	1

SKETCH/NOTES:

REPORTED TO AUTHORITIES: ☐ YES ☐ NO

WATERSHED/SUBSHED:		**DATE:** ___/____/___	**ASSESSED BY:**
SURVEY REACH:	**TIME:**___:____AM/PM	**PHOTO ID** (CAMERA-PIC #): /#	
SITE ID: (*Condition-#*) **ER-**_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____		**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream*)
LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:
DIMENSIONS:
Length (*if no GPS*) LT_______ft and/or RT_________ft Bottom width _______ft
Bank Ht LT_______ft and/or RT__________ft Top width __________ft
Bank Angle LT________° and/or RT________° Wetted Width _______ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown
LAND COVER: ☐ Forest ☐ Field/Ag ☐ Developed:

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY(*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5 4	3 2	1
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5 4	3 2	1

NOTES/CROSS SECTION SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) IB-_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)	

IMPACTED BANK: ☐ LT ☐ RT ☐ Both

REASON INADEQUATE: ☐ Lack of vegetation ☐ Too narrow ☐ Widespread invasive plants ☐ Recently planted ☐ Other:

LAND USE: *(Facing downstream)*

	Private	Institutional	Golf Course	Park	Other Public
LT Bank	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐:

DOMINANT LAND COVER:

	Paved	Bare ground	Turf/lawn	Tall grass	Shrub/scrub	Trees	Other
LT Bank	☐	☐	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐	☐	☐:

INVASIVE PLANTS: ☐ None ☐ Rare ☐ Partial coverage ☐ Extensive coverage ☐ unknown

STREAM SHADE PROVIDED? ☐ None ☐ Partial ☐ Full

WETLANDS PRESENT? ☐ No ☐ Yes ☐ Unknown

POTENTIAL RESTORATION CANDIDATE ☐Active reforestation ☐Greenway design ☐ Natural regeneration ☐ Invasives removal ☐ no ☐ Other:

RESTORABLE AREA

	LT	BANK	RT
Length (ft):	_________		_________
Width (ft):	_________		_________

REFORESTATION POTENTIAL: (*Circle #*)

Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting		Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate		Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting
5	4	3	2	1

POTENTIAL CONFLICTS WITH REFORESTATION ☐ Widespread invasive plants ☐ Potential contamination ☐ Lack of sun ☐ Poor/unsafe access to site ☐ Existing impervious cover ☐ Severe animal impacts (deer, beaver, cattle) ☐ Other:

NOTES:

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **SC-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____		**GPS** (*Unit ID*)

TYPE: ☐ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

FOR ROAD/ RAILROAD CROSSINGS ONLY

SHAPE:	**# BARRELS:**	**MATERIAL:**	**ALIGNMENT:**	**DIMENSIONS:** (*if variable, sketch*)
☐ Arch ☐ Bottomless ☐ Box ☐ Elliptical ☐ Circular ☐ Other:	☐ Single ☐ Double ☐ Triple ☐ Other:	☐ Concrete ☐ Metal ☐ Other:	☐ Flow-aligned ☐ Not flow-aligned ☐ Do not know	Barrel diameter: _________(ft) Height: _________(ft)
CONDITION: (*Evidence of…*) ☐ Cracking/chipping/corrosion ☐ Downstream scour hole ☐ Sediment deposition ☐ Failing embankment ☐ Other (*describe*):			**CULVERT SLOPE:** ☐ Flat ☐ Slight ($2^o – 5^0$) ☐ Obvious ($>5^o$)	Culvert length: _________(ft) Width: _________(ft) Roadway elevation:_________(ft)

POTENTIAL RESTORATION CANDIDATE ☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit
☐ no ☐ Local stream repair ☐ Other:

IS SC ACTING AS GRADE CONTROL ☐ No ☐ Yes ☐ Unknown

If yes for fish barrier

EXTENT OF PHYSICAL BLOCKAGE:
☐ Total ☐ Partial
☐ Temporary ☐ Unknown

CAUSE:
☐ Drop too high Water Drop: ______ (in)
☐ Flow too shallow Water Depth:______ (in)
☐ Other:

BLOCKAGE SEVERITY: (*circle #*)

A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present.	A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish.	A temporary barrier such as a beaver dam or a blockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls.

5 4 3 2 1

NOTES/SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **CM-**_____	*START* **LAT** ____°____'____" **LONG** ____°____'___" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)

TYPE: ☐ Channelization ☐ Bank armoring ☐ concrete channel ☐ Floodplain encroachment ☐ Other:

MATERIAL:			**DIMENSIONS:**
☐ Concrete ☐ Gabion	Does channel have perennial flow?	☐ Yes ☐ No	Height _______________(ft)
☐ Rip Rap ☐ Earthen	Is there evidence of sediment deposition?	☐ Yes ☐ No	Bottom Width _______________(ft)
☐ Metal	Is vegetation growing in channel?	☐ Yes ☐ No	Top Width: _______________(ft)
☐ Other:	Is channel connected to floodplain?	☐ Yes ☐ No	Length: _______________(ft)

BASE FLOW CHANNEL

Depth of flow _____________(in)

Defined low flow channel? ☐ Yes ☐ No

% of channel bottom __________%

ADJACENT STREAM CORRIDOR

Available width LT_________(ft) RT________(ft)

Utilities Present? ☐ Yes ☐ No

Fill in floodplain? ☐Yes ☐ No

POTENTIAL RESTORATION CANDIDATE ☐ Structural repair ☐ Base flow channel creation ☐ Natural channel design ☐ Can't tell ☐ no ☐ De-channelization ☐ Fish barrier removal ☐ Bioengineering

CHANNEL-IZATION SEVERITY: (*Circle #*)	A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel.	A moderate length (> 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel.	An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area.
	5 4	3	2 1

NOTES:

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **TR-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK** _____		**GPS:** (*Unit ID*)

TYPE:	**MATERIAL:**			**SOURCE:**	**LOCATION:**	**LAND OWNERSHIP:**
☐ Industrial	☐ Plastic	☐ Paper	☐ Metal	☐ Unknown	☐ Stream	☐ Public ☐ Unknown
☐ Commercial	☐ Tires	☐ Construction	☐ Medical	☐ Flooding	☐ Riparian Area	☐ Private
☐ Residential	☐ Appliances	☐ Yard Waste		☐ Illegal dump	☐ Lt bank	**AMOUNT** (*# Pickup truck loads*):
	☐ Automotive	☐ Other:		☐ Local outfall	☐ Rt bank	

POTENTIAL RESTORATION CANDIDATE ☐ Stream cleanup ☐ Stream adoption segment ☐ Removal/prevention of dumping
☐ no ☐ Other:

If yes for trash or debris removal	**EQUIPMENT NEEDED :** ☐ Heavy equipment ☐ Trash bags ☐ Unknown	**DUMPSTER WITHIN 100 FT:** ☐ Yes ☐ No ☐ Unknown
	WHO CAN DO IT: ☐ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other	

CLEAN-UP POTENTIAL: (*Circle #*)	A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access	A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe.	A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials
	5 4	3	2 1

NOTES:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **UT-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

TYPE:	**MATERIAL:**	**LOCATION:**	**POTENTIAL FISH BARRIER:**	**PIPE DIMENSIONS:**
☐ Leaking sewer ☐ Exposed pipe ☐ Exposed manhole ☐ Other:	☐ Concrete ☐ Corrugated metal ☐ Smooth metal ☐ PVC ☐ Other:	☐ Floodplain ☐ Stream bank ☐ Above stream ☐ Stream bottom ☐ Other:	☐ Yes ☐ No **CONDITION:** ☐ Joint failure ☐ Protective covering broken ☐ Other:	Diameter: _____in Length exposed: _____ft ☐ Pipe corrosion/cracking ☐ Manhole cover absent

EVIDENCE OF DISCHARGE:		
	COLOR	☐ None ☐ Clear ☐ Dark Brown ☐ Lt Brown ☐ Yellowish ☐ Greenish ☐ Other:
	ODOR	☐ None ☐ Sewage ☐ Oily ☐ Sulfide ☐ Chlorine ☐ Other:
	DEPOSITS	☐ None ☐ Tampons/Toilet Paper ☐ Lime ☐ Surface oils ☐ Stains ☐ Other:

POTENTIAL RESTORATION CANDIDATE ☐ Structural repairs ☐ Pipe testing ☐ Citizen hotlines ☐ Dry weather sampling
☐ no ☐ Fish barrier removal ☐ Other:

If yes to fish barrier, Water Drop: ________ (in)

UTILITY IMPACT SEVERITY: (*Circle #*)			
Leaking= ☐ 5	Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure.	A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event.	Small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel.
	5	4 3	2 1

NOTES:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-_____**	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-_____**	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-_____**	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

RCH

SURVEY REACH ID: ______	WTRSHD/SUBSHD:	DATE: ___/_____/___	ASSESSED BY:
START TIME:____:____AM/PM LMK: ______ LAT____°______'______" LONG ____°______'______" DESCRIPTION:	*END* TIME:____:____AM/PM LMK: ______ LAT____°______'______" LONG ____°______'______" DESCRIPTION:		GPS ID:

RAIN IN LAST 24 HOURS ☐ Heavy rain ☐ Steady rain ☐ None ☐ Intermittent ☐ Trace	PRESENT CONDITIONS ☐ Heavy rain ☐ Steady rain ☐ Intermittent ☐ Clear ☐ Trace ☐ Overcast ☐ Partly cloudy
SURROUNDING LAND USE: ☐ Industrial ☐ Commercial ☐ Urban/Residential ☐ Suburban/Res ☐ Forested ☐ Institutional ☐ Golf course ☐ Park ☐ Crop ☐ Pasture ☐ Other:	

AVERAGE CONDITIONS *(check applicable)*		REACH SKETCH AND SITE IMPACT TRACKING
BASE FLOW AS % CHANNEL WIDTH	☐ 0-25% ☐ 50%-75% ☐25-50 % ☐ 75-100%	*Simple planar sketch of survey reach. Track locations and IDs for all site impacts within the survey reach (OT, ER, IB,SC, UT, TR, MI) as well as any additional features deemed appropriate. Indicate direction of flow*
DOMINANT SUBSTRATE	☐ Silt/clay (fine or slick) ☐ Cobble (2.5 –10") ☐ Sand (gritty) ☐ Boulder (>10") ☐ Gravel (0.1-2.5") ☐ Bed rock	
WATER CLARITY	☐ Clear ☐Turbid *(suspended matter)* ☐ Stained *(clear, naturally colored)* ☐ Opaque *(milky)* ☐ Other *(chemicals, dyes)*	
AQUATIC PLANTS IN STREAM	Attached: ☐ none ☐ some ☐ lots Floating: ☐ none ☐ some ☐ lots	
WILDLIFE IN OR AROUND STREAM	(Evidence of) ☐ Fish ☐ Beaver ☐ Deer ☐ Snails ☐ Other:	
STREAM SHADING (water surface)	☐ Mostly shaded (≥75% coverage) ☐ Halfway (≥50%) ☐ Partially shaded (≥25%) ☐ Unshaded (< 25%)	
CHANNEL DYNAMICS ☐ Unknown	☐ Downcutting ☐ Bed scour ☐ Widening ☐ Bank failure ☐ Headcutting ☐ Bank scour ☐ Aggrading ☐ Slope failure ☐ Sed. deposition ☐ Channelized	
CHANNEL DIMENSIONS *(FACING DOWNSTREAM)*	Height: LT bank ____________(ft) RT bank ____________(ft) Width: Bottom ____________(ft) Top ____________(ft)	

REACH ACCESSIBILITY

Good: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	Fair: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	Difficult. Must cross wetland, steep slope, or sensitive areas to get to stream. Few areas to stockpile available and/or located a great distance from stream. Specialized heavy equipment required.

5 4 3 2 1

NOTES: *(biggest problem you see in survey reach)*

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Overall Stream Condition				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
In-stream Habitat *(May modify criteria based on appropriate habitat regime)*	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Vegetative Protection *(score each bank, determine sides by facing downstream)*	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Bank Erosion **(**facing downstream)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.	Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Floodplain Connection	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Overall Buffer and Floodplain Condition				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
Vegetated Buffer Width	Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone.	Width of buffer zone 25-50 feet; human activities have impacted zone only minimally.	Width of buffer zone 10-25 feet; human activities have impacted zone a great deal.	Width of buffer zone <10 feet: little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Floodplain Vegetation	Predominant floodplain vegetation type is mature forest	Predominant floodplain vegetation type is young forest	Predominant floodplain vegetation type is shrub or old field	Predominant floodplain vegetation type is turf or crop land
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Floodplain Habitat	Even mix of wetland and non-wetland habitats, evidence of standing/ponded water	Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water	Either all wetland or all non-wetland habitat, evidence of standing/ponded water	Either all wetland or all non-wetland habitat, no evidence of standing/ponded water
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Floodplain Encroach-ment	No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures	Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function	Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function	Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Sub Total In-stream: _____ **/80** + Buffer/Floodplain: _____ **/80** = **Total** Survey Reach _____ **/160**

Photo Inventory

(By Camera)

Project: ______________

Group: _______________

Camera: _____________

This field sheet is to be completed AS photos are taken in the field. The intent is to organize pictures taken on each camera. Fill out one sheet per camera (add sheets as needed). Only fill in Date/Reach/Location ID when you start in a new spatial or temporal location.

Date	Stream/ Reach	Location ID	Photo #	Description

Date	Stream/ Reach	Location ID	Photo #	Description

Comments:

(BACK)

CHANNEL ALTERATION CA

Map: ______________ **Team:** ______ **Site:** _________

Date: ____/____/____ **Photo:** ______ **Survey:** ______
MM DD YY

Type: **Co**ncrete, **Ga**bion, **R**ip-**r**ap, **E**arth **C**hannel, **O**ther: _______________

Bottom Width: _______________ in **Length:** _______________ ft.

Does channel have perennial flow? **Y**es **N**o

Is sediment deposition occurring in the channel? **Y**es **N**o

Is vegetation growing in the channel? **Y**es **N**o

Is it part of a road crossing? **No** **Ab**ove **Be**low **Bo**th

Channelized length above road crossing _______________ ft.

Channelized length below road crossing _______________ ft.

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**-1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)

CHANNEL ALTERATION CA

Map: ______________ **Team:** ______ **Site:** _________

Date: ____/____/____ **Photo:** ______ **Survey:** ______
MM DD YY

Type: **Co**ncrete, **Ga**bion, **R**ip-**r**ap, **E**arth **C**hannel, **O**ther: _______________

Bottom Width: _______________ in **Length:** _______________ ft.

Does channel have perennial flow? **Y**es **N**o

Is sediment deposition occurring in the channel? **Y**es **N**o

Is vegetation growing in the channel? **Y**es **N**o

Is it part of a road crossing? **No** **Ab**ove **Be**low **Bo**th

Channelized length above road crossing _______________ ft.

Channelized length below road crossing _______________ ft.

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**-1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)

EROSION SITE ES

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/_____ **Photo:** _______ **Survey:** _______
MM DD YY

Type: **D**owncutting **W**idening **H**eadcutting **U**nknown

Cause: **Be**nd at steep slope, **P**ipe **O**utfall, Below **Ch**annelization, Below **R**oad **C**rossing, **Li**vestock, **L**and **U**se **C**hange Upstream, **O**ther: ___________________________

Length: ______________________ ft. **Average exposed bank height:** _______________________ ft.

Present Land Use Left Side (looking downstream): **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther __________________________

Present Land Use Right Side (looking downstream): **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther __________________________

Threat to Infrastructure?: **Y**es **N**o **Describe**: ____

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

EROSION SITE ES

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/_____ **Photo:** _______ **Survey:** _______
MM DD YY

Type: **D**owncutting **W**idening **H**eadcutting **U**nknown

Cause: **Be**nd at steep slope, **P**ipe **O**utfall, Below **Ch**annelization, Below **R**oad **C**rossing, **Li**vestock, **L**and **U**se **C**hange Upstream, **O**ther: ___________________________

Length: ______________________ ft. **Average exposed bank height:** _______________________ ft.

Present Land Use Left Side (looking downstream): **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther __________________________

Present Land Use Right Side (looking downstream): **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther __________________________

Threat to Infrastructure?: **Y**es **N**o **Describe**: ____

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

EXPOSED PIPE EP

Map: ______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Pipe is: Exposed across bottom of stream, Exposed along stream bank, Exposed manhole, Above stream, Other: ______________________________

Type of Pipe: Concrete, Smooth Metal, Corrugated Metal, Plastic, Terra Cotta, Other: ____________________

Pipe Diameter: _____________ in. **Length exposed:** _______________ ft.

Purpose of Pipe: Sewage, Water Supply, Stormwater, Unknown, Other: ________________________

Evidence of Discharge?: **Y**es **N**o

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: ________________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: ________________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

EXPOSED PIPE EP

Map: ______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Pipe is: Exposed across bottom of stream, Exposed along stream bank, Exposed manhole, Above stream, Other: ______________________________

Type of Pipe: Concrete, Smooth Metal, Corrugated Metal, Plastic, Terra Cotta, Other: ____________________

Pipe Diameter: _____________ in. **Length exposed:** _______________ ft.

Purpose of Pipe: Sewage, Water Supply, Stormwater, Unknown, Other: ________________________

Evidence of Discharge?: **Y**es **N**o

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: ________________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: ________________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

PIPE OUTFALL PO

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type of Outfall: Stormwater, Sewage Overflow, Industrial, Pumping Station, Agricultural, Other: ___________________________

Type of Pipe: Earth Channel, Concrete Channel, Concrete Pipe, Smooth Metal Pipe, Corrugated Metal, Plastic, Other: ___________________________

Location (facing downstream): left bank, right bank, head of stream, Other ____________________

Pipe Diameter: ______________ in. **Channel width:** ______________ ft.

Evidence of Discharge?: **Y**es **N**o

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: ______________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: ______________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

PIPE OUTFALL PO

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type of Outfall: Stormwater, Sewage Overflow, Industrial, Pumping Station, Agricultural, Other: ___________________________

Type of Pipe: Earth Channel, Concrete Channel, Concrete Pipe, Smooth Metal Pipe, Corrugated Metal, Plastic, Other: ___________________________

Location (facing downstream): left bank, right bank, head of stream, Other ____________________

Pipe Diameter: ______________ in. **Channel width:** ______________ ft.

Evidence of Discharge?: **Y**es **N**o

Color: Clear, medium brown, dark brown, green brown, yellow brown, green, other: ______________

Odor: Sewage, oily, musky, fishy, rotten eggs, chlorine, none, other: ______________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

FISH BARRIER FB

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/_____ **Photo:** _______ **Survey:** _______
MM DD YY

Fish Blockage: **To**tal, **Pa**rtial, **Te**mporary, **Un**known

Type of Barrier: **Da**m, **R**oad **C**rossing, **P**ipe **C**rossing, **N**atural **F**alls, **B**eaver **D**am, **Ch**annelized, Instream **Po**nd, **D**ebris **D**am, **Ot**her: __________________________

Blockage because: Too **hi**gh Too **sh**allow Too **fa**st

Water drop: __________________ inches (if too high)

Water depth: ___________________ inches (if too shallow)

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

FISH BARRIER FB

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/_____ **Photo:** _______ **Survey:** _______
MM DD YY

Fish Blockage: **To**tal, **Pa**rtial, **Te**mporary, **Un**known

Type of Barrier: **Da**m, **R**oad **C**rossing, **P**ipe **C**rossing, **N**atural **F**alls, **B**eaver **D**am, **Ch**annelized, Instream **Po**nd, **D**ebris **D**am, **Ot**her: __________________________

Blockage because: Too **hi**gh Too **sh**allow Too **fa**st

Water drop: __________________ inches (if too high)

Water depth: ___________________ inches (if too shallow)

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

INADEQUATE BUFFER — IB

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ (MM DD YY) **Photo:** _______ **Survey:** _______

Buffer inadequate on: **L**eft **R**ight **B**oth (looking downstream)

Is stream unshaded? **L**eft **R**ight **B**oth (looking downstream) **N**either

Buffer width left: _______ ft. **Buffer width right:** _______ ft.

Length left: ____________ ft. **Length right:** ____________ ft.

Present land use left side: **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther _____________________

Present land use right side: **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther _____________________

Has a buffer recently been established: **Y**es **N**o

Are Livestock present: **Y**es **N**o **Type:** **C**attle, **H**orses, **P**igs, **O**ther: _____________________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Wetland Potential	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

(Good wetland potential = low slope, low bank height)

INADEQUATE BUFFER — IB

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ (MM DD YY) **Photo:** _______ **Survey:** _______

Buffer inadequate on: **L**eft **R**ight **B**oth (looking downstream)

Is stream unshaded? **L**eft **R**ight **B**oth (looking downstream) **N**either

Buffer width left: _______ ft. **Buffer width right:** _______ ft.

Length left: ____________ ft. **Length right:** ____________ ft.

Present land use left side: **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther _____________________

Present land use right side: **Cr**op field, **Pa**sture, **La**wn, **Pav**ed, **Sh**rubs & Small Trees, **Fo**rest, **M**ultiflora **R**ose, **O**ther _____________________

Has a buffer recently been established: **Y**es **N**o

Are Livestock present: **Y**es **N**o **Type:** **C**attle, **H**orses, **P**igs, **O**ther: _____________________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Wetland Potential	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

(Good wetland potential = low slope, low bank height)

IN OR NEAR STREAM CONSTRUCTION IC

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type of activity: **Ro**ad, **R**oad **C**rossing, **U**tility, **Lo**gging, **B**ank **S**tabilization, **Re**sidential Development, **In**dustrial Development, **O**ther: _______________________

Sediment Control: **A**dequate **I**nadequate **U**nknown

If inadequate, why? ____

Is stream bottom below site laden with excess sediment? **Y**es **N**o

Length of stream affected: _________________________ ft.

Company doing construction: _____________________________________

Location: ____

Severity Severe **1** **2** **3** **4** **5** Minor Unknown (**-1**)

Contact office as soon as possible: ( )

IN OR NEAR STREAM CONSTRUCTION IC

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type of activity: **Ro**ad, **R**oad **C**rossing, **U**tility, **Lo**gging, **B**ank **S**tabilization, **Re**sidential Development, **In**dustrial Development, **O**ther: _______________________

Sediment Control: **A**dequate **I**nadequate **U**nknown

If inadequate, why? ____

Is stream bottom below site laden with excess sediment? **Y**es **N**o

Length of stream affected: _________________________ ft.

Company doing construction: _____________________________________

Location: ____

Severity Severe **1** **2** **3** **4** **5** Minor Unknown (**-1**)

Contact office as soon as possible: ( )

TRASH DUMPING TD

Map: ______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type of trash: **Re**sidential, **In**dustrial, **Y**ard **W**aste, Flotables, **Ti**res, **Co**nstruction,
Other: ____________________________

Amount of trash: ______________________ pick-up truck loads

Other measure: ______________________

Is trash confined to? **S**ingle site, **L**arge Area

Possible cleanup site for volunteers? **Y**es **N**o

Land Ownership: **Pu**blic **Pr**ivate **Un**known

If public, name: ________________________________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**-1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)

TRASH DUMPING TD

Map: ______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type of trash: **Re**sidential, **In**dustrial, **Y**ard **W**aste, Flotables, **Ti**res, **Co**nstruction,
Other: ____________________________

Amount of trash: ______________________ pick-up truck loads

Other measure: ______________________

Is trash confined to? **S**ingle site, **L**arge Area

Possible cleanup site for volunteers? **Y**es **N**o

Land Ownership: **Pu**blic **Pr**ivate **Un**known

If public, name: ________________________________

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**-1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**-1**)

UNUSUAL CONDITION OR COMMENT UC

Map: ______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type: (circle one) **Unusual Condition** **Comment**

Describe: **Od**or, **Sc**um, Excessive **Al**gae, **W**ater **C**olor/Clarity, **R**ed **F**lock, **S**ewage **D**ischarge, **Oi**l

____

____

____

Potential Cause: ____

____

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

UNUSUAL CONDITION OR COMMENT UC

Map: ______________ **Team:** _______ **Site:** _________

Date: ____/____/____ **Photo:** _______ **Survey:** _______
MM DD YY

Type: (circle one) **Unusual Condition** **Comment**

Describe: **Od**or, **Sc**um, Excessive **Al**gae, **W**ater **C**olor/Clarity, **R**ed **F**lock, **S**ewage **D**ischarge, **Oi**l

____

____

____

Potential Cause: ____

____

Severity	Severe	**1**	**2**	**3**	**4**	**5**	Minor	Unknown (**–1**)
Correctability	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)
Access	Best	**1**	**2**	**3**	**4**	**5**	Worst	Unknown (**–1**)

REPRESENTATIVE SITE RE

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ (MM DD YY) **Photo:** _______ **Survey:** _______

	Optimal	Suboptimal	Marginal	Poor
Macroinvertebrate Substrata				
Embeddedness				
Shelter for fish				
Channel Alteration				
Sediment Deposition				
Velocity and Depth				
Channel Flow				
Bank Vegetation				
Bank Condition				
Riparian Vegetation				

Wetted width: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Thalweg depth: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Bottom type: Silts, Sands, Gravel, Cobble, Boulder, Bedrock

REPRESENTATIVE SITE RE

Map: _______________ **Team:** _______ **Site:** _________

Date: ____/____/____ (MM DD YY) **Photo:** _______ **Survey:** _______

	Optimal	Suboptimal	Marginal	Poor
Macroinvertebrate Substrata				
Embeddedness				
Shelter for fish				
Channel Alteration				
Sediment Deposition				
Velocity and Depth				
Channel Flow				
Bank Vegetation				
Bank Condition				
Riparian Vegetation				

Wetted width: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Thalweg depth: Riffles: _________ in. **Runs:** _________ in. **Pools:** _________ in.

Bottom type: Silts, Sands, Gravel, Cobble, Boulder, Bedrock

HABITAT ASSESSMENT
Rocky Bottom Streams

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Attachment Sites for Macroinvertebrates (see page 67)	Well-developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; cobble predominates; boulders and gravel common.	Riffle is as wide as stream but length is less than two times width; cobble less abundant; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
2. Embeddedness (see page 67)	Fine sediment surrounds and fills in 0-25% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 25-50% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 50-75% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in more than 75% of the living spaces around and in between the gravel, cobble, and boulders.
3. Shelter for Fish (see page 67)	Snags, submerged logs, undercut banks, or other stable habitat are found in over 50% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in over 30-50% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in over 10-30% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in less than 10% of the site.
4. Channel Alteration (see page 67)	Stream straightening, dredging, artificial embankments, dams or bridge abutments absent or minimal; stream with meandering pattern.	Some stream straightening, dredging, artificial embankments or dams present, usually in area of bridge abutments; no evidence of recent channel alteration activity.	Artificial embankments present to some extent on both banks; and 40 to 80% of stream site straightened, dredged, or otherwise altered.	Banks shored with gabion or cement; over 80% of the stream site straightened and disrupted.
5. Sediment Deposition (see page 67)	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at stream obstructions and bends; moderate deposition in pools.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom affected; pools almost absent due to substantial sediment deposition.
6. Stream velocity and depth combinations (see page 67)	Slow (< 1 ft/sec)/shallow (< 1 ft); slow/deep, fast/deep; fast/shallow; all four combinations present	3 of the 4 velocity/depth combinations present; fast current areas generally predominate.	Only 2 of the 4 velocity/depth combinations are present. Score lower if last current areas are missing.	Dominated by 1 velocity/depth category (usually slow/shallow areas)
7. Channel Flow Status (see page 68)	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; <25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
8. Bank Vegetative Protection (see page 68)	More than 90% of the streambank surfaces covered by natural vegetation, including trees, shrubs, or other plants, vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by natural vegetation, but one class of plants is not well-represented; some vegetative disruption evident; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; patches of bare soil or closely cropped vegetation common; less than one half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation, disruption of streambank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
9. Condition of Banks (see page 68)	Banks stable, no evidence of erosion or bank failure; little potential for future problems.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in site have areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank collapse or failure; 60-100% of bank has erosional scars.
10. Riparian Vegetative Zone Width (see page 68)	Width of riparian zone >50 feet; no evidence of human activities (i.e., parking lots, roadbeds, clear-cuts, mowed areas, or crops) within the riparian zone.	Width of riparian zone 35-40 feet.	Width of riparian zone 20-35 feet.	Width of riparian zone <20 feet.

Use the habitat characteristic (parameter) definitions and guidance that follows when completing the habitat assessment field data form. Rocky-bottom streams (Piedmont Streams) are generally fast moving streams with beds that are made up to gravel/cobbles/boulders in any combination and that have definite riffle areas.

1. ***Attachment Sites for Macroinvertebrates*** are essentially the amount of living space or hard substrates (rocks, snags) available for aquatic insects and snails. Many insects begin their life underwater in streams and need to attach themselves to rocks, logs, branches, or other submerged substrates. The greater the variety and number of available living spaces or attachment sites, the greater the variety of insects in the stream. Optimally, there should be a predominance of cobble, and boulders and gravel should be common. The availability of suitable living spaces for macroinvertebrates decreases as cobble becomes less abundant and boulders, gravel, or bedrock become more prevalent.

2. ***Embeddedness*** refers to the extent to which rocks (gravel, cobble, and boulders) are surrounded by, covered, or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the living spaces available to macroinvertebrates and fish for shelter, spawning, and egg incubation are decreased.

   To estimate the percent of embeddedness, observe the amount of silt or finer sediments overlying and surrounding the rocks. If kicking does not dislodge the rocks or cobbles, they may be greatly embedded. It may be useful to lift a few rocks and observe how much of the rock (e.g., 1/2, 1/3) is darker due to algal growth.

3. ***Shelter for Fish*** includes the relative quantity and variety of natural structures in the stream, such as fallen trees, logs, and branches, large rocks, and undercut banks that are available to fish for hiding, sleeping, or laying eggs. A wide variety of submerged structures in the stream provide fish with many living spaces; the more living spaces in a stream, the more types of fish the stream can support.

4. ***Channel Alteration*** is basically a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened (e.g. dredged), or diverted into concrete channels, often for flood control purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when the stream runs through a concrete channel; when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams, bridges, and flow altering structures such as combined sewer overflow pipes are present; when the stream is of uniform depth due to dredging, and when other such changes have occurred.

   Signs that indicate the occurrence of dredging include straightened, deepened, and otherwise uniform stream channels, and the removal of streamside vegetation to provide access to the stream for dredging equipment.

5. ***Sediment Deposition*** is a measure of the amount of sediment that has been deposited in the stream channel and the changes to the stream bottom that have occurred as a result of the deposition. High levels of sediment deposition create an unstable and continually changing environment that is unsuitable for many aquatic organisms.

   Sediments are naturally deposited in areas where the stream flow is reduced, such as pools and bends, or where flow is obstructed. These deposits can lead to the formation of islands, shoals, or point bars (sediments that build up in the stream, usually at the beginning of a meander) or can result in the complete filling of pools. To determine whether or not these sediment deposits are new, look for vegetation growing on them; new sediments will not yet have been colonized by vegetation.

6. ***Stream Velocity and Depth Combinations*** are important to the maintenance of aquatic communities. Restrictions to normal velocity and/or the filling of pools will affect the organisms living in the stream by reducing the dissolved oxygen that is available and by slowing down the movement of food items. Streams function best when the movement of water continually replenishes the supply of oxygen and food, and does not become stagnant.

Slow velocity is generally described as water moving **less than (<) 1 foot/second**

Fast velocity is generally described as water moving **greater than (>) 1 foot/second**

Shallow water is generally described as **less than (<) 1.5 feet**

Deep water is generally described as **greater than (>) 1.5 feet**

Four general categories of velocity and depth are optimal for benthic macroinvertebrate and fish communities. The best streams will have all four velocity/depth combinations and can maintain a wide variety of aquatic life:

(1) slow, shallow
(2) slow, deep
(3) fast, deep
(4) fast, shallow

Depth can be estimated by standing in the stream at various points. If the water level comes to below the bottom of your knee cap, it can be considered shallow. If it reaches above the bottom of your knee cap, consider it deep. Also, you can use the measuring rope to measure the length of your leg to the knee cap to judge depth.

To estimate velocity, use the measuring rope to mark off 10-foot areas of stream in the same general areas where you measured depth. Drop a twig in the stream and count the number of seconds it takes for the stick to travel the 10 feet. Generally it is best to do this in run and pool areas since velocity is difficult to measure in riffles as the twig may get caught up by rocks. Divide 10 by the number of seconds to determine velocity in "feet per second." For example:

If the twig took 6 seconds to travel the 10 foot distance, then divide 6 seconds into 10 feet, which is equal to 1.4 ft/sec. In this case, the velocity would be considered fast, as it is greater than 1 ft/sec.

Since water in riffle areas tends to have the greatest velocity, you can assume that riffle velocity is faster than velocity in either the run or pool areas you measure.

7. ***Channel Flow Status*** is the percent of the existing channel that is filled with water. The flow status will change as the channel enlarges or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of living area for aquatic organisms is limited.

8. ***Bank Vegetative Protection*** measures the amount of the stream bank that is covered by natural (i.e. growing wild and not obviously planted) vegetation. The root systems of plants growing on stream banks help hold soil in place, reducing erosion. Vegetation on banks provides shade for fish and macroinvertebrates, and serves as a food source by dropping leaves and other organic matter into the stream. Ideally, a variety of vegetation should be present, including trees, shrubs, and grasses. Vegetative disruption may occur when the grasses and plants on the stream banks are mowed or grazed upon, or the trees and shrubs are cut back or cleared.

9. ***Condition of Banks*** measures erosion potential and whether the stream banks are eroded. Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered to have a high erosion potential. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Bank failure and the subsequent collapse of portions of the stream bank is referred to as bank sloughing.

10. ***The Riparian Vegetative Zone Width*** is defined here as the width of natural vegetation from the edge of the stream bank. The riparian vegetative zone is a buffer zone to pollutants entering a stream from runoff; it also controls erosion and provides stream habitat and nutrient input into the stream. A wide, relatively undisturbed riparian vegetative zone reflects a healthy stream system; narrow, far less useful riparian zones occur when roads, parking lots, fields, lawns and other artificially cultivated areas, bare soil, rocks, or buildings are near the stream bank. The presence of "old fields" (i.e., previously developed agricultural fields allowed to convert to natural conditions) should rate higher than fields in continuous or periodic use. In arid areas, the riparian vegetative zone can be measured by observing the width of the area dominated by riparian or water-loving plants, such as willows, marsh grasses, and cottonwood trees.

Tool 18
Unified Subwatershed and Site Reconnaissance (USSR) Field Forms

The Center for Watershed Protection's USSR is a rapid field survey to evaluate potential pollution sources and restoration opportunities within urban subwatersheds. The USSR is designed to assess upland areas outside the stream corridor for behaviors that can influence water quality and to identify promising restoration project opportunities. For more details on the USSR and guidance for completing the field forms, see Wright *et al.,* 2004.

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:**	
DATE: ___/___/_____	**ASSESSED BY:**	**CAMERA ID:**	**PIC#:**

A. NEIGHBORHOOD CHARACTERIZATION

Neighborhood/Subdivision Name: ____ Neighborhood Area (acres) _______

If unknown, address (or streets) surveyed:

____

Homeowners Association? ☐ Y ☐ N ☐ Unknown If yes, name and contact information: ___________________________

Residential *(circle average single family lot size):* ___________________________

☐ Single Family Attached (Duplexes, Row Homes) <⅛ ⅛ ¼ ⅓ ⅓ acre ☐ Multifamily (Apts, Townhomes, Condos)

☐ Single Family Detached <¼ ¼ ½ 1 >1 acre ☐ Mobile Home Park

		INDEX*
Estimated Age of Neighborhood: _____ years	Percent of Homes with Garages: _____% With Basements ____%	
Sewer Service? ☐ Y ☐ N		○
Index of Infill, Redevelopment, and Remodeling ☐ No Evidence ☐ <5% of units ☐ 5-10% ☐ >10%		○

Record percent observed for each of the following indicators, depending on applicability and/or site complexity	**Percentage**	**Comments/Notes**	
B. YARD AND LAWN CONDITIONS			
B1. % of lot with impervious cover			
B2. % of lot with grass cover			○
B3. % of lot with landscaping (e.g., mulched bed areas)			◇
B4. % of lot with bare soil			○
**Note: B1 through B4 must total 100%*			
B5. % of lot with forest canopy			◇
B6. Evidence of permanent irrigation or "non-target" irrigation			○
B7. Proportion of *total neighborhood* turf lawns with following management status:	High: ____		○
	Med: ____		
	Low: ____		
B8. Outdoor swimming pools? ☐Y ☐N ☐ Can't Tell Estimated # ____			○
B9. Junk or trash in yards? ☐ Y ☐ N ☐ Can't Tell			○
C. DRIVEWAYS, SIDEWALKS, AND CURBS			
C1. % of driveways that are impervious ☐ N/A			
C2. Driveway Condition ☐ Clean ☐ Stained ☐ Dirty ☐ Breaking up			○
C3. Are sidewalks present? ☐ Y ☐ N If yes, are they on one side of street ☐ or along both sides ☐			
☐ Spotless ☐ Covered with lawn clippings/leaves ☐ Receiving 'non-target' irrigation			○
What is the distance between the sidewalk and street? _____ ft.			◇
Is pet waste present in this area? ☐ Y ☐ N ☐ N/A			○
C4. Is curb and gutter present? ☐ Y ☐ N If yes, check all that apply:			
☐ Clean and Dry ☐ Flowing or standing water ☐ Long-term car parking ☐ Sediment			○
☐ Organic matter, leaves, lawn clippings ☐ Trash, litter, or debris ☐ Overhead tree canopy			◇

* INDEX: ○ denotes potential pollution source; ◇ denotes a neighborhood restoration opportunity

D. ROOFTOPS			
D1. Downspouts are directly connected to storm drains or sanitary sewer			◇ ○
D2. Downspouts are directed to impervious surface			
D3. Downspouts discharge to pervious area			
D4. Downspouts discharge to a cistern, rain barrel, etc.			
**Note: C1 through C4 should total 100%*			
D5. Lawn area present downgradient of leader for rain garden? ☐ Y ☐N			◇
E. COMMON AREAS			
E1. Storm drain inlets? ☐ Y ☐ N If yes, are they stenciled? ☐ Y ☐ N Condition: ☐ Clean ☐ Dirty			◇
Catch basins inspected? ☐ Y ☐ N If yes, include Unique Site ID from SSD sheet: ________________			○
E2. Storm water pond? ☐ Y ☐ N Is it a ☐ wet pond or ☐ dry pond? Is it overgrown? ☐ Y ☐ N What is the estimated pond area? ☐ <1 acre ☐ about 1 acre ☐ > 1 acre			◇
E3. Open Space? ☐ Y ☐ N If yes, is pet waste present? ☐ Y ☐ N dumping? ☐ Y ☐ N			○
Buffers/floodplain present: ☐ Y ☐ N If yes, is encroachment evident? ☐ Y ☐ N			
F. INITIAL NEIGHBORHOOD ASSESSMENT AND RECOMMENDATIONS			
Based on field observations, this neighborhood has significant indicators for the following: (*check all that apply*) ☐ Nutrients ☐ Oil and Grease ☐ Trash/Litter ☐ Bacteria ☐ Sediment ☐ Other ________________			○

Recommended Actions

Specific Action

- ☐ Onsite retrofit potential?
- ☐ Better lawn/landscaping practice?
- ☐ Better management of common space?
- ☐ Pond retrofit?
- ☐ Multi-family Parking Lot Retrofit?
- ☐ Other action(s) ________________________

Describe Recommended Actions:

Initial Assessment

NSA Pollution Severity Index

- ☐ Severe (More than 10 circles checked)
- ☐ High (5 to 10 circles checked)
- ☐ Moderate (Fewer than 5 circles checked)
- ☐ None (No circles checked)

Neighborhood Restoration Opportunity Index

- ☐ High (More than 5 diamonds checked)
- ☐ Moderate (3-5 diamonds checked)
- ☐ Low (Fewer than 3 diamonds checked)

NOTES:

WATERSHED:	**SUBWATERSHED:**		**UNIQUE SITE ID:**
DATE: ___/___/_____	**ASSESSED BY:**	**CAMERA ID:**	**PIC#:**
MAP GRID:	**LAT** ___°_____'_____" **LONG** ___°_____'____"		**LMK #**

A. SITE DATA AND BASIC CLASSIFICATION

Name and Address: ___________________
____
____

Category: ☐ Commercial ☐ Industrial ☐ Institutional ☐ Municipal ☐ Transport-Related
Miscellaneous ☐ Golf Course ☐ Marina ☐ Animal Facility

SIC code (if available): ___________

NPDES Status: ☐ Regulated ☐ Unregulated ☐ Unknown

Basic Description of Operation: _________________________________

	INDEX*
B. VEHICLE OPERATIONS ☐ **N/A** *(Skip to part C)*	**Observed Pollution Source?** ☐
B1. Types of vehicles: ☐ Fleet vehicles ☐ School buses ☐ Other: ____________	
B2. Approximate number of vehicles: _______	
B3. Vehicle activities *(circle all that apply)*: Maintained Repaired Recycled Fueled Washed Stored	○
B4. Are vehicles stored and/or repaired outside? ☐ Y ☐ N ☐ Can't Tell Are these vehicles lacking runoff diversion methods? ☐ Y ☐ N ☐ Can't Tell	○
B5. Is there evidence of spills/leakage from vehicles? ☐ Y ☐ N ☐ Can't Tell	○
B6. Are uncovered outdoor fueling areas present? ☐ Y ☐ N ☐ Can't Tell	○
B7. Are fueling areas directly connected to storm drains? ☐ Y ☐ N ☐ Can't Tell	○
B8. Are vehicles washed outdoors? ☐ Y ☐ N ☐ Can't Tell Does the area where vehicles are washed discharge to the storm drain? ☐ Y ☐ N ☐ Can't Tell	○
C. OUTDOOR MATERIALS ☐ **N/A** *(Skip to part D)*	**Observed Pollution Source?** ☐
C1. Are loading/unloading operations present? ☐ Y ☐ N ☐ Can't Tell If yes, are they uncovered *and* draining towards a storm drain inlet? ☐ Y ☐ N ☐ Can't Tell	○
C2. Are materials stored outside? ☐ Y ☐ N ☐ Can't Tell If yes, are they ☐ Liquid ☐ Solid Description: _______ Where are they stored? ☐ grass/dirt area ☐ concrete/asphalt ☐ bermed area	○
C3. Is the storage area directly or indirectly connected to storm drain (circle one)? ☐ Y ☐ N ☐ Can't Tell	○
C4. Is staining or discoloration around the area visible? ☐ Y ☐ N ☐ Can't Tell	○
C5. Does outdoor storage area lack a cover? ☐ Y ☐ N ☐ Can't Tell	○
C6. Are liquid materials stored *without* secondary containment? ☐ Y ☐ N ☐ Can't Tell	○
C7. Are storage containers missing labels or in poor condition (rusting)? ☐ Y ☐ N ☐ Can't Tell	○
D. WASTE MANAGEMENT ☐ **N/A** *(Skip to part E)*	**Observed Pollution Source?** ☐
D1. Type of waste *(check all that apply)*: ☐ Garbage ☐ Construction materials ☐ Hazardous materials	○
D2. Dumpster condition (*check all that apply)*: ☐ No cover/Lid is open ☐ Damaged/poor condition ☐ Leaking or evidence of leakage (stains on ground) ☐ Overflowing	○
D3. Is the dumpster located near a storm drain inlet? ☐ Y ☐ N ☐ Can't Tell If yes, are runoff diversion methods (berms, curbs) lacking? ☐ Y ☐ N ☐ Can't Tell	○
E. PHYSICAL PLANT ☐ **N/A** *(Skip to part F)*	**Observed Pollution Source?** ☐
E1. Building: Approximate age: ________ yrs. Condition of surfaces: ☐ Clean ☐ Stained ☐ Dirty ☐ Damaged Evidence that maintenance results in discharge to storm drains (staining/discoloration)? ☐ Y ☐ N ☐ Don't know	○ ○

*Index: ○ denotes potential pollution source; ☐ denotes confirmed polluter (evidence was seen)

E2. Parking Lot: Approximate age _____ yrs. Condition: ☐ Clean ☐ Stained ☐ Dirty ☐ Breaking up Surface material ☐ Paved/Concrete ☐ Gravel ☐ Permeable ☐ Don't know	○
E3. Do downspouts discharge to impervious surface? ☐ Y ☐ N ☐ Don't know ☐ None visible Are downspouts directly connected to storm drains? ☐ Y ☐ N ☐ Don't know	○
E4. Evidence of poor cleaning practices for construction activities (stains leading to storm drain)? ☐ Y ☐ N ☐ Can't Tell	○
F. TURF/LANDSCAPING AREAS ☐ **N/A** *(skip to part G)*	**Observed Pollution Source?** ☐
F1. % of site with: Forest canopy ____% Turf grass _____ % Landscaping ____% Bare Soil ____%	○
F2. Rate the turf management status: ☐ High ☐ Medium ☐ Low	○
F3. Evidence of permanent irrigation or "non-target" irrigation ☐ Y ☐ N ☐ Can't Tell	○
F4. Do landscaped areas drain to the storm drain system? ☐ Y ☐ N ☐ Can't Tell	○
F5. Do landscape plants accumulate organic matter (leaves, grass clippings) on adjacent impervious surface? ☐ Y ☐ N ☐ Can't Tell	○
G. STORM WATER INFRASTRUCTURE ☐ **N/A** *(skip to part H)*	**Observed Pollution Source?** ☐
G1. Are storm water treatment practices present? ☐ Y ☐ N ☐ Unknown If yes, please describe: _________________	○
G2. Are private storm drains located at the facility? ☐ Y ☐ N ☐ Unknown Is trash present in gutters leading to storm drains? If so, complete the index below.	○

Index Rating for Accumulation in Gutters

	Clean				Filthy
Sediment	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Organic material	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Litter	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

G3. Catch basin inspection – Record SSD Unique Site ID here: ________ Condition: ☐ Dirty ☐ Clean

H. INITIAL HOTSPOT STATUS - INDEX RESULTS

☐ Not a hotspot (fewer than 5 circles and no boxes checked) ☐ Potential hotspot (5 to 10 circles but no boxes checked)
☐ Confirmed hotspot (10 to 15 circles and/or 1 box checked) ☐ Severe hotspot (>15 circles and/or 2 or more boxes checked)

Follow-up Action:

☐ Refer for immediate enforcement
☐ Suggest follow-up on-site inspection
☐ Test for illicit discharge
☐ Include in future education effort
☐ Check to see if hotspot is an NPDES non-filer
☐ Onsite non-residential retrofit
☐ Pervious area restoration; complete PAA sheet and record
Unique Site ID here: ____________________
☐ Schedule a review of storm water pollution prevention plan

Notes:

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:**	
DATE: ___/___/_____	**ASSESSED BY:**	**CAMERA ID:**	**PIC #:**
MAP GRID:	**LAT** ___°_____'_____" **LONG** ___°_____'_____"		**LMK #**

A. PARCEL DESCRIPTION

Size: ___acre(s) Access to site (*check all that apply*): ☐ Foot access ☐ Vehicle access ☐ Heavy equipment access
Ownership: ☐ Private ☐ Public Current Management: ☐ School ☐ Park ☐ Right-of-way ☐ Vacant land
☐ Other (please describe) ____
Contact Information: ____
Connected to other pervious area? ☐ Y ☐ N If yes, what type? ☐ Forest ☐ Wetland ☐ Other ________________
Estimated size of connected pervious area: ____ acre(s) Record Unique Site ID of connected fragment: ____________

PART I. NATURAL AREA REMNANT

FOREST

B. CURRENT VEGETATIVE COVER

B1. Percent of forest with the following canopy coverage:
Open _____% Partly shaded _____% Shaded _____%
**Note – these should total 100%*
B2. Dominant tree species: ________________________
____
B3. Understory species: ________________________
____
B4. Are invasive species present? ☐ Y ☐ N
☐ Unknown
If yes, % of forest with invasives: _______
Species: ________________________________

C. FOREST IMPACTS

C1. Observed Impacts (*check all that apply*): ☐ Animals ☐ Clearing/encroachment ☐ Trash and dumping ☐ Storm water runoff ☐ Other

D. NOTES

WETLAND

B. CURRENT VEGETATIVE COVER

B1. % of wetland with following vegetative zones:
Aquatic: __________
Emergent: __________
Forested: __________
**Note – these should total 100%*
B2. Dominant species: ____________________________
____
B3. Are invasive species present? ☐ Y ☐ N
☐ Unknown
If yes, % of wetland with invasives: _______
Species: ________________________________

C. WETLAND IMPACTS

C1. Observed Impacts (*check all that apply*): ☐ Animals ☐ Clearing/encroachment ☐ Trash and dumping ☐ Storm water runoff ☐ Hydrologic impacts ☐ Other

D. NOTES

E. INITIAL RECOMMENDATION

☐ Good candidate for conservation/protection
☐ Potential restoration candidate
☐ Poor restoration or conservation candidate

PART II. OPEN PERVIOUS AREAS

A. CURRENT VEGETATIVE COVER

A1. Percent of assessed surface with:
Turf _____% Other Herbaceous _____% None (bare soil) _____% Trees _____% Shrubs ____ % Other _____%
(please describe): ____ **Note – these should total 100%*

A2. Turf: Height: _____ inches Apparent Mowing Frequency: ☐ Frequent ☐ Infrequent ☐No-Mow ☐ Unknown
Condition (*check all that apply*): ☐ Thick/Dense ☐ Thin/Sparse ☐ Clumpy/Bunchy ☐ Continuous Cover

A3. Thickness of organic matter at surface: _______ inches

A4. Are invasive species present? ☐ Y ☐ N ☐ Unknown If yes, % of site with invasives: _____
Species:____

B. IMPACTS

B1. Observed Impacts (*check all that apply*): ☐ Soil Compaction ☐ Erosion ☐ Trash and Dumping
☐ Poor Vegetative Health ☐ Other (describe): _____________________________________

C. REFORESTATION CONSTRAINTS

C1. Sun exposure: ☐ Full sun ☐ Partial sun ☐ Shade ☐ Unknown

C2. Nearby water source? ☐ Y ☐ N ☐ Unknown

C3. Other constraints: ☐ Overhead wires ☐ Underground Utilities ☐ Pavement ☐ Buildings
☐ Other (please describe): ___________________

D. NOTES

E. INITIAL RECOMMENDATION

☐ Good candidate for natural regeneration
☐ May be reforested with minimal site preparation
☐ May be reforested with extensive site preparation
☐ Poor reforestation or regeneration site

PART III. SKETCH

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:**
DATE: ___/___/_____	**ASSESSED BY:**	**CAMERA ID:**
MAP GRID	**RAIN IN LAST 24 HOURS** ☐ Y ☐ N	**PIC #**

A. LOCATION

A1. Street names or neighborhood surveyed:

____

A2. Adjacent land use: ☐ Residential ☐ Commercial ☐ Industrial ☐ Institutional ☐ Municipal ☐ Transport-Related

A3. Corresponding HSI or NSA field sheet? If so, circle HSI or NSA and record its Unique Site ID here ______________

B. STREET CONDITIONS

B1. Road Type: ☐ Arterial ☐ Collector ☐ Local ☐ Alley ☐ Other: __________

B2. Condition of Pavement: ☐ New ☐ Good ☐ Cracked ☐ Broken

B3. Is on-street parking permitted ☐ Y ☐ N If yes, approximate number of cars per block: _________

B4. Are large cul-de-sacs present? ☐ Y ☐ N

B5. Is trash present in curb and gutter? If so, use the index to the right to record amount.	Index Rating for Accumulation in Gutters				
	Clean				Filthy
Sediment	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Organic Material	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Litter	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

C. STORM DRAIN INLETS AND CATCH BASINS

C1. Type of storm drain conveyance: ☐ open ☐ enclosed ☐ mixed

C2. Percentage of inlets with catch basin storage: _________ ☐ N/A

Sample 1-2 catch basins per NSA/HSI	**C3.** Catch basin #1	**C4.** Catch basin #2
Latitude	___° _____' _____"	___° _____' _____"
Longitude	___° _____' _____"	___° _____' _____"
LMK #		
Picture #		
Current Condition	☐ Wet ☐ Dry	☐ Wet ☐ Dry
Condition of Inlet	☐Clear ☐Obstructed	☐Clear ☐Obstructed
Litter Accumulation	☐Y ☐ N	☐Y ☐ N
Organics Accumulation	☐Y ☐ N	☐Y ☐ N
Sediment Accumulation	☐Y ☐ N	☐Y ☐ N
Sediment Depth (in feet)	___________ ft.	___________ ft.
Water Depth	___________ ft.	___________ ft.
Evidence of oil and grease	☐Y ☐ N	☐Y ☐ N
Sulfur smell	☐Y ☐ N	☐Y ☐ N
Accessible to vacuum truck	☐Y ☐ N	☐Y ☐ N

D. NON-RESIDENTIAL PARKING LOT (>2 acres)

D1. Approximate size: __________ acres

D2. Lot Utilization: ☐ Full ☐ About half full ☐ Empty

D3. Overall condition of Pavement: ☐ Smooth (no cracks) ☐ Medium (few cracks) ☐ Rough (many cracks) ☐ Very Rough (numerous cracks and depressions)

D4. Is lot served by a storm water treatment practice? ☐ Y ☐ N If yes, describe: ________________________

D5. On-site retrofit potential: ☐ Excellent ☐ Good ☐ Poor

E. MUNICIPAL POLLUTANT REDUCTION STRATEGIES

E1. Degree of pollutant accumulation in the system: ☐ High ☐ Medium ☐ Low ☐ None

E2. Rate the feasibility of the following pollution prevention strategies:

Street Sweeping:	☐ High	☐ Moderate	☐ Low
Storm Drain Stenciling:	☐ High	☐ Moderate	☐ Low
Catch Basin Clean-outs:	☐ High	☐ Moderate	☐ Low
Parking Lot Retrofit Potential:	☐ High	☐ Moderate	☐ Low

CATCH BASIN SKETCHES

#1

#2

Notes:

Tool 19
Project Investigation Field Sheets

This tool contains a variety of field sheets designed to aid watershed planning by collecting more information on the feasibility of potential restoration sites and developing a workable concept design to narrow down project choices to a manageable level. The following field sheets are available here, and more information and guidance for completing each of the field forms are available in the references below:

Retrofit Reconnaissance Inventory (see CWP, 2006, in press)
Stream Repair Investigation (see Schueler and Brown, 2004)
Urban Reforestation Site Assessment (see Cappiella *et al.*, 2005)
Discharge Prevention Investigations (see Brown *et al.*, 2004)
Contiguous Forest Assessment (see CWP, 2002a)
Rare, Threatened, and Endangered Species Assessment (see CWP, 2002a)

Also included are links to Additional Sensitive Area Assessments

1. **Subwatershed:** ________________ **Site Number:** ____________ **Site Name:** ______________________

2. **Location (Coordinates):** **(Latitude:**____________**Longitude:**____________**)**

   Location (Coordinates) ______________
From County ADC/Locator Map
Indicated by coordinates and quadrants on the map pages (e.g., H3 NW)

   Street Name ____

   Subdivision or Business Name ____

   Notes:

____

____

3. **Describe existing site conditions, including drainage structures/patterns**
   - ☐ Existing Facility **Type**____
   - ☐ Unmanaged Existing Development
   - ☐ Site Identified during stream assessment (e.g., USA, RSAT, RBP)

____

____

____

____

____

____

____

____

4. **Property Ownership (public or private):** __________________

5. **Date of Preliminary Survey:** __________________

6. **Surveyors:** __________________

7. **Photo Roll and Picture #:** **Roll # :**_______ **Photo #:** _______

8. Drainage Area: ___________________

9. Describe drainage area land use:

10. Approximate Imperviousness (%): ___________________

11. Retrofit Volume Computations (i.e., target and available storage):

☐ WQ_v ☐ Cp_v ☐ Q_p

12. Describe elements of potential retrofit:

☐ On-line retrofit ☐ Off-line retrofit

13. Adjacent Land Use (possible conflicts):

____

____

14. Conflicts with Existing Utilities:

____

____

____

15. Construction and Maintenance Access:

____

____

____

16. Wetlands Present? ☐ **Yes** ☐ **No** ☐ **Maybe**

If yes, describe:

____

____

____

____

17. Forested Area or Other Sensitive Areas Present? ☐ **Yes** ☐ **No**

If yes, describe:

____

____

18. Other factors that may increase cost or affect feasibility:

19. Additional Notes and/or Sketch Information:
(Include key existing features and proposed design)

20. Site Candidate for Further Investigation: ☐ **Yes** ☐ **No**

Feasibility	**High**	**5**	**4**	**3**	**2**	**1**	**Low**
Benefits	**High**	**5**	**4**	**3**	**2**	**1**	**Low**

Stream Repair Investigation Form

PROJECT:	**DATE:** ______/______/______	**ASSESSED BY:**
SUBWATERSHED:	**PHOTO ID** (Camera-Pic#): /#	

USA RCH ID:	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** ______	**CONCEPT NO:**
	END **LAT** ____°____'____" **LONG** ____°____'____" **LMK** ______	

INDEX OF USA FORMS

OT:	TR:
ER:	SC:
IB:	CM:
UT:	RCH:

AVERAGE REACH DIMENSIONS (from RCH**)**

BANK OF CONCERN ☐ LT ☐ RT ☐ Both

Length	LT_______ft	RT________ft	Avg bankfull height	______ft
Avg Bank Ht	LT______ft	RT________ft	Avg bottom width	_______ft
Avg Bank Angle	LT______°	RT______°	Avg top width	_______ft
			Avg wetted width	_______ft

Land ownership ☐ Public ☐ Private ☐ Don't Know ☐ Other:

Available riparian corridor ☐ <25 ft ☐ 26 - 50 ft ☐ 51-75ft ☐ 76-100ft ☐ >100ft

CORRIDOR VEGETATION ☐ Mature wooded ☐ Scrub/shrub ☐ Grass or turf ☐ Other:

Degradation severity	**Adjusted channel**: Grade and width fairly stable, with relatively isolated of bank erosion; and poor instream habitat conditions.	**Past downcutting** evident, active stream widening, banks actively eroding at a moderate rate.	**Active Downcutting:** Tall unstable banks on both sides of the stream eroding at a fast rate; erosion contributing significant sediment loads to stream.
	5 4	3	2 1
Upstream/Downstream condition	Upstream and downstream reaches assessed as good or fair.	Either upstream or downstream reach assessed as poor with other assessed as fair/good.	Both upstream and downstream reaches assessed as poor.
	5 4	3	2 1
Construction access to stream	**Good:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	**Difficult:** Must cross wetland, steep slope, or other sensitive areas to access stream, Minimal stockpile areas and/or located a great distance from stream section. Specialized heavy equipment required
	5 4	3	2 1
Infrastructure constraints	Sewers or other infrastructure are **not** present in the project reach corridor	Sewers, other utilities or structures are present in the project reach corridor any may constrain project design	Presence of sewers and other infrastructure will greatly impact project design and may require expensive relocation.
	5 4	3	2 1
Restoration Outcome Potential	Repair expected to restore stable, vegetated streambanks using mostly soft stabilization practices, reconnect floodplain, and significantly improve habitat	Repair expected to restore streambank stability with a mix of rigid and soft streambank stabilization practices, and moderately improve stream habitat conditions	Restoration will structurally maintain stable streambanks using predominately hard streambank protection practices, maintain existing sediment transport regime, little habitat improvement
	5 4	3	2 1
Upstream land use	Older (30-40+ yrs), well-established neighborhoods or commercial areas. Little or no new development expected	A mix of older (30-40+ yrs) development and newer (<10-20 yrs) development. Some new development or redevelopment possible	Most of subwatershed has developed in last ten years, and significant future development is possible
	5 4	3	2 1
Upstream retrofit potential	Upstream retrofits expected to significantly reduce stormwater flows to project reach	Upstream stormwater retrofits expected to produce only marginal reductions in stormwater flows and pollutant loads	No upstream retrofit opportunities exist, existing hydrology will not be improved
	5 4	3	2 1
Scope of planned stream repair	**Comprehensive:** major change in planform, grade, or cross-section of channel, many practices	**Moderate**: Combination of individual stream repair practices, but only minor changes in channel dimensions	**Simple**: use of a few stream repair practices to address a problem at a defined point
	5 4	3	2 1

Concept Sketch: Plan View of stream with approximate locations of stream repair practices	**PROPOSED STREAM REPAIR PRACTICES**
	☐ A. Rigid Bank stabilization _______________linear feet ☐ B. Soft bank stabilization _______________ linear feet ☐ C. Flow deflection _____________# of structures ☐ D. Grade control _____________# of structures ☐ E. Habitat structures _____________# of structures ☐ F. Flow diversion _____________# of structures ☐ G. Fish passage _____________# of structures ☐ H. Comprehensive _______________ linear feet ☐ I. Other:
Comments on Project Design (include any special supplemental design studies or permits needed)	**Planning Level Cost Estimate**

Urban Reforestation Site Assessment (URSA)

1. General Site Information

Location:

Property owner:

Current landuse:

2. Climate

USDA plant hardiness zone:

Sunlight exposure:

- ☐ Full sun (6 hours or more of direct sun per day)
- ☐ Part sun or filtered light (< 6 hours per day)
- ☐ Shade (< 3 hours of direct sun per day)

Micro-climate features (check if present):

- ☐ High wind exposure
- ☐ Re-reflected heat load
- ☐ Other:

3. Topography

Steep slopes

Are any slopes > 15% present in the proposed planting area? Y/N

If Yes, estimate slope:

Low-lying areas

Are any low-lying areas present in the proposed planting area? Y/N

Notes:

4. Vegetation

Regional forest association (or dominant species from reference site):

Current vegetative cover (check all that apply):

- ☐ Mowed turf
- ☐ Other herbaceous
- ☐ None
- ☐ Trees or shrubs

  Note species to be preserved:

Are invasive plants/noxious weeds present? Y/N

If Yes, note species and % coverage at site

Adjacent vegetative cover:

Is forest present? Y/N

If Yes, note dominant species:

Are invasive plants/noxious weeds present? Y/N

If Yes, note species and % coverage at site

5. Soils

Texture:

- ☐ Clay
- ☐ Loam
- ☐ Sand

Drainage:

- ☐ Poor (< 1” per hour)
- ☐ Moderate (1” - 6” per hour)
- ☐ Excessive (> 6” per hour)

Compaction:

- ☐ None
- ☐ Moderate
- ☐ Severe

pH:

- ☐ Acid (5.0 – 6.8)
- ☐ Neutral (6.8 – 7.2)
- ☐ Alkaline (7.2 – 8.0)

Other soil features (check if present and describe:

- ☐ Active or severe soil erosion
- ☐ Potential soil contamination
- ☐ Debris and rubble in soil
- ☐ Recent construction or other soil disturbance
- ☐ Other:

Soil Quality

List results of soil tests if applicable (e.g., levels of phosphorus, salt, or organic matter in the soil). Describe any visual indicators of soil quality.

6. Hydrology

Site hydrology:

- ☐ Upland
- ☐ Riparian

Note: For riparian planting sites where planting is proposed on both stream banks, fill this section out for each bank individually

Stormwater runoff to planting site (check all that apply):

- ☐ Bypasses site in pipe
- ☐ Upslope drainage area outfalls to site

  Note diameter of pipe outfall:
- ☐ Open channel directs flow across or around the site
- ☐ Shallow concentrated flow (e.g., evidence includes rills, gullies, sediment deposits)
- ☐ Sheetflow
- ☐ Unknown

Contributing flow length:

Slope: _____%

Length: _____ft

Dominant cover type:

- ☐ Impervious
- ☐ Pervious

Floodplain connection (riparian areas only):

Are levees present? Y/N

Bank height: _____ft

Depth to water table (optional): _____ft

Stream order: _____

Notes or Sketch:

7. Potential Planting Conflicts

Space limitations (check if present, and note height of overhead wires, signs and lighting):

- ☐ Overhead wires: _____ft
- ☐ Pavement
- ☐ Buildings
- ☐ Signs: _____ft
- ☐ Lighting: _____ft
- ☐ Sewer and drainage pipes
- ☐ Underground utilities
- ☐ Other:

Other limiting factors (check if present and describe below):

- ☐ Trash dumping/debris
  Note type of trash, volume (estimated pickup truck loads), and source if known:
- ☐ Deer, beaver or other animal impacts
- ☐ Mowing conflict (e.g., site is mowed regularly)
- ☐ Wetland present
- ☐ Insect infestation or disease
- ☐ Heavy pedestrian traffic
- ☐ Other:

Notes:

Local Ordinance Setbacks

Check local ordinances and note any required setbacks from these features.

8. Planting and Maintenance Logistics

Site access (check if present):

- ☐ Delivery access for planting materials
- ☐ Temporary storage areas for soils, mulch, etc.
- ☐ Heavy equipment access
- ☐ Volunteer parking
- ☐ Nearby facilities for volunteers

Party responsible for maintenance (if known):

Water source (check all that apply):

- ☐ Rainfall only
- ☐ Storm water runoff
- ☐ Hose hook-up nearby
  Note distance from hook-up to planting area (ft):
- ☐ Irrigation system in place
- ☐ Overbank flow from river or stream
- ☐ Fire hydrant nearby
- ☐ Other:

9. Site Sketch

Sketch the site below and include the following features at a minimum:

- ☐ Property boundary, landmark features (e.g., roads, streams) and adjacent land use/cover
- ☐ Boundary and approximate dimensions of proposed planting area
- ☐ Variations in sun exposure, microclimate and topography within planting area
- ☐ Current vegetative cover, and location of trees to be preserved and invasive species
- ☐ Location and results of soils samples (if variable)
- ☐ Flow paths to planting area and contributing flow length
- ☐ Above or below ground space limitations (e.g., utilities, buildings)
- ☐ Other limiting factors (e.g., trash dumping, pedestrian paths)
- ☐ Water source and access points
- ☐ Scale and north arrow

OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours: Last 48 hours:		
Latitude:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	

Land Use in Drainage Area (Check all that apply):

☐ Industrial
☐ Ultra-Urban Residential
☐ Suburban Residential
☐ Commercial
☐ Open Space
☐ Institutional
Other: ____
Known Industries: ______________________________________

Notes (e.g., origin of outfall, if known):

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ **Closed Pipe**	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: __________	☐ Circular ☐ Eliptical ☐ Box ☐ Other: _____	☐ Single ☐ Double ☐ Triple ☐ Other: _____	Diameter/Dimensions: ______________________	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ **Open drainage**	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____	☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ **In-Stream**	**(applicable when collecting samples)**				
Flow Present?	☐ Yes ☐ No ***If No, Skip to Section 5***				
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial				

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		**RESULT**	**UNIT**	**EQUIPMENT**
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	_____' _____"	Ft, In	Tape measure
	Measured length	_____' _____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only

Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls

Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

1.	Sample for the lab?	☐ Yes	☐ No	
2.	If yes, collected from:	☐ Flow	☐ Pool	
3.	Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM ☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

UPLAND CONTIGUOUS FOREST
FIELD DATA SHEET

PROJECT	**LOCATION**
STATION #	**INVESTIGATORS**
LATITUDE	**LONGITUDE**
FORM COMPLETED BY	**PICTURE #**
DATE ________ **TIME_________ AM PM**	**WEATHER**

ECOREGION/ FOREST ASSOCIATION				
# OF TREES IN PRISM & DBH	Number		DBH	
DOMINANT TREE SPECIES				
SPECIMEN OR RARE SPECIES	Rank (1-5) 5 being highest Describe			
DENSIOMETER READING (# of squares >3/4 filled/total # squares)	North ___/24 = ____%	South ___/24 = ____%	East ___/24 = ____%	West ___/24 = ____%
	Average of above readings = ____%			
WETLAND?	Soils Y N	Hydrology Y N	Plants Y N	
UNDERSTORY CHARACTERIZATION	Dense, Medium, Sparse	Dominant species:		
HABITAT COMPLEXITY	Canopy, Mid Canopy, Understory 3 present 2 present 1 present			
FORBES (herbaceous cover)	Dense, Medium, Sparse			
EVIDENCE OF DISRUPTION AND EXTENT (%)	Natural (ie. storm, disease, deer browsing) Extent (% site coverage)	Anthropogenic (ie. clearing, dirt road, timber harvesting , trash) Extent (% site coverage)		
INVASIVES	Species	Dense, Medium, Sparse	Extent (% site coverage)	
SIZE OF TRACT	Acres			
WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Residential ❑ Other ________________	**Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources		

Explanation of Contiguous Forest Field Data Sheet

Representative or random sites should be chosen for the Contiguous Forest Assessment. Enough points should be chosen to provide a good representative characterization of the land under consideration for protection. General guidance is to sample at least 2 points for less than 100 acres of forest, and at least 4 points for up to 1000 acres of forest.

PROJECT: Project name. Typically refers to the watershed being studied

LOCATION: Station location description (i.e. 100 meters NE of the corner of Rt. 5 and Boon Drive).

STATION #: A unique station identifier. Usually refers the subwatershed being studied (e.g., Scotts Level subwatershed Site #1 might be called SL-1).

INVESTIGATORS: Initials of investigators assessing the site (useful if clarification of the data sheet is needed).

LATITUDE/ LONGITUDE: Use a GPS unit to determine the latitude and longitude of the specific location. If you do not have a GPS unit, an estimate of the location should be made using aerial/orthophoto maps.

PICTURE NUMBERS: Roll and photo numbers for any pictures taken at the site.

FORM COMPLETED BY: Initials of investigator completing the form (often necessary for deciphering hand writing).

WEATHER: Describe the current weather (e.g, sunny, rainy, snowing).

DATE: Day, month and year the survey was completed.

TIME_________ AM PM: Time the survey was completed.

ECOREGION/ Forest Classification: By pre-identifying the eco-region and forest association, the investigator will have an idea of what to expect and what issues may be facing that region. Ecoregion information is available at www.natureserve.org

 # OF TREES IN PRISM and DBH: Number of trees in Prism refers to a 10 Basal Area Factor (BAF) Prism which is used to select out the larger trees at a given site. The size of the trees is quantified by DBH, or Diameter at Breast Height.

DOMINANT TREE SPECIES PRESENT: Common and/or scientific name of dominant tree species present. Be as specific as possible (i.e. chinquapin oak, loblolly pine).

SPECIMEN OR RARE SPECIES: Give each site a rank from 1 to 5 (5 being the highest) based on the presence, age, height, location, and health of rare or specimen species present. For example, the presence of old growth trees, rare plant species, or habitat for an endangered species would constitute a high score of 5. Large mature trees and good quality forest would constitute a score of 3 or 4. A site with only 1 specimen tree might receive a rank of 2, while a site with young trees and no rare species would score a 1. The ranking system may vary and should be pre-determined.

DENSIOMETER READING: A spherical densiometer is used to measure the density of the forest canopy. In other words, you are quantifying how much of the sky above you is blocked by trees. To use a densiometer correctly it must be held level about 12-18” in front of you. When looking into the densiometer you can see the trees above you and grid marks on the densiometer mirror. Count and record the number of grid squares that are more than ¾ filled with tree images as well as the total number of squares to calculate the percent coverage. A densiometer reading should be taken at each of the four compass directions. Take the average of the four readings to get a canopy density % for the site. If the canopy density is greater than 50%, the canopy is closed. If the density is less than 50%, the canopy is open. Densiometers are available through forestry supply companies. As there may be some variation between types, follow manufacturers instructions.

WETLAND: Are there wetlands present? This can be difficult to determine since the time of year and amount of recent rainfall can greatly influence your findings. Knowledgeable personnel and wetland identification guides may be necessary to help determine if wetlands are present.
Soils: Are the soils hydric? Y/N
Hydrology: Is there standing water? Y/N
Plants: Are there wetland plants? Y/N

UNDERSTORY CHARACTERIZATION: Understory refers to the trees located entirely below the general level of the canopy that receive little or no sunlight from above or the sides. Indicate if understory is dense, medium, or sparse and identify the dominant species.

HABITAT COMPLEXITY: Circle the number of different habitats (canopy, mid-canopy, and understory/shrubs) present: 3 present 2 present 1 present.

FORBES: Forbes are herbaceous groundcover, including vegetation such as ferns. Indicate if forbes are dense, medium, or sparse.

EVIDENCE OF DISRUPTION AND EXTENT: Describe any evidence of disruption, indicate whether the disruption is natural or anthropogenic and identify the extent (%) of the site affected.

INVASIVE SPECIES: (non-native plants) Invasive species can overrun native species due to lack of natural predators, and often create a monoculture. Identify and describe the type, density (dense, medium, sparse) and extent (% site coverage) of any invasive species present.

SIZE OF TRACT: (acres) Estimate the size of the tract based on topographical maps or GIS data layers.

WATERSHED FEATURES: Identify the predominant surrounding land use and indicate if evidence of local watershed nonpoint source pollution exists. Nonpoint source pollution (NPS) is pollution that cannot be connected to one specific source such as an industrial sewage treatment plant. Examples of NPS pollution may include runoff from golf courses, commercial development, or residential lawns containing fertilizers, pesticides, sediment, metals and other pollutants.

Glossary

Basal Area – The cross-sectional area of a tree at breast height (4.5 feet above ground). The basal area of all trees in a given area represents forest stand density and is measured in square feet per acre.

Biltmore Stick – A measurement tool resembling a yard stick that is used to estimate the diameter and height of a tree.

Caliper – Tree diameter measured at 2 inches above the root collar.

Canopy – The level of the tallest trees overhanging branches that result in the limitation of sunlight reaching lower levels.

Champion Tree – The largest tree of its species within the United States, the state, county or municipality as determined by the state or local Natural Resources Department or similar agency.

Contiguous Forest – Forested land without significant breaks due to roads, power lines or other clearings.

Critical Habitat Area – A critical habitat for all endangered species and its surrounding protection area.

Densiometer – A monitoring tool used to determine the amount of canopy coverage.

Dominant Trees – Trees with crowns extending above the general level of the crown cover and receiving full sunlight from above and partly from the side; typically larger than the average trees in the stand.

Forest Stand Delineation – A methodology for evaluating the existing natural features and vegetation on a site proposed for development, taking into account the environmental elements that shape or influence the structure or makeup of a plant community.

Forest Structure – A measure of vertical and horizontal structural diversity within a stand, which is related to stand age and habitat.

Natural Regeneration – The natural establishment of trees and other vegetation.

Prism – A piece of precisely angled glass used in large forested areas for estimating basal areas, volumes or number of trees per unit area.

Specimen Tree – Trees having a diameter measured at breast height (4.5 feet above the ground) of 30 inches or more, or trees having 75% or more of the diameter of the current state champion tree of that species.

Understory Trees – Trees with crowns entirely below the general level of the canopy receiving little or no sunlight from above or the sides.

RARE AND THREATENED SPECIES
FIELD DATA SHEET

PROJECT:	**LOCATION**
STATION # **TRACT#**	**STOREт #**
LAT ____________LONG __________	**INVESTIGATORS**
FORM COMPLETED BY	**Picture #s**
DATE ________ **TIME_________ AM PM**	**Weather**

Rare or Threatened Species			
Extent of Population *(if known)*			
Evidence of Potential Threats to Population			
Co-occurrence of other RTE species			
Wetland?	Soils	Hydrology	Plants
RPA Protection?			
HABITAT COMPLEXITY	Canopy, Mid Canopy, Understory 3 present 2 present 1 present		
FORBES	Dense, Medium, Sparse		
Evidence of Disruption and Extent (%)	Natural (ie. storm)	Anthropogenic (ie. clearing, dirt road, timber harvesting)	Disease
Presence of Invasives			
WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Residential ❑ Other ________________	**Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources	

<u>Notes or Sketch on Back</u>

Table 1: Links for Additional Sensitive Areas Assessments	
Type of Assessment	*Link to Assessment Method*
Wetland Delineation	U.S. Army Corps of Engineers Wetland Delineation Manual http://www.saj.usace.army.mil/permit/documents/87manual.pdf
Functional Wetland Assessment	Methods for Evaluating Wetland Condition www.epa.gov/waterscience/criteria/wetlands/ A Hydrogeomorphic Classification for Wetlands http://el.erdc.usace.army.mil/emrrp/emris/EMRIS_PDF/wrpde4.pdf Review of Rapid Methods for Assessing Wetland Condition http://www.epa.gov/owow/wetlands/monitor/RapidMethodReview.pdf The Process of Selecting a Wetland Assessment Procedure: Steps and Considerations http://el.erdc.usace.army.mil/emrrp/emris/emrishelp6/the_process_of_selecting_a_wetland_assessment_procedure_steps_and_considerations.htm North Carolina Coastal Region Evaluation of Wetland Significance http://www.nccoastalmanagement.net/Wetlands/NCCREWSDOC.pdf Wetland Rapid Assessment Procedure http://www.sfwmd.gov/org/reg/nrm/wrap99.pdf Field Identification of Potential Freshwater Wetland Restoration Sites http://www.woonasquatucket.org/documents/ID&Nomination.pdf Spatial Wetland Assessment for Management and Planning http://www.csc.noaa.gov/lcr/text/swamp.html
Vegetative Community Survey	USGS-NPS Vegetation Mapping Program http://biology.usgs.gov/npsveg/fieldmethods/index.html Habitat Evaluation Procedures handbook http://policy.fws.gov/ESMindex.html Soil Quality Test Kit Handbook http://soils.usda.gov/sqi/files/KitGuideComplete.pdf
Rare, Threatened and Endangered Species	New York State Natural Heritage Program Rare Plant Field Techniques http://www.dec.state.ny.us/website/dfwmr/heritage/fieldtech.htm Wyoming Natural Diversity Database Plant Species of Concern Survey Form http://uwadmnweb.uwyo.edu/wyndd/Data/plant_survey_form.pdf Minnesota County Biological Survey Rare Plant Survey http://www.dnr.state.mn.us/ecological_services/mcbs/procedures_plants.html Minnesota County Biological Survey Rare Animal Survey http://www.dnr.state.mn.us/ecological_services/mcbs/procedures_animals.html
Forest Stand Delineation/Tree Inventory	USDA Forest Service Volunteer Training Manual (street tree inventory) www.umass.edu/urbantree/volmanual.pdf Urban Forest Health Monitoring Draft Field Manual www.fs.fed.us/ne/syracuse/Tools/UFHMonitoring.htm Trees Approved Technical Manual (Montgomery County, MD) www.mc-mncppc.org/environment/forest/trees/detail_trees.pdf Maryland Green Infrastructure Assessment

	http://dnrweb.dnr.state.md.us/download/bays/gia_doc.pdf

Tool 20
Stakeholder Profile Sheets

This tool contains a series of short fact sheets that summarize the tasks that must be done during the watershed planning process to identify, recruit and structure the involvement of diverse stakeholders during the watershed restoration planning process. The information provided within this tool is an excerpt from the Center for Watershed Protection's Methods to Develop Restoration Plans for Small Urban Watersheds.

S-1

Stakeholder Involvement Methods

Facilitate Stakeholder Consensus

FSC

Purpose

This method seeks to involve the community in setting watershed goals and objectives to guide the restoration effort. The goal is to attract new and existing stakeholders to forums where they can be educated on watershed topics, raise their own issues, and work together to build a consensus on restoration goals.

Scale	Value
Community-wide	Helpful

Key Stakeholder Targets

The lead local restoration agency usually champions the effort by recruiting other local, state and federal environmental agencies, watershed groups, responsible parties, local advisors and elected officials to participate in the goal setting process.

Outreach Techniques

The most common technique in goal setting is a series of facilitated meetings where stakeholders can provide direct input and feedback on goals. Techniques such as newspaper ads, inserts or stories, bill inserts, brochure mailings, newsletters, press releases, and personal contacts can all be used to invite target stakeholders to attend the goal setting process. Passive methods, such as surveys, response sheets, and interviews can also be used to solicit additional input.

Stakeholder Method

Seven tasks are used to facilitate stakeholder consensus include:

1. Recruit the right stakeholders to participate
2. Convene a comfortable forum for them to interact together
3. Set ground rules for participation in the process
4. React to "strawman" document and brainstorm ideas without major editing
5. Break into small groups to refine and narrow down choices
6. Reconvene as a full group to get concurrence on major choices
7. Follow-up with participants to finalize their agreement

Educational Message

Most stakeholders that are initially invited will have some familiarity with watershed topics, but may not be aware of current water quality and natural resource problems. The message in this step should highlight the Existing Data Analysis (EDA) and provide a clear explanation of any regulatory drivers or community issues that are driving restoration (from the NCA).

Advanced Preparation

Many stakeholders can be identified through the NCA checklist, although additional meetings and phone interviews may be needed to expand recruitment.

Follow-up

Stakeholders should get a follow-up mailing or e-mail that contains final draft language on goals and objectives. Remember to maintain contact with these stakeholders throughout the restoration planning process.

Time Frame / Level of Effort

At least three weeks of staff effort is needed to invite stakeholders to goal-setting meetings, prepare and conduct two meetings, and handle needed aftercare.

S-1

Stakeholder Involvement Methods

Facilitate Stakeholder Consensus

FSC

Further Resources

- Chapter 1, *Manual 1: An Integrated Framework for Small Watershed Restoration*
- *Engaging and Involving Stakeholders in Your Watershed* (MacPherson and Tonning, 2004)
- *Goal Setting and Consensus Building*, (RTCAP, 2003)

Tips for Achieving Consensus on Watershed Restoration Goals

- Invite a broad diversity of stakeholders to attend, not just agency stakeholders.
- Make sure to define what is meant by consensus and how it will be determined.
- Initial goals should be clear, numeric, measurable, time-based and linked to environmental indicators the public understands.
- Try to set realistic and achievable expectations for watershed restoration.
- The lead restoration agency should convene the goal setting forum.
- Small group exercises are an excellent way to get good ideas for goals.
- Stakeholder meetings should be facilitated by an independent party.
- At least two meetings are generally needed; the first to solicit broad input on goals, and the second to narrow them down and obtain agreement on them.
- Don't focus exclusively on water quality or habitat. Be prepared to deal with recurring community issues that almost always come up -- recreation, greenways, flooding, waterfront and neighborhood revitalization, enforcement, dumping, and safety.
- The visibility of this initial effort can be raised by inviting local elected officials.

Involve the community in setting restoration goals involves convening a series of stakeholder meetings.

S-2

Stakeholder Involvement Methods

Restoration Education and Outreach

REO

Purpose

Restoration education is intended to motivate stakeholders into action. This method seeks to educate stakeholders about key watershed problems and solutions, familiarize them with the watershed planning effort so far, and invite them to play a direct role. Stakeholders are offered the opportunity to help develop the list of priority subwatersheds to begin working on first.

Scale	Value
Community- or Watershed-wide	Essential

Key Stakeholder Targets

Initial targets include staff within the lead local restoration agency, local environmental agencies, state and federal agencies, watershed and environmental groups, responsible parties, and local advisors. Next, education and outreach efforts are expanded to individuals and groups further down the stakeholder pyramids (see Appendix B).

Stakeholder Method

Three tasks are involved in restoration education and outreach:

1. Translate watershed data into simple and accessible formats
2. Choose outreach techniques to deliver it to watershed stakeholders
3. Create forums where stakeholders can make restoration decisions

Outreach Techniques

Meetings, individual briefings or workshops are often the traditional method to involve stakeholders in restoration. Initial meetings are often needed to solicit input on the priority subwatershed list. Restoration education information can be distributed through project websites, displays in public spaces, newsletters, newspaper articles, presentations, open houses, brochures, and bill inserts. Several outreach techniques should be used to reach stakeholders that cannot attend meetings.

Educational Message

Stakeholders should get progressively more sophisticated messages on watershed problems and the restoration process. Presentations should emphasize how urban development affects stream health, what restoration practices can be used, and most critically, why restoration is important to each individual stakeholder. Stakeholders should also be oriented to the role they are expected to play in the watershed restoration process.

Advanced Preparation

Short presentations or fact sheets summarizing the initial results of the Comparative Subwatershed Analysis (CSA) and Rapid Baseline Assessment (RBA) should be prepared prior to the first meeting, along with an initial list of subwatershed screening factors. Stakeholders should be given input on the final list of screening factors and their relative weight.

Follow-up

Ideally, restoration education and outreach should be conducted on an ongoing basis throughout the planning process, and may best be handled by a local watershed organization that has "retail" education capability. Contact information for new stakeholders should be maintained in a database, and they should be periodically apprised of the status of the watershed restoration process.

S-2

Stakeholder Involvement Methods

Restoration Education and Outreach

REO

Time Frame / Level of Effort

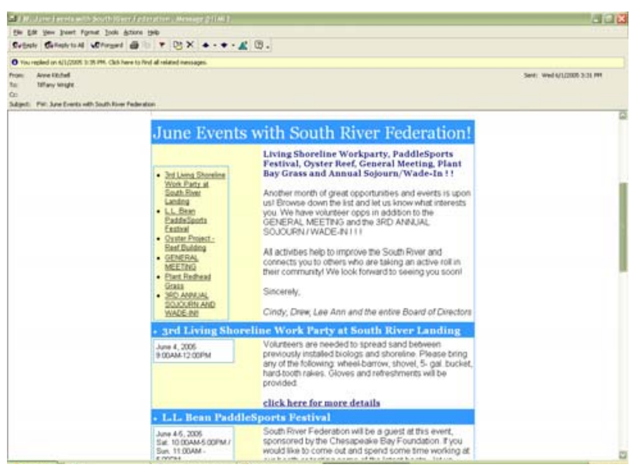
At a minimum, plan on hosting two or three educational meetings, and perhaps as many as a dozen briefings for most watersheds. Restoration education should take place within the first three months of the process. This may take as much as three weeks of total staff time, when advance preparation and follow-up tasks are factored in. More staff time is needed if restoration education and outreach are conducted throughout the entire restoration process.

Further Resources

- *Getting in Step: A guide for conducting watershed outreach campaigns* (McPherson and Tonning, 2003)
- *Community Toolbox for Public Participation* (RTCAP, 2003).

Tips for Communicating Restoration Information

- Watersheds are an abstract concept, and restoration can be a pretty technical business, so make sure outreach materials explain basic concepts with a minimum of jargon, acronyms and bureaucratic terminology.
- Remember that local media love rankings, and consider them quite newsworthy, so make sure they know about the best and worst streams in the community.
- Keep in mind that much of the public has low initial awareness about watersheds, streams, and restoration practices – less than 25% according to NEETF surveys (2003) – so use maps, visuals and photographs to make your key points. Maps are a great educational tool; make sure every new stakeholder understands their subwatershed address.
- Local watershed groups can be direct, effective and low cost retailers of restoration education and outreach. Consider outsourcing some or all of this function to them.
- Local websites are gaining increasing value as a tool for restoration education and outreach, if they are frequently updated and are designed to provide some interaction with stakeholders. They can attract new stakeholders, orient them quickly and enable busy stakeholders to keep up with the restoration process if they cannot attend in person.
- Don't forget the role that local advisors can play in delivering your restoration education and outreach message. Work with them to develop a standard powerpoint presentation they can present to other groups and prospective restoration partners.
- Powerpoint presentations should be short (no more than 30 slides), contain digital photo images of the home watershed, and provide talking points to guide the speaker through the talk.



Email is a quick and easy way to keep stakeholders informed of meetings and events in the watershed.

S-3

Stakeholder Involvement Methods

Stakeholder Identification and Recruitment

SIR

Purpose

This method has two primary purposes. The first is to recruit new stakeholders and maintain the interest of existing stakeholders in the subwatershed restoration process. The second is to get feedback on the roles stakeholders want to play, and discover their preferences as to how and when they want to be involved in the restoration process.

Scale	Value
Subwatershed-wide	Essential

Key Stakeholder Targets

Key targets are recruited progressively further down the four stakeholder pyramids, with an emphasis on stakeholders that live or work in the subwatershed (see Appendix B for information on stakeholder pyramids). New targets include local land-owning or regulating agencies, activist public, neighborhood groups, civic associations, garden clubs, recreational groups, local businesses and landowners, schools, churches and parks.

Outreach Techniques

A wide range of techniques can be used to reach out to stakeholders including interviews, invitation letters, meetings, fact sheet mailouts, subwatershed websites, maps, articles in local papers, stream tours, and educational displays in public spaces and community fairs. Several different outreach techniques are needed to attract and recruit the greatest number of stakeholders, and each should clearly notify them of how they can become involved in the subwatershed restoration process.

Stakeholder Involvement Method

Stakeholders are identified and recruited by performing six tasks:

1. Analyze subwatershed maps to locate major stakeholders
2. Get contact data for neighborhood associations and civic groups
3. Interview outreach multipliers to expand contacts
4. Develop contact database to track stakeholders
5. Survey stakeholders about their involvement preferences
6. Deliver invitations and restoration outreach materials

Educational Message

Many subwatershed stakeholders initially have low restoration awareness, so the educational message should focus on their subwatershed address, what restoration is and why it is needed, and how the plan will influence them. It is also important to outline basic stakeholder duties, roles and time commitments needed, and that it can be both a fun and rewarding service.

Follow-up

All existing, new or potential stakeholders should periodically receive e-mail or newsletter updates on the status of restoration planning efforts. In addition, all stakeholders should be invited to participate in subsequent stakeholder meetings, neighborhood consultation meetings, external plan review, and implementation partnership (see stakeholder involvement steps S-4 through S-7).

S-3

Stakeholder Involvement Methods

Stakeholder Identification and Recruitment

SIR

Time Frame / Level of Effort

A good, current stakeholder contact database is an important stakeholder management tool, so don't scrimp on the staff time needed to assemble one. Plan on at least 3 to 5 days of staff time for the initial effort, and the same amount to maintain it throughout the restoration process.

Further Resources

- *Engaging and Involving Stakeholders in Your Watershed* (MacPherson and Tonning, 2004)
- Manual 8, chapter 4 - *Pollution Source Control Practices*

Tips for Getting the Right Stakeholders to the Table

- The biggest questions on the minds of most potential stakeholders are how much time will it consume and what benefits will it have for them, their neighborhood, or their community at large. Stakeholders are mostly volunteers, so make sure you can clearly and persuasively answer these questions before you contact them.
- The best "pitch" to attract new or potential stakeholders is face-to-face meetings, particularly if they are new to the process or are near the top of the stakeholder pyramid (See Appendix B).
- Find the right hook to motivate each stakeholder to participate (e.g., how restoration can improve their neighborhood), and remember that the hook is usually different for each rung of the four different stakeholder pyramids.
- Send a formal invitation letter and follow-up with a phone call.
- Have a "buddy" encourage their participation.
- Give new stakeholders a prominent role to play at every meeting.
- Ask stakeholders their preferences for meeting times and places, and schedule around these preferences. Stakeholders are often a mix of day-timers (professionals that are expected to be at the table because of their job duties) and night-timers (volunteers that are donating their time and expertise outside of their job and family commitments).
- Market stakeholder service as a great networking opportunity or just a fun event.

S-4

Stakeholder Involvement Methods
Managing Stakeholder Input

MSI

Purpose

The purpose of stakeholder involvement in this steps is to get early input on the full range of environmental and community issues that exist in the subwatershed, and get feedback from stakeholders on the merits of the ISS.

Scale	Value
Subwatershed-wide	Essential

Key Stakeholder Targets

Targets include both “day-timer” and “night-timer” stakeholders, including representatives of local agencies, activist public, neighborhood groups, civic associations, garden clubs, recreational groups, local businesses and landowners, schools, churches and parks and other interested parties.

Outreach Techniques

The traditional technique to involve stakeholders is a series of short evening or weekend meetings. Each meeting requires considerable advanced preparation and follow-up actions. Low-cost outreach techniques to notify stakeholders about meetings and events include letters, flyers, e-mails, phone calls, and announcements in community newspapers. In addition, restoration project websites can be an effective support tool.

Stakeholder Involvement Method

Stakeholder input is achieved by completing three tasks:

1. Prepare for meeting in advance
2. Conduct stakeholder meeting
3. Perform follow-up tasks after meeting

Educational Message

The educational message in this step focuses on increasing awareness about key subwatershed problems, explaining proposed restoration strategies, and outlining the planning process and how stakeholders can interact together.

Advanced Preparation

Advanced preparation for stakeholder meetings includes the following tasks:

- Select the date, venue and piggyback event
- Invite key stakeholders to participate
- Advertise the meeting to stakeholders using multiple outreach techniques
- Develop an agenda that explicitly provides time for stakeholder input
- Prepare condensed presentation materials for the meeting

Follow-up

The outcome of every meeting should be documented, and the results transmitted to all stakeholders who attended and those that could not attend.

Time Frame / Level of Effort

Plan on at least two stakeholder meetings per subwatershed. Effective meetings require plenty of advance preparation and follow-up—as many as four staff days per meeting. Budget an additional week of staff effort if a restoration website needs to be set up.

Further Resources

Many excellent resources exist on stakeholder involvement techniques, including RTCAP (2003), CTIC, (2002), MacPherson and Tonning (2003), and University of Kansas (2002).

S-4	Stakeholder Involvement Methods **Managing Stakeholder Input**	**MSI**

Tips for Running an Effective Stakeholder Meeting

- Keep meetings short (generally less than 1½ hours).
- Entice folks to come by providing food and refreshments.
- Publicize the meeting at least a month in advance.
- Make sure the meeting location is within or reasonably close to the subwatershed.
- Be sensitive to meeting timing issues, such as rush hour, dinner-time and religious holidays.
- Have a clear agenda and establish clear ground rules. Stick to them.
- Provide handouts (beforehand, if possible).
- Assign action items in meeting minutes that are distributed to all those who came and those who could not come to the meeting.
- Select a comfortable venue that is conducive to work.
- Always devote at least a third of the meeting to allow stakeholders to informally share their thoughts, opinions and concerns.
- Never have presentations comprise any more than 50% of the meeting time, and make sure they touch on the basics of Restoration Education and Outreach (Profile Sheet S-2).
- Put a variety of people on the agenda to briefly speak, including some prominent stakeholders.
- It's not always easy to anticipate what new stakeholders want to learn or discuss—so ask them at the first meeting to design the agenda for the second one.
- Stakeholders should be given real work to do and meaningful outlets to provide input, such as small group exercises, brainstorming sessions, and listening stations.
- Consider having an outside facilitator or moderator to keep the meeting focused.
- Piggyback the meeting to another physical activity, like a stream tour, rain barrel demonstration or bayscaping event.
- Many subwatershed stakeholders are unfamiliar with the range of restoration practices, while others may have strong objections about certain practices or sites. It is a good idea to educate stakeholders about the benefits and drawbacks of restoration practices.
- Always provide informal time to socialize and build the relationships and trust needed in later steps. Remember, being a stakeholder should be enjoyable, rewarding and fun.
- While sad, but true, it seems that every stakeholder meeting contains a few individuals that are hostile, uncivil, disruptive or downright nasty. Some tips for dealing with these difficult stakeholders include:
  - Maintain a professional attitude and try not to isolate the stakeholder.
  - Communicate with them after the meeting to learn about their key issues so that you are ready for the next meeting.
  - Give them a task or role to do, and provide suggestions on ways they can resolve their issue or concern.
  - Remind them about ground rules for participating (e.g., each person is permitted to talk no more than a set length of time; everyone must be courteous; folks may not interrupt a speaker or anyone else; all stakeholders who wish to speak are given opportunity to do so; and one should state whom they represent if they are speaking on behalf of a group or organization, etc.). If they continue to be disruptive, consider using a professional facilitator to diminish their influence on the group as a whole.

S-5

Stakeholder Involvement Methods

Neighborhood Consultation Meetings

NCM

Purpose

The purpose of this method is to get feedback from the neighborhood on the acceptability of initial concept designs for larger restoration projects, particularly if they are located in high visibility areas.

Scale	Value
Neighborhood-wide	Essential

Key Stakeholder Targets

The primary targets for neighborhood consultation are the adjacent public and, in some cases, permitting agencies that must ultimately approve the project.

Outreach Techniques

Evening meetings, preferably scheduled to coincide with a regular homeowner/civic association meeting are most effective. Other methods include weekend project walks, one-on-one briefings, and project evaluation workshops. A combination of outreach techniques should be used to advertise neighborhood consultation meetings, including letters sent to affected homeowners and landowners, displays, notices placed in community and homeowner newsletters, and posting of signs at proposed project locations.

Stakeholder Involvement Method

Four tasks are performed to conduct neighborhood consultation meetings:

1. Define who is adjacent to the project
2. Notify every address within the boundary
3. Arrange meeting or project field visit to discuss project
4. Determine neighborhood acceptance and incorporate it into PER

Educational Message

Neighborhood meetings frequently attract brand new stakeholders with fairly low levels of restoration awareness, and in many cases, suspicious attitudes toward local government. Therefore, the basic message should focus on why restoration is needed and the planning process that led to the proposed project.

Advanced Preparation

Several products should be prepared in advance of the meeting, including a summary of Neighborhood Source Assessment (NSA), clear plans and maps of the proposed project, subwatershed fact sheets, locator maps or photos, and any educational resources on neighborhood stewardship practices.

Follow-up

Make sure to get promptly back to neighborhood stakeholders to let them know how their input was reflected in project ranking and final design, and immediately follow-up with individuals that raise serious project concerns.

S-5

Stakeholder Involvement Methods

Neighborhood Consultation Meetings

NCM

Level of Effort

The actual number of consultation meetings will be different in each subwatershed, depending on the number of large restoration projects that are contemplated. If there are more than a half-dozen projects, consider consolidating them into a single meeting using a listening station approach (see tips below). Plan on at least 20 hours of preparation/follow-up for each neighborhood consultation meeting.

Further Resources

Consult Profile Sheet S-4 for stakeholder meeting tips.

Tips for Consulting With Neighborhoods on Restoration Projects

- Neighborhood consultation is essential when large storage retrofits, widespread on-site retrofits or comprehensive stream repair projects are being considered in a subwatershed.
- Don't oversell the project. Anticipate potential project concerns, and be ready to respond to them in an even-handed manner. It makes little sense to avoid or gloss over potential problems, since someone from the audience is sure to raise them anyway.
- The meeting may be the first time an angry resident has an opportunity to interact with local government, so be ready to listen and respond to concerns not directly related to the project in question. Complaints about garbage pickup, illegal dumping, mowing regimes, rats, abandoned cars, pond maintenance and any number of other legitimate neighborhood concerns are quite common. Although the project can't solve these problems, do some advance homework so that you can refer them to the right person in local government who might be able to address the problem.
- Keep meetings short, and try some of the meeting tricks outlined in Profile Sheet S-4. Consultation meetings are particularly well suited to an informal "listening station" format, which entails several tables or stations that are spread across a large meeting room. Each station is manned by an individual who can provide information on a particular restoration project or stewardship practice, so that individual residents can get information and provide feedback without having to endure a long meeting.
- Always mix in several stewardship practices with the larger restoration project being considered, so residents can learn about tree planting, rain barrels, and low input lawn care. Remember to bring along educational resources to promote neighborhood stewardship.
- Neighborhood meetings have the greatest potential to attract difficult stakeholders, particularly if they are well-attended (e.g., stakeholder comments like "this is the first time I heard about this", "our property values are going to drop like a rock," etc.). Try to deal with hostile stakeholders using the tools described in Profile Sheet S-4, but if opposition is widespread or intense, be ready to drop projects, or at least suspend them until another meeting can be held to respond to their concerns.

S-6	Stakeholder Involvement Methods **External Plan Review**	**EPR**

Purpose

The purpose of this method is to transform stakeholders into restoration partners by explaining the expected benefits and costs associated with the plan, and offering a final opportunity for comment. Stakeholders are often asked to support or endorse the plan and commit to early actions during this step.

Scale	Value
Community-wide	Helpful

Key Stakeholder Targets

Every stakeholder who has participated up to this point should be given an opportunity to comment on the plan, although prospective partners, such as local agency partners, activist public, landowning agencies, funders and responsible parties are particular targets.

Outreach Techniques

A wide range of techniques can be used to distribute the plan and solicit comment, including mailing of plan summaries (with response sheets), posting the plan on the project website, distributing the draft plan electronically, individual partner briefings, a final subwatershed stakeholder meeting, review by an advisory committee, and hosting of small listening sessions, open houses, or town hall meetings.

Stakeholder Involvement Methods

Four tasks are needed to solicit external review of the plan:

1. Choose audience for external review
2. Develop condensed plan summary
3. Operate multiple processes to get plan feedback
4. Provide timely revisions to plan

Educational Message

The educational message in this step explains the overall plan and how it meets restoration goals, review its benefits and costs, and explain how partners can assist in plan implementation.

Advanced Preparation

It is a good idea to prepare a condensed summary of the plan that contains major recommendations, a matrix of key projects and their expected completion dates, and a summary of how the plan will meet watershed goals, based on the subwatershed treatment analysis.

Follow-up

It is important to acknowledge and respond to all comments in a timely manner (even if they cannot be fully addressed in the plan). If a reviewer is generally supportive of the plan, try to obtain a letter of support, endorsement, or a commitment to testify in favor of the plan.

Level of Effort

A minimum window of at least one month is usually needed to solicit and respond to comments, and often much more. Plan on two weeks of staff time to distribute the plan, respond to comments, revise the plan, and secure endorsements.

S-6

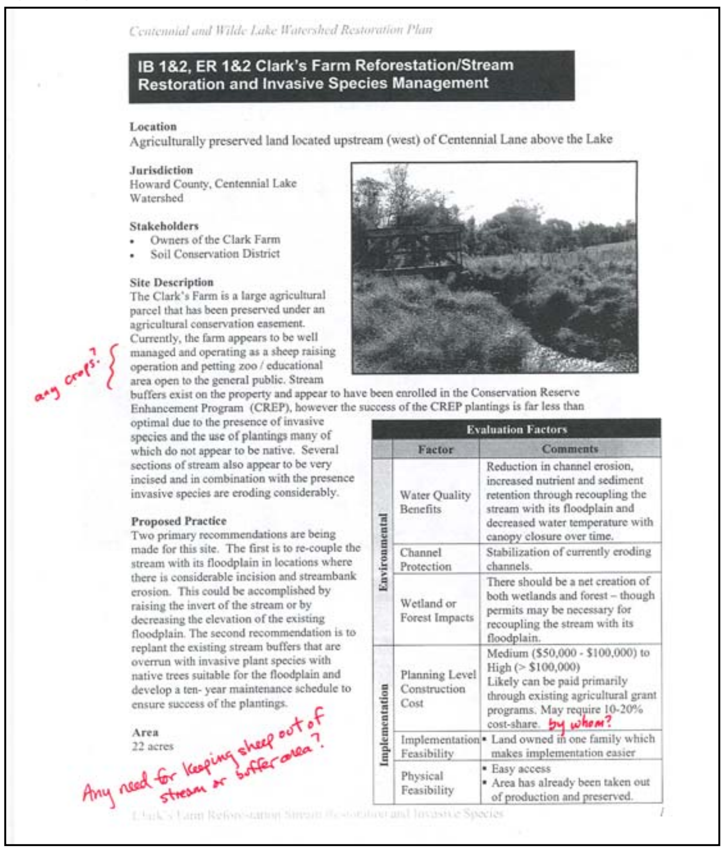
Stakeholder Involvement Methods

External Plan Review

EPR

Tips for Getting Great Plan Reviews and Partner Support

- Avoid public hearings and other types of formal review processes.
- Clearly indicate the type and scope of review you want—remind reviewers that the purpose of their review is to support the best implementation for the subwatershed, and not necessarily produce the fanciest or most perfect document.
- Make sure all stakeholders who participated at any point in the planning process get a crack at reviewing the plan.
- Make sure that any partner expected to play a role in implementation understands and is comfortable with their intended role, as written in the plan.
- Most stakeholders don't want to review thick documents, so just ask them to review the summary. If you have a long plan, assign different stakeholders to review specific sections of the plan, and not the whole thing.
- In general, the objective of external review is to get partners to support and endorse the general plan, and the specific actions that they are being asked to perform.
- Don't expect 100% of your stakeholders to review the plan, but make sure to get at least verbal approval from 100% of the key restoration partners.
- If support or endorsement is sought from a group or organization, add time to the review process, since they usually need more time to get together and take official action.
- Prominently acknowledge all stakeholders who participated in putting together the draft plan, but don't imply that they automatically concur with any or all recommendations. Stakeholders and partners who see their name on a plan are more likely to carefully read and review it.
- It always seems a new stakeholder appears at this stage claiming they are hearing about the plan for the first time, and the process should be halted to accommodate their interests. In most cases, patience and special attention can get the new stakeholder aligned to the process.



Centennial and Wilde Lake Watershed Restoration Plan

IB 1&2, ER 1&2 Clark's Farm Reforestation/Stream Restoration and Invasive Species Management

Location
Agriculturally preserved land located upstream (west) of Centennial Lane above the Lake

Jurisdiction
Howard County, Centennial Lake Watershed

Stakeholders
- Owners of the Clark Farm
- Soil Conservation District

Site Description
The Clark's Farm is a large agricultural parcel that has been preserved under an agricultural conservation easement. Currently, the farm appears to be well managed and operating as a sheep raising operation and petting zoo / educational area open to the general public. Stream buffers exist on the property and appear to have been enrolled in the Conservation Reserve Enhancement Program (CREP), however the success of the CREP plantings is far less than optimal due to the presence of invasive species and the use of plantings many of which do not appear to be native. Several sections of stream also appear to be very incised and in combination with the presence invasive species are eroding considerably.

any crops?

Proposed Practice
Two primary recommendations are being made for this site. The first is to re-couple the stream with its floodplain in locations where there is considerable incision and streambank erosion. This could be accomplished by raising the invert of the stream or by decreasing the elevation of the existing floodplain. The second recommendation is to replant the existing stream buffers that are overrun with invasive plant species with native trees suitable for the floodplain and develop a ten- year maintenance schedule to ensure success of the plantings.

Area
22 acres

Any need for keeping sheep out of stream or buffer area?

Evaluation Factors		
	Factor	**Comments**
Environmental	Water Quality Benefits	Reduction in channel erosion, increased nutrient and sediment retention through recoupling the stream with its floodplain and decreased water temperature with canopy closure over time.
Environmental	Channel Protection	Stabilization of currently eroding channels.
Environmental	Wetland or Forest Impacts	There should be a net creation of both wetlands and forest – though permits may be necessary for recoupling the stream with its floodplain.
Implementation	Planning Level Construction Cost	Medium ($50,000 - $100,000) to High (> $100,000) Likely can be paid primarily through existing agricultural grant programs. May require 10-20% cost-share. by whom?
Implementation	Implementation Feasibility	• Land owned in one family which makes implementation easier
Implementation	Physical Feasibility	• Easy access • Area has already been taken out of production and preserved.

Clark's Farm Reforestation Stream Restoration and Invasive Species 1

This is an example of comments made to a retrofit sheet by the local government partner

S-7

Stakeholder Involvement Methods

Maintain Restoration Partnerships

MRP

Purpose

The purpose of stakeholder involvement in Step 7 is to build a strong and broad coalition in the community that can attract political support needed to get the plan adopted and funded.

Scale	Value
Community-wide	Helpful

Key Stakeholders

Primary targets include local elected officials, partner agencies, watershed groups and all potential funders for the restoration effort.

Outreach Techniques

Outreach techniques are used to announce the adoption of the plan and acknowledge key partners involved in it. Examples include signing ceremonies, photo opportunities in the subwatershed, and watershed events and celebrations that provide favorable political exposure to elected officials and partners. Elected officials require specialized attention, which may include formal or informal background on the plan, negotiations to develop memoranda of understanding among partners, budget presentations and carefully managed council or commission meetings to get the plan adopted.

Stakeholder Involvement Method

Five tasks are performed to create and maintain restoration partnerships:

1. Define expectations for the partnership
2. Define the benefits that partner will receive
3. Meet with individual partners to enlist their support
4. Determine proper partner recognition
5. Maintain partner relationships over time

Educational Message

The three key educational messages to stress in this step are the political and community benefits associated with the restoration plan, the budget and funding sources needed to implement it, and the width and breadth of the community partners that support it.

Advanced Preparation

A condensed summary of the final plan, letters of support, partner agreements, and private briefings with local political champions and key local agency heads are extremely helpful in streamlining the approval process.

Follow-up

Successful adoption of a restoration plan should be immediately followed by thanks and acknowledgements to all stakeholders, partners and elected officials. Press releases, tours, signing ceremonies and watershed celebrations can all maximize political exposure through local media.

Level of Effort

S-7 | Stakeholder Involvement Methods

Maintain Restoration Partnerships

MRP

The precise amount of time and staff effort needed to create the restoration partnership depends to a great extent on the number of partners, current budget conditions and the local political landscape. At a minimum, schedule at least three months to get concurrence on the final plan, and at least three staff weeks of effort to make it happen.

Tips for Attracting Political Support for Restoration

Ideally, elected officials will not be a brand new stakeholder at this point, and should have been informed by senior agency heads about progress made during the restoration planning process. Some other tips to keep local officials enthused about restoration are to:

- Frequently ask for their advice (so they think it was their idea all along).
- Invest in the political relationship (constructively work with them on other community issues, attend their events, and even consider donating a few dollars to their campaigns).
- Introduce yourself to them so they know you first hand, and not just what they read in the paper.
- Provide them with photo opportunities to demonstrate their local environmental commitment.
- Promote any positive contributions elected officials make in any restoration education and outreach materials produced.
- Entice them with opportunities to speak to these potential voters at larger stakeholder meetings.
- Get to know their key staff and advisors since elected officials rely on them heavily.
- Avoid partisanship and emphasize how restoration is really a simple constituent service.
- Work with several local elected officials simultaneously, since they are voted in (or out of) office on a routine basis.
- Keep them involved by inviting them to participate in low risk and high visibility annual events, such as canoe trips, school tree plantings and stream cleanups.
- Make sure to express appreciation when they vote favorably for restoration, and don't criticize them if they do not always vote the exact way you would like.

Note the wide range of partners included in the Antietam Creek Watershed effort

Photo courtesy of Rob Schnable, Chesapeake Bay Foundation

S-8	Stakeholder Involvement Methods **Ongoing Management Structure**	**OMS**

Purpose

This method seeks to establish and sustain an ongoing management structure that enables stakeholders to advocate for the restoration plan during the many years over which implementation is expected to occur.

Scale	Value
Community- or watershed-wide	Essential

Key Stakeholder Targets

The membership of the ongoing management structure varies somewhat depending on the organizational model selected. Normally, local agencies, local advisors, the activist public, key funders and restoration partners form the core of the management structure (i.e., decision-making authority and coordination). Ultimately, the management structure should provide opportunities for all types of stakeholders to participate in restoration activities, and should extend as far down each stakeholder pyramid as possible. Economies of scale make it easier to sustain a management structure at the community or watershed scale, as compared to the subwatershed scale.

Outreach Technique

At least one person within a larger watershed management structure should be designated direct responsibility for subwatershed coordination. The duties and functions of this position depend on the organizational model selected and available funding. Several different outreach techniques can be used to report progress and maintain interest in subwatershed restoration. They include annual reports, indicator scorecards, conferences, demonstration projects, project ribbon-cuttings, tours of constructed restoration practices, annual celebrations or canoe trips, adopt-a-stream programs, volunteer monitoring, and subwatershed stewardship campaigns.

Stakeholder Involvement Method

Four tasks are used to create an ongoing management structure:

1. Review existing organizational and volunteer capacity
2. Choose the most important roles it could play
3. Agree on the organizational model to pursue
4. Seek funding to launch the organization

Educational Message

The key message is to continuously remind stakeholders about progress made in restoring the subwatershed, and report on trends in stream and subwatershed quality over time.

Advanced Preparation

S-8

Stakeholder Involvement Methods

Ongoing Management Structure

OMS

A fair amount of advance preparation is needed to establish an ongoing management structure, regardless of the organizational model selected. Key restoration partners need to get together to choose the organizational model; establish its charge, membership and bylaws; determine who will provide needed administrative support to coordinate the partners; and decide how staff time will be paid for.

Follow-up

The main follow-up activity is to sustain membership and participation in the ongoing management structure that will, in turn, maintain momentum in subwatershed restoration. The subwatershed coordinator should regularly keep in touch with restoration partners, and convene a stakeholder meeting at least once a year.

Level of Effort

Considerable effort is needed to establish and sustain an ongoing management structure. Plan on a minimum of 0.25 to 0.5 staff years to get the watershed organization started, and a minimum of 0.5 staff years/year thereafter. At least 0.25 staff years per year should be allocated to the specific duties of the subwatershed coordinator.

Further Resources

- *Rapid Watershed Planning Handbook* (CWP, 1998)
- *Getting in Step: Engaging and Involving Stakeholders in Your Watershed* (MacPherson and Tonning, 2004)

Tips for Establishing and Sustaining an Ongoing Management Structure

- Since restoration requires a strong partnership between local government and other partners, the hybrid organizational model is recommended as the most effective watershed management structure to handle subwatershed restoration implementation.
- Most communities either have a local agency champion or local watershed group, but not both. A good strategy is to first strengthen the existing management structure, and then gradually develop its hybrid counterpart.
- Every watershed management structure will be unique and dynamic, as more restoration partners are enlisted and the scope of implementation grows. The critical element is funding to support the subwatershed coordinator role.
- Many excellent resources exist on how to improve the capacity of organizations to restore watersheds, including River Network (http://www.rivernetwork.org) and the Institute for Conservation Leadership (http://www.icl.org).

Tool 21
Stakeholder Education Resources

This tool includes resources that explain how to create and distribute watershed messages to stakeholders, as well as links to free materials that will explain why watershed protection is important and what stakeholders can do to help

Stakeholder Education Resources

The stakeholder education resources listed below are guides that explain how to create and distribute watershed messages to stakeholders, as well as links to free materials that will explain why watershed protection is important and what stakeholders can do to help. Resources were identified and selected based on ease of access (most are free for download), applicability to watershed planning, and how often they are referenced by other documents on stakeholders.

Alliance for the Chesapeake Bay. *Outreach and Training*. Website: http://www.acb-online.org/outreach.cfm

The Alliance for the Chesapeake Bay is a regional nonprofit organization that builds and fosters partnerships to protect and to restore the Bay and its rivers. The Alliance has a number of products available free for download that translate technical or complex information on watershed issues into easy-to-understand toolkits and guidebooks for lay audiences. These products range from "do-it-yourself" guides and publications to training modules and workshops that provide general advice and direction to non-technical audiences on how to better treat land and water resources for the ultimate protection of the Chesapeake Bay.

Chesapeake Bay Program. *Community Watershed Dialogue*. Website: http://www.chesapeakebay.net/watersheddialogue.htm

The Community Watershed Dialogue is a project of the Watershed Assistance workgroup at the EPA Chesapeake Bay Program. Watershed assistance staff, in collaboration with Maryland, Pennsylvania, Virginia and West Virginia, are organizing and conducting Dialogues to engage community leaders and key stakeholders in managing watersheds. The Dialogues are a series of collaborative discussions on approaches for community engagement, consensus building, and strengthening commitment to comprehensive resource management. Participants learn to integrate watershed management into sound land use decisions and practices.

Christie, J. 2001. *Wetlands Outreach: Getting the Message Out: New Techniques and Partners for the Millennium.* Association of State Wetland Managers. Website: http://www.aswm.org/propub/pubs/pdf/outreach.pdf

This report synthesizes the results of a two-day conference on wetland outreach. While the report is focused on wetlands, many of the tips for improving education and outreach are applicable to watershed planning outreach efforts. The pointers on why outreach fails and hints for developing a good program are especially relevant to watershed planners.

MacPherson, C. and B. Tonning. 2003. *Getting In Step: A Guide for Conducting Watershed Outreach Campaigns.* Tetra Tech, Inc. EPA 841-B-03-002. U.S. EPA Office of Wetlands, Oceans and Watersheds. Washington, D.C. Website: http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf

This guide provides an overview of the tools watershed managers will need to develop and implement effective watershed outreach plans. The guide is divided into three parts: Part I provides the overall framework for creating and executing your outreach plan using a step-by-step development process; Part II examines techniques and examples for developing and enhancing outreach materials; Part III discusses working with the news media to get your water quality message out through improved media coverage. The publication also includes watershed graphics, work sheets for developing your plan, and additional resources for outreach and education, including contact information.

Maryland Department of Natural Resources. No date. *Maryland Education Resources at the Department of Natural Resources*. Website: http://www.dnr.state.md.us/education/

This is a list of resources that Maryland Department of Natural Resources offers for educators. They include student activities, in-class presentations, educator professional development opportunities, and outdoor education opportunities for all ages. The list includes both website and contacts for resources focused toward watershed education.

Maryland Department of the Environment. No date. *Water Fact Sheets*. Website: http://www.mde.state.md.us/ResearchCenter/Factsheets/waterfactsheets/index.asp

This website provides a variety of fact sheets on issues related to watershed health in Maryland that can be used to educate stakeholders. Among the choices:

- Stormwater and the Chesapeake Bay
- Building a Rain Barrel
- Your Bay, Your Watershed: Pathways to the Bay: The Chesapeake Watershed
- Nontidal Wetlands and Their Values

McKenzie-Mohr, Doug and Smith, W. No date. *Fostering Sustainable Behavior Guide*. McKenzie-Mohr Associates, Fredericton, N.B., Canada. Website: http://www.cbsm.com/Chapters/preface.htm.

This online book details how community-based social marketing can uncover the barriers that inhibit individuals from engaging in sustainable behaviors. Community-based social marketing uses social psychology research to promote behavior change at the community level through direct contact with people. The guide provides a set of "tools" that social science research has demonstrated to be effective in fostering and maintaining behavior change. The online guide also details how to design and evaluate programs. The website (http://www.cbsm.com/) also contains searchable databases of articles, case studies and graphics related to fostering sustainable behavior as well as a discussion forum.

Northern Rhode Island Conservation District, RI Urban Rivers Team—Health & Education Subcommittee, and U.S. Environmental Protection Agency. No date. *Toolkit for Urban Rivers: Public Education and Outreach Programs and Strategies*. Northern RI Conservation District, Greenville, RI. Website: http://www.nricd.org/ToolKit/ToolKit.pdf

This publication highlights the lessons learned by the creators of the "Woonasquatucket River Do's & Don'ts" Education & Outreach Campaign. The creators have made this document available as a model for other programs to use in developing education programs. The publication is both a guide and a workbook. Eight steps for creating a program are presented, and each step includes questions that can be helpful in defining the process as well as pointers on setting goals and objectives at each step in the process.

United States Environmental Protection Agency (EPA). *Chesapeake Bay Program*. Website: http://www.chesapeakebay.net/involved.htm

The EPA's Chesapeake Bay Program website has a number of resources available describing actions that can help the restoration of the Bay. The "How to Get Involved" website provides links to resources or programs for teachers, students, citizens, local government officials, business owners or the members of a watershed organization on how they can help to reduce impacts to the Chesapeake

Bay. Visitors to the site can find links to the watershed they live in, get a list of contacts for more information, and find other local groups active in their area.

United States Environmental Protection Agency (EPA) Office of Water, Office of Wetlands Oceans, and Watersheds. *Watershed Outreach*. Website: http://www.epa.gov/owow/watershed/outreach/outreachnonjs.html

This website has many educational materials available to help promote watershed protection. Some materials are downloadable, while others must be requested by telephone, email, or regular mail. The types of materials available include watershed-related pictures and clip art, activities just for kids, and links to watershed related web sites with activities and information.

United States Environmental Protection Agency (EPA) *Stormwater Month Outreach Materials and Reference Documents*. Website: http://cfpub.epa.gov/npdes/stormwatermonth.cfm

The EPA has developed a set of materials that state or local governments can customize and use in their own stormwater outreach campaigns. The downloadable electronic files on this page are customizable so that watershed planners can add their own contact information and inexpensively reproduce these materials. Materials are available for the general public, homeowners, construction site operators, and children.

United States Environmental Protection Agency (EPA). *Watershed Academy Web Training Modules*. Website: http://www.epa.gov/watertrain/

EPA offers more than 40 free, self-paced web-based training modules that present a basic but broad introduction to watershed planning. The length and complexity of each module varies and each module can require ½ to 2 hours each to complete. Self-tests enable trainees to check their retention and see immediate results. Completing a series of 15 of these modules can earn a Watershed Academy Web Training Certificate that allows the user to document their leaning. Of particular relevance to watershed planners interested in education is the online training for *Getting in Step: A Guide to Effective Outreach in Your Watershed*.

Tool 22
Management Profile Sheets

This tool contains a series of fact sheets on management products that help agencies, partners and stakeholders make key restoration decisions by managing people, partnerships and resources toward common goals. The information provided within this tool is an excerpt from the Center for Watershed Protection's Methods to Develop Restoration Plans for Small Urban Watersheds.

M-1

Management Methods to Get to Restoration Decisions

Finalize Watershed Goals

FWG

Restoration Decision

The key decision is to agree on clear and measurable goals and objectives to guide the watershed restoration process and select the corresponding indicators that will be used to measure progress toward achieving them.

Scale	Value
Watershed-wide	Essential

Management Method

Four tasks needed to finalize watershed goals are:

1. Educate stakeholders on the basics of watershed restoration
2. Define meaning of watershed goals, objectives and indicators
3. Work through a facilitated process to refine them
4. Decide how goals will be formally adopted

Product or Instrument

Restoration goals are best formalized through a watershed agreement, memorandum of understanding, interagency directive or consensus statement that clearly articulates restoration goals and the local commitment to achieve them. The final product articulating the goals, objectives and indicators is typically only two to 10 pages long.

Intended Audience

Broad dissemination of watershed goals and objectives is an extremely important tool to educate the full range of watershed stakeholders and the general public. Some effective techniques to deliver and publicize the agreement are press releases, signing ceremonies, watershed events, web sites, and brochures.

Time Frame / Level of Effort

Given the large number of parties that must understand and support the agreement, it can take several months to complete this task. The required staff effort ranges from two to six weeks to draft the agreement, conduct meetings, respond to comments, and navigate it through the system. As a rule of thumb, plan on one week of staff effort per signatory of the agreement, and triple everything if more than one jurisdiction is involved.

Decision-making Process

The lead watershed agency usually drafts an initial “strawman” document describing general ideas for goals, objectives and indicator goals. The strawman is synthesized from the needs and capabilities assessment (NCA), existing data analysis (EDA) and stakeholder consensus process produced earlier in this step. Once the draft is prepared, it is then circulated to agencies and municipal or regional stakeholders for review and comment.

Tips for Setting Watershed Goals and Objectives

- A frequent barrier to consensus is real or perceived concerns among some parties that they are being obligated to spend money in the future or over an unrealistic timeframe. To avoid these perceptions, initial goals should not contain explicit financial commitments. Financial commitments can be added later in the process when the true price tag for restoration is known, partnerships are better established, and the joint funding strategies are accepted.

M-1

Management Methods to Get to Restoration Decisions

Finalize Watershed Goals

FWG

Tips for Setting Watershed Goals and Objectives

- Given all the hard work it takes to achieve consensus on goals, make sure they are prominently featured in all websites, reports and other products during the remainder of the restoration process.
- The restoration team should strive to have balance in the proposed goals for restoration. A few examples should be selected from each of the four goal categories: physical, water quality, biological and community.
- At the same time, stakeholders should resist the temptation to add too many goals to the list. A good rule of thumb is to keep the total number of watershed goals to about a half dozen or so. If there are still too many, ask stakeholders to vote on their most important priorities, and consider lumping a few together.
- Stakeholders should make sure to give their goals a “reality check” to make sure they are truly achievable and realistic. In particular, they should check to make sure the goals are consistent with the amount of impervious cover in the watershed now or in the future.
- Goals should always be listed in priority order.
- Sometimes it is helpful to get stakeholders to sharpen their goals by asking them what specific indicator they would use to measure the goal. Good indicators are directly linked to goals and should be a tangible measure of aquatic or community health.

Real World Example

Cobbs Creek is a 22 square mile urban watershed in the City of Philadelphia that suffers from storm water and combined sewer overflow problems. The watershed has almost 50% impervious cover, is home to more than 135,000 residents, and contains extensive open space and recreational users. The Office of Watersheds of the City of Philadelphia Water Department completed an extensive subwatershed plan to implement more than $200 million of restoration practices over the next 20 years to achieve three progressively more ambitious goals. The first goal was to improve dry-weather water quality and aesthetics in the stream corridor, the second goal was to restore healthy living resources in the stream and the last goal was to improve the water quality and flooding during wet-weather conditions. More than a dozen different indicators were selected to track progress toward each goal during the 20-year period to implement all the restoration practices. The indicators and stakeholder weighting are shown on the next page. Monitoring is expected to maintain public interest and allow the plan to be adapted over time to improve the performance and cost-effective delivery of restoration projects (CPWD, 2004).

M-1

Management Methods to Get to Restoration Decisions
Finalize Watershed Goals

FWG

Real World Example

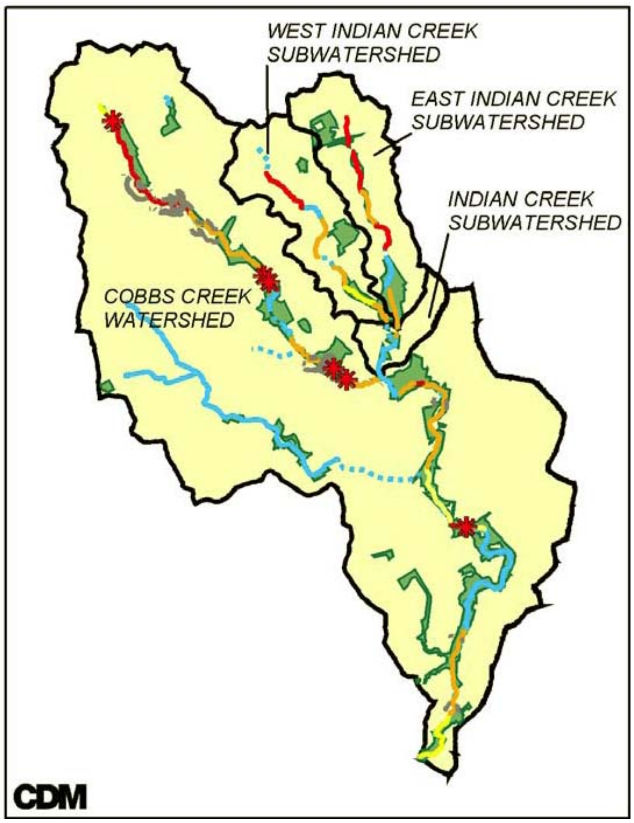


Table 3-1: Stakeholder Priorities as Weights for Goals

Streamflow and Living Resources. Reduce the impact of urbanized flow on the living resources (increase baseflow and recharge, reduce impervious area and runoff peaks, improve stormwater ordinances).	12
Stream Habitat and Aquatic Life. Improve stream habitat and indices of aquatic integrity (improve physical habitat, benthic, fish, algae).	9
Stream Channels and Banks. Reduce streambank and stream channel deposition and scour to protect and restore the natural functions of aquatic habitat and ecosystems, streambanks, and stream channels (increase stabilized areas, reduce frequency of bankfull flow).	7
Flooding. Decrease flooding (improve stormwater management, trouble spots, inlet cleaning, floodplain management and structures).	11
Water Quality. Improve dry and wet weather stream quality (meet designated uses, prevent fish advisories).	9
Pollutant Loads. Decrease pollutant loads to surface waters (decrease runoff, SSO, septic tank, CSO, and debris loads).	10
Stream Corridors. Protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands.	11
Quality of Life. Enhance community environmental quality of life (protect open space, access and recreation, security, aesthetics, historical/cultural resources).	12
Stewardship. Foster community stewardship (increase awareness and responsibility, volunteer programs, education).	11
Coordination. Improve inter-municipal, inter-county, state-local, and stakeholder cooperation and coordination on a watershed basis.	8

Stakeholders developed key watershed goals and weighted their importance in this Philadelphia watershed, which helped determine where to start first.

Source: Philadelphia Water Department (CPWD), 2004

M-2	Management Methods to Get to Restoration Decisions **Priority Subwatershed List**	**PSL**

Restoration Decision

To agree on which subwatershed or group of subwatersheds to begin working on first, and devise a longer-range schedule to assess restoration needs in all subwatersheds.

Scale	Value
Watershed- or Community-wide	Helpful

Management Method

The priority subwatershed list is compiled by performing four tasks:

1. Review initial subwatershed rankings from CSA
2. Revise list based on stakeholder input
3. Scope out schedule and budget for priority subwatersheds
4. Develop a longer-range plan to assess all subwatersheds

Product or Instrument

1. A short report that supports the choice of priority subwatersheds, documents key assumptions used in the CSA, and depicts their locations on a simple watershed map
2. A scope of work that outlines the desktop analysis, field assessment and stakeholder involvement methods needed to prepare restoration plans for priority subwatersheds, accompanied by a budget and schedule

Intended Audience

The draft priority subwatershed list and map should be distributed to the full range of watershed stakeholders.

Time Frame / Level of Effort

The priority list can take as little as a month to complete if there are no major technical or political disputes about the ranking process. The required staff effort is about two weeks to assemble the memo, solicit stakeholder input and respond to comments. The timeframe to put together a priority subwatershed list will be extended by six months or more if an RBA is needed to support the decision.

Decision-making Process

Subwatersheds are prioritized by the lead watershed agency. The priority list is then circulated to local agencies and other stakeholders for review and comment. The lead watershed agency usually approves the final priority list, and commits funding for subsequent phases of subwatershed assessment.

Tips for Developing a Priority Subwatershed List

- A priority subwatershed list is attractive to many agency and elected stakeholders that are unfamiliar with restoration, since it limits their future budget liability. The basic idea is to “practice” in a few subwatersheds to acquire experience on restoration methods, costs and results. Future restoration work in other subwatersheds can then be adapted to reflect the lessons learned.

M-2

Management Methods to Get to Restoration Decisions

Priority Subwatershed List

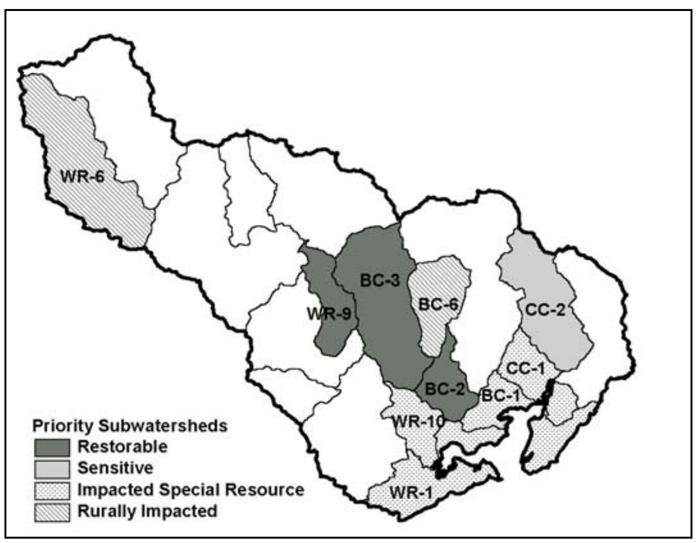
PSL

Tips for Developing a Priority Subwatershed List

- Some stakeholders may question why restoration efforts are being deferred in their favorite subwatershed, if it doesn't make the final cut. A long-range plan to assess restoration potential in all subwatersheds may help counter this concern. It should be stressed that low-priority subwatersheds are not being sacrificed, and will be addressed in the future.
- Stakeholders often have a hard time deciding whether priority should be placed on the subwatersheds in the worst shape or the ones with the greatest restoration potential. The choice is never easy, and may require more restoration education and outreach among stakeholders.
- The priority list should not be solely viewed as a technical analysis. Community interest and concern are extremely important in successful restoration, so make sure to weight these factors heavily. Stakeholders are a great resource for "measuring" non-technical subwatershed metrics and providing insights on how they should be weighted.
- An agreement on priority subwatersheds is always a newsworthy event, and yet another opportunity for restoration education and outreach.
- Watershed web sites or fact sheets with simple maps and graphics are an excellent way to publicize priority subwatersheds.

Real World Example

The Bush River watershed provides a good example of the subwatershed screening process. Located in the northeastern corner of Maryland, the watershed is 117 square miles and contains 19 subwatersheds (Winer, 2003). Given its size, watershed managers wanted to choose priority subwatersheds for early action. Abundant GIS data was already available to conduct a comparative subwatershed analysis (CSA). Numerous stream corridor and upland screening factors were chosen for the CSA spreadsheet, with the weight for each factor decided by watershed stakeholders. In a relatively short time, 10 subwatersheds were chosen for initial action. This CSA was not only used to identify restorable watersheds and those most vulnerable to future development, but it identified special resource areas for added protection and even rural areas that required attention.



Map of priority subwatersheds in the Bush River Watershed
Source: Winer, 2003

M-3	Management Methods to Get to Restoration Decisions **Initial Subwatershed Strategy**	ISS

Restoration Decision

The key restoration decision is to agree on an initial restoration strategy that outlines which combination of candidate project investigations to be pursued in Step 4.

Scale	Value
Subwatershed-wide	Essential

Management Method

Four tasks are needed to develop an Initial Subwatershed Strategy:

1. Review priority restoration elements from DSA
2. Engage core team in brainstorming meeting
3. Decide on the type and number of CPIs needed
4. Develop a detailed scope of work and budget

Product or Instrument

The final product is a detailed work plan to investigate restoration practices within the subwatershed. The work plan outlines the type, number and locations of restoration practices that will be investigated, and guides the efforts of the core team to assess, design and implement individual restoration practices.

Intended Audience

Once the strategy memo has been completed, it is good practice to distribute it to subwatershed stakeholders, local agencies, and interested parties. Effective outreach techniques include creating a project website, sending the strategy memo electronically, or providing hard copies upon request.

Time Frame / Level of Effort

The initial strategy takes about two weeks to complete, assuming the other supporting methods in Step 3 have already been completed.

Decision-making Process

The strategy memo is primarily an internal document, although it may be worth sharing with key stakeholders (particularly land management agencies). Normally, the ISS is derived from technical data obtained during the DSA, USA and USSR surveys and SIR. The strategy and scope of work are approved by the lead watershed agency/group, and are subject to normal budgetary constraints.

Further Resources

Figures 25 and 26 (Chapter 4 of Manual 1) provide helpful guidance on how impervious cover influences subwatershed restoration strategies. Chapter 9 of this manual should be consulted for unit costs to help create the scope of work and budget for subsequent phases.

Tips for Crafting an Effective Initial Subwatershed Strategy

- The best way to hash out an initial restoration strategy is to engage in a series of brainstorming sessions with the core team to analyze desktop analysis, field assessment and stakeholder management data produced to date. It may be helpful to bring other stakeholders to these sessions to add an outside perspective.

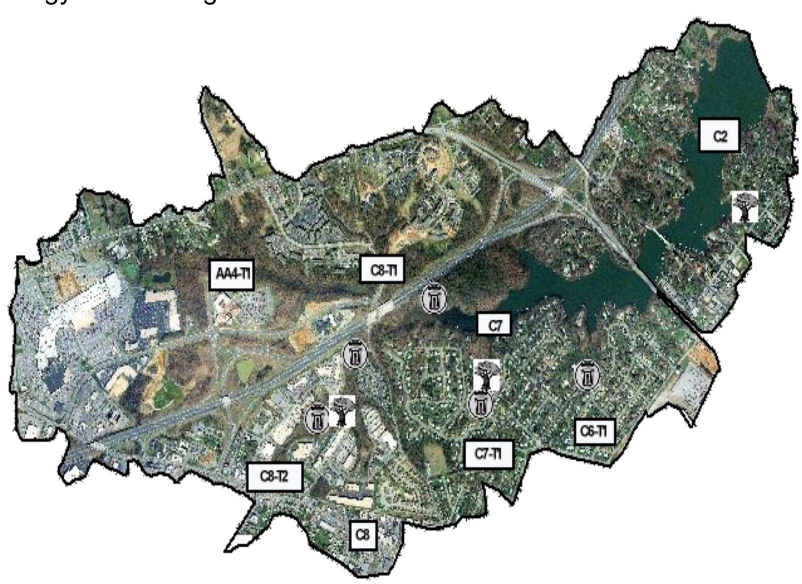
M-3	Management Methods to Get to Restoration Decisions **Initial Subwatershed Strategy**	ISS

Tips for Crafting an Effective Initial Subwatershed Strategy

- Start the sessions by reminding the team about the watershed restoration goals that are guiding the effort.
- Look at simple counts of the number of each kind of restoration practice to determine which are most widespread or numerous in the stream corridor and upland areas. Check to see if practices are clustered in certain neighborhoods, areas or stream reaches. If possible, visually estimate the total area or length that the restoration practices could potentially treat in the subwatershed. Try to narrow down the number and type of restoration practices that need to be investigated.
- This is one of the big money steps in subwatershed planning since many of the candidate project investigations considered can be quite expensive to perform, particularly if there a lot of them.
- The scope of work will always be constrained by available budget, and the core team will always face hard choices on what tasks to include and exclude from the next steps of subwatershed planning. Carefully analyze each task to see if it is more sophisticated or expensive than is actually needed. One useful trick is to allocate time during a stakeholder meeting to practice subwatershed budgeting in a small group setting.
- Remember, that just as some dogs don't hunt, some subwatersheds just don't work out. They may simply not have enough potential locations for restoration practices to make enough of a difference. Don't get discouraged -- there is usually a better subwatershed out there.

Real World Example

Weems Creek is a small coastal plain watershed located near Annapolis, Maryland. Concerns about declining water quality and habitat in its tidal coves prompted a strong local effort to restore this watershed. A comprehensive strategy was lacking until detailed subwatershed and stream corridor assessments were undertaken, and an intensive effort was made to involve the public. This broad restoration strategy enabled watershed partners to agree on a common framework for more detailed restoration investigations (Sturm, 2002).



M-4

Management Methods to Get to Restoration Decisions

Inventory of Restoration Opportunities

IRO

Restoration Decision

The decision in Step 4 is to identify the combination of feasible restoration projects in the subwatershed that can achieve overall watershed restoration goals. All feasible restoration projects are assembled into a single binder/document so that their cumulative effect on treatment can be assessed at the subwatershed level.

Scale	Value
Subwatershed-wide	Essential

Management Method

Two tasks are required to complete an Inventory of Restoration Opportunities:

1. Assemble project concept designs into master binder or GIS
2. Produce subwatershed project locator map and inventory summary table

Product or Instrument

The typical product is a detailed report known as a subwatershed restoration inventory, which is usually 40 to 60 pages long, with appendices showing individual restoration project assessment sheets and maps.

Intended Audience

The full inventory is primarily used by the core restoration team as a planning reference, but summary tables and maps are often shared with subwatershed stakeholders and restoration partners.

Time Frame / Level of Effort

The inventory can usually be assembled in about two weeks of staff time, assuming other tasks are completed.

Decision-making Process

The draft inventory is usually prepared by the lead watershed agency, and is then circulated for review and comment by subwatershed stakeholders. The subwatershed restoration inventory is normally compiled from the individual project concept designs developed after candidate project investigations and initial subwatershed stakeholder meetings.

Tips for Putting Together a Restoration Inventory

- An interdisciplinary team should compile the inventory since it requires knowledge about many diverse groups of restoration practices.
- The inventory should be divided into sections for each of the seven major groups of restoration practices, and summary tables should be prepared to track project counts within each section.
- The subwatershed map should not only show the location of each project but the approximate area that it treats.
- Subwatershed location is important. Look for synergies among different kinds of restoration practices in the same area (e.g., upstream retrofit above stream repair project also associated with riparian reforestation project).

M-4

Management Methods to Get to Restoration Decisions

Inventory of Restoration Opportunities

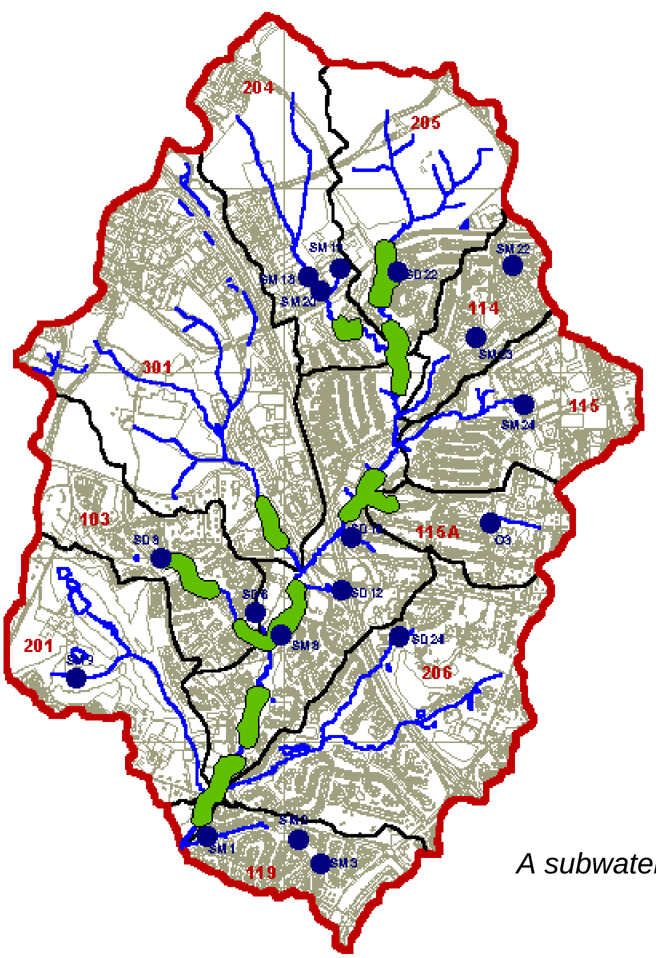
IRO

Tips for Putting Together a Restoration Inventory

- Comparative tables on project cost, area treated, pollutants reduced and relative feasibility are extremely helpful in sorting out the most effective projects to consider in the subwatershed plan.
- Keep in mind that ALL potential restoration projects should be included in the inventory, even if they do not currently appear to be feasible or cost-effective. They may ultimately be needed if more treatment is needed to meet subwatershed goals.

Real World Example

Watts Branch is a small watershed located in suburban Maryland, where an extensive subwatershed restoration inventory was completed. Initially, more than 70 feasible projects were identified in the subwatershed. Stakeholders were actively involved throughout the inventory process, which helped to make a final list of 23 projects acceptable to all parties (Brown and Claytor, 2001). The map below shows the final locations of restoration projects in the watershed.



A subwatershed locator map helps organize the retrofit inventory

M-5	Management Methods to Get to Restoration Decisions **Draft Subwatershed Plan**	**DSP**

Restoration Decision

Agree on a short and concise subwatershed plan that recommends restoration projects and programs and outlines the budget, phasing, responsible parties and funding strategy needed for implementation. The plan is usually no more than 20 to 40 pages long, with a table of key project recommendations and a subwatershed map showing their locations.

Scale	Value
Subwatershed-wide	Essential

Management Method

Five basic tasks are involved in writing an effective subwatershed plan:

1. Draft an outline for the plan
2. Define subwatershed objectives
3. Identify early action commitments
4. Develop project implementation matrix
5. Prepare technical appendices supporting the plan

Product or Instrument

The product is a draft subwatershed restoration plan prepared by the lead watershed agency. The draft plan is synthesized from the project evaluation and ranking (PER) and neighborhood consultation meetings (NCM).

Intended Audience

The draft plan is normally circulated to partners and stakeholders for external review and comment (see Profile Sheet M-6). A condensed summary of the plan and map can also be posted on the project website.

Time Frame

A short plan can be written using two to three weeks of staff time scheduled over a two-month time period if there are no technical problems.

Decision-making Process

The draft subwatershed plan undergoes several more checks before it is ready to be finally adopted. Steps 6 and 7 focus on subwatershed treatment analysis, external plan review, creation of restoration partnerships and an implementation strategy that can effectively navigate the draft plan through the local political, budget and agency landscape.

Tips for Drafting the Plan

- Before getting started, take some time to review the original watershed goals and objectives that are driving the restoration process and make sure the subwatershed plan is consistent with them.

- The draft plan is no time to be cautious about implementation. The plan should show how all the priority restoration projects will be completed within a maximum of five to seven year period. Individual projects should be phased to implement the ones that provide the maximum initial subwatershed or stream corridor treatment.

M-5

Management Methods to Get to Restoration Decisions

Draft Subwatershed Plan

DSP

Tips for Drafting the Plan

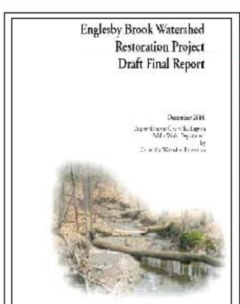
- Try to think through everyone who will play a role in the actual implementation of individual restoration projects, and make sure they fully understand the permitting, landowner approval, and maintenance responsibilities set forth in the plan.

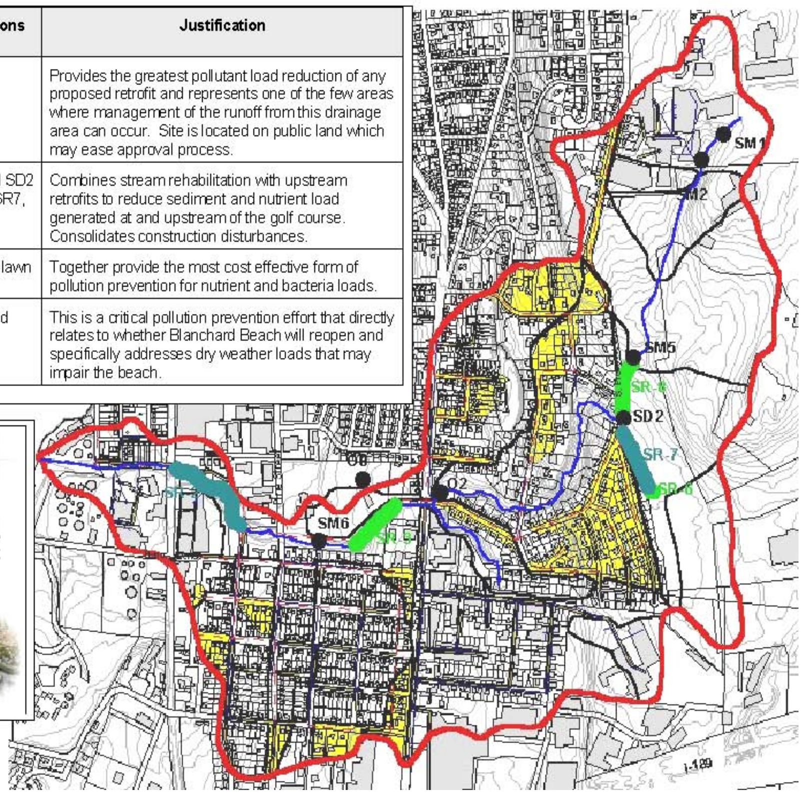
- Be creative and assign restoration partners multiple responsibilities for action in the plan, whether they are other local agencies, watershed groups, funding sources, or state resource agencies and others. The key to creating a strong restoration partnership is shared action, and the draft plan is a good opportunity to share what some of these actions might be.

Real World Example

Englesby Brook is a very small urban watershed that drains to Lake Champlain near Burlington, Vermont. Storm water runoff from the subwatershed had earlier been identified as the cause of the closure of a popular swimming beach. A draft subwatershed plan was developed to identify key restoration projects and costs, and was used by stakeholders to define the final implementation strategy to correct the problem through a combination of storm water retrofits and source control efforts (Claytor *et al.*, 2001).

Keystone Recommendations for Implementation	Justification
Stormwater retrofit: O8	Provides the greatest pollutant load reduction of any proposed retrofit and represents one of the few areas where management of the runoff from this drainage area can occur. Site is located on public land which may ease approval process.
Stormwater retrofit: SM5 and SD2 Stream rehabilitation: SR6, SR7, and SR8	Combines stream rehabilitation with upstream retrofits to reduce sediment and nutrient load generated at and upstream of the golf course. Consolidates construction disturbances.
Pet waste management and lawn care education	Together provide the most cost effective form of pollution prevention for nutrient and bacteria loads.
Illicit connection detection and removal	This is a critical pollution prevention effort that directly relates to whether Blanchard Beach will reopen and specifically addresses dry weather loads that may impair the beach.





M-6	Management Methods to Get to Restoration Decisions **Subwatershed Implementation Strategy**	**SIS**

Purpose

The purpose of this step is to put together a strategy to get the plan adopted, funded and implemented over time. The restoration team needs to think through how they will navigate the plan through the local political and budgetary process and persuade key members of the community to support the action.

Scale	Value
Community-wide	Essential

Management Method

Six tasks are needed to develop the Subwatershed Implementation Strategy:

1. Investigate funding available for implementation
2. Schedule realistic implementation time frame
3. Establish restoration partnership structure
4. Decide on early action commitments
5. Determine minimum local budget needs
6. Learn the local budget process and begin briefings

Product or Instrument

The initial products are presentations describing the subwatershed improvements expected from the plan that are targeted to the interests of local decision-makers.

Intended Audience

Once the subwatershed evaluation has been finalized, an organized campaign commences to present that case to the influential members of the community that can make it happen, such as elected officials, regulators, local media, state and federal funding sources, and the activist public.

Time Frame / Level of Effort

The required staff effort can range from a few weeks to several months. Obviously, the time frame will need to be extended if the Subwatershed Treatment Analysis (STA) suggests that the plan must be revised or expanded to meet watershed restoration goals.

Decision-making Process

The final implementation strategy is derived from the STA (D-6) and External Plan Review (S-6). The lead watershed agency or group normally performs the analysis, and then circulates it to appropriate stakeholders for technical review.

Tips in Deriving Subwatershed Implementation Strategy

- This is a great time in the planning process to pause for a moment and think big, strategic and long term. It may have taken a year or more to get to this point, but you still have many years to go in terms of actual implementation. Start by revisiting the goals that are driving local restoration, since better decisions are always made when endpoints are clear and defined.

- A brief retreat is often an effective way to develop the strategy. The core team, key partners, budget experts, senior agency heads and elected official staff should be invited to chart a common course of action, as well as some outside advisors to bring fresh perspectives.

M-6

Management Methods to Get to Restoration Decisions

Subwatershed Implementation Strategy

SIS

Tips in Deriving Subwatershed Implementation Strategy

- One of the most critical "to do" items in the strategy is to determine who will perform the remaining steps of the restoration process in the coming years. More likely than not, these important tasks were not fully budgeted or scoped in the original restoration planning effort.

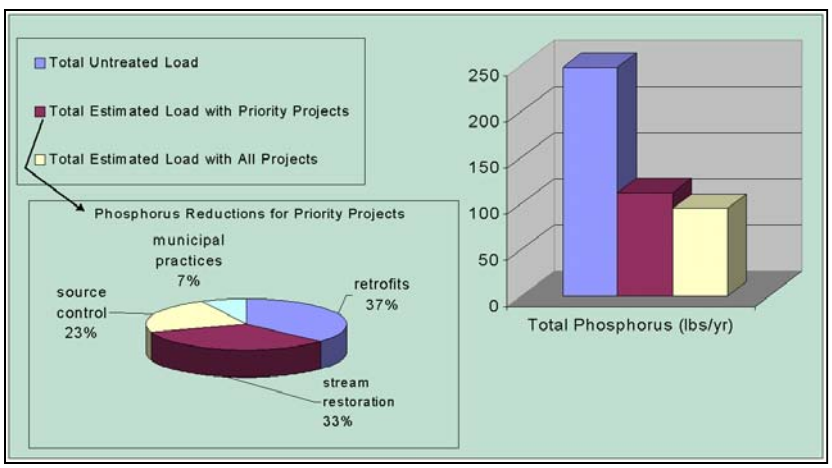
- The strategy should focus on how to pay for the delivery of multiple restoration projects in a relatively short time period. The future costs and staff effort needed to perform final design, permitting, construction, project management, monitoring, coordination and ongoing management will normally far exceed what has been spent so far on restoration planning. The strategy should designate who will perform each task, and carefully estimate how much it will cost. Guidance on scoping, budgeting and phasing the final steps in restoration implementation is provided in Chapter 9.

- Long-range thinking is good, but the strategy should also identify the early action restoration projects that can be installed in a year's time. Early action projects are low cost restoration projects that are easy to design and permit, and can demonstrate early results on the ground. Good early action projects include reforestation, stream cleanups, residential stewardship, illicit discharge detection, and some fish barrier removals.

- Lastly, the core team should think about how it will market the restoration effort and build a persuasive case for why it is needed and the benefits it will provide. At some point in the near future, the core team will be asked tough questions to justify the considerable community investment in restoration—and it pays to anticipate these tough questions in advance and be prepared with an effective response.

Real World Example

Englesby Brook is a good example of how to evaluate subwatershed treatment. Local managers wanted to make sure that the recommended combination of restoration projects would help solve their water quality problems, yet they did not have the resources to support sophisticated watershed modeling. The Watershed Treatment Model (WTM) was used to evaluate the expected pollutant reduction that could be achieved by the draft plan. As shown in the graph below, the results of the WTM indicated that the plan could sharply reduce phosphorus loads (Claytor *et al.*, 2001).



M-7	Management Methods to Get to Restoration Decisions **Adopt Final Plan**	**AFP**

Restoration Decision

Agree on the final details of subwatershed restoration implementation and get local elected officials to endorse the plan and appropriate short and long-term funds for implementation

Scale	Value
Community-wide	Essential

Management Method

Four tasks are involved in getting the final plan adopted:

1. Decide which plan elements require adoption
2. Convert plan elements into legislative and budgetary language
3. Make persuasive case about restoration benefits
4. Navigate the appropriate approval pathway

Product or Instrument

There are many instruments that can be used to adopt a plan, including formal votes, dedicated long term capital budgets, passing a line item in an agency operating budget, authorizing cost-sharing or grants, or similar actions.

Intended Audience

The formal adoption of a restoration plan is a superb opportunity for effective watershed outreach. Good watershed managers recognize this fact, and widely announce the agreement through the media, press releases, ribbon cuttings, photo opportunities, presentations, and other public relation tools. All publicity should liberally dispense credit, recognition and thanks to the elected officials and stakeholders that made it happen.

Time Frame Level of Effort

This method can take as little as a month of staff effort to complete if there are no major surprises or unforeseen costs encountered in the final design process. However, the actual time-frame to adopt the plan is often much longer, given the crowded schedules of elected officials and timing of local budget processes.

Decision-making Process

The final plan is developed based on final project costs and external review and normally requires formal approval by elected officials and other responsible parties.

Tips for Getting the Plan Adopted

- The political landscape and budgetary situation is different in every community, but it is surprising how many restoration plans are developed with little regard to either important factor. Quite simply, a good plan submitted at a bad time may not be adopted.

M-7

Management Methods to Get to Restoration Decisions

Adopt Final Plan

AFP

- 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?
  - How tight are local budgets expected to be in the next few years?
  - How favorably disposed are elected officials to restoration issues?
  - Is more education needed to get them up to speed?
  - What key issues will motivate them to support restoration (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 restoration projects inserted into local operating and capital budgets?
  - 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 restoration?
- 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).
- The real trick in getting a plan adopted is to gauge what elements to pull out of the plan to recommend for adoption, and how much and how many years of actual budget commitment can be realistically expected in the current political landscape. In many cases, it may require many votes over many months or years to get the entire restoration budget authorized.
- While it may be a good idea to ask for a vote to endorse the plan as a whole, a short “adoption” document should be prepared that summarizes the recommended actions at the current point in time. The adoption document should be no longer than a half-dozen pages at most, and contain a matrix of key recommendations, including the specifics of who, what, when, where and how much will it cost to implement them.
- The adoption document should always emphasize any recommendations that are low or no cost recommendations, such as early action projects or changes that can be implemented administratively or through changes in municipal operations.
- The adoption document should also reaffirm the goals of the restoration effort and recognize all key partners involved in implementation.

M-7

Management Methods to Get to Restoration Decisions

Adopt Final Plan

AFP

Real World Example

The City of Rockville, MD is an excellent example of a proactive approach to financing the implementation of a subwatershed plan. The purpose of the Watershed Management Program is to make the city's stream corridors environmentally stable and enjoyable for residents, and to reduce nonpoint source to the Potomac River and the Chesapeake Bay. The City's dedicated storm water management fund makes the watershed management program self-supporting. Money is primarily collected from fee-in-lieu contributions for storm water management and storm water management and sediment control permit fees. These funds cover design and construction of public facilities and stream restoration, watershed studies, and other restoration programs. The table below presents the capital improvement projects implementation schedule for priority restoration sites that were identified in the City's Watts Branch Management Plan (Brown and Claytor *et al*., 2001). Over a 10-year period, the City plans to spend more than $2.7 million on the restoration of Watts Branch.

Watts Branch Watershed Study Projects Proposed CIP Implementation Schedule – Fiscal Years 2002-2012

WATTS BRANCH PROJECTS	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	
SM18 & SM20 (270 Industrial Park & Carnation Drive Ponds) & 204-5	*$81,000*		$259,000								
205-1 to 2, 204-1, 302-12; 205-5 to 8 (Upper Watts Br. Park Streamwork)					*$80,000*		$256,800				
SM23 (College Gardens Park Pond)			*$50,000*		$198,000						
O3 (Welsh Park Pond)				*$40,000*		$133,000					
302-3 to 4, 302-6, 302-8; 115A-1 to 3 (Woodley Gardens Park Streamwork)			*$70,000*		$193,000						
401-15 to 18, 103-1 to 2 (Woottons Mill Park-Upper Streamwork)	*$60,000*		$166,000								
401-8 to 11 (Woottons Mill Park-Rockshire Streamwork)		*$40,000*		$110,000							
401-2 to 3, 401-5 to 6 (Woottons Mill Park-Lower Streamwork)									*$40,000*		$
SM1, SM2 & SM3 (Horizon Hill Park Ponds)					*$88,000*		$293,000				
SM9 (Lakewood Country Club Pond)									*$10,000*		

M-8

Management Methods to Get to Restoration Decisions

Adapt Subwatershed Plan

ASP

Restoration Decision

The key decision is whether the plan needs to be adapted over time to respond to ongoing monitoring data, project experience and unforeseen financial opportunities. While it is impossible to anticipate the future, it is important to create an adaptive management process to oversee plan implementation.

Scale	Value
Subwatershed-wide	Helpful

Management Method

Four tasks are needed to adapt subwatershed plans:

1. Reconvene stakeholders once a year
2. Evaluate long-term trends in aquatic indicators
3. Assess the first round of implementation projects
4. Revise or expand restoration goals

Product or Instrument

The ongoing management structure (OMS) periodically produces annual reports, special monitoring studies, project progress reports, newsletters, or progress meetings to document progress made in plan implementation and stream indicator response.

Intended Audience

The OMS is the key player to keep the full range of all stakeholders informed about progress made in restoration. They are also ideally positioned to quickly respond to new funding opportunities to enhance the restoration plan.

Time Frame

The typical time frame for the first round of implementation is typically five years or longer. The original plan should be revisited every five to seven years, and possibly revised to account for indicator trends, project experience and other factors.

Decision-making Process

Adaptive management is triggered by the results of project tracking and sentinel or performance monitoring, and presumes the existence of an ongoing management structure that can make the appropriate changes to the plan when the time comes.

Tips for Sustaining Progress

- Communities often experience great difficulty in sustaining restoration efforts over the long run, given the inevitable budget shortfalls, staffing changes, election cycles and competing environmental priorities that emerge. This underscores the pivotal importance of an ongoing management structure that can advocate for the plan during these difficult times, and sustain progress toward restoration.

- The subwatershed plan should be flexible enough that the management structure can respond to unanticipated grant opportunities, new partners, and innovative practices.

Tips for Sustaining Progress

M-8	Management Methods to Get to Restoration Decisions **Adapt Subwatershed Plan**	**ASP**

- The management structure should get together at least once a year to strategically evaluate the restoration plan. Emphasis should be placed on how restoration projects can be delivered faster and more cheaply, how the restoration partnership can be expanded, and what new funding opportunities can be pursued.

Real World Example

Located in central Delaware, the Appoquinimink River watershed drains agricultural areas, small historic towns, and new residential subdivisions before discharging into the Delaware Bay Estuary. As part of the State's Tributary Action Strategy program, local stakeholders developed a pollution control strategy (PCS) to help meet recent TMDLs for the Appoquinimink and its tributaries. Stream walks, storm water retrofit inventories, and hotspot and residential source control assessments were performed to identify specific restoration projects to be implemented per the PCS. An implementation plan was developed in 2005 that outlined specific project concepts, responsible parties, estimated costs, and a 5 year implementation horizon. The plan also recommended annual reporting and project tracking by the watershed coordinator (the OMS). The overall plan is to be reevaluated and updated by 2010 to make sure PCS goals are being met.