Urban Subwatershed Restoration Manual Series

2

Methods to Develop Restoration Plans for Small Urban Watersheds

Version 2.0

August 2005

CENTER FOR WATERSHED PROTECTION

Manual 2

Foreword

The Center has been involved in dozens of urban watershed restoration efforts over the years, and has gradually developed and refined a set of methods to get them done faster and more effectively. This manual outlines our current thinking on how to do small watershed restoration plans, but we continue to refine it to more affect urban watersheds. As such, we continue to refine and test each method in real watershed settings—in the office, the field, and the board room. We encourage you to do the same and adapt and modify these methods to suit the unique conditions present in your community.

Many thanks are extended to external reviewers who carefully looked over previous drafts of this manuscript. They include Derek Booth, University of Washington Center for Water and Watershed Research, and Thomas Davenport, national nonpoint source expert for the U.S. Environmental Protection Agency.

The entire Center staff contributed to the development of this manual, including Ted Brown, Anne Kitchell, Chris Swann, Karen Cappiella, Hye Yeong Kwon, Jennifer Zielinski, Rebecca Winer, and Stephanie Sprinkle. Their hard work, real-world watershed experience, and practical insights are reflected throughout the manual. In addition, Tiffany Wright and Lauren Lasher cannot be thanked enough for their able assistance in editing, proofing and producing this manual. Lastly, we would like to acknowledge the patience, insights and flexibility of our EPA project officer, Robert Goo, during the two years it took to produce this manual series under a cooperative agreement with U.S. EPA Office of Water (CP-82981501).

Sincerely,

Tom Schueler
Director of Watershed Research and Practice

About the Restoration Manual Series

This is the second in an 11-manual series that provides detailed guidance on how to repair urban watersheds. The entire series of manuals was written by the Center for Watershed Protection to organize the enormous amount of information needed to restore small urban watersheds into a format that can easily be accessed by watershed groups, municipal staff, environmental consultants and other users. The contents of the manuals are organized as follows:

Manual 1: An Integrated Approach to Restore Small Urban Watersheds

The first manual introduces the basic concepts and techniques of urban watershed restoration, and sets forth the overall framework we use to evaluate subwatershed restoration potential. The manual emphasizes how past subwatershed alterations must be understood in order to set realistic expectations for future restoration. Toward this end, the manual presents a simple subwatershed classification system to define expected stream impacts and restoration potential. Next, the manual defines seven broad groups of restoration practices, and describes where to look in the subwatershed to implement them. The manual concludes by presenting a condensed summary of a planning approach to craft effective subwatershed restoration plans.

Manual 2: Methods to Develop Restoration Plans for Small Urban Watersheds

The second manual contains detailed guidance on how to put together an effective plan to restore urban subwatersheds. The manual outlines a practical, step-by-step approach to develop, adopt and implement a subwatershed plan in your community. Within each step, the manual describes 32 different desktop analysis, field assessment, and stakeholder involvement methods used to make critical restoration management decisions.

The next seven manuals provide specific guidance on how to identify, design, and construct the seven major groups of watershed restoration practices. Each of these "practice" manuals describes the range of techniques used to implement each practice, and provides detailed guidance on subwatershed assessment methods to find, evaluate and rank candidate sites. In addition, each manual provides extensive references and links to other useful resources and websites to design better restoration practices. The seven manuals are organized as follows:

Manual 3: Storm Water Retrofit Practices

The third manual focuses on storm water retrofit practices that can capture and treat storm water runoff before it is delivered to the stream. The manual describes both off-site storage and on-site retrofit techniques that can be used to remove storm water pollutants, minimize channel erosion, and help restore stream hydrology. The manual then presents guidance on how to assess retrofit potential at the subwatershed level, including methods to conduct a retrofit inventory, assess candidate sites, screen for priority projects, and evaluate their expected cumulative benefit. The manual concludes by offering tips on retrofit design, permitting, construction, and maintenance considerations in a series of 17 retrofit profile sheets.

Manual 4: Urban Stream Repair Practices

The fourth manual concentrates on practices used to enhance the appearance, stability, structure, or function of urban streams. The manual offers guidance on three broad approaches to urban stream repair – stream cleanups, simple repairs, and more sophisticated comprehensive repair applications. The manual emphasizes the powerful and relentless forces at work in urban streams, which must always be carefully evaluated in design. Next, the manual presents guidance on

how to set appropriate restoration goals for your stream, and how to choose the best combination of stream repair practices to meet them.
The manual also outlines methods to assess stream repair potential at the subwatershed level, including basic stream reach analysis, more detailed project investigations, and priority screenings. The manual concludes by offering practical advice to help design, permit, construct and maintain stream repair practices in a series of more than 30 profile sheets.

Manual 5: Riparian Management Practices

The fifth manual examines practices to restore the quality of forests and wetlands within the remaining stream corridor and/or flood plain. It begins by describing site preparation techniques that may be needed to make a site suitable for planting, and then profiles four planting techniques for the riparian zone, based on its intended management use. The manual presents several methods to assess riparian restoration potential at the subwatershed level, including basic stream corridor analysis, detailed site investigations, and screening factors to choose priority reforestation projects. The manual concludes by reviewing effective site preparation and planting techniques in a series of eight riparian management profile sheets.

Manual 6: Discharge Prevention Practices

The sixth manual covers practices used to prevent the entry of sewage and other pollutant discharges into the stream from pipes and spills. The manual describes a variety of techniques to find, fix and prevent these discharges that can be caused by illicit sewage connections, illicit business connections, failing sewage lines, or industrial/transport spills. The manual also briefly presents desktop and field methods to assess the severity of illicit discharge problems in your subwatershed. Lastly, the manual profiles different "forensic" methods to detect and fix illicit discharges. Manual 6 is also known as the *Illicit Discharge Detection and Elimination Guidance Manual: a guidance manual for program development and technical assessment*, and is referenced as Brown *et al*., 2004, throughout this manual.

Manual 7: Watershed Forestry Practices

The seventh manual reviews subwatershed practices that can improve the quality of upland pervious areas, which include techniques to improve conditions, revegetate pervious areas, and restore natural area remnants. When broadly applied, these techniques can improve the capacity of these lands to absorb rainfall and sustain healthy plant growth. This manual also outlines methods to assess the potential for these techniques at both the site and subwatershed scale.

Manual 8: Pollution Source Control Practices

Pollution source control practices reduce or prevent pollution from residential neighborhoods or storm water hotspots. Thus, the topic of the eighth manual is a wide range of stewardship and pollution prevention practices that can be employed in subwatersheds. The manual presents several methods to assess subwatershed pollution sources in order to develop and target education and/or enforcement efforts that can prevent or reduce polluting behaviors and operations. The manual outlines more than 100 different "carrot" and "stick" options that can be used for this purpose. Lastly, the manual presents profile sheets that describe 21 specific stewardship practices for residential neighborhoods, and 15 pollution prevention techniques for control of storm water hotspots.

Manual 9: Municipal Practices and Programs

The ninth manual focuses on municipal programs that can directly support subwatershed restoration efforts. The five broad areas include improved street and storm drain maintenance practices, development/redevelopment standards, stewardship of public land, delivery of municipal stewardship services, and watershed education and enforcement. This last “practice” manual presents guidance on how municipalities can use these five programs to promote subwatershed restoration goals. The manual also contains a series of profile sheets that recommends specific techniques to implement effective municipal programs.

The series concludes with two user manuals that explain how to perform field assessments to discover subwatershed restoration potential in the stream corridor and upland areas.

Manual 10: The Unified Stream Assessment (USA): A User’s Manual

The Unified Stream Assessment (USA) is a rapid technique to locate and evaluate problems and restoration opportunities within the urban stream corridor. The tenth manual is a user’s guide that describes how to perform the USA, and interpret the data collected to determine the stream corridor restoration potential for your subwatershed.

Manual 11: The Unified Subwatershed and Site Reconnaissance (USSR): A User’s Manual

The last manual examines pollution sources and restoration potential within upland areas of urban subwatersheds. The manual provides detailed guidance on how to perform each of its four components: the Neighborhood Source Assessment (NSA), Hotspot Site Investigation (HSI), Pervious Area Assessment (PAA) and the analysis of Streets and Storm Drains (SSD). Together, these rapid surveys help identify upland restoration projects and source control to consider when devising subwatershed restoration plans.

Individual manuals in the series are scheduled for delivery in 2006 and 2007. Be sure to check our website, www.cwp.org, to find out when each manual will be available and how it can be accessed.

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List of Acronyms and Abbreviations

The following list describes the many acronyms and abbreviations used in the manual to describe the methods, practices, and models used to restore small urban watersheds.

AFP:	Adopt Final Plan
ASP:	Adapt Subwatershed Plan
CPI:	Candidate Project Investigation
CSA:	Comparative Subwatershed Analysis
CSO:	Combined Sewer Overflow
DPI:	Discharge Prevention Investigation
DSA:	Detailed Subwatershed Analysis
DSP:	Draft Subwatershed Plan
EDA:	Existing Data Analysis
EDS:	Engineering and Design Surveys
EPR:	External Plan Review
EPT:	Macroinvertebrate index that examines sensitive aquatic insect species
FC:	Forest Cover
FDC:	Final Design and Construction
FEMA:	Federal Emergency Management Agency
FSC:	Facilitating Stakeholder Consensus
FTE:	Full Time Equivalent
FWG:	Finalize Watershed Goals
GIS:	Geographic Information System
GPS:	Global Positioning System
HCI:	Hotspot Compliance Investigation
HOA:	Homeowners Association
HSI:	Hotspot Site Investigation
IBI:	Index of biotic integrity
IC:	Impervious Cover
ICM:	Impervious Cover Model
ISS:	Initial Subwatershed Strategy
IRO:	Inventory of Restoration Opportunities
K:	Thousand

MOA:	Municipal Operations Analysis
MRP:	Maintain Restoration Partnerships
MSI:	Managing Stakeholder Input
NARA:	Natural Area Remnant Analysis
NCA:	Needs and Capabilities Assessment
NCM:	Neighborhood Consultation Meeting
NPDES:	National Pollutant Discharge Elimination System
NSA:	Neighborhood Source Assessment
OMS:	Ongoing Management Structure
ORI:	Outfall Reconnaissance Inventory
PAA:	Pervious Area Assessment
PCD:	Project Concept Design
PER:	Project Evaluation and Ranking
PMP:	Performance Monitoring of Practices
PSL:	Priority Subwatershed List
RBA:	Rapid Baseline Assessment
RBP:	Rapid Bioassessment Protocol
REO:	Restoration Education and Outreach
RRI:	Retrofit Reconnaissance Inventory
RSAT:	Rapid Stream Assessment Technique
RTE:	Rare, Threatened and Endangered Species
SCP:	Source Control Plan
SIR:	Stakeholder Identification and Recruitment
SIS:	Subwatershed Implementation Strategy
SMS:	Sentinel Monitoring Stations
STA:	Subwatershed Treatment Analysis
SRI:	Stream Repair Investigation
SSD:	Streets and Storm Drains
STORET:	U.S. EPA's repository for environmental data (short for STOrage and RETrieval)
TPI:	Tracking Project Implementation
TMDL:	Total Maximum Daily Load
USA:	Unified Stream Assessment
USGS:	United States Geological Survey
URSA:	Urban Reforestation Site Assessment
USSR:	Unified Subwatershed and Site Reconnaissance
QA/QC:	Quality Assurance/Quality Control
WTM:	Watershed Treatment Model

Introduction

This manual presents a framework to guide teams through a sequence of methods to develop, adopt, implement, and track small watershed restoration plans. The manual starts by introducing the basic eight-step framework for developing small watershed restoration plans. Common elements of desktop analysis, field assessment, stakeholder involvement and restoration management are described. The introduction summarizes the individual methods performed in each of the eight steps, and emphasizes how to put together a core restoration team to get the job done. The remainder of the manual is organized into nine different chapters. Profile Sheets appear at the end of Chapters 1-8, and provide a two-page summary of each task – including its scale, necessity, the components, and tips and/or real world examples of these tasks at work.

Chapter 1: Methods to Develop Watershed Restoration Goals

Many different goals can drive local watershed restoration. The first chapter describes four methods to develop clear and achievable goals, objectives and indicators to guide local restoration efforts.

Chapter 2: Methods to Screen Priority Subwatersheds

Most communities have too many subwatersheds to restore at one time and must prioritize where to start first. The chapter describes four methods to screen subwatersheds with the greatest restoration potential, and discusses the value and use of more than twenty metrics that can discriminate restoration potential among a large group of subwatersheds.

Chapter 3: Methods to Evaluate Subwatershed Restoration Potential

Restoration potential can only be discovered in the field, and then only after the best opportunities have been screened from the office. The third chapter describes rapid desktop analysis and field assessment methods used to find restoration potential at the subwatershed level, emphasizing the Unified Stream Assessment (USA) and Unified Subwatershed and Site Reconnaissance (USSR). The chapter highlights how data from both methods, along with stakeholder input, can be woven together to craft an initial restoration strategy for a subwatershed.

Chapter 4: Methods to Investigate Restoration Projects

More sophisticated methods are needed to translate restoration possibilities into potential restoration projects. The fourth chapter describes eight different field investigations to evaluate the feasibility of individual restoration projects and determine if they should be carried forward to project concept design. The chapter also explains how individual projects are assembled into an inventory of subwatershed restoration opportunities.

Chapter 5: Methods to Assemble Projects into Subwatershed Plans

This step transforms the restoration inventory into a draft plan that recommends the most cost effective combination of restoration practices to apply in the subwatershed. The chapter discusses screening factors that identify, evaluate and rank the most effective and feasible projects for priority implementation. Community acceptance is normally a very important screening factor, so the chapter emphasizes how to conduct effective meetings to elicit neighborhood feedback on proposed projects.

Chapter 6: Methods to Determine if Plan Meets Watershed Goals

This step answers the question about whether the recommended group of restoration projects contained in the plan will achieve watershed goals. The sixth chapter introduces the concept of subwatershed treatment, and how it can be rapidly assessed in the context of the Watershed Treatment Model. The chapter concludes by describing methods to needed to get external plan review and navigate it through the final adoption process.

Chapter 7: Methods to Implement the Plan

Implementing a subwatershed plan is no simple task. The seventh chapter describes four methods to translate the plan into reality, starting with final design and construction and the engineering designs surveys needed to support it. The chapter also emphasizes how to create restoration partnerships and political support to get the final plan adopted and funded.

Chapter 8: Methods to Measure Improvements Over Time

Implementation of a subwatershed plan seldom occurs in less than five years. The eighth chapter explores five methods to sustain and monitor implementation progress during this crucial phase. The chapter describes how to develop a project tracking system and an ongoing management structure to manage the continued delivery of restoration practices in the subwatershed. The chapter also presents guidance on how to establish sentinel monitoring stations to measure long-term trends in stream indicators, and measure the performance of individual restoration practices. Feedback from each method provides the essential data needed to adapt the plan to achieve the greatest degree of subwatershed improvement.

Chapter 9: Scoping and Budgeting a Restoration Plan

Each of the methods in the restoration planning process costs money. The final chapter contains guidance on how to scope and budget subwatershed plans, and presents unit cost data for each of the 32 restoration methods. The chapter presents tips on how to economize on subwatershed planning in order to choose the most essential methods needed for implementation.

Regrettably, the manual contains dozens of new acronyms and terms that may not be initially familiar to the reader. Consequently, a list of acronyms and glossary are provided, which can be consulted when the going gets tough. Technical appendices are included at the end of the manual that offer additional details and resources on restoration methods.

The Eight-Step Framework for Small Watershed Restoration

The eight-step framework guides teams through a sequence of methods to develop, adopt, implement, and track restoration plans. In general, the framework applies to smaller urban watersheds less than ten square miles in area. The framework has been developed and applied over the last decade to organize the many different tasks needed to produce an effective restoration plan. It is particularly helpful in scoping out the essential tasks of a watershed restoration plan, whether done by a municipality, watershed group or private consultant, or a combination of all three.

The basic restoration framework consists of eight key steps, as shown in Figure 1. More detail on the individual steps of the framework can be found in *Manual 1: An Integrated Framework for Restoring Small Watersheds*, which is a useful prerequisite to this manual. Four different types of methods are used to complete each step of the planning framework -- desktop analysis, field assessment, stakeholder involvement and restoration management (Figure 2).

- *Desktop analysis methods* occur in the office and are used to organize, map and interpret subwatershed information in order to make better restoration decisions. Desktop methods are used in each step to organize, map and interpret subwatershed information. Each desktop method relies to some extent on a watershed-based GIS, and provides direct support for field assessment and stakeholder

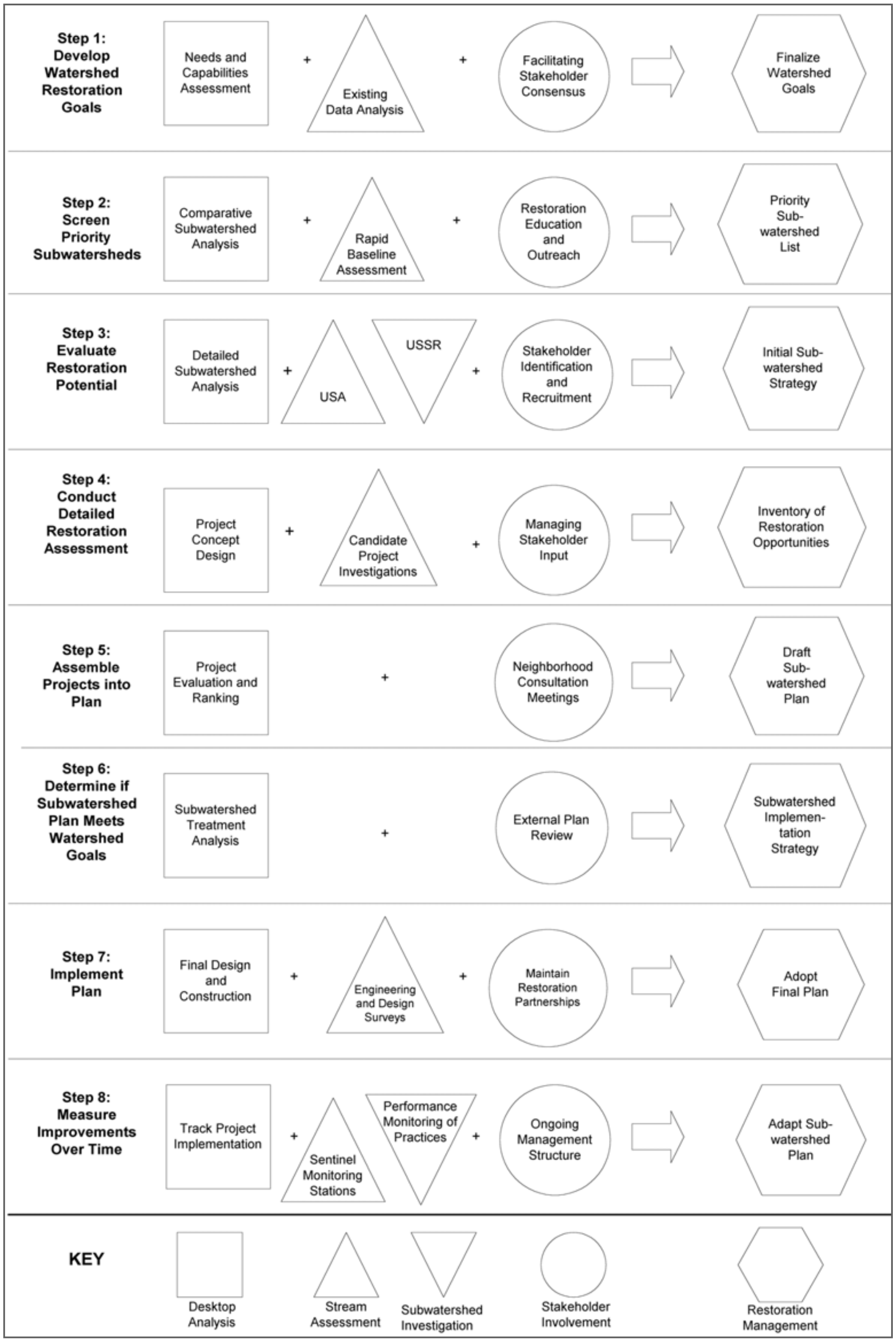


Figure 1: Eight steps of the restoration planning framework and the 32 corresponding methods to implement them

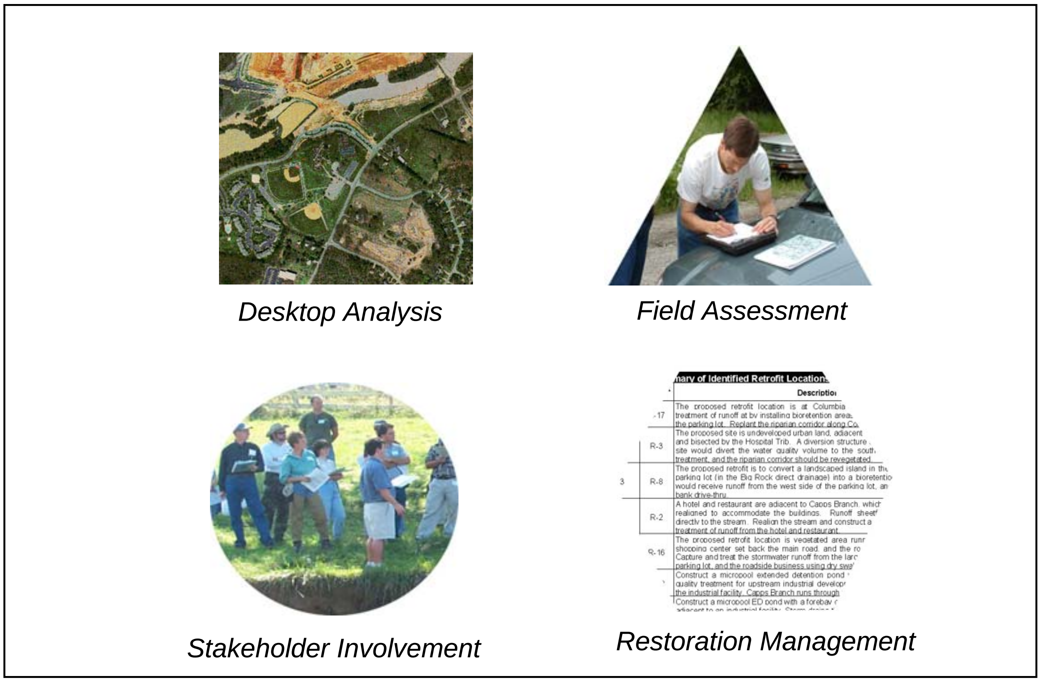


Figure 2: Four Categories of Restoration Methods

involvement methods. Desktop methods also provide the technical foundation for most restoration management decisions. Each desktop analysis method is designated by a square in this manual.

- *Field assessment methods* take place in the stream corridor and subwatershed, and are used to rapidly identify, design and rank restoration practices and/or monitor improvements in stream quality. Six steps in the restoration framework rely on field assessment methods to get data on stream impairments, restoration potential and acquire information needed to implement restoration practices. The field methods focus on the most critical data to collect, the least costly and fastest means to acquire it, and the best ways to interpret it to evaluate restoration potential at the subwatershed scale. Field assessments methods are symbolized by a triangle in this manual.

- *Stakeholder involvement methods* are used to identify, recruit and structure the involvement of diverse stakeholders during all eight steps of the restoration planning process. The methods help align the resources of stakeholders toward common goals and are essential in adopting and implementing any restoration plan. Each stakeholder involvement method has a unique purpose, is targeted to a different combination of stakeholders, and employs customized outreach techniques. Stakeholder involvement helps ensure that the restoration plan is realistic, scientifically sound, and reflects community values and desires. The goal is used to progressively transform stakeholders into partners that support and implement the plan. Stakeholder involvement methods are denoted by a circle in this manual.

- *Restoration management methods* refer to products that help agencies, partners and stakeholders make key restoration decisions. Each method culminates in a product or agreement that supports and justifies key restoration decisions made during each of the eight restoration steps. Management methods navigate the plan through the maze of political, regulatory, bureaucratic and advocacy interests within the community. Management methods fundamentally differ from the other restoration methods in that they are focused on managing people, partnerships and resources toward common goals. Restoration management methods are designated by a hexagon in this manual.

Taken together, a total of 32 possible methods can be used to develop a restoration plan, although not all of them will be needed in every subwatershed. In general, the manual presents the simplest, fastest and least expensive method to accomplish each step, and advances to the next step of the planning process. Most take only a few days or weeks of staff time to complete. In some cases, a community may choose more sophisticated methods in order to justify the community investment in watershed restoration. The manual provides extensive references to these more sophisticated and costly methods.

Each method can be applied at one of five possible geographic scales, as shown in Figure 3 and described below.

- *Community* refers to the entire land area controlled by a single political jurisdiction, such as city, county, village or town. Most communities contain numerous watersheds, not all of which may be fully contained within the political boundaries of the community. The community scale is where political decisions are made to take action on restoration.

- *Watersheds* consist of land areas that drain to a downstream water body, such as a river, lake or estuary. Their total drainage area may range from 20 to 100 square miles or more, and they often encompass many different communities and land uses. The watershed scale normally shapes the goals and objectives that drive community restoration efforts.

- Each watershed is composed of many artificially defined smaller drainage units, known as *subwatersheds*. As a general rule of thumb, subwatersheds are less than 10 square miles in drainage area and frequently even smaller. They are the primary restoration unit in the context of this manual and are the focus of subwatershed plans.

- *Neighborhoods* are an even smaller restoration unit and are defined as relatively homogenous residential land use within a subwatershed. Individual neighborhoods have markedly different characteristics and are the location where source control and other restoration practices are actually constructed. Neighborhoods are also the scale at which community acceptance of individual projects is gauged.

- *The project site or reach* is the smallest scale for restoration, and is where individual restoration practices are implemented. Practices may need to be installed at dozens or even hundreds of sites and/or reaches to achieve restoration goals at the subwatershed level.

A basic directory of restoration methods is provided in Table 1, containing the name and abbreviation for each method and where more information can be found in this manual, or others in the series. Table 2 indicates the geographic scale at which each method is applied, and compares them from the standpoint of their value, cost and required skills. Once again, further explanation is in order:

- *Value* refers to whether the method is essential or optional in the development of a subwatershed plan. Some methods can be skipped, while others are absolutely essential. Communities should carefully analyze each method to determine whether it is needed given their unique watershed goals, budget constraints and available resources. Chapter 9 provides guidance on how to scope and budget the planning process to get the most actual restoration out of limited local resources.

- *Cost* evaluates the relative cost needed to complete each method. Many of the methods are relatively inexpensive and cost from $2,000 to $15,000 to perform. A few essential methods are more expensive, however, and tend to dominate watershed restoration budgets – most notably candidate project investigations, project concept design and final design and construction.

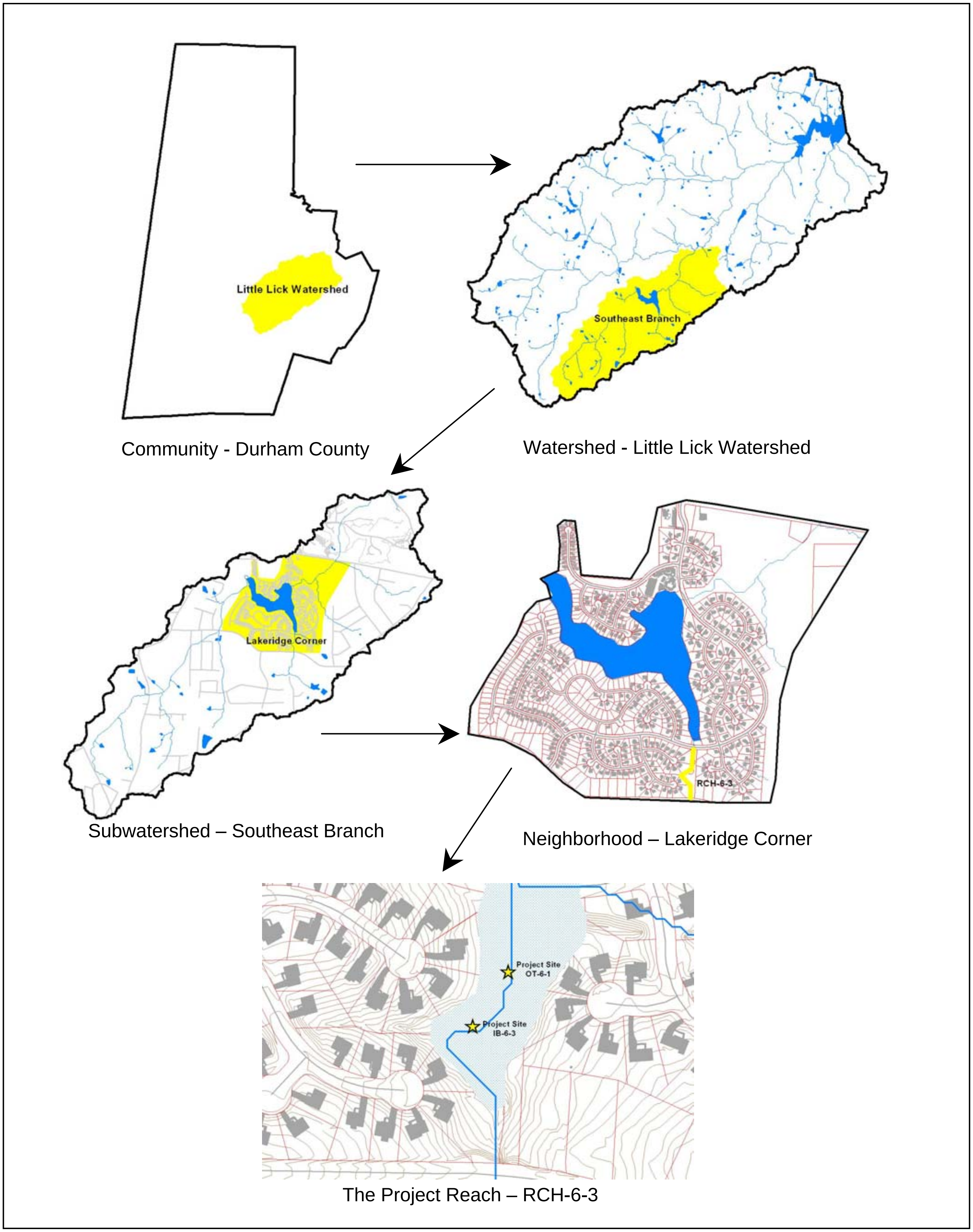


Figure 3: The Geographic Scales of Watershed Restoration

- *Skill* denotes the relative amount of specialized knowledge, experience or training needed to apply each method. Some methods are easily performed by trained volunteers, while others require experienced staff or contractors that possess specialized skills and professional training. Managers need to form a strong restoration team with the right mix of skills and talents to effectively perform the full range of restoration methods.

Getting Started

As communities get started, they need to decide how to organize their efforts to support restoration assessment, planning and implementation. In general, this entails six initial management tasks:

1. Organize the core restoration team
2. Design the architecture of watershed-based GIS
3. Make the GIS operational
4. Delineate watershed and subwatershed boundaries
5. Acquire equipment and supplies to support field work
6. Develop overall stakeholder management strategy

1. Organize the core restoration team

Watershed restoration can only be effective when the talents of many people are combined together into a core team to take advantage of their diverse skills, professional disciplines and experience. Consider for a moment the "job description" for watershed restoration. The core team must be skilled in GIS, public outreach, project management, budgeting, watershed assessment, design review, contracting, design, facilitation and have some degree of political acumen. The team must also draw heavily from many different disciplines -- planners, engineers, foresters, wetland scientists, hydrologists, geomorphologists, water quality experts and educators to name just a few. The team will be physically located in many different places and expected to play different roles in the restoration process -- some may be local agency staff, consultants, contractors, stakeholders and volunteers. Clearly, the management and coordination of such a large, diverse and separated team can be challenging, and managers need to think from the outset how to effectively harness these talents.

2. Design the architecture of the watershed-based GIS

A watershed-based Geographic Information System (GIS) provides the foundation for many subsequent desktop and field assessment methods. The basic concept is that the GIS will be the primary tool to store, organize and analyze all watershed restoration data generated throughout the eight-step restoration process. A watershed-based GIS offers many advantages for urban restoration planning since it can:

- Provide accurate locational information to plan and design restoration projects
- Enable restoration data to be associated with map layers
- Allow quick and easy data manipulation and analysis
- Allow for rapid updates of data to reflect new information
- Track project implementation and monitoring data
- Utilize many free or nominal cost GIS data layers from the internet
- Generate multiple copies of printed maps at low cost

Communities often have different mapping resources and analysis capabilities; the methods described in this manual assume a basic level of access to GIS resources. 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 restoration opportunities, and track changes over time.

Table 1: Directory of Methods Used to Prepare Subwatershed Plans			
No.	**Name of Method**	**Abbreviation**	**Where to Find It**
D-1	Needs and Capabilities Assessment	NCA	Manual 2, Appendix C
F-1	Existing Data Analysis	EDA	Manual 2, Chapter 1
S-1	Facilitate Stakeholder Consensus	FSC	Manual 2, Chapter 1
M-1	Finalize Watershed Goals	FWG	Manual 2, Chapter 1
D-2	Comparative Subwatershed Analysis	CSA	Manuals 2,3,4,5,6,7
F-2	Rapid Baseline Assessment	RBA	Manual 2, Chapter 2
S-2	Restoration Education and Outreach	REO	Manual 2, Chapter 2
M-2	Priority Subwatershed List	PSL	Manual 2, Chapter 2
D-3	Detailed Subwatershed Analysis	DSA	Manuals 3,4,5,6,7,8,9
F-3a	Unified Stream Assessment	USA	Manual 10
F-3b	Unified Subwatershed & Site Reconnaissance	USSR	Manual 11
S-3	Stakeholder Identification and Recruitment	SIR	Manual 2, Chapter 3
M-3	Initial Subwatershed Strategy	ISS	Manual 2, Chapter 3
D-4	Project Concept Design	PCD	Manuals 3,4,5,6,7,8
F-4	Candidate Project Investigations *	CPI	Manuals 3,4,5,6,7,8,9
S-4	Managing Stakeholder Input	MSI	Manual 2, Chapter 4
M-4	Inventory of Restoration Opportunities	IRO	Manual 2, Chapter 4
D-5	Project Evaluation and Ranking	PER	Manuals 2,3,4,5,6,7
S-5	Neighborhood Consultation Meetings	NCM	Manual 2, Chapter 5
M-5	Draft Subwatershed Plan	DSP	Manual 2, Chapter 5
D-6	Subwatershed Treatment Analysis	STA	Manual 2, Chapter 6
S-6	External Plan Review	EPR	Manual 2, Chapter 6
M-6	Subwatershed Implementation Strategy	SIS	Manual 2, Chapter 6
D-7	Final Design and Construction	FDC	Manuals 2, 3, 4, and 5
F-7	Engineering and Design Surveys	EDS	Manuals 3 and 4
S-7	Maintain Restoration Partnerships	MRP	Manual 2, Chapter 7
M-7	Adopt Final Plan	AFP	Manual 2, Chapter 7
D-8	Tracking Project Implementation	TPI	Manual 2, Chapter 8
F-8a	Sentinel Monitoring Stations	SMS	Manual 2, Chapter 8
F-8b	Performance Monitoring of Practices	PMP	Manual 2, Chapter 8
S-8	Ongoing Management Structure	OMS	Manual 2, Chapter 8
M-8	Adapt Subwatershed Plan	ASP	Manual 2, Chapter 8

Key: D= Desktop Analysis, F= Field Assessment S= Stakeholder Involvement and M= Restoration Management.

***CPIs** include: Retrofit Reconnaissance Inventory (RRI), Stream Repair Investigation (SRI), Urban Reforestation Site Assessment (URSA), Discharge Prevention Investigation (DPI), Hotspot Compliance Inspection (HCI), Natural Area Remnant Analysis (NARA), Source Control Plan (SCP) and Municipal Operations Analysis (MOA)

Table 2: General Comparison of Small Watershed Restoration Methods						
No.	**Name of Method**	**Abbr**	**Scale**	**Value**	**Cost**	**Skill**
D-1	Needs and Capabilities Assessment	NCA	C	O	$	+
F-1	Existing Data Analysis	EDA	C,W,S	O	$	+
S-1	Facilitate Stakeholder Consensus	FSC	C	O	$	+
M-1	Finalize Watershed Goals	FWG	W	E	$$	++
D-2	Comparative Subwatershed Analysis	CSA	C, S	O	$$	++
F-2	Rapid Baseline Assessment	RBA	W, S	O	$$$	++
S-2	Restoration Education and Outreach	REO	W	E	$$	+
M-2	Priority Subwatershed List	PSL	W,S	O	$$	+
D-3	Detailed Subwatershed Analysis	DSA	S	E	$$	++
F-3a	Unified Stream Assessment	USA	S	E	$$$	++
F-3b	Unified Subwatershed & Site Reconnaissance	USSR	S	E	$$$	++
S-3	Stakeholder Identification and Recruitment	SIR	S	E	$$	+
M-3	Initial Subwatershed Strategy	ISS	S	E	$$	++
D-4	Project Concept Design	PCD	P	E	$$$	+++
F-4	Candidate Project Investigations	CPI	P	E	$$$$	+++
S-4	Managing Stakeholder Input	MSI	S	E	$$	+
M-4	Inventory of Restoration Opportunities	IRO	S	E	$$	++
D-5	Project Evaluation and Ranking	PER	S	E	$	+
S-5	Neighborhood Consultation Meetings	NCM	N	E	$$	+
M-5	Draft Subwatershed Plan	DSP	S	E	$$	++
D-6	Subwatershed Treatment Analysis	STA	S	O	$$	+++
S-6	External Plan Review	EPR	C	O	$$	+
M-6	Subwatershed Implementation Strategy	SIS	S,C	E	$$	++
D-7	Final Design and Construction	FDC	P, S	E	$$$$	++++
F-7	Engineering and Design Surveys	EDS	P	E	$$$	++++
S-7	Maintain Restoration Partnerships	MRP	C	O	$$	++
M-7	Adopt Final Plan	AFP	C	E	$$	++
D-8	Tracking Project Implementation	TPI	S	E	$	+
F-8a	Sentinel Monitoring Stations	SMS	S	O	$$$	++
F-8b	Performance Monitoring of Practices	PMP	P	O	$$$	+++
S-8	Ongoing Management Structure	OMS	C,W,S	E	$$$	++
M-8	Adapt Subwatershed Plan	ASP	S	O	$	+

Key:
Scale: C = Community, W = Watershed, S = Subwatershed, P = Project site or reach, N= Neighborhood
Value: E = Essential, O = Optional
Cost: $ = >5K $$ = 5 to 15 K $$$ = 15K to 30 K $$$$ = more than 30K
Skill: + = least training and skill → ++++ most highly specialized skills and experience

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 or that a new or expanded watershed-based GIS must be developed. Some general tips on designing an effective watershed-based GIS are provided in Table 3.

3. Make the GIS operational

Many upfront decisions are needed to structure a watershed-based GIS so that it can effectively support future restoration methods. Four key tasks are needed to make a GIS operational:

a. Choose support hardware
b. Purchase GIS software
c. Acquire needed data layers
d. Assign a GIS coordinator and train user

Table 3: Tips for Designing an Effective Watershed-Based GIS
• *Make sure the resolution of GIS data is detailed enough for desktop analysis*. In particular, the scale of land use and cover layers can vary greatly across a watershed with data of different resolutions. Generally, a rule of thumb is to obtain land use data of at least 1:24,000 scale or better.
• *Choose one projection system for the GIS data and stick with it.* Nothing is more confusing than trying to overlay two data layers in different projections when one or both projections are unknown. A good rule of thumb is to use the projection that the land use data is in (e.g. aerial photos) because these cannot be converted to a different projection without special software extensions.
• *Develop an organizational structure for storing GIS data, maps and other data that is centrally located,* and be sure all staff follow this structure. This usually involves creating a series of subfolders with different types of data in each folder. An important note here is to be aware of any limitations of the GIS software regarding data structure. Some software programs do not allow some data files to be moved or copied after mapping files are created.
• *Remember to check the age and quality of all GIS layers*. Just because a layer is stored in a GIS doesn't mean that it is accurate or up-to-date. Be especially careful with layers that are more than 5 years old. Always try to get the most recent land use and impervious cover data available. Older layers may fail to portray potential restoration sites, yield inaccurate impervious cover estimates, or show pervious areas that no longer exist (which can waste valuable field time).
• *Develop a standard naming convention for all GIS files to which all users must adhere.* Many different but similar GIS layers are generated during desktop analysis that can become difficult to differentiate. A general guideline is to be as detailed as possible when naming a GIS file, including its generation date.
• *Keep track of metadata.* Metadata, or "data about data" is information regarding the source, data, projection and accuracy of your GIS data. Usually, a text file containing the metadata will accompany a GIS data file. Do not delete these files since they may be needed later to figure out what projection the data is in, determine its scale or age, or how to contact the data originator if there is a problem.
• A GIS starter kit geared towards environmental non-profits was produced by the Conservation GIS Consortium and is available at http://www.pacificbio.org/conservation-gis-consortium/starterkit1.htm. Other useful GIS primers include Griffin (1995), and Queen and Blinn (1993).

a. Choose support hardware
Most GIS software programs can be run on reasonably high-end personal computers that cost $1500 and up. Optional hardware to purchase includes printers and digitizers. Large color plotters start at $3,500 and are useful for printing large maps. Less expensive color printers are available that produce smaller, but still serviceable maps with a maximum size of 11”x17”. Printing supplies (e.g., paper, ink) should be factored into the total cost, and will vary based on how much map printing is planned. Digitizers, which cost about $500, are a good investment since they can convert paper map attributes by hand into GIS, or redraw data directly on the screen.

b. Purchase GIS software
Basic GIS software programs cost $1,500 and up, although some limited-function programs are available online for free download. Free programs do not usually allow for much data manipulation, but can create basic field and subwatershed maps for printing. Special extensions are available for some software packages for more advanced analyses, but these can also cost $2,500 or more. A list of popular software programs, cost and requirements is provided in Appendix A.

c. Acquire needed data layers
Most communities will lack some of the data layers needed for a watershed-based GIS and will need to derive or acquire them. Table 4 provides a summary list of GIS data layers that support each step of the restoration planning process. An expanded version can be found in Appendix A that indicates the step in which each data layer is used, derived or created. Appendix A also provides tips on how to find and access common data layers, although some local sleuthing is usually needed to track them all down. Many data layers are available for free online or from cooperating local and regional agencies.

Both time and money can be saved when data layers are compiled and standardized early in the restoration planning process. While the cost and availability of data layers may be a limiting factor, it should never become a roadblock to moving forward. Some data layers, such as topography, hydrology and land use/cover, are used repeatedly throughout the eight-step process, while others may only be needed during a single step. While the summary list in Table 4 appears daunting, not all layers are needed to get restoration planning started. Efforts should be focused on gathering the data layers needed for the first four steps, such as aerial photos, local land use, zoning, impervious cover, topography, and hydrology.

The data layer that is normally the hardest to find and most expensive to purchase are recent aerial photos. If the cost of acquiring high-resolution aerial photography is too high, consider holding off on purchasing any photos until priority subwatersheds are selected. Alternatively, less expensive lower resolution photos can be ordered from the USGS or downloaded for free (see Appendix A). Some data layers may simply not exist and must be created or derived. For example, impervious cover layers may need to be digitized from aerial photos or derived by multiplying land use layers by land use/impervious cover coefficients (Cappiella and Brown 2001).

Assembling and integrating existing electronic and paper data layers in a common format is the most labor-intensive task involved in building a watershed-based GIS**.** In many cases, paper maps must be digitized and re-projected into digital files. In other cases, tabular or geo-spatial data generated during restoration assessments need to be processed or entered into the GIS. Examples include data on historical monitoring, stakeholder contacts, rapid baseline scores, restoration project and adopt-a-stream segments.

d. Assign a GIS coordinator and train team users
At least one member of the team should be trained in the GIS software and be designated as the watershed GIS coordinator. Their role is to provide quality control for mapping layers and set the rules and procedures by which new data is entered into the system. In addition, the data coordinator trains other team users on how to use the GIS during each subsequent step. Basic GIS training classes can be expensive (up to $1000 for a week-long course), although some online classes may be available for as little as $100.

Table 4: Useful Mapping Data for Watershed Restoration Planning		
Category	**Data Layers**	
Hydro-geomorphic features	• Topography (10 ft contours)* • 2 ft contours (for design) • Perennial streams * • Surface water features*	• Steep slopes • Wetlands* • 100-yr floodplain • Soils
Boundaries	• Watershed boundaries* • Subwatershed boundaries*	• Municipal boundaries* • Parcel boundaries
Land Use and Land Cover	• Aerial photos* • Land use * • Zoning* • Roads* • Buildings* • Parking lots*† • Stream buffers	• *Current impervious cover** • Parks* • Forest cover* • Turf cover • Soils • *Developable land*
Utilities	• Sanitary sewer lines* • Storm drain network * • Storm water practices	• Storm water outfalls • Other utilities
Point Sources and Hotspots	• Industrial NPDES storm water permits • Other NPDES permit dischargers • ESC construction permits	• SSO/CSO occurrences • Brownfields • Permitted hazmat sites
Special Areas	• Historic sites† • Conservation areas	• Rare, threatened or endangered species
Stream Condition	• Monitoring stations • Impaired stream segments	• *USA and USSR metrics*
Restoration Sites	• *Storm water retrofit sites* • *Stream repair sites* • *Riparian restoration sites* • *Illicit connections*	• *Potential hotspots* • *Pervious area sites* • *Neighborhood source areas* • *Municipal practice sites*

Data in italics are derived from field assessments or desktop analysis techniques discussed in this manual.
- Layers typically indicate the minimum data you'll need to get started
- † Layers are not very common, but could be useful

4. Delineate watershed and subwatershed boundaries

The first test of a watershed-based GIS is the delineation of watershed and subwatershed boundaries. In reality, teams should exercise considerable discretion when drawing actual boundaries to make sure they serve practical management purposes. Some techniques for delineating subwatersheds are illustrated in Figure 4, and are described below:

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

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

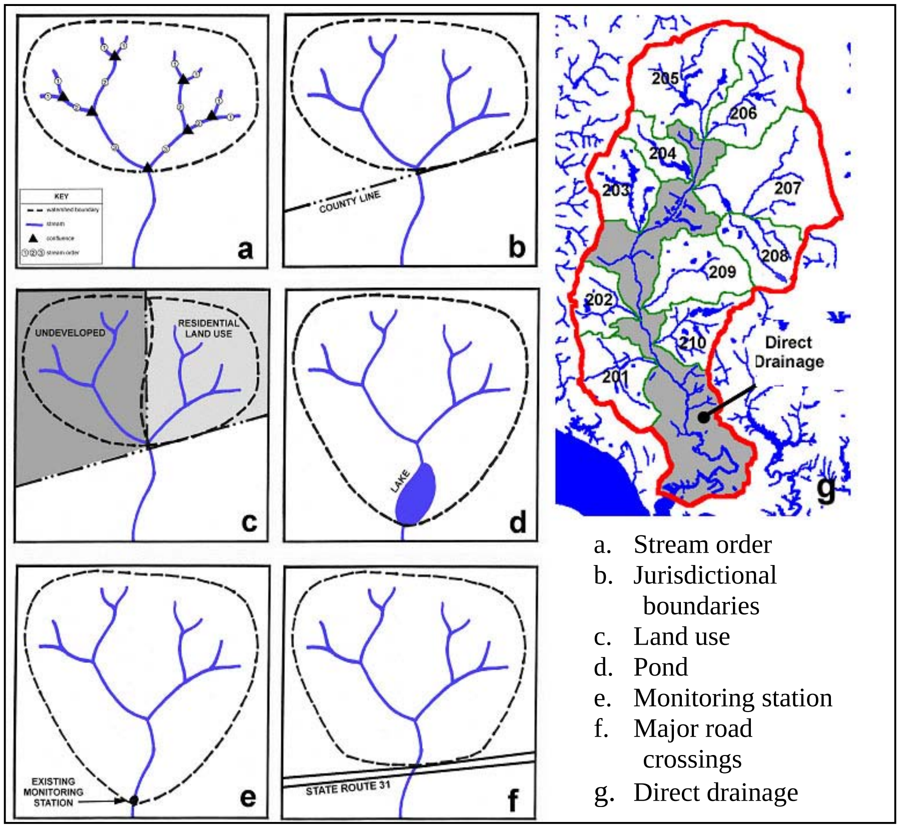


Figure 4: Considerations for Subwatershed Delineation

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.

5. Acquire equipment and supplies to support field work

While most field assessment methods featured in this manual do not require expensive or sophisticated equipment, some basic gear and supplies must be acquired prior to fieldwork. The most expensive items are Global Positioning System (GPS) units and digital cameras which can be purchased for about $100-$150 each. Other field gear includes waders, clipboards, first-aid kits, measuring tapes or rods. Additional field equipment may be needed to support baseline, performance or sentinel monitoring, depending on the indicators chosen.

6. Develop Overall Strategy to Involve Stakeholders

The term *stakeholder* is loosely defined as any agency, organization, or individual that is involved in or affected by the decisions made in a watershed plan. Each has a different stake in the outcome of the plan, and will be expected to perform different roles in the watershed restoration effort. Each comes to the table with varying degrees of watershed awareness, concern and/or expertise. Stakeholders also have different preferences in how, when, and in what manner they want to be involved in the process. More information on stakeholder classification is provided in Appendix B.

In the context of this manual, stakeholders are grouped into four broad categories that include the public, agencies, watershed partners and potential funders. All four of the stakeholder groups interact together to produce the restoration plan. A pyramid is often used to describe the expanding levels of involvement within each group of stakeholders. The base of the pyramid contains the greatest number of stakeholders, many of which are initially unaware of watershed problems and their potential role in restoration. The awareness and involvement of stakeholders becomes progressively greater as one moves toward the top of the pyramid.

The core team should think through an overall strategy to involve stakeholders during the restoration process, focusing on the following factors:

- What stakeholder groups need to be involved in the restoration 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 restoration project website needed?

Chapter 1: Methods to Develop Watershed Restoration Goals

STEP 1 AT-A-GLANCE

No.	ID	Name	How it Guides Restoration
D-1	**NCA**	**Needs and Capabilities Assessment**	Establishes community interest and regulatory drivers that will shape watershed goals and evaluates existing local restoration capacity and needs.
	1. Identify and interview potential restoration partners 2. Review current technical resources and regulatory drivers 3. Prepare draft needs and capabilities memo and share with stakeholders		
F-1	**EDA**	**Existing Data Analysis**	Defines key problems and impairments in the watershed to target for restoration and shape goals and objectives through an analysis of historical monitoring data.
	1. Assemble watershed data and critically evaluate its quality 2. Segregate and analyze data by subwatershed 3. Identify key watershed impacts and pollutant(s) of concern 4. Summarize key findings and share with stakeholders		
S-1	**FSC**	**Facilitate Stakeholder Consensus**	Solicits broad stakeholder involvement to define key watershed issues and obtain community consensus on the goals and objectives that will guide the watershed restoration effort.
	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” and brainstorm ideas without major editing 5. Break into small groups to refine and narrow down choices 6. Reconvene as full group to get concurrence on major choices 7. Follow-up with participants to finalize their agreement		
M-1	**FWG**	**Finalize Watershed Goals**	Agree on clear and measurable goals and objectives to guide the watershed restoration process and select the indicators that will be used to measure progress towards them.
	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		

The first step in the restoration process analyzes watershed conditions in order to develop clear consensus among stakeholders on the goals, objectives and indicators that will guide restoration.

The process starts by examining existing regulatory, programmatic, and scientific information that will influence restoration. This review is conducted on a watershed-wide or community scale, in cooperation with regional stakeholders. The core team also considers local capacity, existing data, and stakeholder concerns when setting restoration goals.

Many diverse and potentially competing objectives may exist for watershed restoration. Possible restoration goals often include many different physical, hydrologic, water quality, biological and community measures of watershed health (see Manual 1).

Early consensus on a set of clear restoration goals is essential for many reasons. Clear goals can:

- Express quickly what restoration really means to the public, elected officials and potential partners
- Provide clear direction on how to make choices in subsequent steps of the restoration process
- Demonstrate to funders what the outcome or benefit will be from their restoration investment
- Provide accountability to the watershed restoration effort over time

From the outset, it is important to carefully define the terms used in watershed goal setting, since they often create confusion among stakeholders. The terms goals, objectives and indicators each have a specific meaning in the context of watershed restoration. Table 5 provides guidance on how each term is defined in this manual.

Table 5: 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 restoration will broadly accomplish	Outlines the specific actions that need to happen to achieve the goal	Tracks progress made over time in reaching goal
Single phrase or slogan	Series of bullets that outline what, how, who, when and where of restoration	Chart or statistic showing indicator change over time
Bring the salmon back to our urban streams	City to remove all fish barriers impeding salmon migration in Bear Creek by 2009	Year-to-year change in salmon spawning run counts measured at station X in Bear Creek
Understood by the public	Instructions to managers	Interpreted by scientists

1.1 Needs and Capabilities Assessment

Communities may perceive that watershed restoration is a daunting task, but most already possess many of the ingredients needed for success. Although it may take some looking, many of the potential regulatory drivers, experienced staff, potential partners, community support and existing resources already exist in the community. The Needs and Capabilities Assessment (NCA) is a checklist of 47 questions that helps the restoration team understand its strengths and weaknesses, and identifies programs and resources to build an effective watershed restoration program (Table 6). The entire NCA checklist is provided in Appendix C, and tips on completing the checklist can be found in Profile Sheet D-1 at the end of the chapter.

The NCA is completed in three basic tasks, as shown below:

1. Identify and interview potential restoration partners
2. Review current technical resources and regulatory drivers
3. Prepare draft needs and capabilities memo and share with key stakeholders

1. Identify and interview potential restoration partners

In this task, the team fills out as much of the NCA checklist as it can, and then contacts other agency staff and prospective partners to fill in missing information. The goal is to produce a "rolodex" of potential local and non-local restoration partners, each of which is subsequently interviewed to understand the potential resources they offer. As many as a dozen phone calls or meetings may be needed to fully understand local restoration capacity.

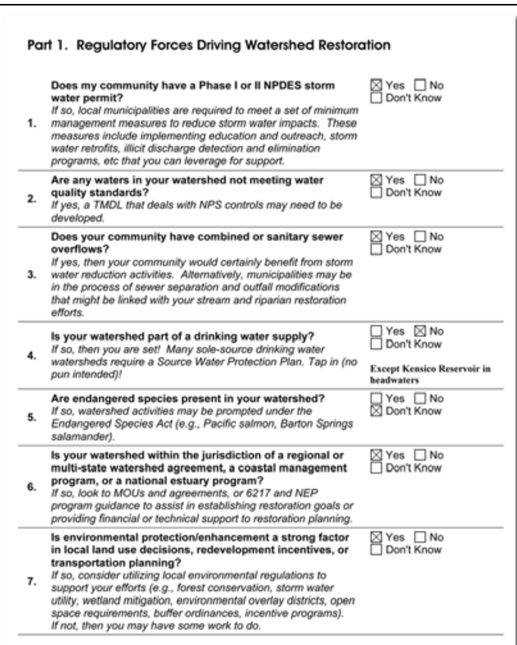
2. Review current technical resources and regulatory drivers

This task burrows deeper into agencies and institutions to discover the technical resources, mapping and monitoring data that currently exists for the watershed. Selected technical staff are interviewed to find the sources and formats of any GIS mapping layers and watershed monitoring data. Local, state and federal regulatory staff are also queried to learn about any regulatory drivers that may influence watershed restoration.

3. Prepare draft needs and capabilities memo and share with key stakeholders

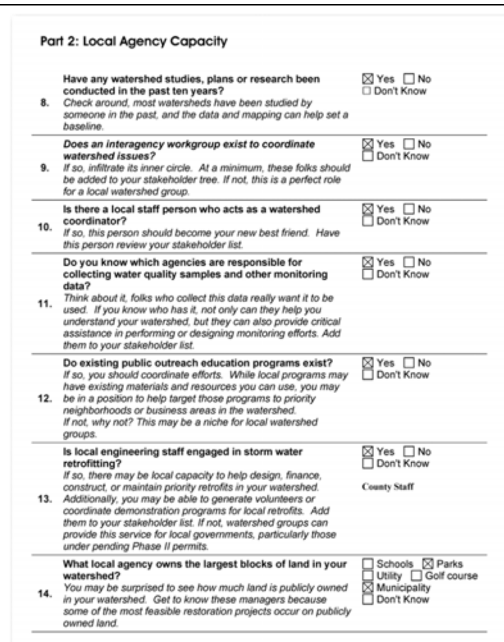
A short memo summarizing local restoration needs and capabilities is then prepared and shared at the first watershed stakeholder meeting. Stakeholders are asked to thoroughly review the report to find any resources, stakeholders or capabilities that were missed.

Table 6: Summary of the Five Parts of The NCA
1. Regulatory Forces Driving Watershed Restoration
Part 1 asks questions about federal and state "regulatory drivers" that may influence local watershed restoration, such as the Clean Water Act, Safe Drinking Water Act, and Endangered Species Act. The NCA asks for details about the whether the community is subject to TMDLs, municipal storm water NPDES permits, Source Water Control Plans, FEMA floodplain restrictions, combined sewer overflow abatement, or nonpoint source controls in the coastal zone.
2. Local Agency Capacity
Part 2 asks questions about existing municipal capacity to perform watershed restoration. It seeks to find out which local agencies perform watershed management, storm water, forestry, monitoring, outreach, education, sewer, parks, recreation, floodplain management, enforcement, development review, stream monitoring, mapping and land management functions in the community. This part of the NCA entails an agency-by-agency review of existing local staff, programs, funding and mapping resources that can be potentially applied to watershed restoration. In addition, questions are asked about local budgeting, contracting and grantsmanship procedures.
3. Local Agency Rolodex
Part 3 asks questions to discover the individuals and agency units that currently handle restoration functions such as GIS, public land management street and storm drain maintenance, storm water design, emergency spill response, sewer maintenance, environmental compliance, municipal stewardship, tree planting and development review.
4. Finding Non-Local Government Partners
Part 4 asks questions about potential partners and stakeholders that are not affiliated with local government, including watershed groups, colleges or universities, civic associations, non-governmental organizations, state agencies, local land trusts, private institutions, local media and others that may have prior restoration experience or resources to share.
5. Community Attitudes About Restoration
The last part of the NCA asks questions about general community attitudes about restoration, including common water quality concerns, recreational interests and watershed awareness. Questions are also asked about the current level of awareness and interest by senior agency staff, local elected officials and the media.



Part 1. Regulatory Forces Driving Watershed Restoration

1.	**Does my community have a Phase I or II NPDES storm water permit?** *If so, local municipalities are required to meet a set of minimum management measures to reduce storm water impacts. These measures include implementing education and outreach, storm water 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.*	☒ Yes ☐ No ☐ Don't Know
3.	**Does your community have combined or sanitary sewer overflows?** *If yes, then your community would certainly benefit from storm water reduction activities. Alternatively, municipalities may be in the process of sewer separation and outfall modifications that might be linked with your stream and 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 Except Kensico Reservoir in headwaters
5.	**Are endangered species present in your watershed?** *If so, watershed activities may be prompted under the Endangered Species Act (e.g., Pacific salmon, Barton Springs salamander).*	☐ Yes ☐ No ☒ Don't Know
6.	**Is your watershed within the jurisdiction of a regional or multi-state watershed agreement, a coastal management program, or a national estuary program?** *If so, look to MOUs and agreements, or 6217 and NEP program guidance to assist in establishing restoration goals or providing financial or technical support to restoration planning.*	☒ Yes ☐ No ☐ Don't Know
7.	**Is environmental protection/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 (e.g., forest conservation, storm water 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



Part 2: Local Agency Capacity

8.	**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
9.	***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
10.	**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
11.	**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
12.	**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
13.	**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 County Staff
14.	**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.*	☐ Schools ☒ Parks ☐ Utility ☐ Golf course ☒ Municipality ☐ Don't Know

1.2 Existing Data Analysis

Before embarking on any new monitoring, the core team should critically review any monitoring done in the past. An Existing Data Analysis (EDA) is a rapid synthesis of historical monitoring, modeling and mapping data previously conducted in the watershed. In many cases, a wealth of data has been generated over the years that can help define critical water resource problems. Consequently, the EDA reviews available hydrology, water quality and biological data across the watershed to characterize conditions and define major impacts. Four tasks are needed to complete an EDA, as shown below:

1. Assemble watershed data and critically evaluate its quality
2. Segregate and analyze data by subwatershed
3. Identify key watershed impacts and pollutant(s) of concern
4. Summarize key findings and share with stakeholders

Further guidance on conducting an EDA is provided in Profile Sheet F-1 at the end of the chapter.

1. Assemble watershed data and critically evaluate its quality

While a great deal of watershed data is usually available in most watersheds, the challenge is discovering where it is actually located. Consequently, most of the effort devoted to an EDA involves an intensive search for generators of watershed data. Generators may include academic institutions, federal databases, regional GIS centers, state and local agencies, and non-governmental organizations. Data may be found in electronic format, databases, and published and unpublished monitoring reports. Appendix A contains a listing of internet sources of watershed GIS data layers.

The team should search for the following watershed data:

- Basic watershed characterization data (e.g., land use and land cover)
- State and local water quality monitoring data
- USGS hydrology gauging stations
- Local floodplain modeling studies
- NPDES permit discharge databases (e.g., industrial, wastewater, storm water)
- Biological data, such as fishery, aquatic insect, and habitat data
- Community data on watershed population and demographics

The team then consolidates the data into a central repository such as 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.

2. Segregate and analyze data by subwatershed

The restoration team then analyzes the distribution of each kind of watershed data to determine if it can be segregated on a subwatershed basis to allow derivation of summary metrics. *Summary metrics* are a single numeric value that characterizes stream impairments and/or restoration potential over an entire subwatershed. An example might be the long-term average dry weather fecal coliform concentration recorded at a fixed stream station in a subwatershed. These summary metrics are a key input to a Comparative Subwatershed Analysis (CSA) in Step 2, which defines priority subwatersheds.

3. Identify key watershed impacts and pollutant(s) of concern

The team analyzes existing data to look for patterns that define key watershed problems and impacts that will be targeted for restoration, and reflected in watershed goals. In particular, water quality data should be reviewed to pick the one or two pollutants in the watershed that are most responsible for water quality impairments and will be the primary focus of pollution reduction efforts.

4. Summarize key findings and share with stakeholders

The team summarizes key findings in a short memo with a technical appendix that describes the location and sources of watershed data used in the analysis. The synthesis memo reviews existing and historic monitoring data in the context of possible watershed restoration goals and objectives, and should:

- Characterize the critical water resources problems to target for restoration
- Identify the primary pollutant(s) of concern in the watershed
- Provide support material for use in restoration education and outreach
- Determine if data gaps warrant a Rapid Baseline Assessment in Step 2
- Generate metrics to input into the Comparative Subwatershed Analysis in Step 2

The short memo serves as primary technical resource in the watershed goal setting process, and should be shared with stakeholders who are asked to check for any missing data sources.

1.3 Facilitate Stakeholder Consensus

Goal-setting requires extensive input from stakeholders to identify important community concerns that should drive local watershed restoration efforts. This method creates forums to find out what stakeholders think about urban watersheds and the issues they want incorporated into the restoration 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 restoration efforts. This method focuses on how to facilitate a broad range of stakeholder interests to achieve consensus. The watershed goal-setting process normally involves seven tasks:

1. Recruit the right stakeholders to participate
2. Convene a comfortable forum for them to interact together
3. Set ground rules for their participation in the process
4. React to “strawman” and brainstorm ideas without major editing
5. Break into small groups to refine and narrow down choices
6. Reconvene as full group to get concurrence on major choices
7. Follow-up with participants to finalize their agreement

Some effective tips on how to work with stakeholders to achieve consensus can be found in Profile Sheet S-1.

1. Recruit the right stakeholders to participate

Goal-setting works best when the right group of stakeholders are at the table. In the context of watershed restoration, this means stakeholders have some prior watershed knowledge, environmental concerns, community involvement or regulatory interest. Normally, the process is championed by the lead local restoration agency, and includes other local, state and federal environmental agencies, watershed and environmental groups, and active civic and business groups. Many of these stakeholders are identified through the NCA checklist, although additional meetings and phone interviews are needed to recruit them.

2. Convene a comfortable forum for them to interact together

The meeting environment is an important factor in goal-setting. Ideally, the meeting venue should be a comfortable retreat in a natural watershed setting, away from the hectic demands and distractions of the home office. Profile Sheet S-4 provides guidance on how to create a comfortable environment for stakeholders to interact together.

3. Set ground rules for participation in the process

At the beginning of the meeting, the facilitator should establish clear ground rules to structure how stakeholders will interact, and be extremely clear how consensus will be defined. The facilitator normally proposes the ground rules, and then asks the group to accept them before starting. Common ground rules include: common courtesy, no interruptions, how long individuals can speak, how questions will be called, everyone given a chance to speak or provide written comments, etc.

4. React to "strawman" and brainstorm ideas without major editing

It can be frustrating for stakeholders to create goals and objectives from scratch. It is often helpful to kickstart the process by proposing an advance "strawman" document of potential goals to prompt reaction and stimulate thinking. The strawman should be general and provide several options so that stakeholders don't feel that they are being railroaded toward a preordained conclusion.

5. Break into small groups to refine and narrow down choices

The real work in goal-setting should be done in small groups of six to eight who work to refine and narrow choices (Figure 5). 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 prioritizing their most important goals.

6. Reconvene as full group to get concurrence on major choices

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.

7. Follow-up with participants to finalize their agreement

All stakeholders should be offered a chance to comment on the final language on goals, objectives and indicators after they are drafted. In many cases, this may simply involve e-mails or mail-outs to the stakeholders, with a fax-back or e-mail reply request to affirm whether they agree, on 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.

Figure 5: Stakeholder Participation

These two photos were taken of group breakout sessions at a stakeholder meeting during the Yarmouth Creek watershed planning process to identify key watershed issues and to gain consensus.

1.4 Finalize Watershed Goals

The purpose of this method is to gain agreement on clear and measurable goals, objectives and indicators that command the broadest possible public support. Assuming an agreement can be reached, it is helpful to codify it in the form of watershed agreement, memorandum of understanding or similar directive that can be executed by elected officials, key stakeholders and/or senior agency leaders. Such agreements are extremely useful in elevating the profile of watershed restoration and ensuring greater interagency coordination in subsequent steps. Goals are finalized using a facilitated process that includes four basic tasks:

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

Some tips on how to develop watershed goals, objectives and indicators are presented in Profile Sheet M-1.

1. Educate stakeholders on the basics of watershed restoration

Most stakeholders may have some general familiarity with watershed topics, but may not be aware of specific water quality and natural resource problems. Highlights of the Existing Data Analysis (EDA) should be featured in brief presentations, as well as a clear explanation of any regulatory or community issues that are driving restoration (from the NCA).

2. Define what is meant by watershed goals, objectives and indicators

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 restoration 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 5.

3. Work through a facilitated process to refine goals

Facilitated meetings are the best process to get direct stakeholder input and feedback on goals. The basic tricks to facilitate stakeholders to work towards consensus are described in Section 1.3 and Profile Sheet S-1.

4. Decide whether goals should be formally adopted

Restoration 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.

D-1	Desktop Analysis **Needs and Capabilities Assessment**	NCA

Purpose

The purpose of the NCA is to establish the community concerns and regulatory climate that will shape watershed goals and objectives, and to comprehensively evaluate local restoration capacity -- available resources, programs, mapping and watershed data -- that can contribute to local restoration effort.

Scale	Value
Community-wide	Helpful

Analysis Method

The NCA is usually completed in three tasks:

1. Identify and interview potential restoration partners
2. Review current technical resources and regulatory drivers
3. Prepare draft needs and capabilities memo and share with stakeholders

Product

The product is a short memo that contains the following summary information:

- List of available GIS resources
- Architecture of GIS needed to manage subsequent restoration
- Sources of current and historic watershed data
- Initial list of agencies and organizations to recruit as stakeholders
- Preliminary assessment of regulatory drivers

Mapping Needs

The NCA reviews the quality and accessibility of existing GIS and mapping resources in the community, which are often spread among many multiple agencies and organizations. The inventory of mapping resources evaluates data gaps and explores whether the current GIS can serve as a watershed information management system for all subsequent restoration data.

Other Data Needs

A good organizational chart of local and state governmental agencies is extremely useful to identify the specific individuals to interview to fill out the NCA checklist.

Time Frame / Level of Effort

The restoration team should plan on spending two to three weeks of staff time to complete the NCA checklist and draft the summary memo.

Further Resources

The full NCA checklist is provided in Appendix C of this manual.

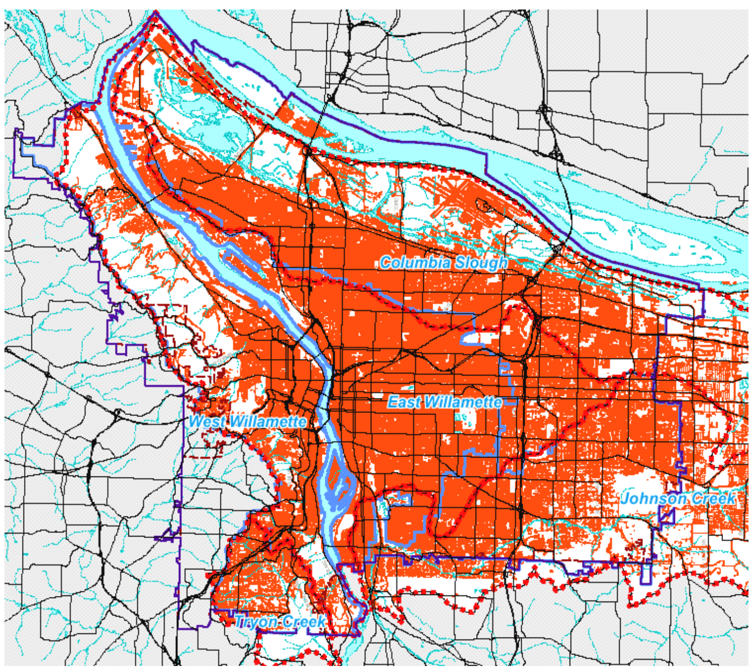
Tips for Conducting a Needs and Capabilities Assessment

- Meetings and phone interviews are the best ways to elicit information about local needs and capabilities. Plan on calling or meeting at least 10 to 20 individuals to accurately complete the NCA checklist in most communities.

D-1	Desktop Analysis **Needs and Capabilities Assessment**	**NCA**

Tips for Conducting a Needs and Capabilities Assessment

- Make sure to go over the NCA results at the first stakeholder meeting to get input on anything that was missed. Be sure to give folks who have already done restoration work, monitoring or mapping a chance to speak about their experience and resources at the meeting.
- Take a historical view when conducting the NCA and look for the old-timers that can remember watershed studies, projects and policies.
- Many of the individuals that are initially contacted during the NCA may not be familiar with watershed restoration, so remember to follow-up with a short letter or fact sheet on the purpose of local restoration efforts. Keep in mind that each individual is a potential partner or stakeholder and their first interview or meeting will shape their impressions of the restoration effort.
- If you want a more thorough community assessment of how well local watershed restoration programs are integrated, consider using the Smart Watershed Benchmarking Tool (Rowe, 2005). The evaluation tool assesses more than 50 restoration benchmarks in 14 local program areas and is customized based on community size (e.g., small, medium and large populations).
- The NCA is helpful in identifying existing and historical resources that can be applied to restoration and can ensure the team does not "re-invent the wheel."



The NCA helps identify key resources, stakeholders, and regulatory drivers that influence local watershed restoration.

F-1

Field Assessment Method
Existing Data Analysis

EDA

Purpose

The primary purpose of the EDA is to rapidly review existing data to define key problems and impacts in the watershed that will be targeted for restoration, and thus refine watershed goals and objectives. The review should encompass all the watersheds in the community and include important receiving waters.

Scale	Value
Community-wide	Helpful

Basic Method

Four tasks are required to complete an EDA:

1. Assemble watershed data and critically evaluate its quality
2. Segregate and analyze data by subwatershed
3. Identify key watershed impacts and pollutant(s) of concern
4. Summarize key findings and share with stakeholders

Information Provided for Restoration Decisions

An EDA helps make a persuasive case for why watershed restoration is needed, and what specific impacts or problems it should address. As such, it provides critical support for watershed goal setting. In addition, the EDA helps decide whether enough data exists to start the restoration process, or whether a Rapid Baseline Assessment (RBA) is needed. Lastly, summary metrics developed in the EDA may be used as input to a Comparative Subwatershed Analysis (CSA).

Advanced Preparation

Data-generating agencies and organizations should have been previously identified during the Needs and Capabilities Assessment (NCA). Additional phone interviews and meetings are needed to track down specific studies, monitoring stations and databases where data is housed.

Data Management & Reporting

The product of the EDA is a short memo that describes the key water quality and resource problems and conditions that should drive future restoration efforts. The memo can be supplemented with technical appendices that detail where the actual watershed data is located, and who collected it.

Time Frame / Level of Effort

Expect to spend at least one week of staff time tracking down existing monitoring data, a second week to analyze the data, and a third to write up the findings.

Tips for Performing an Existing Data Analysis

- Remember the goal of an EDA is to identify the top half-dozen watershed impacts that restoration will need to address—not produce a voluminous compilation of data.
- The real skill involved in an EDA is to translate and condense complex technical data into simple, understandable formats that present a persuasive case to watershed stakeholders as to why restoration is urgently needed.
- If the EDA does not discover much watershed data, key monitoring gaps should be identified and included in a subsequent Rapid Baseline Assessment (Chapter 2).

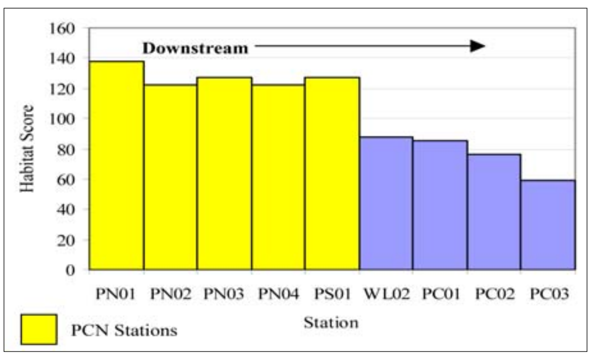
F-1

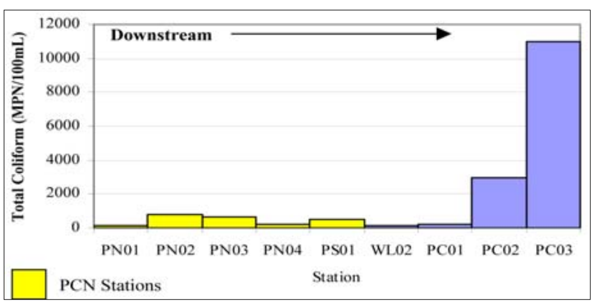
Field Assessment Method
Existing Data Analysis

EDA

Tips for Performing an Existing Data Analysis

- Because of their relatively small size, most subwatersheds will have limited sampling coverage for most parameters of interest.
- Historic maps, aerial photos and interviews with old-timers are often of great value.
- Sometimes the watershed data is less important than the persons who collected it. Folks that have collected monitoring data in the past should be considered “watershed historians,” treated as important technical advisors, and invited to participate in the restoration process. They can offer excellent perspectives on how conditions have changed over the years, since they have sampled the same streams and receiving waters in the past.
- The greatest value of historical data is that it reveals the water quality and fishery conditions that were supported in the past, thus providing a glimpse of future restoration potential during the watershed goal setting process.
- Some useful sources to consult during an EDA are researchers at local colleges and universities, state fishery biologists, state natural resource agencies, state water quality monitoring agencies, the U.S. Geological Survey, EPA national STORET database, statewide monitoring organizations and water quality staff in local water and wastewater utilities.





Comparing data between subwatersheds can target pollutants of concern to focus management efforts.

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.

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

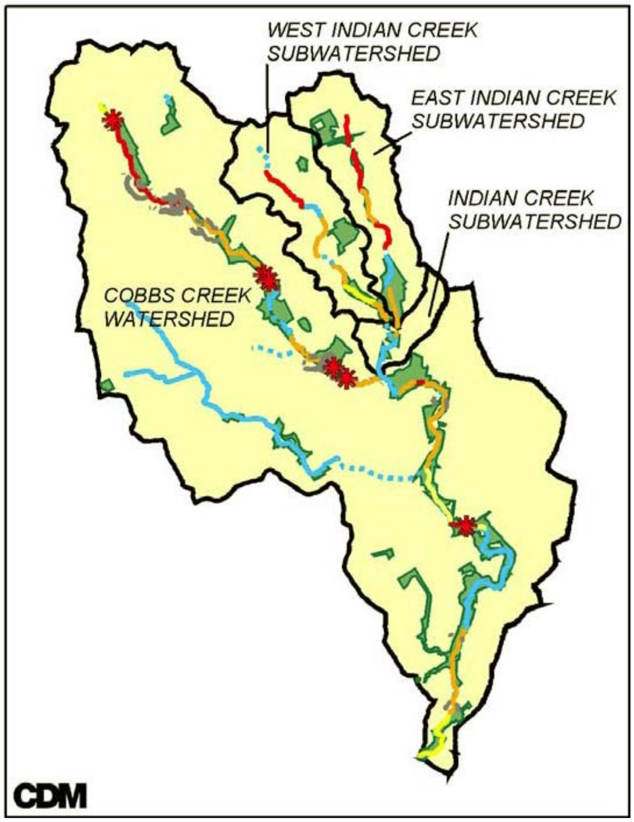


Table 3-1: Stakeholder Priorities as Weights for Goals

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

Chapter 2: Methods to Screen Priority Subwatersheds

<table>
<tr><th colspan="4">STEP 2 AT-A-GLANCE</th></tr>
<tr><th>No.</th><th>ID</th><th>Name</th><th>How it Guides Restoration</th></tr>
<tr><td rowspan="2">D-2</td><td>CSA</td><td>Comparative Subwatershed Assessment</td><td>Screens the many subwatersheds in the community to find the ones with greatest restoration potential to work on first.</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td rowspan="2">F-2</td><td>RBA</td><td>Rapid Baseline Assessment</td><td>Watershed-wide synoptic sampling of stream indicators at representative stations to get a comparative snapshot of current aquatic health across all subwatersheds and establish a baseline from which future improvements can be measured.</td></tr>
<tr><td colspan="3">1. Choose the right stream quality indicators
2. Choose the least cost and most rapid method to sample them
3. Locate representative fixed monitoring stations in each subwatershed
4. Conduct synoptic sampling across all subwatersheds
5. Analyze indicator data and derive subwatershed metrics for CSA</td></tr>
<tr><td rowspan="2">S-2</td><td>REO</td><td>Restoration Education and Outreach</td><td>Educate stakeholders about key watershed problems and solutions, familiarize them with the watershed restoration planning process, and invite them to participate in early decisions</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td rowspan="2">M-2</td><td>PSL</td><td>Priority Subwatershed List</td><td>Agree on which group of subwatersheds to begin working on first and devise a longer-range schedule to assess restoration needs in all subwatersheds</td></tr>
<tr><td colspan="3">1. Review initial priority 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</td></tr>
</table>

Small watershed planning should be done at the subwatershed level. Communities with limited resources may need to target a subset of subwatersheds within the context of a larger watershed. The core team needs to effectively discriminate among all subwatersheds and prioritize the ones with the greatest promise for restoration. If a community has already selected its target subwatersheds, they can skip this step.

2.1 Comparative Subwatershed Analysis (CSA)

It is relatively easy to screen subwatershed restoration potential from a desktop using the concept of subwatershed "metrics." *Metrics* are a single numeric value that characterizes the relative restoration potential of a subwatershed. More than 25 different subwatershed metrics can be used for screening purposes. Metrics can either be derived from GIS analysis, review of other subwatershed data, or based on stakeholder input.

The basic method to conduct a CSA consists of four general tasks:

1. Delineate subwatershed boundaries 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

More guidance on conducting a CSA is provided in Profile Sheet D-2.

1. Delineate subwatershed boundaries and review available metric data

The first task in a CSA is to delineate subwatershed boundaries, if this has not already been done. Tips on subwatershed delineation are provided in the introduction of this manual. Next, the core team reviews available mapping layers and other data sources to determine which subwatershed metrics can be calculated. Table 7 summarizes 27 examples of metrics that can be used to discriminate among subwatersheds. They are roughly divided between upland metrics that characterize overall subwatershed conditions and metrics that evaluate conditions in the urban stream corridor. The rationale for each metric and the basic methods to derive them are described in detail in Appendix D.

At this point, the watershed GIS, stakeholder input and other data sources are analyzed to determine which metrics can be calculated to support the CSA. Table 8 summarizes some of the common GIS mapping layers needed to derive various upland and stream corridor metrics. Few communities have enough data to compute all 27 metrics, but generally only a dozen or so are needed to perform an adequate CSA.

2. Choose and compute metrics that best describe restoration potential

This task chooses the subwatershed metrics that best describe restoration potential in the context of watershed goals and restoration potential. The exact combination of upland and stream corridor metrics selected for a CSA will be unique to each watershed. Some general guidance on how subwatershed metrics influence the feasibility of various restoration practices is offered in Table 9. It is often a good idea to ask partners and stakeholders to help choose the metrics to apply in the CSA.

Once the metrics are selected, the team analyzes GIS data and other information to develop numeric metric scores for each subwatershed. Computation of metric scores is the most labor-intensive task of a CSA. Specific methods for computing upland and stream corridor metrics are described in Appendix D. Individual subwatershed metric scores are typically entered into a master spreadsheet, so that range or distribution of scores among all subwatersheds can be determined.

Table 7: Examples of Upland and Stream Corridor Metrics Used in the CSA	
Upland Metrics	**Stream Corridor Metrics**
1. Current impervious cover	14. Subwatershed stream density
2. Current forest cover	15. Stream corridor forest cover
3. Storm water pond density	16. Available area in stream corridor
4. Subwatershed development potential	17. Road crossings
5. Percent publicly-owned land	18. Storm water outfall density
6. Percent detached residential land	19. RBA composite scores*
7. Age of subwatershed development *	20. Connection to downstream waters*
8. Percent industrial land	21. Public ownership of corridor
9. Storm Water hotspot density *	22. Violations of water quality standards*
10. Condition of sewer system *	23. Fishery status*
11. Sum of forest/parks/wetlands	24. Stream corridor recreational value*
12. Citizen concern *	25. Water quality regulatory status*
13. Community organization *	26. Severity of streambank erosion*
	27. Severity of flooding problems*
Note: an asterisk indicates that metrics are derived from non-GIS sources of subwatershed information, such as stakeholder input, interviews, or analysis of water quality data. See Appendix D for more information on how each metric is derived.	

Table 8: Basic GIS Mapping Data Layers Used for a CSA	
Frequently Used GIS Layers	
• Topography (10 foot contours) • Surface water features • Watershed/subwatershed boundaries • Parks • Land use/land cover • Zoning • Roads, buildings	• Parcel boundaries • Sanitary sewer lines • Storm drain network • Aerial photos • Storm Water BMPs • Forest cover • Wetlands
Consult Appendix D for more guidance on how to derive each metric in the context of a watershed-based GIS	

3. Develop weighting and scoring rules to assign points for each metric

This task converts subwatershed metric scores into numeric screening factors that enable the team to compare restoration potential among subwatersheds, and is done in two phases. The first phase assigns a relative weight to each CSA metric that reflects its perceived influence on restoration potential. The weighting normally assigns a variable number of points to each metric so that the maximum score of all metrics together totals 100. Table 10 presents a hypothetical example of weighting and scoring for a hypothetical watershed where the primary restoration goal is to recover the fish community.

The second phase analyzes the range of metric scores among all subwatersheds to determine the scoring rules that assign points to individual subwatersheds. As an example, consider a CSA where storm water pond density was chosen as a metric to reflect storm water retrofit potential and assigned a relative weight of ten points. Subsequent analysis indicated that storm water pond density ranged from 0 to 12 ponds per square mile in the watershed. Based on this range, a decision rule was developed to award one point for each pond per square mile above two, with the reasoning that greater pond density might result in a greater range of potential storage retrofit sites (see Table 10).

There are no hard and fast rules on how to weigh and score metrics in a CSA. Each choice basically represents an educated guess about restoration potential, and is inherently subjective in nature. Considerable professional judgment needs to be exercised, and the quality of decisions are enhanced when partners or stakeholder are invited to participate in the process.

Table 9: Subwatershed Metrics that Influence the Feasibility of Specific Restoration Practices

Subwatershed Metric	Storm-water Retrofits	Stream Repair	Riparian Mgmt	Discharge Prevention	Upland Forestry	Source Controls
1. Current impervious cover	●	●	⦿	⦿	⦿	⦿
2. Subwatershed forest cover	⦿	⦿	⦿	○	●	○
3. Storm water pond density	●	⦿	○	○	⦿	⦿
4. Subwatershed development potential	●	●	⦿	○	●	○
5. % publicly-owned land	●	●	●	○	●	⦿
6. % detached residential land	●	○	○	⦿	●	●
7. Age of subwatershed development	●	●	○	●	●	⦿
8. % industrial land	●	○	○	●	⦿	●
9. Storm water hotspot density	⦿	○	○	●	○	●
10. Condition of sewer system	⦿	○	○	●	○	⦿
11. Sum of forest, wetlands and parks	⦿	●	●	○	●	○
12. Citizen concern	●	●	●	●	●	●
13. Community organization	●	●	●	●	●	●
14. Subwatershed stream density	⦿	●	●	⦿	○	○
15. Stream corridor forest cover	⦿	⦿	●	○	⦿	○
16. Available stream corridor area	●	●	●	○	○	○
17. Road crossings	●	●	○	○	○	○
18. Storm water outfall density	●	⦿	○	●	○	○
19. RBA composite scores	⦿	●	⦿	●	○	⦿
20. Connection to downstream waters	○	●	⦿	⦿	⦿	⦿
21. Public ownership of corridor	●	●	●	⦿	○	○
22. Violations of water quality standards	⦿	⦿	○	●	○	●
23. Fishery status	⦿	●	●	○	⦿	⦿
24. Corridor recreational value	●	●	●	●	○	○
25. Water quality regulatory status	●	○	○	●	○	●
26. Severity of flooding problems	●	⦿	○	⦿	○	○
27. Severity of streambank erosion	●	●	○	○	○	○

KEY ● = strong feasibility indicator ⦿ = moderate feasibility indicator ○ = poor feasibility indicator

Table 10: Example of Metric Scoring and Weighting in Hypothetical Watershed			
Metric	**Weight (points)**	**Subwatershed Range**	**Scoring Rules**
1. Current Impervious Cover	20	8 % to 65% IC	Deduct 1 pt for each 3% increment of IC above 10%
3. Storm Water Pond Density	10	0 to 12 ponds per square mile	Add 1 pt for each pond per square mile
7. Age of Subwatershed Development	10	40 years to buildout to 50+ years after buildout	Add 2 pts for each decade after subwatershed buildout Zero pts if not yet built out
12. Citizen Concern	10	No concern to moderate concern	Pts developed by stakeholders
14. Subwatershed Stream Density	5	0.4 to 2.0 stream miles per square mile	Add 1 pt for each 0.4 stream miles/square miles
16. Available Stream Corridor Area	10	12 to 64 acres per stream mile	Add 1 pt for each 5 acres above 15 acres/stream mile
17. Road Crossings per stream mile	10	2 to 14 crossings per stream mile	Deduct 1 pt for each crossing/square mile
20. Connection to Downstream Waters	10	Open to closed	10 pts open 5 pts unknown 0 pts closed
23. Fishery Status	15	Fish-IBI scores range from 12 to 38	10 pts above 30 5 pts above 20 0 pts below 20

4. Compute aggregate scores and develop initial subwatershed ranking

In this task, numeric metric scores are entered into a spreadsheet database, and aggregate scores are computed to determine comparative restoration potential. Priority subwatersheds are then selected based on highest total scores. A hypothetical example of CSA scoring is provided in Table 11. In this example, subwatershed metrics were weighted and scored based on fishery objectives, and total scores for the 10 subwatersheds ranged from 12 to 86 points (with a maximum of 100). The four subwatersheds with the highest scores were targeted as priorities for initial restoration.

It is often a good idea to check the individual metric scores of the highest scoring subwatersheds to see if any are “deal killers.” This occurs when a subwatershed has a high total score, but has an individual metric score that might preclude or restrict restoration (e.g., a zero or negative score in a heavily weighted metric). An example might be a subwatershed with otherwise high fish recovery potential, but which is projected to have high future development potential and many more decades until final buildout. Based on these final adjustments, an initial subwatershed ranking is proposed for review by stakeholders and managers later in this step. Figure 6 shows an example of a watershed map with relative priorities.

Table 11: Example of CSA Ranking Analysis for Hypothetical Set of Subwatersheds

Subwatershed ID No.	Subwatershed Metric									
	1	3	7	12	14	16	17	20	23	Total
	20 pts	10 pts	10 pts	10 pts	5 pts	10pts	10 pts	10 pts	15 pts	100
SW-101	2	2	6	4	1	0	4	5	0	24
SW-102	6	6	0	4	3	7	5	5	2	38
SW-103	14	4	7	4	4	6	8	10	8	65
SW-104	12	5	6	7	4	8	9	5	6	62
SW-105	0	0	2	4	2	1	3	0	0	12
SW-106	18	3	8	7	5	9	7	10	13	80
SW-107	8	4	0	0	2	4	2	0	3	23
SW-108	20	5	5	9	5	10	8	10	14	86
SW-109	12	8	4	5	4	7	7	5	6	58
SW-110	14	9	4	5	3	7	6	5	12	65

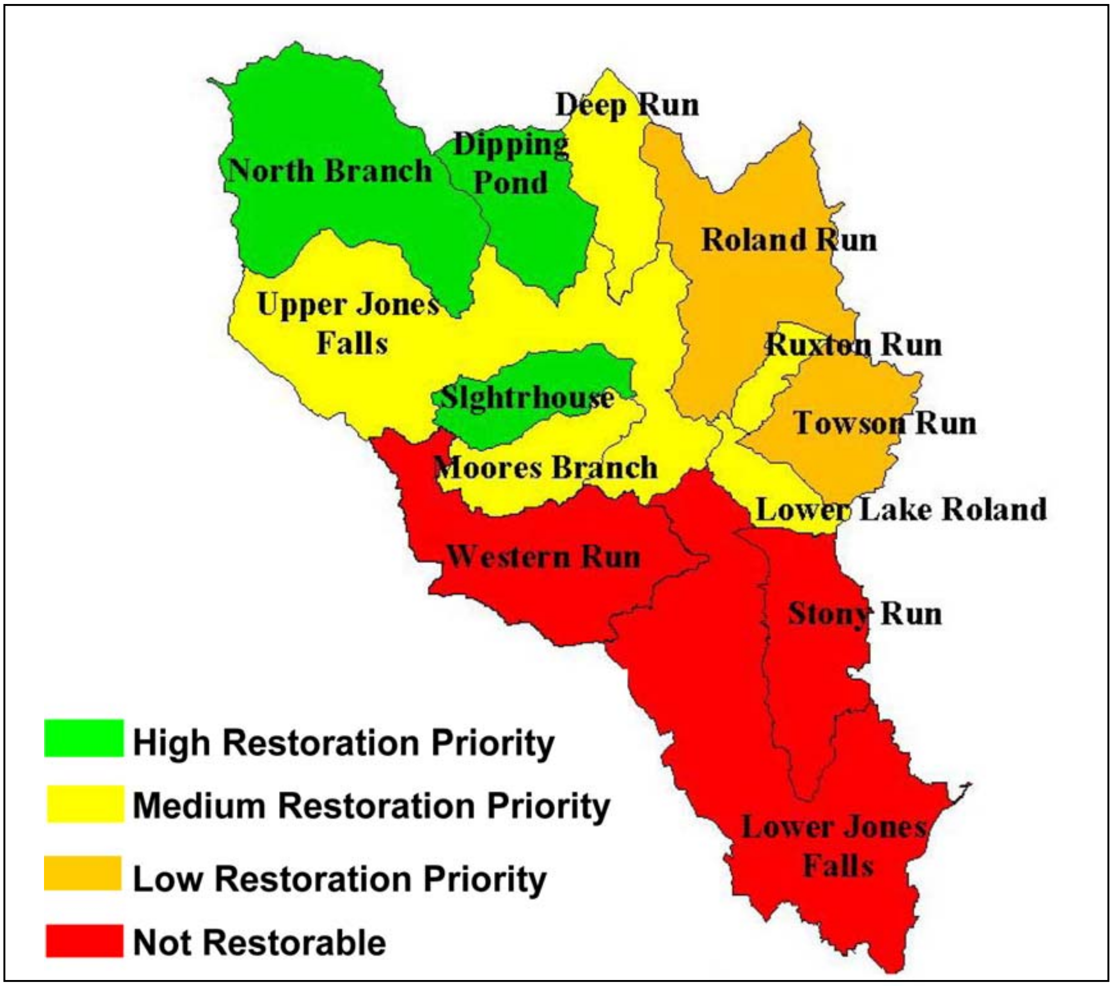


Figure 6: Example of a Comparative Subwatershed Analysis (CSA)

A CSA was conducted for the Jones Falls watershed in Maryland. Of the 13 subwatersheds assessed, 3 were identified as priorities for restoration, 5 were identified as secondary priorities, and 2 were identified as low priorities. Three of the subwatersheds were identified as being poor candidates for restoration. (Source: Adapted from Kitchell and Law, 2004)

2.2 Rapid Baseline Assessment

Communities may want to collect additional indicator monitoring data to better characterize water quality, habitat or biological conditions in their subwatersheds. This method is known as a Rapid Baseline Assessment (RBA) and consists of a network of fixed stations where stream indicator parameters are rapidly measured to get a comparative snapshot of current aquatic health across all subwatersheds. The RBA is designed to get reliable data within a few months to feed into the Comparative Subwatershed Analysis (CSA).

Conducting a RBA can be expensive and time consuming, and should only be done if a community:

- Lacks basic data on water quality, habitat or biological conditions
- Cannot agree on restoration goals due to a lack of data on what is causing the problem
- Needs more data to effectively target restoration practices
- Does not understand the major sources or locations of watershed pollutants

It may actually be cheaper to skip the RBA and substitute a Unified Stream Assessment (USA) instead. The USA provides a more detailed assessment of stream impairment and restoration potential (see Section 3.2).

An RBA consists of five tasks, as shown on the following page:

1. Choose the right stream quality indicators
2. Choose the least costly and most rapid method to sample them
3. Locate representative fixed monitoring stations in each subwatershed
4. Conduct synoptic sampling across all subwatersheds
5. Analyze indicator data and derive subwatershed metrics for CSA

More information on conducting an effective RBA is summarized in Profile Sheet F-2.

1. Choose the right indicators

The RBA is intended to generate metrics for the CSA to screen subwatersheds that are most severely impaired or possess the greatest restoration potential. Thus, the initial choice of indicators should be driven by the goals established for the watershed. Table 12 presents some common indicators that can establish a baseline for various physical, water quality, biological or community restoration goals. For example, if water quality improvement is an important watershed goal, then the RBA should target a dry weather water quality indicator linked to the pollutant of greatest concern.

It is also important to choose indicators that can effectively discriminate between subwatersheds, i.e., show pronounced differences. For example, some aquatic insect and habitat indicators may not show pronounced differences among subwatersheds that have similar land use. It may also be helpful to select indicators that are compatible with historic monitoring efforts.

2. Choose the least costly and most rapid method to sample them

Numerous sampling methods can rapidly assess stream conditions. Table 13 summarizes common methods to sample indicators, as well as the average unit cost to collect indicator samples at each station. Sampling costs and turn-around often drive the scope of a baseline assessment. In most cases, detailed quantitative sampling methods are not needed for baseline assessment. For example, fish and aquatic insects sampling should be limited to the lowest taxonomic level practical and fewest metrics needed. The choice of the most appropriate sampling method also depends on the type of stream being assessed (mountain, piedmont, coastal plain), and the prevailing land use (urban, agricultural, undeveloped). State natural resource or water quality agencies should be consulted to find out which sampling protocols are most appropriate.

<table>
<tr><th colspan="2">Table 12: Common Indicators Measured During Rapid Baseline Assessment</th></tr>
<tr><th>Physical Indicators</th><th>Biological Indicators</th></tr>
<tr><td>• Stream habitat index (RBP or RSAT)
• Riparian habitat index
• Average summer baseflow
• Channel/Bank stability (USA)
• Summer stream temperature</td><td>• Fish diversity (Fish-IBI)
• Aquatic insect diversity (Benthic-IBI)
• Single indicator species (e.g., trout, salmon, mussels)
• Spawning or migration success
• Riparian plant diversity</td></tr>
<tr><th>Dry Weather Water Quality Indicators</th><th>Community Indicators</th></tr>
<tr><td>• Fecal coliform (or other pathogen indicator)
• Ammonia or phosphorus concentration
• Benthic algal growth
• Intra-gravel dissolved oxygen
• Pesticide concentrations
• Turbidity</td><td>• Trash and debris levels
• Recreational usage
• Public access
• Resident participation in stewardship activities</td></tr>
</table>

3. Locate representative fixed monitoring stations in each subwatershed

An RBA requires at least one fixed sampling station or survey reach be located in every subwatershed. Ideally, each station should be established in the same basic location in the subwatershed (e.g., below the confluence of two second-order streams or below the most downstream road crossing). If land use or stream gradient vary within the subwatershed, consider establishing additional upstream stations. 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 bridges, outfalls or pollution discharges. Stations should also be located at points with easy and safe access to the stream. The total number of sampling stations greatly influences the cost of a RBA. For example, a 100 square mile watershed containing 15 subwatersheds may require 15 to 30 RBA stations. Figure 7 provides a visual display of subwatershed monitoring stations.

4. Conduct synoptic sampling across all subwatersheds

Indicator sampling should be scheduled to get synoptic or "snapshot" data, which means that indicators are sampled at essentially the same time and under the same conditions. In general, sampling should generally occur only during dry weather conditions to minimize influence from recent runoff events. Multiple field crews need to be coordinated to rapidly collect samples within a few days or weeks.

Indicator sampling must normally be repeated several times to get a reliable and representative value for each subwatershed. The precise number of samples that need to be collected at each subwatershed station depends on the type of indicator selected. In general, physical indicators require the least replication, followed by fish and aquatic insects. Dry weather water quality indicators usually must be measured many times to get a reliable subwatershed value.

5. Analyze indicator data and develop subwatershed metrics for CSA

The last task in an RBA involves entering the indicator data into a common baseline database and analyzing how the data varies between subwatersheds. In most cases, RBAs do not produce enough samples to perform a rigorous statistical analysis, but means and ranges should be computed, and compared among subwatersheds. The resulting indicator data should be converted into subwatershed metrics, following the procedures set forth for Metric 19 (Appendix D).

Table 13: Comparative Station Costs to Measure Baseline Indicators	
Cost	**Assumptions**
Dry Weather Water Quality Grab Sampling	
$20 to $150 per sample, per station	• Synoptic grab samples collected across all subwatersheds on same day • Cost is related to number, sophistication and type of water quality parameters analyzed
Stream Temperature Monitoring	
$400 to $500 per station, per year	• Automated samplers recording hourly stream temperatures • Based on yearly monitoring costs and temperature meters • Deployed once, data downloaded into a desktop computer twice per year. • Additional staff time needed to process data and compute daily mean and extreme temperatures
Fish Diversity	
$400 to $475 per sample, per site	• Based on methodology of Barbour *et al*. (1999) • Cost for first or second order stream (only one electrofishing shocker required) • Three staff members per site (one intern)
Macro-Invertebrate Sampling	
$500 to $600 per sample, per site	• Based on EPA Rapid Bioassessment Protocol • Two staff members required per site • Identification to family level, for 100 individual sub-sample count
Single Species Indicator	
$375 to $425 per sample, per site	• Two staff members required per site • Based on fish electro-shocking surveys of trout or salmon • For start-up costs add: Electrofishing equipment, computer(s) and basic field gear
Composite Indicators	
$900 to $1,075 per sample, per site	• Based on combining fish and macro-invertebrate sampling at one site • Two field staff members required per site • Assumes two biological indicators investigated per site
Physical Habitat Assessment	
$800 to $1,200 per day (1 to 2.5 mi. per day)	• Based on physically walking stream and stopping at intervals to assess physical habitat conditions along a predetermined sample segment length (75 to 100 m) • 10 to 12 assessment stations/day (depends on station interval, typically 500 to 1,000 ft) • Two staff members required per field assessment team • Methods: EPA Rapid Bioassessment Protocol (Barbour *et al*. 1999) or Rapid Stream Assessment Technique (Galli, 1992)
Note: Costs adapted from Claytor and Brown, 1996.	

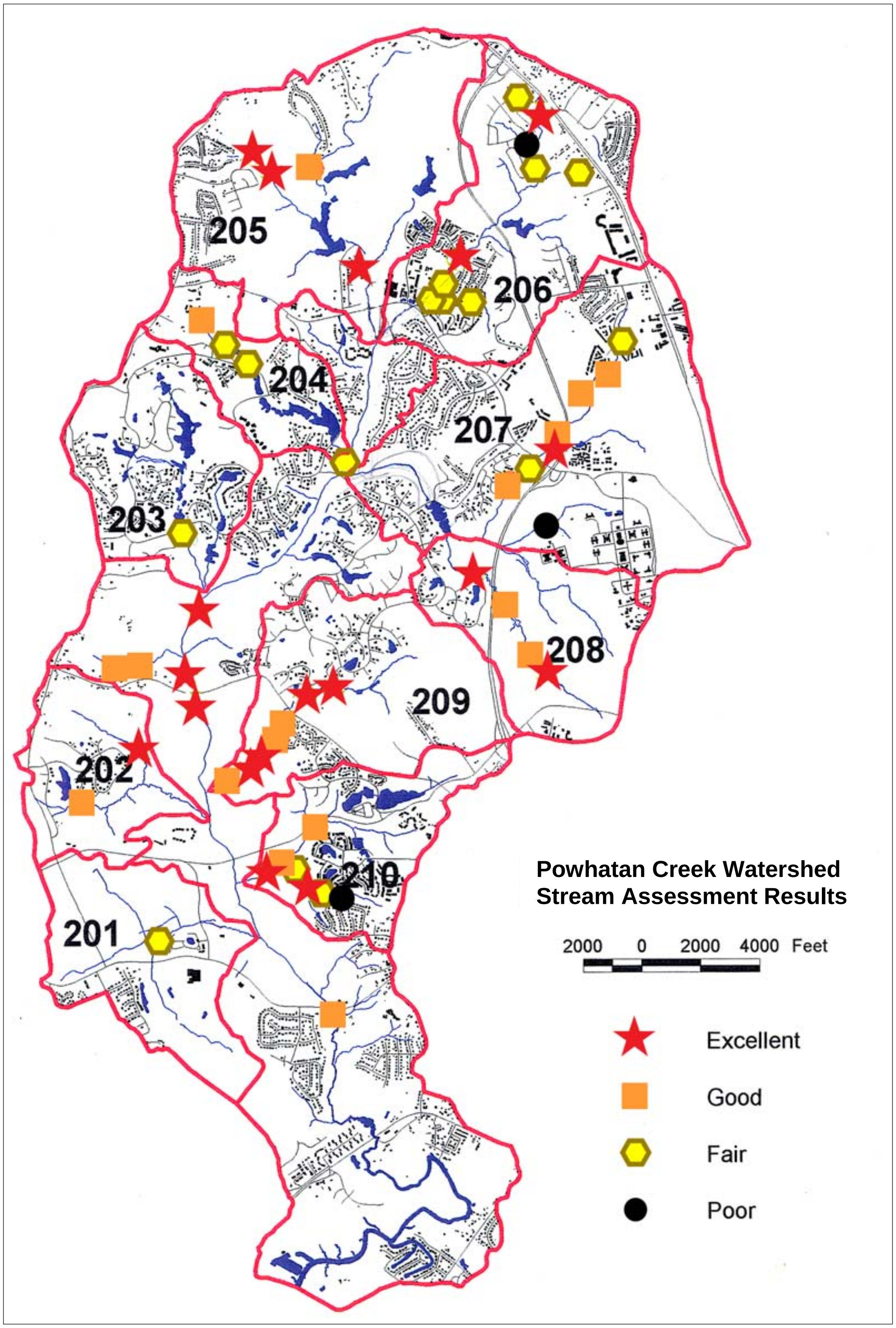


Figure 7: Rapid Baseline Assessment

As part of the Rapid Baseline Assessment conducted for the Powhatan Creek watershed plan, EPA's Rapid Bioassessment Protocol was used to assess the stream at 56 sample points. The data collected covered 10 subwatersheds and the mainstem, and assisted in identifying the most impaired stream reaches (black dots) as well as the highest quality reaches (stars). (Source: Sturm and Kitchell, 2001)

2.3 Restoration Education and Outreach

Selecting priority watersheds is not just a technical exercise. Stakeholder input is needed to support and justify the choices made. The main focus in this step is basic restoration education and outreach. Stakeholders need to be educated about key watershed problems and solutions, become familiar with watershed planning efforts, and learn the roles they can play in the process. Stakeholders may also be given the opportunity to help develop the list of priority subwatersheds. Three basic tasks are used to translate and condense restoration data into effective outreach materials to educate new and existing stakeholders:

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

More tips on restoration education can be found in Profile Sheet S-2.

1. Translate watershed data into simple and accessible formats

Restoration education seeks to increase public understanding about local watershed problems, set realistic expectations for restoration and recruit new stakeholders to the cause. The basic educational message should stress how urban development affects stream health, what restoration practices can be used, and why restoration is important to each individual stakeholder.

A great deal of watershed data has already been generated that can be used to develop restoration education materials. The real challenge is how to distill it 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 restoration issues to create a powerful educational message. The core team should avoid using a lot of text, data or complex maps in their basic restoration message, although they should allow stakeholders to get access to more detailed information if they want to learn more. Figure 8 depicts a clear, organized way data can be displayed in a smaller, more concise plan.

2. Choose outreach techniques to deliver the information to watershed stakeholders

A broad range of outreach techniques can deliver the basic restoration message to watershed stakeholders (Table 14). Some direct outreach techniques include workshops, community meetings, open houses, and field trips. Indirect outreach techniques may also be needed to reach stakeholders that cannot attend meetings. Effective techniques to distribute the restoration message include project websites, displays in public spaces, newsletters, newspaper articles, stream tours, and special events. These outreach techniques should always describe where stakeholders can learn more and how they can directly participate in the process.

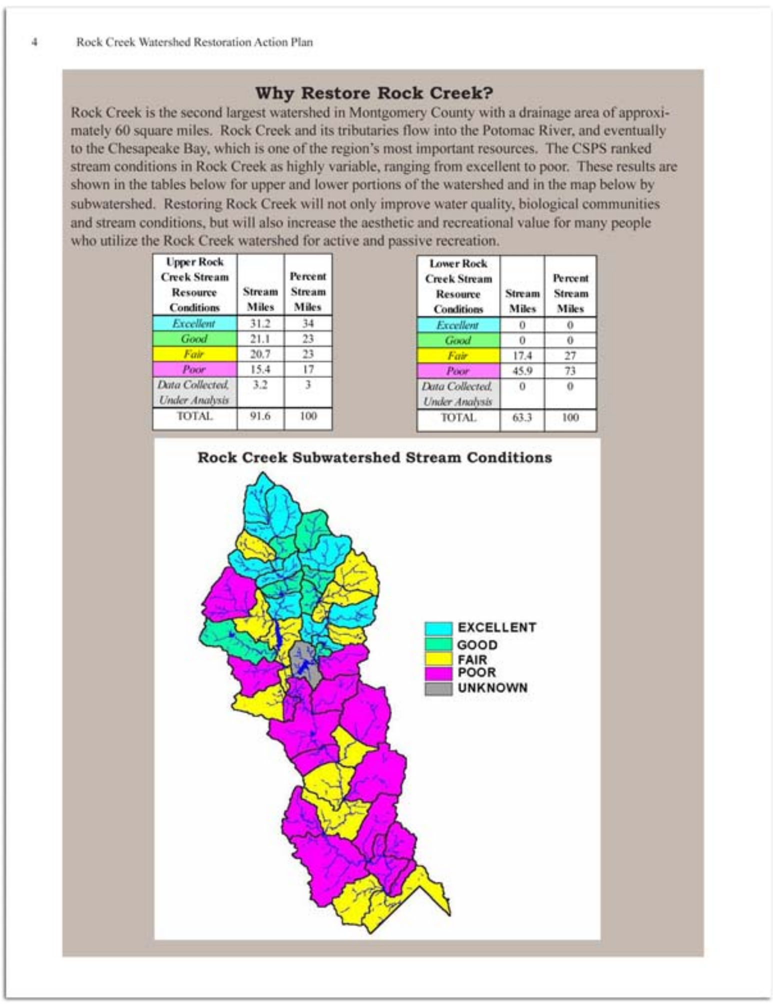
3. Create forums where stakeholders can make restoration decisions

Restoration 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 restoration decisions. The priority subwatershed list represents an early opportunity to involve stakeholders in decision-making. Stakeholders can also participate in choosing and weighting the CSA screening factors and also provide direct input into metrics related to citizen concern and community organization.

Table 14: Summary of Techniques to Reach Out to Stakeholders

• Watershed website • Fact sheets • Newsletters • Brochures • Issue papers • Technical reports • Newspaper advertisements • Newspaper inserts newspaper story • Bill stuffer • Press releases • Hotlines	• Briefings • Expert panels • Interviews • Mail surveys • Response sheets • Telephone or internet surveys • E-mail updates displays in public spaces • Community facilitators • Focus groups • Stream tours • Open houses • Community fairs	• Evening meetings • Daytime meetings • Consensus building techniques • Advisory committees • Task forces • Workshops • Signing ceremony • Photo opportunity • News conference • Watershed maps • Watershed festivals • Subwatershed plan

Adapted from IAP2 (2003) and other sources


4 Rock Creek Watershed Restoration Action Plan

Why Restore Rock Creek?

Rock Creek is the second largest watershed in Montgomery County with a drainage area of approximately 60 square miles. Rock Creek and its tributaries flow into the Potomac River, and eventually to the Chesapeake Bay, which is one of the region's most important resources. The CSPS ranked stream conditions in Rock Creek as highly variable, ranging from excellent to poor. These results are shown in the tables below for upper and lower portions of the watershed and in the map below by subwatershed. Restoring Rock Creek will not only improve water quality, biological communities and stream conditions, but will also increase the aesthetic and recreational value for many people who utilize the Rock Creek watershed for active and passive recreation.

Upper Rock Creek Stream Resource Conditions	Stream Miles	Percent Stream Miles
Excellent	31.2	34
Good	21.1	23
Fair	20.7	23
Poor	15.4	17
Data Collected, Under Analysis	3.2	3
TOTAL	91.6	100

Lower Rock Creek Stream Resource Conditions	Stream Miles	Percent Stream Miles
Excellent	0	0
Good	0	0
Fair	17.4	27
Poor	45.9	73
Data Collected, Under Analysis	0	0
TOTAL	63.3	100

Figure 8: Excerpt of the Rock Creek Watershed Restoration Action Plan

The plan was condensed into a simple 16-page document that translated watershed data and recommendations into a simple and accessible format. Shown above is a page from the document that summarizes stream conditions in the watershed and explains the need for a restoration plan. (Source: Cappiella, 2001)

2.4 Priority Subwatershed List

The restoration decision in Step 2 is simple: an agreement on which group of subwatersheds to work on first. The exact process needed to reach this decision will be different in every community, but generally consists of four tasks:

1. Review initial subwatershed rankings from CSA
2. Revise priority list based on stakeholder input
3. Scope out schedule and budget for priority subwatersheds
4. Develop a longer-range plan to assess all subwatersheds

Additional tips on developing a priority subwatershed list can be found in Profile Sheet M-2.

1. Review initial subwatershed rankings from CSA

The core team prioritizes subwatersheds by synthesizing data from the first three methods of this step (the DSA, RBA, when needed, and REO). A short memo is then prepared that supports the choice of priority subwatersheds, documents assumptions used in the CSA, and depicts their locations on a simple watershed map. The body of the report should be less than 10 pages long, with longer appendices that detail ranking methods, subwatershed data and stakeholder input. The report should include a map of the priority subwatersheds such as the example shown in Figure 9.

2. Revise priority list based on stakeholder input

The draft priority list is then circulated to local agencies and other stakeholders for review and comment. Further meetings or open forums may be needed if stakeholders cannot agree on the basis for the prioritization.

3. Scope out schedule and budget for priority subwatersheds

Once the list is finalized, the lead watershed agency scopes out the schedule and budget needed to assess restoration potential in priority subwatersheds. Guidance on scoping and budgeting subwatershed restoration plans can be found in Chapter 9.

4. Develop a longer-range plan to assess all subwatersheds

It may be desirable to develop a long-range plan to assess all subwatersheds in the community particularly if stakeholders are concerned that restoration efforts are being deferred in non-priority subwatersheds.

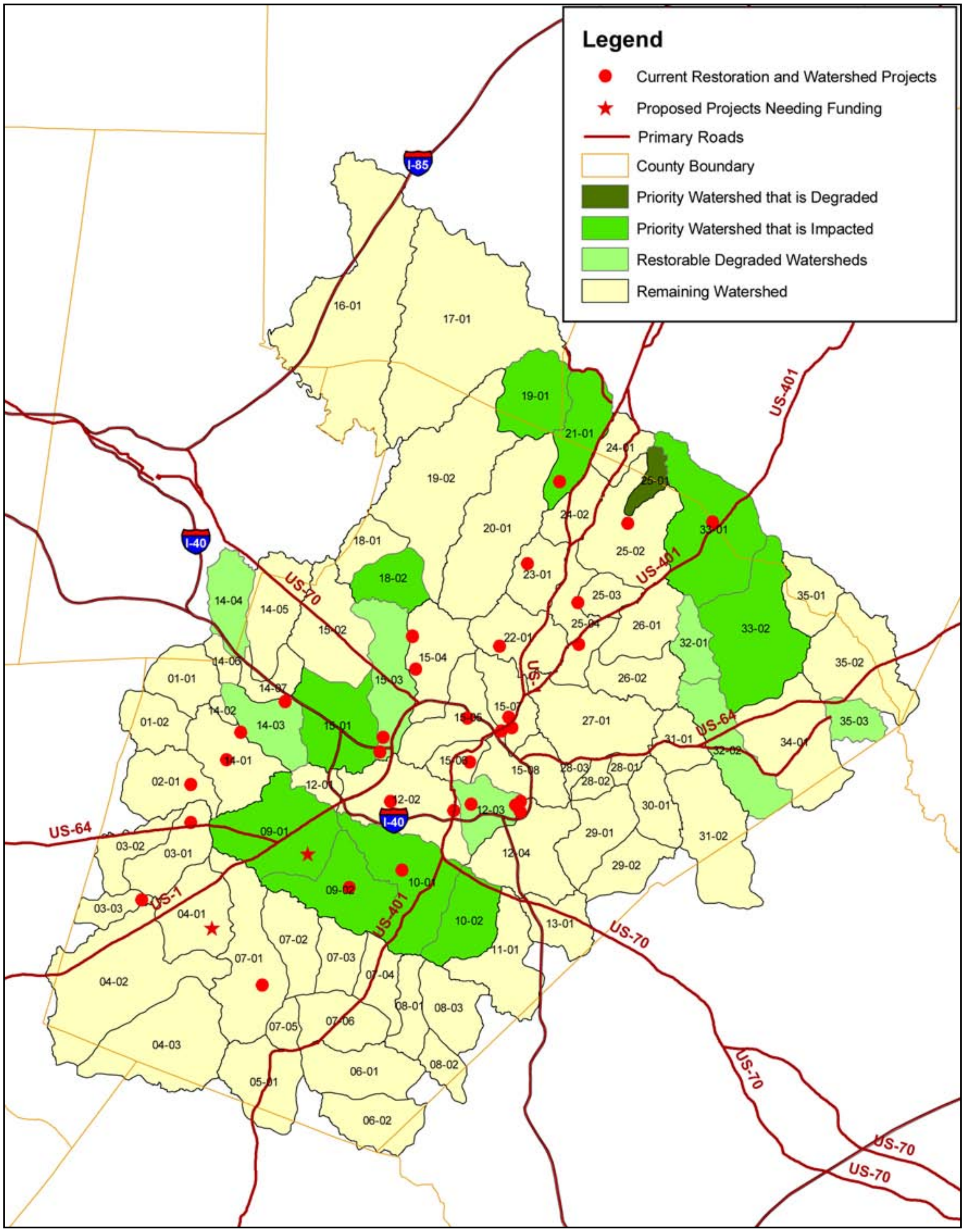


Figure 9: Example of map showing priority subwatershed list

The Wake County watershed management planning process evaluated 81 watersheds ranging in size from 0.9 to 53.3 square miles. Based on a comparative subwatershed analysis, rapid baseline assessments, and input received from stakeholders, 18 watersheds were prioritized for restoration, as shown above. (Source: CH2MHILL, 2003)

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.

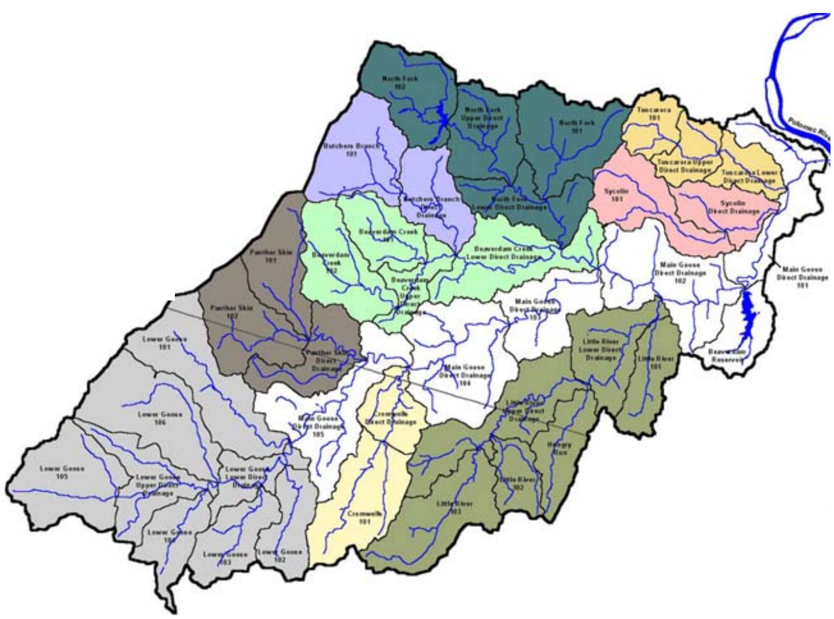
Tips for Conducting a Comparative Subwatershed Analysis

- 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

F-2	Field Assessment Method **Rapid Baseline Assessment**	**RBA**

Purpose

The RBA rapidly characterizes stream quality conditions among subwatersheds to support the Comparative Subwatershed Analysis (CSA) and develop a baseline to track future restoration improvements. The RBA is a quick, synoptic survey of aquatic health where a few key stream indicators are measured at one or two stations in each subwatershed to provide a comparative snapshot of current conditions. Stream indicators are chosen based on their relationship to watershed goals and their ability to discriminate among subwatersheds.

Scale	Value
Watershed- and Subwatershed-wide	Helpful

Basic Method

An RBA is completed by performing five tasks:

1. Choose the right stream quality indicators
2. Choose the least costly and most rapid method to sample them
3. Locate representative fixed monitoring stations in each subwatershed
4. Conduct synoptic sampling across all subwatersheds
5. Analyze indicator data and derive subwatershed metrics for CSA

Information Provided for Restoration

An RBA is needed when the Existing Data Analysis (EDA) reveals that there is not enough data to characterize current stream impairments, or stakeholders want more information on specific indicators related to their watershed goal. For example, they may want to know which streams have the greatest salmon recovery potential, are the most habitat-limited, or have the worst dry-weather bacteria levels.

Advanced Preparation

Training is often needed to ensure that multiple field crews are sampling indicators in a consistent manner. Route planning is also important since synoptic sampling requires many distant stations to be sampled at the same time.

Data Management

Quality Assurance and Quality Control (QA/QC) procedures need to be developed and implemented to ensure that field crews collect reliable and accurate indicator data.

Time Frame / Level of Effort

The goal of the RBA is to get good comparative subwatershed data in nine months or less. The cost of an RBA can be fairly high, and is based on the indicator(s) chosen, sampling methods used, number of subwatershed stations, and number of samples taken at each station. Unit costs for various indicators are provided in Table 13. Costs can add up quickly and it is not uncommon to spend 20K to 100K to conduct an RBA when many subwatersheds are evaluated.

Further Resources

- Numerous biological and physical methods have been developed to rapidly evaluate stream conditions. The Watershed Science Institute (2001) has prepared a summary of over 40 different assessment tools.
- The *Rapid Bioassessment Protocols* (RBP) is part of a suite of tools for assessing streams and rivers developed and tested over a wide range of watershed conditions and land uses (Barbour *et al.*, 1999).
- The *Stormwater Effects Handbook* (Burton and Pitt, 2001) is a very useful resource for defining water quality indicators in urban streams.

F-2

Field Assessment Method

Rapid Baseline Assessment

RBA

Tips for Getting Useful Results from an RBA

- Avoid the pitfall of sampling too many indicators. Picking a lot of indicators greatly increases the cost of an RBA without necessarily providing much more restoration information. Try to choose a small list of indicators that are most directly linked to the watershed goals selected in Step 1.
- Select RBA station locations with a mind toward their future use as sentinel monitoring stations to track progress in restoration (see Profile Sheet F-8a).
- RBA stations should have easy access, be representative of the subwatershed as a whole, and not be influenced by local conditions such as a bridge crossing, fish barrier, adjacent pollution discharge, or major outfall.
- Try to establish baseline stations in a consistent location across all subwatersheds (e.g., below the confluence of two second order streams).
- Multiple stations may be needed if subwatershed conditions are variable. A composite indicator score can then be computed to characterize average conditions for the subwatershed.
- Short-term baseline monitoring may not always reveal real differences among stations because of spatial and temporal variability.
- It may actually be cheaper to skip the RBA and substitute a Unified Stream Assessment (USA) instead. The USA provides a more detailed assessment of stream impairment and restoration potential than the RBA.

Rapid bioassessment techniques can help produce a comparative snapshot of stream health across all subwatersheds

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

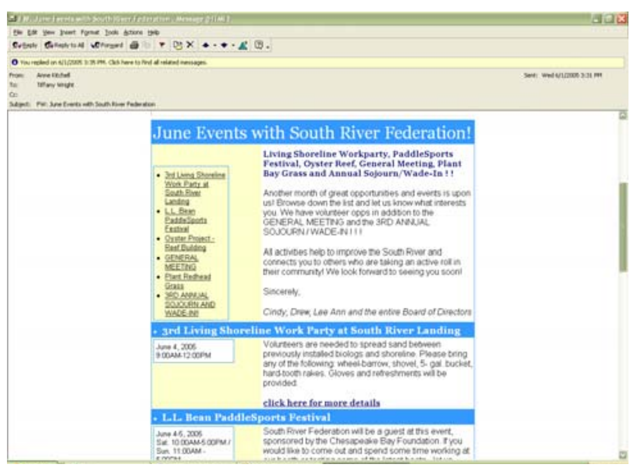
At a minimum, plan on hosting two or three educational meetings, and perhaps as many as a dozen briefings for most watersheds. Restoration education should take place within the first three months of the process. This may take as much as three weeks of total staff time, when advance preparation and follow-up 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.

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

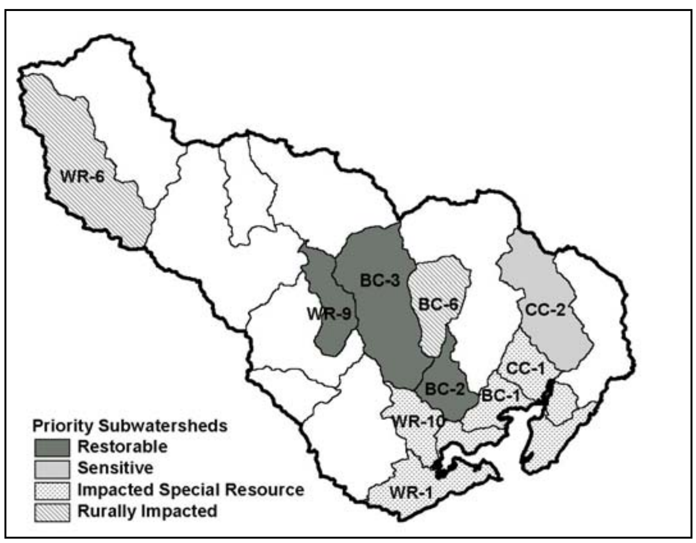
PSL

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

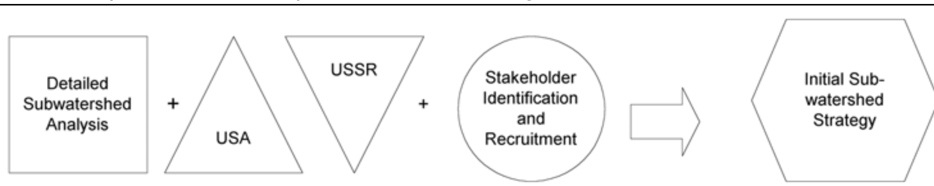
The Bush River watershed provides a good example of the subwatershed screening process. Located in the northeastern corner of Maryland, the watershed is 117 square miles and contains 19 subwatersheds (Winer, 2003). Given its size, watershed managers wanted to choose priority subwatersheds for early action. 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

Chapter 3: Methods to Evaluate Subwatershed Restoration Potential

STEP 3 AT-A-GLANCE			
No.	**ID**	**Name**	**How it Guides Restoration**
D-3	DSA	**Detailed Subwatershed Analysis**	Develops maps and other materials to support field work in the stream corridor and upland areas, and then organizes and analyzes the resulting data to choose the major practices to include in restoration strategy.
	1. Choose USA/USSR forms to use in field 2. Delineate survey reaches and upland survey sites 3. Generate base maps for field work 4. Plan routes and train field crews 5. Manage data and perform quality control checks 6. Enter checked data into master spreadsheet/GIS 7. Map and analyze impairments and restoration opportunities 8. Recommend elements of the ISS		
F-3a	USA	**Unified Stream Assessment**	Continuous walking assessment of stream corridor to identify major stream impacts and scout potential locations for storage retrofit, stream repair, riparian management and discharge prevention projects in a subwatershed.
F-3b	USSR	**Unified Subwatershed and Site Reconnaissance**	Windshield survey to identify potential pollution source in upland areas of a subwatershed and assess the feasibility of source control, on-site retrofits, reforestation, and enhanced municipal practices.
S-3	SIR	**Stakeholder Identification and Recruitment**	Recruit new stakeholders and maintain interest of existing stakeholders in the restoration process by soliciting input on their preferences on the roles they want to play and the manner by which they will be involved.
	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		
M-3	ISS	**Initial Subwatershed Strategy**	Distill subwatershed data into a strategy that outlines the best combination and locations of restoration projects to investigate in the next step, along with a workplan and budget.
	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		



In this step, the restoration team goes out in the field to evaluate actual restoration opportunities in the subwatershed. The resulting data is used to develop an initial subwatershed strategy that scopes out the types of restoration practices that best meet restoration goals. Five inter-related methods are needed to achieve this outcome.

3.1 Detailed Subwatershed Analysis

Desktop analysis in this step is split into two phases-- advance field preparation and post-field processing. The first phase analyzes mapping and other data to generate base maps that support field surveys of the stream corridor and subwatershed (i.e., USA and USSR surveys or equivalents). Advance field preparation helps define stream reaches and upland sites that will be surveyed by field crews. Extra time spent in the office preparing for surveys can prevent a lot of headaches and save a lot of time in the field.

The post-field processing phase compiles, maps and interprets data on collected on subwatershed restoration practices. Stream reach, neighborhood and upland site data collected during the USA and USSR is mapped and analyzed to show the locations of stream impairments, upland pollution sources, and potential candidate sites for restoration practices. The two phases of a Detailed Subwatershed Analysis (DSA) are performed in eight tasks:

Phase 1: Advance Field Preparation

1. Choose USA/USSR forms to use in field
2. Delineate survey reaches and upland survey sites
3. Generate base maps for field work
4. Plan routes and train field crews

Phase 2: Post-Field Processing

5. Manage data and perform quality control checks
6. Enter checked data into master spreadsheet/GIS
7. Map and analyze impairments and restoration opportunities
8. Recommend elements of the ISS

This section provides more detail on how to complete each of the eight tasks. Further tips on performing a DSA can be found in Profile Sheet D-3

Phase 1: Advance Field Preparation

1. Choose USA/USSR forms to use in field
One advantage of the two field surveys is that they can be customized to collect only the specific information relevant to local restoration needs. Table 15 outlines the different survey forms that can be used during USA and USSR surveys. The choice of whether to use all the forms or just some of them is usually driven by budget considerations. Each survey form should be carefully analyzed to see if any assessment questions need to be adapted or modified to account for unique local conditions.

2. Delineate stream reaches and upland survey sites
Stream reach and upland sites must be delineated prior to field work. The stream network of the subwatershed should be divided into discrete reaches of uniform character that are about a quarter mile in length. Maps are analyzed to delineate survey reaches and look for good access points to the stream corridor. Practical guidance on delineating survey reaches is outlined in Table 16.

The USSR also requires significant pre-processing of mapping data to locate upland survey sites to be visited by field crews. Potential upland survey sites are identified through an analysis of subwatershed GIS data, aerial photos and business databases. Table 16 provides more guidance on the selection criteria used to discover upland survey sites.

Table 15: Range of Survey Forms that can be Used	
Survey	**Survey Forms**
Unified Stream Assessment (USA)	**OT**: Storm water outfalls **ER**: Severe bank erosion **IB**: Impacted buffers **UT**: Utilities in stream corridors **TR**: Trash and debris **SC**: Stream crossings **CM**: Channel modification **MI:** Miscellaneous impacts **RCH**: Reach level assessment
Unified Subwatershed and Site Reconnaissance (USSR)	**NSA**: Neighborhood source assessment **HSI**: Hotspot site investigation **PAA**: Pervious area assessment **SSD**: Streets and storm drains
More guidance on each method can be found in Manuals 10 (USA) and 11 (USSR) of the Urban Subwatershed Restoration Manual Series	

Table 16: Defining Units to Visit during Field Work	
USA	
Survey Reach	Survey reaches should: • be about a quarter mile in length • have at least one convenient access point to the corridor • include only one stream channel • start or end at the confluence of another stream • start or end at road crossing or culvert • have relatively homogenous corridor land cover • possess uniform stream gradient • have a clear and consistent identification number
USSR	
Neighborhood Units	Delineate contiguous residential subdivisions that possess similar lot size, age of development and vegetative cover, using some discretion to include homeowner or neighborhood association boundaries, if available. Each neighborhood unit is visited to perform an NSA.
Storm Water Hotspots	Screen business databases to determine SIC codes associated with potential hotspots or illicit discharge generators for all operations in the subwatershed. Add addresses of any NPDES, SARA 312 and RCRA facilities discovered in state permit databases, and any commercial, industrial, municipal or transport-related operations greater than five acres in size*.
Large Turf Areas	Screen GIS or aerial photos to find all publicly-owned open sites greater than two acres to assess reforestation or retrofit potential*. A five-acre threshold is applied for privately-owned parcels*.
Natural Area Remnants	Screen GIS, aerial photos and/or wetland maps to find all publicly-owned contiguous forests/wetlands parcels greater than two acres in size to visit to natural area restoration potential*. A five-acre threshold is applied for privately-owned parcels*.

Table 16 (continued): Defining Units to Visit During Field Work	
USSR	
Large Parking Lots	Screen GIS or aerial photos to find all parking lots greater than two acres in size to visit to assess retrofit potential*.
Streets and Storm Drains	Randomly select five road sections to visit for each class of road present in the subwatershed: arterial, collector, local roads, and alleys.
Major Stakeholders and Landowners	Locate all schools, large institutions, churches, parks, and major landowners in the subwatershed that may serve as potential stakeholders.
An asterisk denotes an acreage threshold intended to reduce the number of potential upland survey sites to a manageable number, and may be increased or decreased depending on the intensity of subwatershed development.	

3. Generate base maps for field work

Base maps are generated before going out in the field to help crews navigate their way through the stream corridor and upland areas. The scale and level of detail provided on the field maps should reflect crew preferences and the general character of the subwatershed. While GIS can generate very detailed maps, USA and USSR field maps should be simple and uncluttered so crews can orient themselves in the filed and record their findings spatially. Table 17 indicates which mapping layers are required or are helpful in creating field base maps.

At a minimum, USA field maps should:

- Have a 1:24,000 or finer scale (i.e., 1” = 2000’ or 7.5 minute USGS quadrangle)
- Show labeled streets, blue line streams, wetlands, urban landmarks, general land use and property boundaries
- Define survey reaches and access points to the corridor
- Be supplemented by low altitude aerial photographs, where available

USSR field maps should also have the same scale as USA maps, but only need to show streets, urban landmarks, neighborhood units and upland survey sites. Aerial photography is also an excellent supplement when available.

Table 17: Mapping Layers needed to Support USA and USSR Surveys

Field Survey	Required Mapping	Helpful Mapping
Unified Stream Assessment (USA)	• Hydrology • Defined survey reaches • Roads and other landmarks • Subwatershed boundaries	• Aerial photos • Topography • 100-year floodplains • Wetlands • Land ownership (parcel boundaries) • Buildings • Storm drain network
Unified Subwatershed and Site Reconnaissance (USSR)	• Roads • Subwatershed boundaries • Land use/Land cover • Neighborhood delineations • Open space	• Aerial photography • Land ownership • Storm water practices • Storm drain network • Forest cover • Potential hotspot operations • Soils • Sanitary sewer lines

4. Plan routes and train field crews
Crews should be thoroughly trained on the USA and USSR protocols in the office and field so that they record information in a consistent manner. Crew leaders should analyze base maps to plan their survey routes and schedules, and agree on common naming conventions for both survey reaches and upland survey sites. In addition, time should be devoted to prepare an access authorization letter, assemble an emergency problem phone contact list, order field supplies, and make copies of the proper field forms.

Both the USA and USSR surveys create a wealth of data, and it is not uncommon to end up with dozens if not hundreds of forms for a single subwatershed. Therefore, it is important to perform quality control checks to ensure the forms are accurate and consistent, and develop an organized system to compile and process subwatershed data as it comes in. Once subwatershed data is consolidated into a spreadsheet/GIS format, restoration opportunities can be identified in the post-field processing phase.

Phase 2: Post-Field Processing

5. Manage data and perform quality control checks
Several quality control checks are performed in the field and back in the office to ensure the quality of subwatershed data. The first is an end-of-day field briefing where crews compare notes on what they have observed, check forms for thoroughness and accuracy, and make sure GPS waypoints and digital photos are correctly logged. Forms are then compiled into a master three-ring binder, along with supporting information. A sub-set of field forms are checked back in the office for accuracy, and are carefully organized according to stream reach and type of upland survey site. Additional desktop analysis is often needed to finalize field forms, such as calculation of NSA, HSI and RCH index values, or making recommendations for potential restoration practices.

6. Enter checked data into master spreadsheet/GIS
The field data is now ready to be entered into a master spreadsheet linked to the watershed-based GIS. The Center has developed databases to facilitate data entry for USA and USSR field forms, which are provided in Manuals 10 and 11. The process of entering data can be lengthy and tedious, so a subset of the entries should be checked for mistakes.

7. Map and analyze impairments and restoration opportunities
USA and USSR data can be manipulated in many ways to get a better picture of stream impairments, pollution sources and subwatershed restoration opportunities, including:

- Indexes of stream impairment and habitat quality
- Indexes of the severity of neighborhood and hotspot pollution
- Counts of stream corridor impairments
- Counts of corridor and upland restoration opportunities
- Maps of stream corridor impairments and upland pollution sources
- Maps of the distribution of potential restoration opportunities
- Summary metrics at the stream reach, neighborhood and subwatershed scale

8. Recommend elements of the Initial Subwatershed Strategy
In the last task, the core team sorts through all the maps, counts, indexes and metrics and recommends priority elements for the initial subwatershed strategy. Each of these can shed light on major subwatershed problems and the likely combination of restoration practices most capable of solving them. The priority restoration elements identify the:

- Major stream impairments and pollution sources in the subwatershed
- Key stakeholders to involve in the restoration planning process
- Specific locations where restoration efforts need to be targeted

- Major groups of restoration practices that can be effectively employed in the subwatershed
- Number and type of candidate project investigations to pursue in the next step

Additional guidance on how to formulate an initial subwatershed strategy can be found in Section 3.5 and Profile Sheet M-3.

3.2 The USA and USSR Surveys

The Unified Stream Assessment (USA) and Unified Subwatershed and Site Reconnaissance (USSR) are typically applied together to evaluate restoration potential in the stream corridor and upland areas. Detailed guidance on tasks involved in USA and USSR surveys can be found in Manuals 10 and 11, respectively; only a brief introduction is provided here.

The USA is a comprehensive field survey to evaluate stream impairments and restoration potential within the urban stream corridor. The USA relies on a continuous walk of the entire stream network of a subwatershed, focusing on pre-designated survey reaches (Figure 10). Within each survey reach, up to eight individual stream impairments are documented, as well as the condition of the reach as a whole. Stream impairments are identified based on visual habitat assessment surveys, and are documented using GPS coordinates and digital photos. The USA survey also documents any restoration opportunities in the stream corridor, most notably for stream repair, riparian restoration, storm water retrofit, and discharge prevention practices.

The USSR is a comprehensive survey of upland areas to identify potential pollution sources and restoration opportunities of the subwatershed. Field crews drive down all the streets in a subwatershed and visit pre-designated upland survey sites to evaluate pollution source areas and potential upland restoration projects. The USSR is a “windshield survey” that quickly characterizes subwatershed conditions and evaluates whether pollution source control, on-site storm water retrofits, watershed forestry, natural area management or enhanced municipal practices make sense as a restoration strategy.

When USA and USSR surveys are used together, they generate sufficient data to devise an initial subwatershed strategy that scopes out which candidate restoration project investigations will be pursued in the next step. More guidance on both surveys is provided in Profile Sheets F-3a and F-3b.

Figures 11 and 12 provide examples of data gathered and mapped as part of both the USA and USSR surveys, respectively.

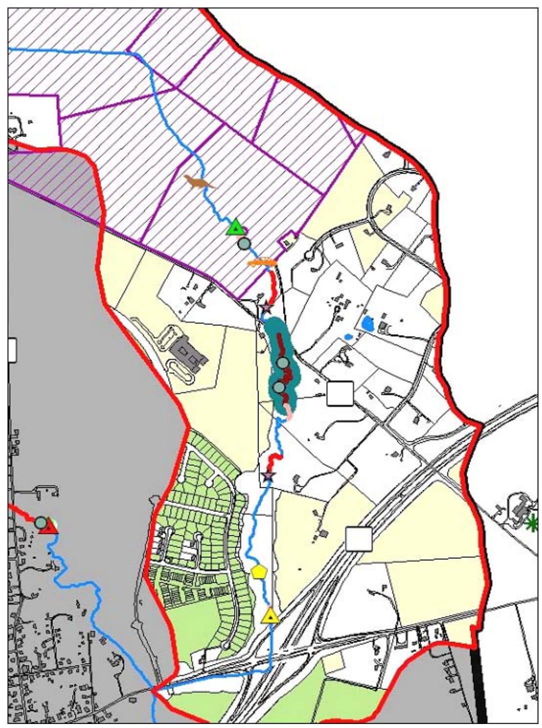


Figure 10: Example of Stream Corridor Map used for the USA

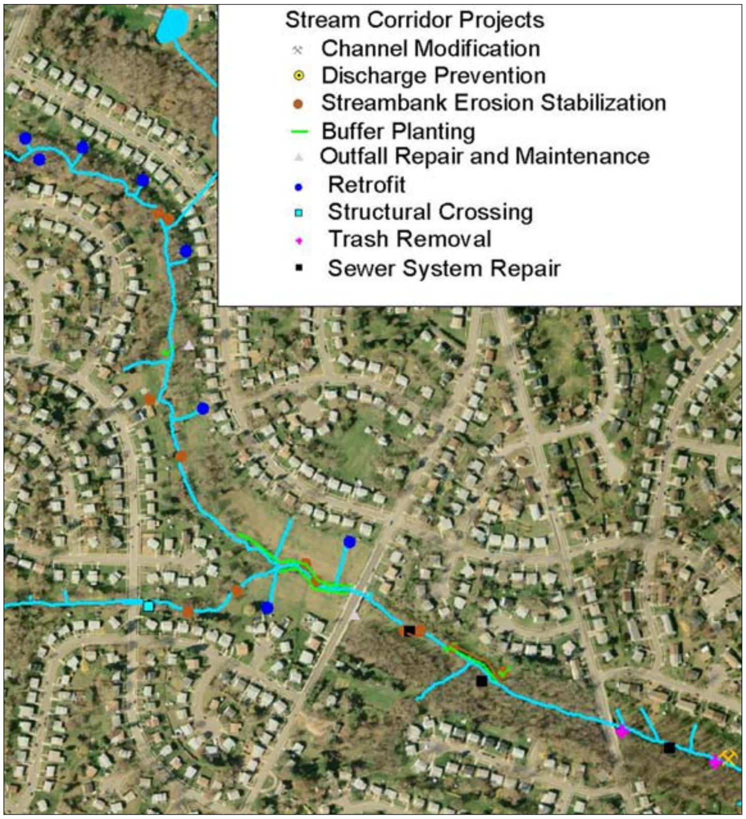


Figure 11: Example of Unified Stream Assessment

A USA was conducted in the Scotts Level Branch, a subwatershed in the Gwynns Falls watershed. Numerous storm water retrofit opportunities were identified at outfalls, as shown above, along with several areas where stream bank stabilization projects are needed. A handful of sanitary sewer repair projects were identified, as were areas where volunteer trash clean-ups could be conducted.

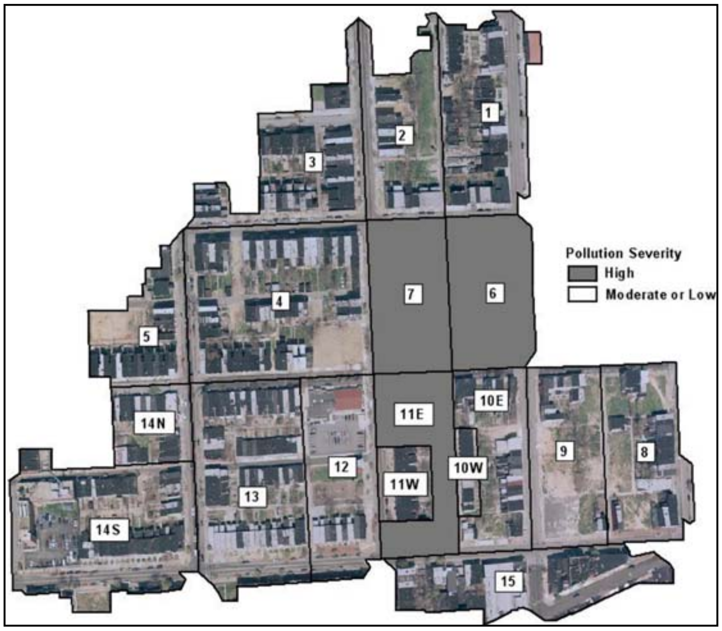


Figure 12: Example of Unified Subwatershed and Site Reconnaissance

This USSR was conducted in Catchment O of Watershed 263. The Catchment was subdivided into 18 neighborhoods and data collected were used to assign a "pollution severity" rating to each neighborhood – three neighborhoods earned a high pollution severity rating, 11 neighborhoods were rated as moderate, and four received a low rating. (Source: Zielinski, 2005)

3.3 Stakeholder Identification and Recruitment

This method is used to identify and recruit stakeholders that live or work in the subwatershed to participate in the restoration planning process. Common stakeholder targets include civic groups, churches, neighborhood associations, schools, institutional landowners, businesses, and other groups. Many stakeholders can be identified during the USSR survey, but additional contacts and networking are often needed to get the right people to the table. Effective stakeholder identification and recruitment consists of six basic tasks, as described below:

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

Each task is briefly reviewed below, and further tips of finding and recruiting stakeholders can be found in Profile Sheet S-3.

1. Analyze subwatershed maps to locate potential stakeholders

Subwatershed maps should be carefully analyzed to locate potential stakeholders, such as schools, large institutions, churches, parks, and large landowners. These potential stakeholders should be visited during USSR surveys to acquire address and contact information.

2. Get contact data for neighborhood associations and civic groups

Not all stakeholders will show up on maps. For example, 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 to expand contacts

Community multipliers should be interviewed to expand the stakeholder list. Community multipliers are already very active and influential in civic affairs, and are five times more likely to attend a community meeting than their peers (NEETF, 2003). Examples of community multipliers are people involved in schools, churches, recreational groups, parks, and business organizations. These individuals not only actively seek environmental information, but also are predisposed to support and adopt stewardship practices (NEETF, 2003), and possibly bring in new stakeholders. Consequently, it is a good idea to call or meet with community multipliers and tap into their networks to get contact information on additional stakeholders.

4. Develop contact database to track stakeholders

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 e-mail information for each stakeholder, and be capable of quickly printing mailing labels and e-mail lists for outreach efforts. Many excellent contact management databases are now available that allow the core team to keep track of the current status and contact history of each individual stakeholder.

5. Survey stakeholders about their involvement preferences

The team should find out how individual stakeholders want to be involved in the restoration 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. 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). In addition, some stakeholders may not want to attend regular meetings, but still want to be kept informed about restoration progress through other means.

6. Deliver invitations and restoration outreach materials

In the last task, invitations and educational materials are sent to potential stakeholders to recruit them into the restoration process. A wide range of outreach techniques exist to get the invitations out to stakeholders including invitation letters, face-to-face meetings, fact sheet mailouts, project websites, articles in local papers, stream tours and educational displays in public spaces and community fairs. Several different outreach techniques should be used to recruit the greatest number of stakeholders, and let them know about the subwatershed restoration process.

3.4 Devise Initial Subwatershed Strategy

The methods used up to this point produce a great deal of data on subwatershed restoration potential in a short time. The challenge is to synthesize the data into an Initial Subwatershed Strategy (ISS) that outlines the best combination of restoration practices that should be pursued more intensively in Step 4. As such, the ISS seeks to limit the scope of restoration to the practices that will make the greatest difference in the subwatershed. These choices are important since subsequent candidate project investigations and design methods can be extremely expensive.

Four tasks are used to develop an ISS:

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

1. Review priority restoration elements from DSA

The recommended restoration elements produced in the DSA should be reviewed, along with supporting maps, counts, indexes and metrics derived from USA and USSR surveys. Data should be organized into formats that the core team can readily access. A sample map generated during the ISS is shown in Figure 13.

2. Engage core team in brainstorming meeting

Brainstorming sessions with the core restoration team are the best way to hammer out the ISS. It may be helpful to bring other stakeholders to these sessions to add an outside perspective.

The core team should be reminded of watershed goals, and asked to recommend what types, numbers and combinations of practices appear to make the most sense for restoration. These informal sessions are designed to reach consensus on the ISS, and should focus on five key elements that establish restoration priorities for the subwatershed:

1. Major stream impairments and pollution sources in the subwatershed
2. Key stakeholders to involve in the restoration planning process
3. Specific locations where restoration efforts need to be targeted
4. Major groups of restoration practices that are recommended for the subwatershed
5. Number and type of candidate project investigations to pursue in the next step

3. Decide on the type and number of CPIs needed

Once consensus is reached on the initial strategy, the core team needs to estimate the approximate number, type and location of potential restoration practices that will require detailed candidate project investigations in Step 4.

4. Develop a detailed scope of work and budget

A detailed scope of work or work plan is relatively easy to produce once the number and type of restoration practices are known. Chapters 4 and 9 provide unit cost data to develop budgets for candidate site investigations for each group of restoration practices. The resulting work plan guides agencies, watershed groups or consultants through the remaining steps to put together the draft subwatershed plan.

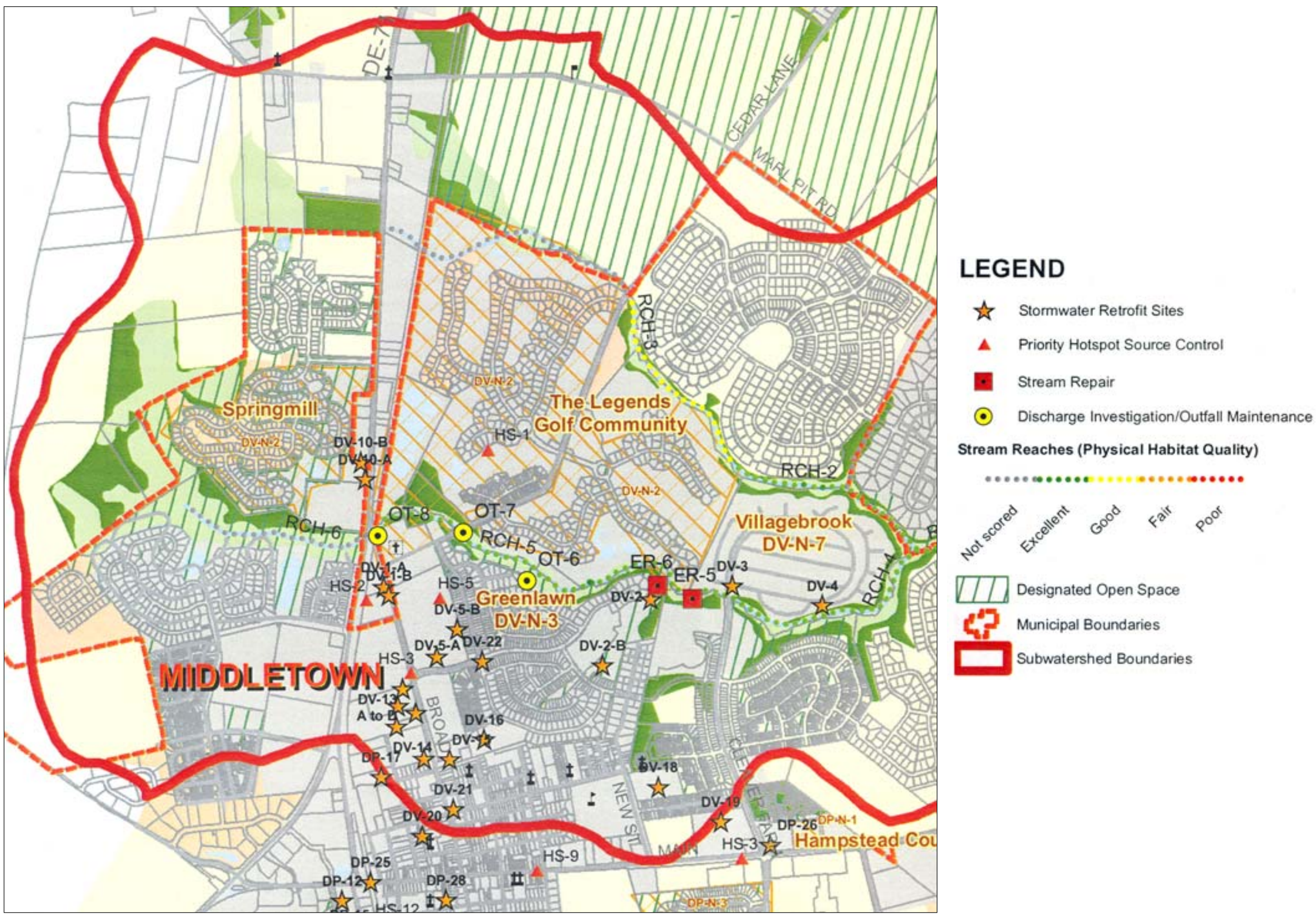


Figure 13: Initial Subwatershed Strategy of the Appoquinimink Watershed Management Plan

This excerpt shows where data was collected during the stream and subwatershed assessments and analyzed. A large number of potential restoration projects were selected. Of these, a limited number of priority locations were selected for further investigation. (Source: Kitchell, 2005)

D-3	Desktop Analysis **Detailed Subwatershed Analysis**	**DSA**

Purpose

The purpose of this method is to plan out field assessments, analyze field data, and identify initial restoration projects for further investigation. A desktop analysis provides the technical foundation to make decisions on the initial restoration strategy and choose what groups of restoration practices to pursue in subsequent steps.

Scale	Value
Subwatershed-wide	Essential

Analysis Method

The DSA is divided into advance field preparation and post-field processing phases, and involves eight tasks:

Phase 1: Advance Field Preparation

1. Choose USA/USSR forms to use in field
2. Delineate survey reaches and upland survey sites
3. Generate base maps for field work
4. Plan routes and train field crews

Phase 2: Post-Field Processing

5. Manage data and perform quality control checks
6. Enter checked data into master spreadsheet/GIS
7. Map and analyze impairments and restoration opportunities
8. Make recommendations on the ISS

Products

1. Base field maps for USA and USSR surveys
2. Maps, counts and indexes of stream corridor and subwatershed condition
3. List of potential sites for more detailed assessment

Mapping / Other Data Needs

Base maps at a minimum scale of 1:24,000 that show roads, landmarks, stream networks and neighborhoods are needed to support field work. Aerial photos and other maps can be helpful. See Table 17 for required and supplemental mapping layers. The core team may also need to access permit and business databases to identify potential hotspot sites to visit.

Time Frame / Level of Effort

Expect to spend three weeks on the DSA per subwatershed - one week for advance field preparation and two weeks for post-field processing.

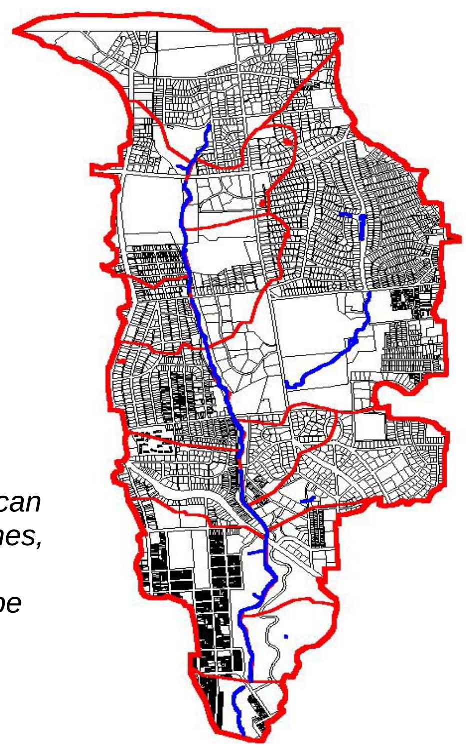
Further Resources

Detailed guidance on advance field preparation and post-field processing can be found in Manuals 10 and 11 of this series.

D-3	Desktop Analysis **Detailed Subwatershed Analysis**	**DSA**

Tips for Handling Detailed Subwatershed Analysis

- Lack of mapping or GIS data layers should not hold up field investigations at this stage; most communities should have enough mapping to go out in the field.
- Be careful not to put too much information on base maps – field crews need to handle a lot of information out in the field and primarily use maps to find out where they are and locate impairments and restoration opportunities. Too much map clutter or too many maps make fieldwork unwieldy.
- The value of the USA and USSR surveys are magnified when they are applied at the same time and the results are interpreted together. Maps that show the connection between upland pollution sources and downstream impairments are highly effective, as are maps showing the relation of upland restoration practices with practices in the stream corridor.
- Some relatively simple counts, indexes and metrics can be derived from USA and USSR data that provide good insights to develop the Initial Subwatershed Strategy - so be sure to allocate some time back in the office to derive them. More guidance on how to derive them and use them to target where restoration is needed can be found in the final chapters of Manuals 10 and 11.
- Remember that the USA and USSR are intended to be rapid assessment methods - so don't go overboard on advanced preparation and post-field processing.



Advanced mapping can identify stream reaches, upland sites, and neighborhoods to be surveyed.

F-3a

Field Assessment Method

Unified Stream Assessment

USA

Purpose

This method is used to investigate the entire stream corridor for major impairments and scout potential locations for storm water retrofit, stream repair, riparian management, and discharge prevention practices.

Scale	Value
Subwatershed stream corridor	Essential

Basic Method

Up to nine different impact assessment forms are used to document conditions along the stream corridor. They include:

OT: Storm water outfalls
ER: Severe erosion
IB: Impacted buffers
UT: Utilities in stream corridors
TR: Trash and debris
SC: Stream crossings
CM: Channel modification
MI: Miscellaneous features
RCH: Reach level assessment

Information Provided for Restoration

The USA provides a wealth of data to:

- Rank severity of stream corridor problems at the reach and subwatershed level
- Identify potential sites for restoration practices
- Derive stream corridor metrics
- Screen overall subwatershed restoration potential

Advanced Preparation

Guidance on choosing forms, defining survey reaches, and generating field maps is provided in the advance field preparation steps of the Detailed Subwatershed Analysis (DSA).

Mapping Needed

The advance field preparation steps described for the DSA provide guidance on how to generate USA field maps. Recent aerial photos are a helpful field supplement if they are readily available.

Data Management & Reporting

Guidance on how to manage and interpret USA data can be found in the post field processing discussion under DSA. USA data on impairments and restoration potential are frequently expressed in simple counts, maps, stream corridor metrics and reach screening.

Level of Effort / Cost

Staff effort to perform the USA method varies with the size of the subwatershed and the number of walkable stream miles. The most urbanized subwatersheds will generally have fewer stream miles to walk due to stream enclosure. Expect to allocate three staff for each USA field crew, which should be able to cover an average of two miles of stream per day. One-time field equipment costs are typically less than $1000.

Further Resources

Complete documentation on the USA method can be found in Manual 10 of this series: *The Unified Stream Assessment: A User's Manual*

F-3a

Field Assessment Method

Unified Stream Assessment

USA

Tips for Conducting an Effective USA

- Digital photos are used to document stream impairments in the USA, and these "home-grown" pictures are a great resource to include in future educational materials and presentations.
- The USA can be a great tool to teach watershed groups and agency staff about urban stream impacts and restoration potential, so make sure to invite some volunteers to help out on the surveys (it helps cut costs too).
- Naming conventions are extremely important to keep track of the dozens of survey reaches in a subwatershed, not to mention the even greater number of impact forms. Some simple but effective naming conventions are provided in Manual 10.
- The USA generates a lot of forms and data from each survey. A handy spreadsheet database has been developed to quickly organize and compile all field data, and get to the important job of figuring out restoration potential.
- Keep safety in mind when conducting urban stream assessments – safety gear like gloves, cell phones, pepper spray, and first aid kits should always be in your backpack.
- USA surveys are a good systematic way to find the best stream segments for a local adopt-a-stream program -- the most accessible survey reaches found during the USA are normally the best candidates for adoption.
- The season of the year can be important when scheduling USA surveys, particularly when dense vegetative growth conceals outfalls and other features. In most regions of the country, dry weather periods during the non-growing season are the best times to schedule a USA survey.
- If illicit discharges are suspected to be problem in a subwatershed, combine the USA survey with the more detailed Outfall Reconnaissance Inventory (ORI) to collect more outfall and water quality data needed to track down problem discharges. The ORI method is described in Brown *et al*. (2004).
- Each of the basic USA forms exists in Microsoft Word format so they can be customized to reflect local concerns and corridor assessment needs.

F-3b

Field Assessment Method

Unified Subwatershed and Site Reconnaissance

USSR

Purpose

The USSR is a rapid field method to identify potential pollutant source areas in upland portions of the subwatershed and to assess the feasibility of upland restoration practices such as source control, discharge prevention, watershed forestry, on-site retrofits and enhanced municipal operations.

Scale	Value
Neighborhoods and upland areas of the subwatershed	Essential

Basic Method

The USSR consists for four inter-related surveys:

1. Neighborhood Source Assessment (NSA)
2. Hotspot Site Investigation (HSI)
3. Pervious Area Assessment (PAA)
4. Analysis of Streets and Storm Drains (SSD)

Information Provided for Restoration

The USSR provides extensive information to evaluate upland restoration potential, including:

- Identifying upland pollution source areas
- Scouting for potential sites for upland restoration practices
- Providing basic information to assemble a subwatershed source control plan
- Developing subwatershed metrics
- Screening neighborhoods and subwatersheds for restoration potential

Advanced Preparation

Guidance on choosing forms, delineating homogenous neighborhood units and upland survey sites, screening for potential hotspots, and generating USSR field base maps can be found in the advance field preparation in the Detailed Subwatershed Analysis (DSA). In addition, time needs to be devoted to plan survey routes, order supplies, and train field crews on the USSR method.

Mapping Required

Guidance on generating USSR field maps is provided in the DSA advance field preparation discussion. Simple street maps and recent aerial photos are very helpful.

Data Management & Reporting

The post field processing discussion for the DSA provides practical guidance on how to manage and interpret USSR data. Simple counts, maps, neighborhood indexes and subwatershed metrics provide insights about upland pollution source areas and restoration potential.

Level of Effort / Cost

In general, plan on a two-staff team covering 2.5 square miles per day if they conduct all four USSR assessment components. One-time field equipment costs are typically less than $500.

Further Resources

Complete documentation on the USSR method can be found in Manual 11: *The Unified Subwatershed and Site Reconnaissance: A User's Manual*

F-3b

Field Assessment Method

Unified Subwatershed and Site Reconnaissance

USSR

Tips for Getting the Most Out of a USSR Survey

- Think about whether all four USSR component surveys are really needed – if water quality is not a major goal, then you may be able to get by with just the PAA.
- In many cases, USSR forms may need to be customized to account for local conditions and development patterns. For example, the basic NSA form is oriented toward typical large lot suburban development. Consider adapting the NSA form if local subwatersheds are older, intensively-developed, or contain mixed land uses.
- Digital photos taken during NSA and HSI surveys are often great visuals to highlight common pollution problems – make sure the best ones are incorporated into educational materials and presentations at stakeholder meetings.
- Make sure to have a letter from a local agency that authorizes field crews to perform the survey – folks walking around neighborhoods and businesses with clipboards never fail to attract residents and owners wanting to know what they are doing. Take a long a few educational brochures since these impromptu interactions can be a good teaching moment.
- Each of the USSR surveys can be completed by trained volunteers, which can greatly reduce the cost of survey efforts. In particular, working directly with a homeowner's association to fill out an NSA sheet or a business owner to fill out an HSI can be a great educational experience.
- Most USSR surveys generate a lot of field forms. They can be hard to keep track of without standard naming conventions and a master spreadsheet database to store them.

The NSA involves a rapid windshield survey to identify pollution sources and stewardship opportunities at the neighborhood scale.

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.

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

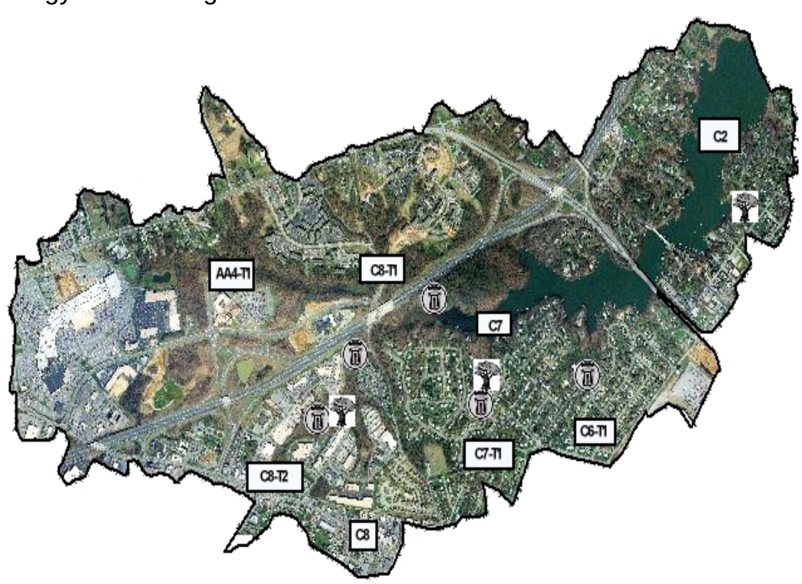
ISS

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.

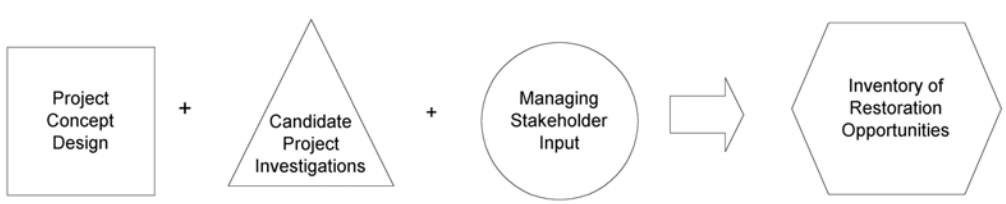
Real World Example

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).



Chapter 4: Methods to Investigate Restoration Projects

STEP 4 AT-A-GLANCE			
No.	**ID**	**Name**	**How it Guides Restoration**
D-4	**PCD**	**Project Concept Design**	Develops simple concept designs for feasible restoration practices with enough detail to allow their comparative evaluation at subwatershed scale.
	1. Review CPI data for subwatershed 2. Analyze available mapping at project sites 3. Decide on type and extent of restoration treatment 4. Work up final concept and sketch 5. Develop initial cost estimate 6. Assemble concepts for entry into IRO		
F-4	**CPI**	**Candidate Project Investigations**	Eight different field surveys to collect detailed field data at individual restoration project sites to develop workable concept designs for the most feasible projects
	1. Retrofit Reconnaissance Inventory (RRI) 2. Stream Repair Investigation (SRI) 3. Urban Reforestation Site Assessment (URSA) 4. Discharge Prevention Investigations (DPI) 5. Hotspot Compliance Inspections (HCI) 6. Natural Area Remnant Analysis (NARA) 7. Source Control Plan (SCP) 8. Municipal Operations Analysis (MOA)		
S-4	**MSI**	**Managing Stakeholder Input**	Get direct stakeholder input on the full range of subwatershed issues and get feedback on the merits of the initial restoration strategy
	1. Prepare for meeting in advance 2. Conduct stakeholder meeting 3. Perform follow-up tasks after meeting		
M-4	**IRO**	**Inventory of Restoration Opportunities**	Assemble the full spectrum of all feasible restoration projects that could potentially be installed in the subwatershed into a single document.
	1. Assemble projects into master binder or GIS 2. Produce subwatershed project locator map and inventory summary table		



The purpose of this step is to conduct detailed investigations of candidate restoration projects in the subwatershed   Eight different types of investigations can be performed, depending on which types of restoration practices were selected in the ISS. Each candidate site is revisited to acquire more detailed information to work up an initial project concept design.

Some individual projects may be eliminated at this stage because they fail to meet basic feasibility criteria. The remaining projects are then assembled into an inventory of restoration projects that is shared with stakeholders. More detailed guidance on candidate project investigations and project concept design for each type of restoration practices can be found in Manuals 3-9.

4.1 Project Concept Design

Desktop analysis is used to work up project concept designs for individual candidate restoration projects. After potential sites are investigated in the field, site data and mapping are analyzed to create simple concept designs for each project. This may or may not involve additional mapping work. Project design data is then entered into a master binder, spreadsheet and/or watershed-based GIS. At this stage, relatively simple concept plans may be feasible for riparian reforestation or source control practices. More complex restoration projects such as retrofits and stream repairs, however, may require additional engineering and design surveys before a final design can be completed.

Six common tasks are performed to prepare consistent and comparable concept designs for all types of restoration practices in the subwatershed.

1. Review CPI data for the subwatershed
2. Analyze available mapping at project sites
3. Determine the type and extent of restoration treatment
4. Work up final concept and sketch
5. Develop initial cost estimate
6. Assemble concepts for entry into IRO

Further tips in formulating good project concept designs are provided in Profile Sheet D-4 at the end of the Chapter.

1. Review CPI data for the subwatershed

Field data should be reviewed back in the office within a few weeks of the CPI investigation while the site is still fresh in mind. This enables the core team to assess project feasibility and compare it to other restoration opportunities in the subwatershed. The team reviews all CPI forms to identify the best restoration project opportunities that deserve more intensive concept design effort and drop smaller, marginal or infeasible projects.

2. Analyze available mapping at the project site

The team then scrutinizes available mapping at priority project sites, as well as any adjacent areas or contributing drainage. 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 design team delineates project boundaries from the maps and derives a better estimate of site area. The drainage area and land cover contributing to the project should always be delineated for storm water retrofit or stream repair projects (especially impervious cover).

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. If mapping layers are not sufficient to assess project feasibility, additional engineering design surveys may need to be budgeted in Step 7.

3. Determine type and extent of restoration treatment

The next task chooses the specific type and extent of restoration treatment that will be provided by the proposed project. Using a storage retrofit as an example, this would entail calculating the volume of storm water treated, and deciding whether the storage would be in the form of a permanent pool, wetland, or extended detention. Table 18 summarizes the sequence of steps needed to determine the type and extent of treatment for the seven groups of restoration practices.

4. Work up final concept and sketch

The final concept should have a sufficient level of detail to thoroughly assess project feasibility and cost, and allow groups of projects to be compared at the subwatershed level in Step 5. The term 15% design is often used to describe the scope of effort for concept designs. The concept should include detailed description of the project goals and a decent plan view sketch that shows how the project will work, and estimated storage or treatment calculations for the proposed project.

5. Develop initial cost estimate

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, acre feet of retrofit storage, acres planted, street miles swept, outreach population targeted or simply the number of unit practices installed. The appropriate construction unit is then multiplied by an average construction cost (which is provided in Table 47 in Chapter 9). The average construction costs should always be checked against regional or local data. The initial planning estimate is only used to compare projects for ranking purposes; accurate project cost estimates are computed during Final Design and Construction (Chapter 7). The initial cost estimate should always indicate whether any additional costs are anticipated to secure environmental permits, conduct engineering design studies or hold neighborhood consultation meetings.

6. Assemble concepts for entry into IRO

Draft project concept designs are then double-checked for accuracy and thoroughness. Each concept design is assigned a unique restoration practice and subwatershed identification number. Handwritten entries may need to be neatened, sketches redrawn, and calculations checked. All supporting field forms, digital photos, sketches, field notes and mapping data should be archived into a single project folder. Individual project concept designs are then finalized in the form of a 2 to 4 page restoration project summary that includes the feasibility assessment, sketch, narrative and initial cost estimate.

Table 18: Key Steps in Producing Project Concept Design
Storage Retrofit Practices
• Review Retrofit Reconnaissance Inventory Form • Delineate drainage areas and impervious cover to potential sites • Estimate approximate surface area available at site and calculate available retrofit storage volume • Evaluate feasibility factors and other site constraints • Select type of storm water practice to be employed • Sketch proposed design and provide 15% concept • Derive cost estimate for project based on storage volume equations • Evaluate the need for any special design or permitting studies
On-site Retrofit Practices
• Review NSA data from USSR survey • Determine the number of potential on-site retrofits for the neighborhood • Evaluate typical on-site retrofit conditions (soils, basements, etc.) • Select on-site retrofit techniques to be employed, including standard spec and unit costs • Determine delivery mechanism to construct on-site retrofits • Develop neighborhood-wide implementation cost estimate
Stream Repair Practices
• Review Stream Repair Investigation for survey reach • Field determination of dominant channel process and phase of channel adjustment • Desktop analysis of project feasibility factors • Select combination of stream repair practices to be applied • Sketch concept design over reach length, showing general type and location of repair practices • Derive planning level cost estimates based on unit stream repair costs • Evaluate the need for any special design or permitting studies
Riparian Management Practices
• Review Urban Reforestation Site Assessment (URSA) Form • Examine tax or parcel maps to verify property ownership and landowner contact • Delineate planting areas at the site and estimate total area • Evaluate feasibility factors and site preparation methods needed at the site • Select riparian management strategy for the site, and associated preparation/planting method(s) • Derive planning level cost estimate based on unit planting area and unit cost for the selected prep and planting methods
Discharge Prevention Practices
• Identify most severe problem outfalls from water quality monitoring data, USA OT scores or Outfall Reconnaissance Inventory (ORI) scores • Based on outfall size, decide whether to conduct a drainage area investigation or trunk investigation to find the source • When the discharge has been isolated between two manhole junctions, employ dye, smoke or video testing to find the illicit connection • Take enforcement action to fix or eliminate the connection • Proceed to the next problem outfall

Table 18 (continued): Key Steps in Producing Project Concept Design
Watershed Forestry Practices
• Review Urban Reforestation Site Assessment (URSA) form • Measure approximate planting area for the site • Modify based on site constraints, including boundaries, ownership, adjacent land uses, onsite retrofit potential • Evaluate whether site preparation is needed • Select planting methods based on intended use • Sketch planting plan and estimate planting materials and species • Derive planning level cost estimate based on unit planting area and unit cost for the selected site preparation and planting methods
Pollution Source Control Practices
Begin by reviewing NSA and HSI data from USSR survey. The "concept design" is equivalent to a Source Control Plan, which has ten steps: • Choose pollutant of concern • Link pollutant to key subwatershed indicators • Locate specific pollutant source areas in the subwatershed • Identify priority outreach targets • Develop overall source control strategy • Craft a clear and simple message • Select the most effective outreach techniques • Choose mix of source control practices • Estimate subwatershed source control budget • Put together partnership to distribute practices
Municipal Operations and Practices
• Evaluate USSR SSD data to assess relative pollutant accumulation in streets, curbs and catch basins • Evaluate on-street parking, traffic, street conditions, access and other factors influencing sweeping and cleanouts • Determine optimal sweeping routes and/or priority catch basin cleanouts in the subwatershed as well as desired frequency • Calculate additional or incremental costs for enhanced sweeping and/or cleanout operations

4.2 Candidate Project Investigations

This method involves field assessments to collect the data needed to develop workable concept designs for individual restoration projects in the subwatershed. Eight different types of candidate project investigations (CPI) can be performed, with the exact number determined during the scoping phase of the initial subwatershed strategy. The eight candidate project investigations and the corresponding restoration practice they evaluate are:

1. Retrofit Reconnaissance Inventory (RRI) – *storm water retrofits*
2. Stream Repair Investigations (SRI) – *stream repair and restoration*
3. Urban Reforestation Site Assessment (URSA) -- *riparian and upland reforestation*
4. Discharge Prevention Investigations (DPI) – *illicit discharge detection and elimination*
5. Hotspot Compliance Inspections (HCI) – *hotspot source control*
6. Natural Area Remnant Analysis (NARA) – *restoration of natural area remnants*
7. Source Control Plan (SCP) -- *residential stewardship and pollution practices*
8. Municipal Operations Analysis (MOA) – *street sweeping and other municipal practices*

Most CPI surveys can be completed in a matter of a few hours or days, and are used to develop a basic concept design for each project or to determine how to effectively deliver restoration programs. Table 19 indicates the approximate level of effort needed to visit and assess each candidate site for each of the eight CPI surveys. Each CPI survey 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 19. The next sections briefly describe the basic scope of CPI surveys; further detail on each individual CPI survey can be found in Manuals 3 through 9 of this series.

1. 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 storm water treatment in locations where practices previously did not exist or were ineffective, and include modification to existing storm water practices or construction of new practices. 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 right-of-ways, open spaces, parking lots, and existing detention ponds.

The following information is collected at each candidate retrofit site:

- Unique site number
- Location (GPS coordinates)
- Description of site
- Approximate drainage area and contributing impervious cover
- Property ownership
- Retrofit volume calculations for water quality, channel protection and flood control
- Unique elements of retrofit
- Adjacent land use
- Utility conflicts
- Construction and maintenance access
- Presence of wetlands
- Presence of forest
- Photos
- Notes
- Recommendation to proceed

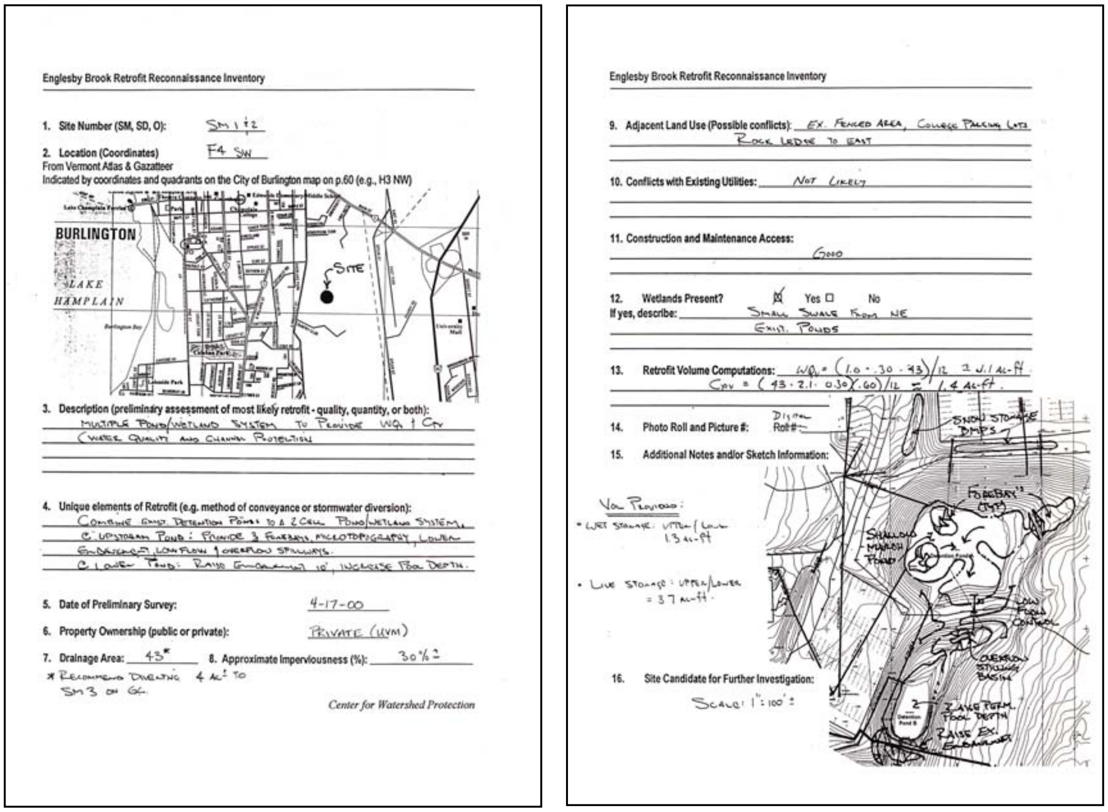
Candidate retrofit sites are identified through the USA and USSR surveys and detailed analysis of storm drain maps. At each site, a field sheet is completed, digital photos are taken, GPS coordinates are logged and an initial plan-view concept sketch prepared. An example RRI form is provided in Figure 14. Complete guidance on the field methods to conduct a retrofit reconnaissance inventory can be found in Manual 3.

A retrofit inventory team typically consists of two people who can visit up to 15 sites per day. Field equipment needed for the RRI includes field sheets, clipboards, pencils, GPS unit, camera, scale, calculator, measuring tape and a field map.

Table 19: Summary of the Eight Candidate Project Investigations

Candidate Project Investigation	Staff Time Per Investigation		
	Unit	CPI	Project Concept Design
Retrofit Reconnaissance Inventory	Storage site	4 hrs	8 hrs
Stream Repair Investigation	Survey reach	4 hrs	6 hrs
Urban Reforestation Site Assessment	Planting site	2 hrs	6 hrs
Discharge Prevention Investigation	Problem outfall	1 hr	4 hrs
Hotspot Compliance Inspection	Potential hotspot	2 hrs	6 hrs
Natural Area Remnant Analysis	Natural remnant	4 hrs	Varies
Source Control Plan	Subwatershed	20 hrs	140 hrs
Municipal Operations Analysis*	Community	8 hrs	24 hrs

** subwatershed assessment of street sweeping and catch basin cleanout only*



Englesby Brook Retrofit Reconnaissance Inventory

1. Site Number (SM, SD, O): SM 1 & 2
2. Location (Coordinates) F4 SW
From Vermont Atlas & Gazatteer
Indicated by coordinates and quadrants on the City of Burlington map on p.60 (e.g., H3 NW)

3. Description (preliminary assessment of most likely retrofit - quality, quantity, or both):
MULTIPLE POND/WETLAND SYSTEM TO PROVIDE WQ & CPV
(WATER QUALITY AND CHANNEL PROTECTION

4. Unique elements of Retrofit (e.g. method of conveyance or stormwater diversion):
COMBINE EXIST. DETENTION PONDS TO A 2 CELL POND/WETLAND SYSTEM.
C. UPSTREAM POND: PROVIDE 3 FOREBAYS, MICROTOPOGRAPHY, LOWER EMBANKMENT, LOW FLOW & OVERFLOW SPILLWAYS.
C. LOWER POND: RAISE EMBANKMENT 10', INCREASE POOL DEPTH.

5. Date of Preliminary Survey: 4-17-00
6. Property Ownership (public or private): PRIVATE (UVM)
7. Drainage Area: 43* 8. Approximate Imperviousness (%): 30% ±
* RECOMMEND DIVERTING 4 AC ± TO SM 3 OR 6.

Center for Watershed Protection

Englesby Brook Retrofit Reconnaissance Inventory

9. Adjacent Land Use (Possible conflicts): EX. FENCED AREA, COLLEGE PARKING LOTS
ROCK LEDGE TO EAST
10. Conflicts with Existing Utilities: NOT LIKELY
11. Construction and Maintenance Access: GOOD
12. Wetlands Present? Yes ☐ No
If yes, describe: SMALL SWALE FROM NE
EXIST. PONDS
13. Retrofit Volume Computations: $WQ_v = (1.0 \cdot .30 \cdot 43)/12 \cong 1.1$ AC-FT
$C_{pv} = (43 \cdot 2.1 \cdot 0.30)(.60)/12 \cong 1.4$ AC-FT.
14. Photo Roll and Picture #: DIGITAL Roll #
15. Additional Notes and/or Sketch Information:
VOL PROVIDED:
• WET STORAGE: UPPER & LOWER 1.3 AC-FT
• LIVE STORAGE: UPPER/LOWER = 3.7 AC-FT.
16. Site Candidate for Further Investigation:
SCALE: 1" = 100' ±

Figure 14: Example of a Retrofit Reconnaissance Inventory

An RRI was performed in the Englesby Brook watershed as part of a watershed planning process. During the field inventory, staff verified the feasibility of the site and collected basic information needed, as shown above, to proceed with conceptual design of the retrofit.

Field maps are prepared prior to the inventory, and typically include: hydrology, topography, drainage areas, storm water treatment practices, land use, property boundaries, gas, water and sewer lines, and impervious cover. Candidate retrofit sites are initially identified from these maps, and the drainage area to each site is normally delineated and calculated before going out to the field.

2. Stream Repair Investigation

The problem reaches identified during the USA are used as the starting point for a Stream Repair Investigation (SRI). An 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 (Figure 15). Manual 4 provides extensive guidance on how to perform an SRI and contains master field forms that can be easily adapted for local surveys.

The initial concept design is intended to be a fairly rapid and organized description of the general approach to stream repair within a defined project reach, and is primarily used to determine whether the candidate project has enough merit to take it to the next stage of stream assessment and design. An SRI form consists of four basic parts, as described below:

A. Basic Project Reach Information
The header section provides essential information about the location and condition of the project reach, and cross-references any USA forms that were previously filled out that may provide additional information to derive the concept design.

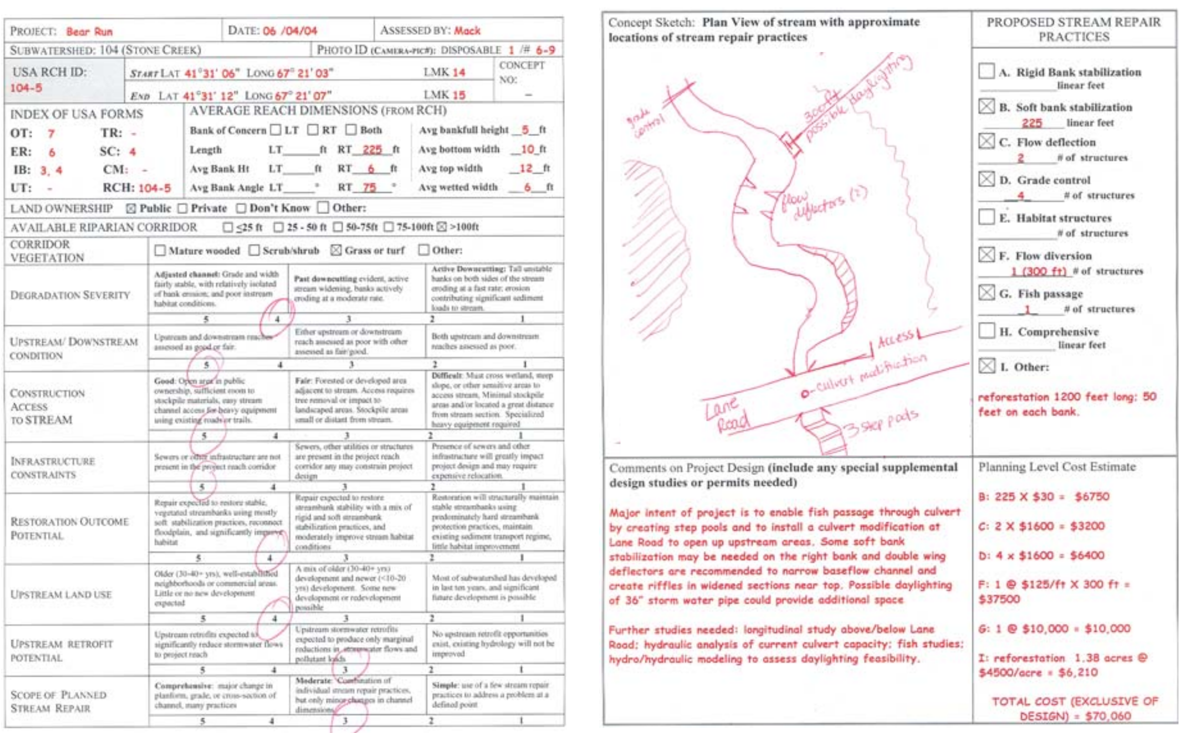
B. Stream Repair Feasibility Factors
The second part of the form evaluates nine key screening factors that influence the feasibility of stream repairs within the project reach, including:

- Land ownership
- Available riparian corridor
- Degradation severity
- Upstream/downstream condition
- Construction access
- Infrastructure constraints
- Upstream age of development
- Upstream retrofit potential
- Scope of planned repairs

Manual 4 provides narrative guidance on how to assess and rate each feasibility factor. If one or more factors suggest that a stream repair project is infeasible or impractical (e.g., uncooperative landowner and no construction access), then further work on the concept plan should be halted.

C. Concept Sketch and Proposed Stream Repair Practices
The sketch is the heart of the initial concept plan, and should show the stream and corridor in plan view, along with the approximate locations where proposed stream repair practices would be installed. The sketch also shows the limits of forest cover, potential access routes, and the general location of any sewers or utilities. The sketch indicates the location of major stream repair practices to be applied in the survey reach and depicts the estimated number, type and dimensions of individual practices proposed for installation.

D. Overall Approach, Permitting and Cost Estimates
The last part of a stream repair investigation provides a brief narrative of the overall stream repair strategy for the project reach, along with notations as to whether any additional monitoring studies or special permits or approvals are needed. An initial planning level cost estimate is calculated for the project reach as a whole, using



PROJECT: Bear Run	DATE: 06 /04/04	ASSESSED BY: Mack
SUBWATERSHED: 104 (STONE CREEK)	PHOTO ID (CAMERA-PIC#): DISPOSABLE 1 /# 6-9	
USA RCH ID: 104-5	START LAT 41°31' 06" LONG 67° 21' 03" LMK 14 END LAT 41°31' 12" LONG 67° 21' 07" LMK 15	CONCEPT NO: –

INDEX OF USA FORMS: OT: 7 TR: - ER: 6 SC: 4 IB: 3, 4 CM: - UT: - RCH: 104-5

AVERAGE REACH DIMENSIONS (FROM RCH): Bank of Concern ☐ LT ☐ RT ☐ Both; Length LT___ft RT 225 ft; Avg Bank Ht LT___ft RT 6 ft; Avg Bank Angle LT___° RT 75 °; Avg bankfull height 5 ft; Avg bottom width 10 ft; Avg top width 12 ft; Avg wetted width 6 ft

LAND OWNERSHIP ☒ Public ☐ Private ☐ Don't Know ☐ Other:

AVAILABLE RIPARIAN CORRIDOR ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

CORRIDOR VEGETATION ☐ Mature wooded ☐ Scrub/shrub ☒ Grass or turf ☐ Other:

Factor	5 – 4	3	2 – 1
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 225 linear feet
- ☒ C. Flow deflection 2 # of structures
- ☒ D. Grade control 4 # of structures
- ☐ E. Habitat structures ___ # of structures
- ☒ F. Flow diversion 1 (300 ft) # of structures
- ☒ G. Fish passage 1 # of structures
- ☐ H. Comprehensive ___ linear feet
- ☒ I. Other:

reforestation 1200 feet long: 50 feet on each bank.

Comments on Project Design **(include any special supplemental design studies or permits needed)**

Major intent of project is to enable fish passage through culvert by creating step pools and to install a culvert modification at Lane Road to open up upstream areas. Some soft bank stabilization may be needed on the right bank and double wing deflectors are recommended to narrow baseflow channel and create riffles in widened sections near top. Possible daylighting of 36" storm water pipe could provide additional space

Further studies needed: longitudinal study above/below Lane Road; hydraulic analysis of current culvert capacity; fish studies; hydro/hydraulic modeling to assess daylighting feasibility.

Planning Level Cost Estimate

B: 225 X $30 = $6750

C: 2 X $1600 = $3200

D: 4 x $1600 = $6400

F: 1 @ $125/ft X 300 ft = $37500

G: 1 @ $10,000 = $10,000

I: reforestation 1.38 acres @ $4500/acre = $6,210

TOTAL COST (EXCLUSIVE OF DESIGN) = $70,060

Figure 15: Example of Stream Repair Investigation Form
This SRI was completed for a potential stream repair site identified during a steam assessment. An initial concept design was developed during this follow up field visit.

the practice dimensions indicated on the sketch multiplied by unit cost data. Normally, the last part of the concept design is worked up back in the office.

3. Urban Reforestation Site Assessment

The purpose of an Urban Reforestation Site Assessment (URSA) is to collect data on the most promising reforestation sites in riparian and upland areas of a subwatershed. Potential riparian sites are obtained directly from the Impacted Buffer (IB) form completed as part of USA surveys and the Pervious Area Assessment (PAA) form recorded during USSR surveys. 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 form evaluates five major elements at each potential reforestation site to develop an effective planting strategy. URSA data is then used to design, rank and select the best reforestation sites in the subwatershed as a whole.

A. General Information
The first part of the URSA worksheet records information about the location, property owner and current and proposed land use at the site. This part also includes boxes to assign a unique ID number for the site and cross-reference any IB or PAA forms that provide additional data about the site.

B. Growing Conditions at the Site
The second part of the URSA form evaluates site factors that will influence the selection of tree and shrub species planted at the site and determine whether soil amendments or invasive plant control is needed to enhance tree survival. The field crew records the following information about growing conditions at the site:

Climate
- Hardiness zone
- Sun exposure
- Wind exposure

Topography
- Slope

Soils
- Texture
- Drainage
- Compaction
- pH
- Soil quality
- Other soil disturbance
- Depth to water table (riparian only)

Vegetation
- Regional forest association or dominant species from reference site
- Current vegetative cover
- Presence and coverage of invasive species

C. Potential Planting Conflicts and Constraints
The third part of the URSA form evaluates whether special site preparation, planting or maintenance techniques will be needed to address site constraints. In addition, potential conflicts that might reduce the space available at the planting site are explored. Field crews record the following data at each reforestation site:

Space limitations
- Presence of underground or overhead utilities
- Adjacent pavement and structures
- Overhead signs and lighting
- Required setbacks in local ordinances

Other site constraints
- Trash and dumping to be removed
- Deer browsing or beaver activity
- Excessive storm water runoff or concentrated flow
- Potential mowing conflicts
- Wetland status
- Pedestrian or vehicular traffic

D. Planting and Maintenance Logistics at the Site
The fourth part of the URSA evaluates logistical factors that may influence tree survival and future maintenance needs. Crews check out several important factors, including:

- Access to the site
- Presence of water source
- Party responsible for maintenance

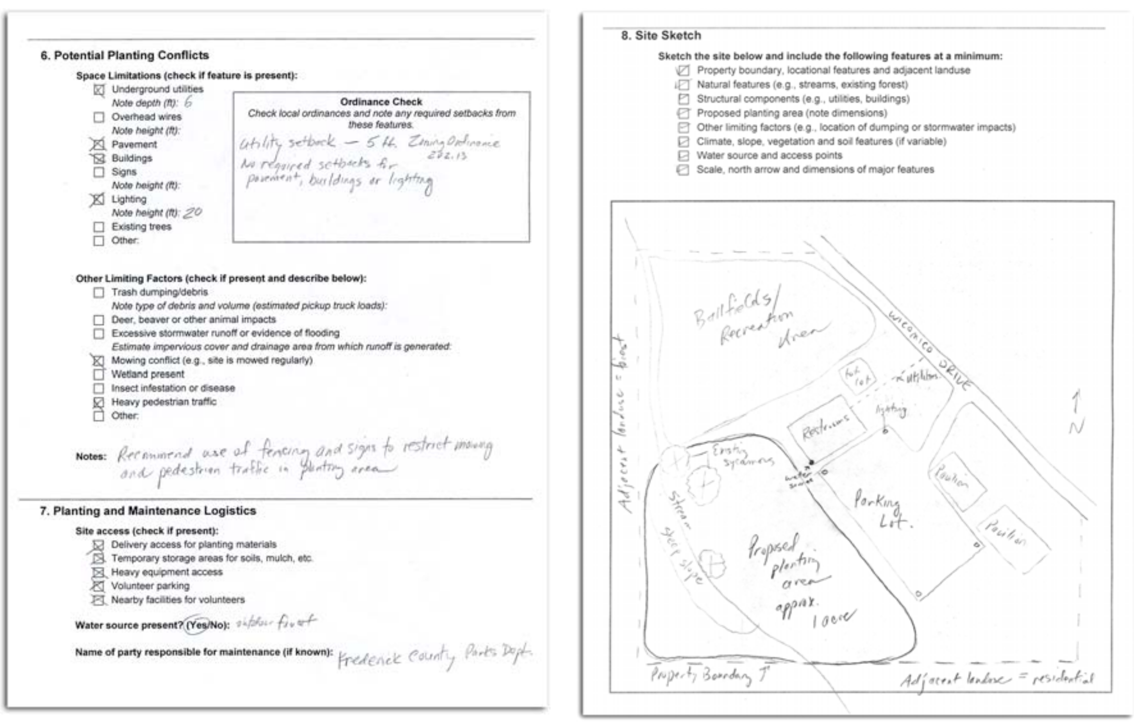
E. Sketch of the Planting Site
The last part of the URSA form consists of an initial sketch showing the layout and approximate size of planting site. The crew sketches the following features.

- Property lines, locational features and adjacent land use
- Scale, North arrow and dimensions of major features
- Natural features
- Water source and access points
- Structures (Buildings, utilities, roads, parking lots, etc.)
- Proposed planting area and dimensions
- Variability in growing conditions at the site (e.g., climate, topography, soils and vegetation)

The data collected during an URSA provides sufficient information to prepare a detailed planting plan for the site including:

- Number, size, and location of selected species to be planted
- Planting and initial maintenance schedule
- Any site preparation needs
- Estimated total planting cost
- Long term vegetation management plan

Cappiella *et al.* (2005b) provides further guidance on the field methods to conduct an URSA, along with the field forms that can be adapted for local conditions. An example of an URSA worksheet is provided in Figure 16.



6. Potential Planting Conflicts

Space Limitations (check if feature is present):

- ☒ Underground utilities
  Note depth (ft): 6
- ☐ Overhead wires
  Note height (ft):
- ☒ Pavement
- ☒ Buildings
- ☐ Signs
  Note height (ft):
- ☒ Lighting
  Note height (ft): 20
- ☐ Existing trees
- ☐ Other:

Ordinance Check
Check local ordinances and note any required setbacks from these features.
Utility setback — 5 ft. Zoning Ordinance 2?2.13
No required setbacks for pavement, buildings or lighting

Other Limiting Factors (check if present and describe below):

- ☐ Trash dumping/debris
  Note type of debris and volume (estimated pickup truck loads):
- ☐ Deer, beaver or other animal impacts
- ☐ Excessive stormwater runoff or evidence of flooding
  Estimate impervious cover and drainage area from which runoff is generated:
- ☒ Mowing conflict (e.g., site is mowed regularly)
- ☐ Wetland present
- ☐ Insect infestation or disease
- ☒ Heavy pedestrian traffic
- ☐ Other:

Notes: Recommend use of fencing and signs to restrict mowing and pedestrian traffic in planting area

7. 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

Water source present? (Yes/No): outdoor faucet

Name of party responsible for maintenance (if known): Frederick County Parks Dept.

8. Site Sketch

Sketch the site below and include the following features at a minimum:

- ☑ Property boundary, locational features and adjacent landuse
- ☑ Natural features (e.g., streams, existing forest)
- ☑ Structural components (e.g., utilities, buildings)
- ☑ Proposed planting area (note dimensions)
- ☑ Other limiting factors (e.g., location of dumping or stormwater impacts)
- ☑ Climate, slope, vegetation and soil features (if variable)
- ☑ Water source and access points
- ☑ Scale, north arrow and dimensions of major features

Figure 16: Urban Reforestation Site Assessment Worksheet
The field sheet completed during an Urban Reforestation Site Assessment (above) was used to develop a more detailed concept design and implementation plan for reforestation at a county park.

4. Discharge Prevention Investigations

Discharge Prevention Investigations (DPI) involve three phases of field assessments to find suspect outfalls or discharges and track down and fix their specific source. The methods described here 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 can be found in Brown *et al.* (2004).

A. Find Suspect Outfalls in the Subwatershed
The first phase of a DPI seeks to find suspect outfalls in the subwatershed. Monitoring techniques used to isolate problem outfalls are illustrated in Figure 17. The first technique involves dry weather monitoring of in-stream indicators, such as ammonia or bacteria that signify the presence of a possible wastewater discharge. The second technique, known as an Outfall Reconnaissance Inventory (ORI), 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 ORI process is outlined in Brown *et al.* (2004), and a sample field form is shown in Figure 18.

B. Trace Problems Back up the Storm Drain Network
The second phase of a DPI traces the problem progressively up the storm drain network to find the likely discharge source. 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.

C. Isolate Specific Illicit Connections within the System
Once a discharge has been narrowed down to a specific pipe segment, the last phase of a DPI 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. More guidance on these methods can be found in Brown *et al.* (2004).

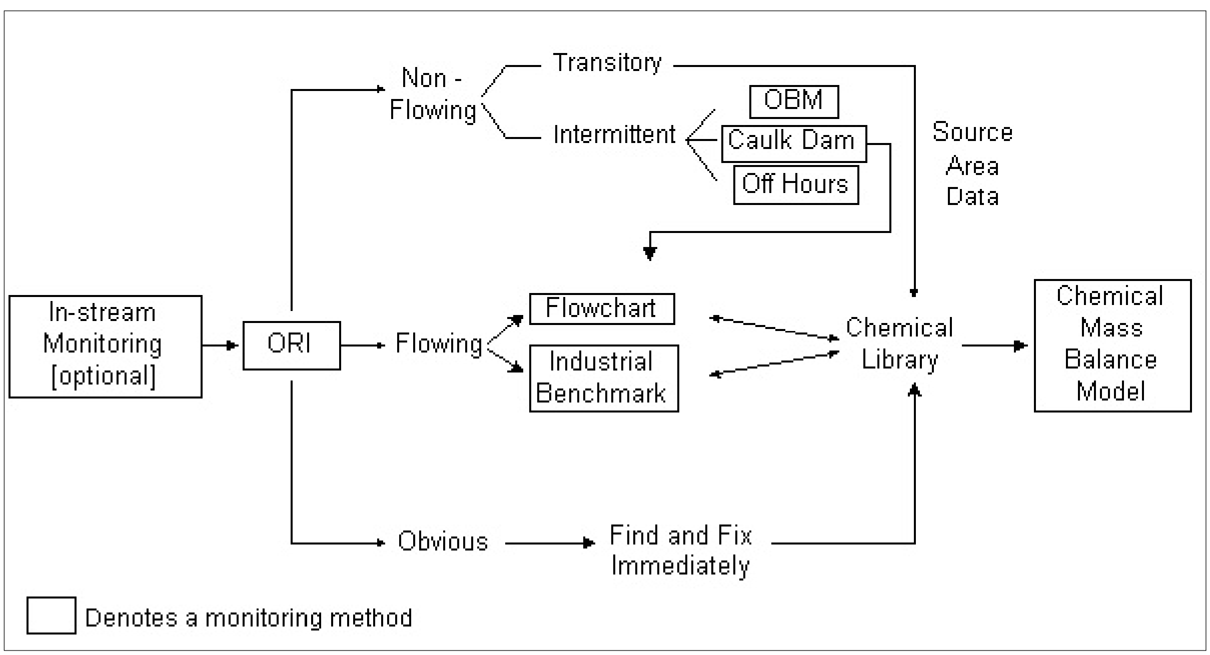


Figure 17: Monitoring Methods Involved in a Discharge Prevention Investigation

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	NONE
Deposits/Stains	☒	☐ Oily ☒ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	NONE
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	ODOR ASSOCIATED WITH CULVERT NOT OUTFALL
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	NONE

Section 6: Overall Outfall Characterization
☐ Unlikely ☐ Potential (presence of two or more indicators) ☒ Suspect (one or more indicators with a severity of 3) ☐ Obvious
AMMONIA HIT

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)?

Figure 18: Example of Outfall Reconnaissance Field Sheet

This excerpt shows how data is collected during the Outfall Reconnaissance Inventory in the Bronx River watershed, above, is used to identify the most severe problem outfalls in the area.

5. Hotspot Compliance Inspections

A hotspot compliance inspection (HCI) entails a more detailed examination of the sites designated as confirmed or severe storm water hotspots in the earlier USSR survey in the subwatershed (Manual 11; Figure 19). The HCI can be a voluntary business inspection or mandatory enforcement action, depending on the regulatory status of the site and the severity of the hotspot. Local enforcement staff should have full access to the site for the inspection and the owner/operator must be present. The three phases of the HCI are outlined below.

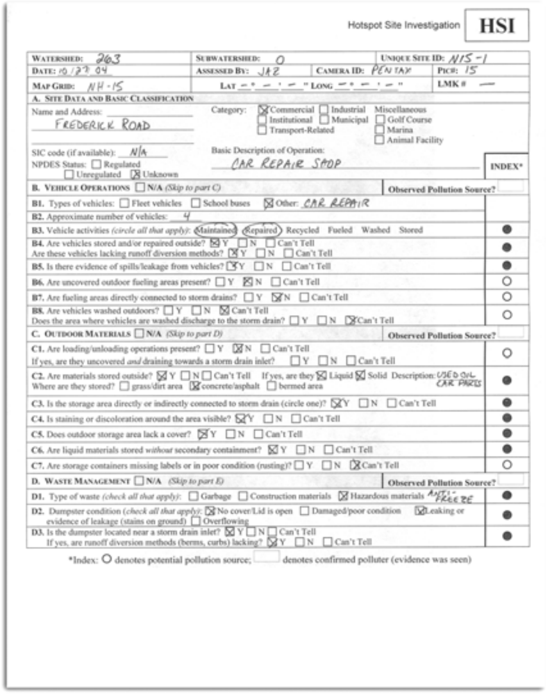
A. Evaluate Regulatory Status of the Site
The first phase of a HCI establishes the regulatory status of the hotspot site. Some hotspots are regulated under the EPA Industrial Storm Water NPDES program, and must file and maintain a storm water pollution prevention plan. Other businesses may be designated as hotspots under the municipal discharge prevention ordinance. In either case, the inspector should check records to determine if the operator has filed the requisite paperwork and is in compliance with their permit. Next, the owner or operator should be contacted to arrange a mutually convenient time for an on-site inspection.

B. Inspect Hotspot Using the HSI Form
The second phase of a HCI utilizes the Hotspot Site Investigation (HSI) to assess six potential operations at the site that may cause storm water quality problems at the site, including:

- Vehicle operations
- Outdoor materials
- Waste management practices
- Physical plant maintenance
- Turf/landscaping practices
- Condition of storm water infrastructure

Inspectors focus attention on specific pollution source areas and their connection to the storm drain system to determine the appropriate pollution prevention and storm water management practices needed to control pollutants at the site.

C. Recommend Pollution Prevention and On-site Retrofit Practices
In the last phase of the HCI, inspectors evaluate the adequacy of any pollution prevention practices currently used at the site, and recommend additional pollution prevention or on-site retrofit practices needed to control storm water runoff. Guidance on pollution prevention practices the design of on-site retrofit practices can be found in Manual 8 and 3, respectively. The inspector then presents the owner with a recommended (or required) plan for the site, and establishes a timetable for compliance, training and follow-up inspection.



Hotspot Site Investigation **HSI**

WATERSHED: 263 | SUBWATERSHED: O | UNIQUE SITE ID: N15-1
DATE: 10/27/04 | ASSESSED BY: JAZ | CAMERA ID: PENTAX | PIC#: 15
MAP GRID: NH-15 | LAT — ° — ' — " LONG — ° — ' — " | LMK # —

A. SITE DATA AND BASIC CLASSIFICATION

Name and Address: FREDERICK ROAD
Category: ☒ Commercial ☐ Industrial ☐ Institutional ☐ Municipal ☐ Transport-Related; Miscellaneous ☐ Golf Course ☐ Marina ☐ Animal Facility
SIC code (if available): N/A
NPDES Status: ☐ Regulated ☐ Unregulated ☒ Unknown
Basic Description of Operation: CAR REPAIR SHOP
INDEX*

B. VEHICLE OPERATIONS ☐ N/A *(Skip to part C)* — Observed Pollution Source?
B1. Types of vehicles: ☐ Fleet vehicles ☐ School buses ☒ Other: CAR REPAIR
B2. Approximate number of vehicles: 4
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: USED OIL CAR PARTS
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 ANTI-FREEZE ●
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 ●

*Index: ○ denotes potential pollution source; ☐ denotes confirmed polluter (evidence was seen)

Hotspot Site Investigation **HSI**

E. PHYSICAL PLANT ☐ N/A *(Skip to part F)* — Observed Pollution Source?
E1. Building: Approximate age: 50 yrs. Condition of surfaces: ☐ Clean ☐ Stained ☒ Dirty ☐ Damaged ○
Evidence that maintenance results in discharge to storm drains (staining/discoloration)? ☒ Y ☐ N ☐ Don't know ●
E2. Parking Lot: Approximate age ____ yrs. Condition: ☐ Clean ☐ Stained ☐ Dirty ☐ Breaking up N/A
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 N/A ○

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:

Figure 19: Hotspot Site Investigation

An auto repair shop was identified as a confirmed hotspot (above) during a Hotspot Site Investigation in Catchment O of Watershed 263. This led to a more detailed investigation of the site, and the development of a pollution prevention plan in partnership with the auto repair shop owner.

6. Natural Area Remnant Analyses

Natural area remnant sites can be quickly identified during the Pervious Area Assessment (PAA) of the USSR, but further investigations are often needed to assess their quality and function in order to better conserve, manage or restore them. Five different types of field methods may be used for this purpose. The resulting data help determine the current quality and restoration potential of remaining forest and wetland fragments in a subwatershed. In most cases, additional field studies are needed to derive a restoration plan for the natural area remnant. Table 20 provides website resources where more information can be accessed on each field method. The five types of natural area remnant analysis are discussed below. Figure 20 provides a sample map that was derived from data gathered during a wetland analysis.

A. Wetland Delineation
The first step in managing wetland remnants is to define their precise boundaries. Three field criteria are generally accepted as defining wetlands - hydrology, vegetation and the presence of hydric soils. All three criteria must be present to define a wetland, and specific indicators must be observed or inferred during the field investigation. More guidance on accepted wetland delineation methods can be found in Table 20.

B. Functional Wetland Evaluation
Most urban wetlands are impacted or disturbed to some degree, and may not be providing all of their original functions. Consequently, field surveys are used to evaluate wetland quality from a functional standpoint, which provides insight into the impacts that may be degrading it. More than a hundred wetland assessment procedures have been developed to identify and measure wetland functions, and several excellent reviews of these field methods are provided in Table 20.

C. Inventories of the Vegetative Community
These surveys profile the entire vegetative community within each natural area remnant. The survey begins by quantitatively mapping vegetation from aerial photos and then ground-truthing vegetation attributes for each remnant in the field. The final inventory lists the plant species present, defines community structure and locates plant communities or species that warrant further protection or restoration. Table 20 lists several methods for developing an inventory of the vegetative community to better manage natural area remnants.

D. Forest Stand Delineation
Forest fragments can be analyzed to determine their dominant species, age, structure and restoration needs. Most forest surveys are used to delineate stands, evaluate species composition and measure the average age and health of trees, understory species, canopy closure, and basal area. Several good field methods for assessing urban forest stands can be accessed from Table 20. Data from forest surveys structure can provide insights into the management needs of urban forest remnants.

E. Rare, Threatened and Endangered (RTE) Species Assessment
Some urban subwatersheds may still contain populations of plants and animals that are rare, threatened or endangered and merit protection under state or federal law. State and federal natural resource agencies maintain extensive databases that indicate the general historical distribution of RTE populations (Table 20). If consultations with resource agencies suggest the possibility that RTE species may be present, rapid field surveys are undertaken to find the locations and current condition of remaining populations in the subwatershed. The surveys sample specific habitat types or plant communities known to support the species. When RTE populations are found, they are verified in the field, fixed on the watershed-based GIS, and referred to the appropriate resource authority for immediate management.

Table 20: Links to Field Methods for Natural Area Remnant Analyses	
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

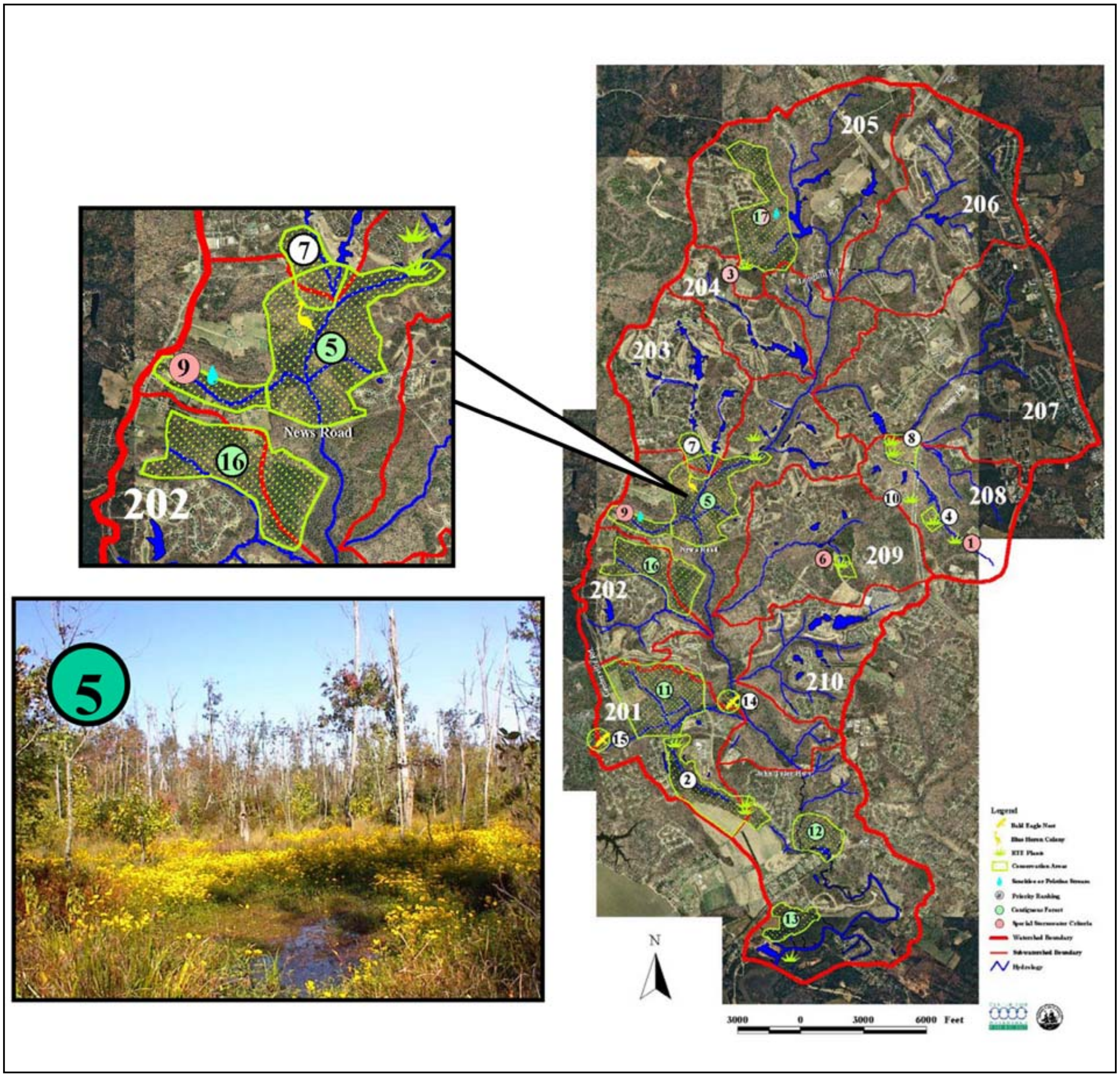


Figure 20: Natural Area Remnant Analysis for Powhatan Creek

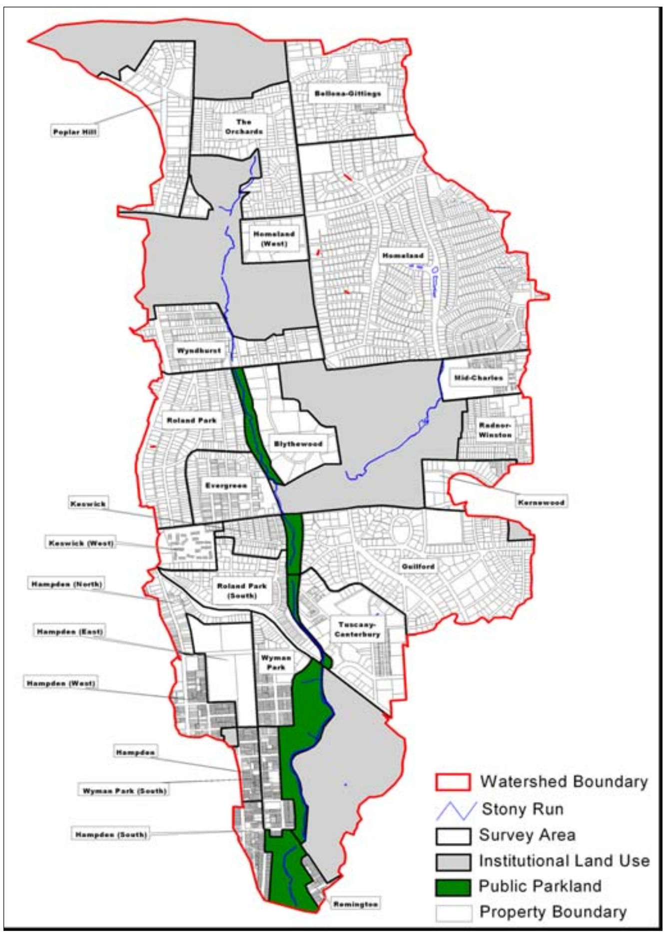
A natural areas assessment in the Powhatan Creek watershed examined wetlands; contiguous forest; and rare, threatened, and endangered species habitat. The wetland shown above, which was home to a heron rookery, was starting to show impacts from storm water runoff. (Sturm and Kitchell, 2001)

7. 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 ten basic steps involved in preparing an SCP are briefly summarized:

A. Select key pollutant of concern
B. Link pollutant to key subwatershed indicators
C. Locate specific pollutant source areas in the subwatershed
D. Identify and understand priority outreach targets
E. Develop overall source control strategy
F. Craft a clear and simple message
G. Select the most effective outreach techniques
H. Choose the mix of source control practices
I. Estimate subwatershed source control budget
J. Put together partnership to distribute practices

More guidance on the methods to prepare an SCP for a subwatershed can be found in Manual 8, and Figure 21 shows an example SCP map and summary table.



Neighborhood	Scoop the Poop	Rain Barrel Implementation	Convert Your Lawn	Use Fertilizers and Pesticides Wisely	Compost Your Kitchen and Yard Waste
Evergreen	✔	✔	✔		✔
Guilford	✔	✔	✔	✔	
Hampden (North)	✔		✔		
Hampden (South)	✔	✔			
Hampden (West)	✔		✔		
Homeland		✔	✔	✔	
Kernewood		✔	✔	✔	
Keswick	✔	✔	✔	✔	✔
Keswick (West)			✔	✔	
Mid-Charles		✔	✔	✔	✔
Poplar Hill		✔	✔	✔	
Remington	✔				
Roland Park		✔	✔	✔	
Roland Park (South)		✔	✔	✔	
The Orchards	✔	✔	✔	✔	
Tuscany- Canterbury			✔		✔
Wyman Park	✔	✔	✔		✔
Wyndhurst	✔	✔	✔	✔	✔

Figure 21: Source Control Plan – Stony Run

A Neighborhood Source Assessment was conducted in 24 neighborhoods in the Stony Run subwatershed with the goal of identifying residential pollutant source areas. Stewardship opportunities to reduce the pollutants of concern – primarily nutrients and bacteria – were identified. This information was used to develop education and outreach messages specific to each neighborhood (above). (Source: Zielinski, 2002)

8. Municipal Operations Analysis

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

A. Assess street sweeping feasibility
B. Assess catch basin cleanouts
C. Inspect municipal hotspot facilities
D. Review road maintenance practices
E. Review employee training
F. Investigate subwatershed sewage discharges
G. Assess pollution hotline reports and spill response
H. Identify existing municipal stewardship services
I. Analyze future subwatershed development
J. Inspect existing storm water treatment practices

Figure 22 shows the results of a streets and storm drains analysis that provided information on where additional street sweeping and catch basin cleanouts were needed. More detail on the specific assessment procedures for each of the 10 municipal operations is provided in Table 21.

Figure 22: Municipal Operations Analysis Example

A Streets and Storm Drains assessment was conducted in Catchment O of Watershed 263. Nearly two-thirds of the street curbs were found to be moderately to highly dirty and a similar number of catch basins were clogged or obstructed by sediment – suggesting significant opportunities for additional pollutant removal through expanded street sweeping and storm drain cleanout practices. (Source: Zielinski, 2005)

Table 21: Ten Components of a Municipal Operations Analysis (MOA)	
A. Assess street sweeping feasibility	• Evaluate current sweeping schedule and technology • Analyze USSR SSD data to compare relative pollutant accumulation in subwatershed streets • Evaluate on-street parking, traffic, street conditions and other sweeper effectiveness factors • Determine optimal sweeping routes and schedule • Calculate incremental cost for additional sweeping
B. Assess catch basin cleanout feasibility	• Evaluate current cleanout schedule and removal methods • Analyze USSR SSD data to compare relative pollutant accumulation in subwatershed catch basins • Evaluate access, traffic and other feasibility factors • Determine optimal cleanout schedule • Calculate incremental cost for additional cleanouts
C. Inspect municipal hotspot facilities	Determine if any municipal facilities are located in the subwatershed are regulated under NPDES storm water permits. All public golf courses, landfills, solid water facilities, school bus depots, public works yards, wastewater treatment plants and maintenance depots should be inspected to determine current compliance.
D. Review road maintenance practices	Interview transportation staff to determine current sanding and salting practices, review pesticide application and mowing practices in the right-of -way, and find out about any future road repair/widening projects in the subwatershed that may present opportunities for culvert repair/replacements or enhanced storm water management.
E. Review employee training in pollution prevention	Interview management at municipal facilities to determine the nature and frequency of any employee training on pollution prevention or other environmental topics, and whether it could be adapted to focus more on specific source control needs in the subwatershed.
F. Investigate subwatershed sewage discharges	Review maintenance records for sewer infrastructure in the subwatershed for patterns or clusters of sewage overflows, spills, leaks and other problems. Perform sewer inspections on problem lines, and inquire about future infiltration/inflow or sewer upgrade projects that could present opportunities for greater discharge prevention.
G. Assess pollution hotline reports and spill response	Assemble all local and state phone numbers the public can use to report erosion, spills, illegal dumping, sewer overflows, water main breaks, recycling, homeowner assistance, fish kills, flooding and other subwatershed problems. Determine if these can be integrated within a single pollution hotline number, and evaluate capability to respond to complaints in timely manner. Check current spill response capability with local emergency responders.
H. Identify existing municipal stewardship services	Check with local agencies as to the range of municipal stewardship services or programs currently being offered to residents in the subwatershed, such as storm drain stenciling, adopt a stream, citizen monitoring, household hazardous waste and used oil collection, lawn care and tree planting advice, and free compost. Assemble a resource directory and distribute to subwatershed residents.
I. Analyze future subwatershed development	Consult with local planning and zoning authority to see if any major public or private sector development projects are anticipated in the subwatershed in coming years, and what opportunities they present to implement restoration practices as part of the development/redevelopment approval process.
J. Inspect existing storm water treatment practices	Check to see the last time that major storm water treatment practices were inspected in the subwatershed. If more than three years, conduct rapid inspections to determine maintenance condition, and whether practice performance could be significantly enhanced through increased maintenance.

4.3 Managing Stakeholder Input

Early stakeholder involvement is essential when restoration projects are being investigated. The first stakeholder meeting is a chance to report on initial results and get feedback from the "night-timer" 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 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 meeting in advance
2. Conduct stakeholder meeting
3. Perform follow-up tasks after meeting

1. Prepare for meeting in advance

Most of the stakeholder meeting effort involves advance preparation. The core team needs to:

- Select the date and venue for the meeting
- Invite key stakeholders to participate
- Advertise the meeting to stakeholders using multiple outreach techniques
- Develop a tight and interesting agenda that explicitly provides time for stakeholder input
- Prepare condensed presentation materials for the meeting

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. Several approaches that work well include:

- Large, uncluttered subwatershed maps that show community landmarks
- Digital photos of stream problems from USA and USSR surveys
- Fact sheets that summarize key elements of the initial subwatershed strategy

2. Conduct stakeholder meeting

Numerous tips on running effective stakeholder meetings are provided in Profile Sheet S-4. 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:

- Who attended the meeting
- What action items were assigned (and who is responsible for completing them)
- When upcoming meetings are scheduled (and what issues will be discussed)
- What educational materials were requested (and how it will be distributed)
- When additional watershed events are planned
- What key stakeholder concerns were raised (and how they 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. E-mail is probably the least costly technique, but hard copies probably have a greater hit rate. A few random stakeholders should be contacted after the meeting to get their opinion on how future meetings could be improved.

4.4 Inventory of Restoration Opportunities

The management product for Step 4 is an inventory of all of feasible projects that could be applied to restore the subwatershed. Two tasks are used to assemble an inventory of restoration opportunities.

1. Assemble project concept designs into master binder or GIS
2. Produce subwatershed project locator map and overall summary table

More tips on putting together an inventory of restoration opportunities can be found in Profile Sheet M-4.

1. Assemble project concept designs into master binder or GIS

Project concept designs for all restoration projects are then assembled into a master binder that is organized into sections for each of the major restoration practice groups. A table is then created for each restoration practice section that summarizes the projects in terms of their ID number, cost, treated area and basic description. The table also serves as an index for each section, with individual projects listed in descending order based on treatment area or size. When completed, the master binder serves as the subwatershed project archive.

3. Produce subwatershed project locator map and overall summary table

The front-end of the restoration inventory should contain a subwatershed project locator map (Figure 23) and a summary table that compares project data across all seven major restoration practice groups. At this point, the inventory sufficiently organizes restoration project data to permit project evaluation and ranking needed for the subwatershed plan.

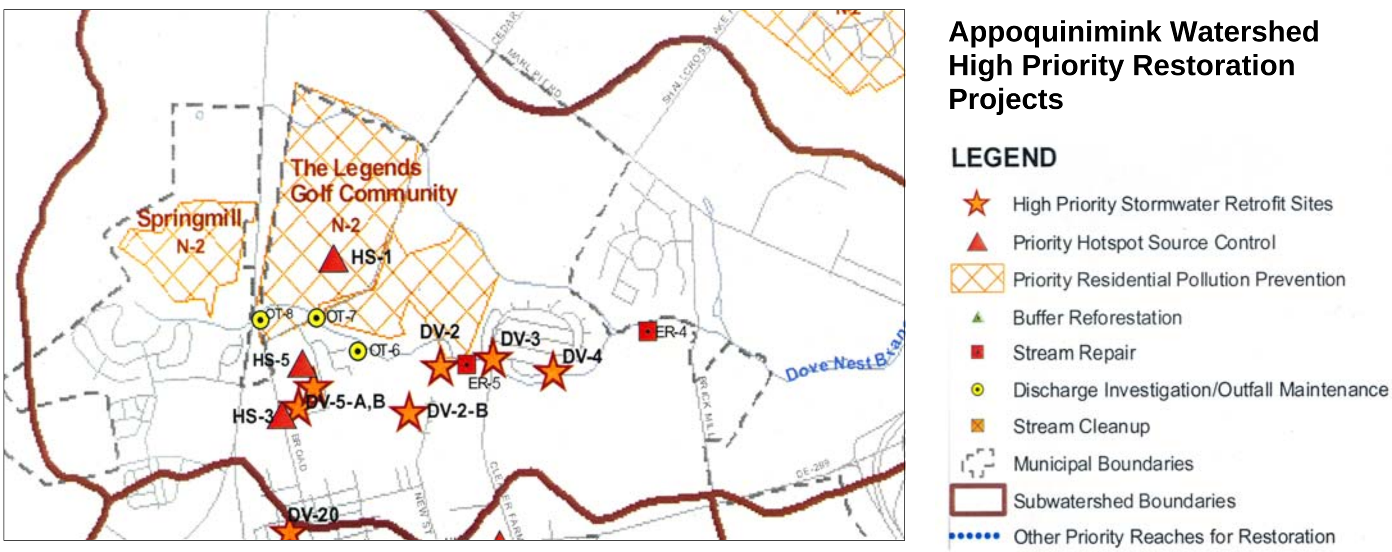


Figure 23: Dove Nest Branch Subwatershed Management Map

An inventory of stream repair and storm water retrofit opportunities was conducted in the Appoquinnimink watershed. In all, 54 candidate storm water retrofit sites were identified in the 6.5 square mile watershed (above), including 26 retrofits at storm drain outfalls, and 24 retrofits of existing dry ponds. Of the 54 original candidate sites, 17 were deemed infeasible or impractical based on field surveys. Also identified were 62 stream reach locations that were in need of stabilization or stream repair. (Source: Kitchell, 2005)

D-4	Desktop Analysis **Project Concept Design**	PCD

Purpose

The main purpose is to prepare simple concept designs for feasible restoration projects that have enough detail to permit their comparative evaluation at the subwatershed level. Each concept design includes a narrative and sketch showing the restoration approach, an analysis of key feasibility factors, and a planning-level cost estimate for the project.

Scale	Value
Project site or stream reach	Essential

Analysis Method

The precise steps for concept design depend on the type of restoration practice being considered. Most restoration practice concept designs are developed by performing the following six tasks in the office:

1. Review CPI data for subwatershed
2. Analyze available mapping at project sites
3. Decide on the type and extent of restoration treatment
4. Work up final concept and sketch
5. Develop initial cost estimate
6. Assemble concepts for entry into IRO

The specific procedures for developing concept designs for each of the seven types of restoration practices can be found in Table 18, with more documentation provided in Manuals 3 through 9, respectively.

Product

Each project concept design is usually only two to four pages long, including the form, plan view, sketch, narrative and digital photo, and is assigned a unique subwatershed and restoration practice ID.

Mapping Needs

More detailed mapping is often needed in this step to support the candidate project investigations in the field and then refine the feasibility concept designs. Key layers that bear on project feasibility include wetlands, finer scale topography (2 to 5 foot contours), storm drain maps, sewer maps, utilities and land ownership, among others. Specific GIS data layers recommended for both project concept design and candidate project investigations can be found in Appendix A.

Time Frame / Level of Effort

The level of effort to work up each project concept design depends on the type of restoration practice being investigated; some planning level estimates are provided in Table 19. Expect to spend up to 10 weeks of staff time to workup concept design for an entire subwatershed.

Further Resources

Guidance on project concept designs for each of the restoration practices can be found in Manuals 3 through 8.

D-4	Desktop Analysis **Project Concept Design**	**PCD**

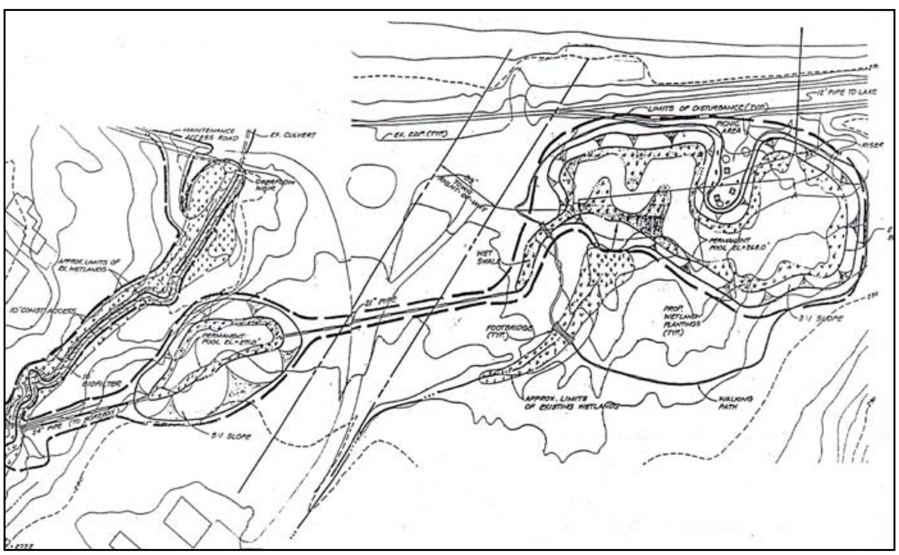
Tips for Developing Effective Project Concept Designs

- Final design for most restoration practices is very expensive, so there is little point to advancing toward final design until a project is determined to be effective, feasible and acceptable to the community.

- The core team sometimes get confused about how much detail is needed to support a concept design. In general, concept designs are expressed as a percentage of the total effort to get to final design.

  - "15% design" consists of a decent plan view sketch drawn to scale and including appropriate detail, an analysis of project feasibility, some approximate storage or treatment calculations, and a planning level cost-estimate. 15% design is appropriate for most restoration projects that are being investigated in this step.
  - "30% design" entails somewhat more detailed engineering design, and may include hydrologic and other modeling to determine the size and feasibility of the project. 30% design may be needed for larger or more complex storage retrofit and stream repair projects.
  - "100% design" involves final design calculations, engineering drawings, standard details, construction sequencing, permit approvals/conditions and bid documents. More detail on final design can be found in Profile Sheets D-7 and F-7.

- When it comes to concept design, invest more time on the largest projects that treat the greatest amount of subwatershed area or longest stream reach. Standard details can be used for the smaller restoration practices that are normally most numerous in the subwatershed.



An example of a project concept design for a proposed pond retrofit in Portland, ME

F-4

Field Assessment Method
Candidate Project Investigations

CPI

Purpose

These field investigations collect more information on the feasibility of potential restoration sites and develop a workable concept design. Most subwatersheds have many more potential restoration projects than available resources for either design or construction. This method helps narrow down the choices to a manageable level.

Scale	Value
Project site or stream reach	Essential

Basic Methods

Depending on the Initial Subwatershed Strategy, this may entail up to eight different site investigations:

- Retrofit Reconnaissance Inventory (RRI)
- Stream Repair Investigation (SRI)
- Urban Reforestation Site Assessment (URSA)
- Discharge Prevention Investigations (DPI)
- Hotspot Compliance Inspections (HCI)
- Natural Area Remnant Analysis (NARA)
- Source Control Plan (SCP)
- Municipal Operations Analysis (MOA)

Most of the investigations can be completed within two to six hours at the site, and are used to develop a basic concept design for feasible restoration projects.

Restoration Information

These investigations are used to develop the concept designs for restoration projects that are assembled into a subwatershed restoration inventory

Advanced Preparation

- Review locations of candidate sites from USA or USSR surveys
- Modify field forms as necessary
- Acquire any detailed mapping needed
- Train field crews on investigation methods

Data Management & Reporting

- Assign unique project ID number for every candidate site assessed
- Completed field forms, digital photos and notes are stored in a master binder
- Spot check entries on field forms for quality control
- Fill in blanks back in the office

Time Frame / Level of Effort

The cost to perform each CPI depends on the type of restoration practice being evaluated. Planning level estimates of staff effort needed for each of the eight candidate project investigations are provided in Table 19. Expect to spend at least three to seven weeks in the field, depending on the size of your subwatershed.

Further Resources

Chapter 4 of Manual 1 describes the general approach to envision restoration opportunities at the subwatershed level. The basic field methods to conduct each of the eight CPI surveys are detailed in Manual 3 through 9.

F-4

Field Assessment Method
Candidate Project Investigations

CPI

Tips for Conducting Effective Candidate Project Investigations

The ISS developed in the Step 3 outlines the type, number and locations of candidate sites that warrant further investigation. Most subwatersheds will possess dozens and even hundreds of candidate projects worth evaluating in the field.

Although not much time is needed to perform a CPI at each individual site (typically one to four hours, depending on the project type), the core team should collectively expect to devote several hundred hours to this important step in the subwatershed as a whole.

Crew leaders should plan efficient travel routes between sites so as to spend more time in the field and less time in transit.

Considerable field time can be saved by "pre-qualifying" sites through a desktop analysis of topographic and drainage system maps, as well as visual inspection of aerial photos. Establishing simple rules of thumb on the minimum available area needed for effective storm water treatment and the minimum feasible project area can help whittle down the master list of sites to a manageable number.

Manuals 3 through 9 contain helpful site assessment forms for each type of restoration practice investigation, as well as detailed guidance on how to train crews on how to accurately fill out the forms at each site.

Project investigations always involve a balance between creatively looking for opportunities to make a project work and keeping a careful eye out for constraints that would render it unfeasible. Crews should be trained to recognize the presence of wetlands, high quality forests and underground utilities in the field, and be able to read and fully understand topographic, storm drain and parcel maps.

It helps if at least one member of the crew has some prior experience in evaluating the type of restoration practice being investigated. They play a key role in training fellow crew members on the art and science of site investigation. The ultimate goal is to get all crews cross-trained so they can assess multiple restoration practices across a subwatershed.

A field crew investigates a candidate retrofit project in a Delaware subwatershed

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.

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).

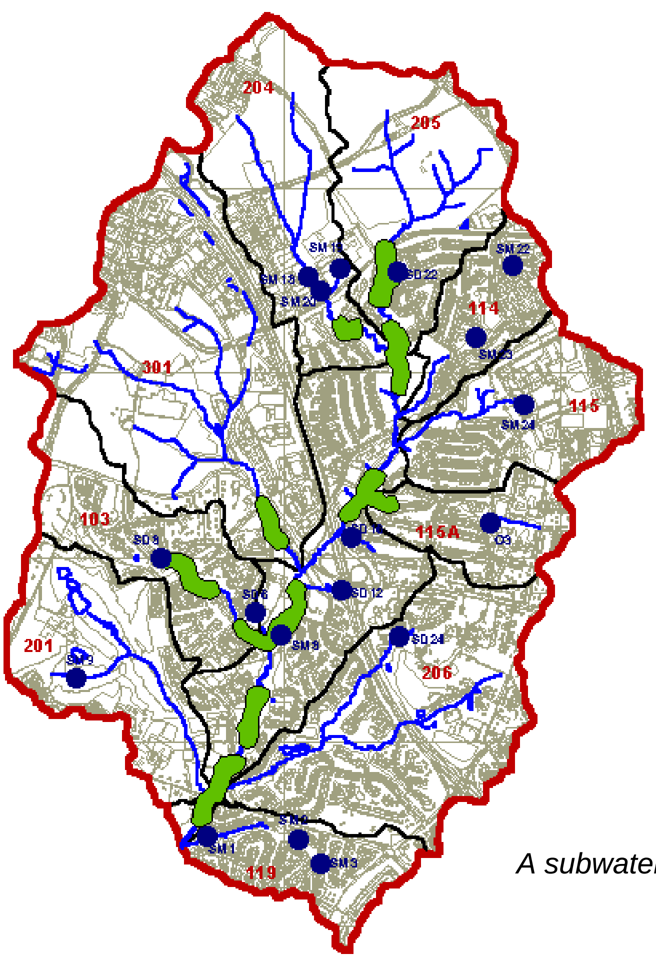
M-4	Management Methods to Get to Restoration Decisions **Inventory of Restoration Opportunities**	**IRO**

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

Chapter 5: Methods to Assemble Projects into Subwatershed Plans

<table>
<tr><th colspan="4">Step 5 AT-A-GLANCE</th></tr>
<tr><th>No.</th><th>ID</th><th>Name</th><th>How it Guides Restoration</th></tr>
<tr><td rowspan="2">D-5</td><td>PER</td><td>Project Evaluation and Ranking</td><td>Allows full range of restoration practices to be compared on a common basis to find the most cost effective and constructible projects in the subwatershed that will be priorities for implementation.</td></tr>
<tr><td colspan="3">1. Choose project screening factors, weighting and scoring rules
2. Score individual project concept designs and enter into spreadsheet
3. Run the spreadsheet to find projects with greatest aggregate score
4. Evaluate new project list to see if it meets subwatershed treatment criteria
5. Finalize project list and create subwatershed project map</td></tr>
<tr><td rowspan="2">S-5</td><td>NCM</td><td>Neighborhood Consultation Meetings</td><td>Provide opportunities to get feedback from neighbors and adjacent landowners on the acceptability of larger restoration projects.</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td rowspan="2">M-5</td><td>DSP</td><td>Draft Subwatershed Plan</td><td>Prepare a concise summary of the recommended restoration practices and programs needed for the subwatershed, along with budget, early action items, proposed partners and long-range funding.</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td colspan="4"></td></tr>
</table>

This step transforms the restoration inventory into a draft plan that recommends the most cost-effective group of restoration projects and programs for the subwatershed. Three methods are needed to put the final touches on the subwatershed plan

5.1 Project Evaluation and Ranking

This desktop method evaluates and ranks the entire range of projects and programs contained within the restoration inventory. Each project is ranked according to subwatershed area treated, cost, feasibility, environmental benefits, public acceptance and other key implementation factors. Project ranking is typically done through simple spreadsheet analysis, and the results are used to select the package of projects to take to final design and construction (Step 7).

Project ranking allows all restoration practices to be compared on a common basis to find the most cost-effective and buildable projects in the subwatershed. More than a dozen ranking factors can be easily derived from individual project concept design sheets. The exact ranking factors and their corresponding weights are unique in every subwatershed since they reflect different restoration goals and stakeholder preferences.

Five basic tasks are involved in project evaluation and ranking, as shown below:

1. Choose project screening factors, weighting and scoring rules
2. Score individual project concept designs and enter into spreadsheet
3. Run the spreadsheet to find projects with greatest aggregate score
4. Evaluate new project list to see if it meets subwatershed treatment criteria
5. Finalize project list and create subwatershed project map

More tips on how to evaluate and rank restoration projects at the subwatershed level can be found in Profile Sheet D-5.

1. Choose project screening factors, weighting and scoring rules

Restoration projects are ranked based on a series of screening factors that evaluate the treatment provided by the practice, as well as its comparative cost, feasibility, environmental benefits and community acceptance. Table 22 defines 15 different screening factors that have been used in project ranking, and presents guidance on how they can be defined and measured.

The core team begins by choosing the best combination of screening factors that can be easily derived from project concept designs. The screening factors chosen should allow a direct and fair comparison among all proposed restoration projects in the subwatershed. Next, the restoration team assigns a relative weight to each screening factor that reflects its perceived influence on restoration project success. The weighting normally assigns a variable number of points to each screening factor so that the maximum score of all factors together will total 100. Next, the core team analyzes the range of scores among all restoration projects to determine the scoring rules that will be used to award or deduct points from individual projects.

2. Score individual project concept designs and enter into spreadsheet

This task converts data from individual project concept design sheets into points for each screening factor, based on the scoring rules established previously. There are no hard and fast rules on how to score each project, since each choice basically represents an educated guess about project success. The best way to minimize the inherent subjectivity of scoring is to have several team members jointly involved in the scoring process and to review scoring decisions for consistency after all projects have been scored.

Table 22: Possible Screening Factors For Use in Project Ranking
Total Construction Cost: Cost is normally the most important screening factor and can be derived from preliminary cost estimates from each individual concept design. Restoration practices such as storm water retrofits and stream repairs consistently cost much more than other restoration practices, so it is often preferable to directly compare practices based on cost per unit treatment (see below).
Cost Per Treated Area: This screening factor expresses cost in terms of the acres or stream miles treated by a practice. All seven groups of restoration practices can be evaluated by the same basic factor: retrofits (drainage area treated), stream repairs (linear feet treated), discharge prevention (drainage area treated), riparian reforestation (acres planted), source controls (neighborhood /hotspot acres treated), watershed forestry (acres planted) and municipal operations (acres of road swept).
Cost Per Pollutant Removed: If water quality is a primary restoration goal, then it is a good idea to rank projects based on the relative cost to remove pollutants. This requires a little more analysis to compute loads using the Simple Method (Schueler, 1987) or the Watershed Treatment Model (see Section 6.1 of this manual) and then assess the expected pollutant removal rate for the practice. Reliable planning level estimates can be developed for retrofit practices using published storm water BMP removal rates (Winer, 2000), and some level of pollutant reduction can be indirectly inferred for most other restoration practices (Caraco, 2002).
Compatibility with Watershed Goals: This factor rates how well the proposed project conforms to the overall goals for watershed restoration. Maximum points are awarded for projects that directly support restoration goals (e.g., a fish barrier removal project in a watershed where salmon recovery is the objective). Fewer points are awarded to projects that only indirectly support watershed goal (e.g., a stream repair project in a watershed where pollution reduction is the primary goal). And, there always seem to be a few projects in the inventory that don't support watershed goals in any meaningful way.
Maintenance Burden: Restoration projects differ greatly in their long-term maintenance burden. The burden factor should not only estimate future maintenance costs but also whether a responsible party exists to do it. The long-term maintenance needs of each project should be assessed and points deducted if vegetation management, sediment removal and clogging are expected to be problems. Points may also be deducted if maintenance is not clearly vested with a responsible party.
Landowner Cooperation: This screening factor rates the willingness of private or public landowners to have the restoration project installed on their property. Points are deducted for projects where permission is uncertain, easements must be secured, or landowners are uncooperative.
Permitting Burden: Some restoration projects require as many as a dozen different permits and approvals before ground can be broken. In many cases, permitting agencies may require special studies, impose costly permit conditions, or disapprove the project altogether. Points are deducted for projects subject to multiple permits or a single difficult permit (e.g., 404 wetland). Local engineers who have experience working the permit process should be consulted to develop local scoring criteria.

Table 22 (continued): Possible Screening Factors For Use in Project Ranking
Interaction with Other Restoration Practices: This factor evaluates whether the project can be integrated with other restoration practices at the same site or stream reach to maximize restoration benefits. A classic example would be a storage retrofit located above a comprehensive stream repair project, which is adjacent to a riparian reforestation project. The benefit of the three projects combined together is presumably greater than the benefits of each one alone.
Neighborhood Acceptance: This factor ranks the community acceptance of the project based on feedback from neighborhood consultation meetings. Points are deducted for controversial projects, or for situations where concerns are raised about safety, forest loss, aesthetics, public access, construction noise and impact on property values. A project that scores a zero should probably be dropped from further consideration. Maximum points are awarded for projects that get enthusiastic neighborhood support and have prospects for actual community involvement during construction or maintenance.
Access: This factor assesses the ability to get heavy construction equipment to the site during installation, and later for any needed maintenance. Points are deducted for sites with steep or unstable side-slopes, where construction access disrupts neighbors, when significant tree clearing is required, when special erosion and sediment control requirements are triggered or when an access/maintenance easements must be secured from a private landowner.
Use of Innovative Practices: Some projects make more sense because they utilize an innovative practice or technology that has not yet been implemented in the community. These projects are often awarded extra points because of their demonstration value (although they also pose a higher inherent risk of failure if they have not been tested elsewhere).
Partnership Opportunities: This screening factor looks at the number of potential restoration partners (particularly landowners) that may be involved in project implementation. Projects with many partners or a new partner are normally awarded more points since they can leverage resources available for the project. Maximum points are awarded for projects with new landowner partners that may be willing to locate more practices on their land in the future and take a greater role in restoration and maintenance. An example would be the first restoration project installed on local parkland.
Public Visibility: This factor examines the visibility and potential demonstration value of a proposed site. Points are awarded for projects that have public access, experience heavy use, are linked to trails and bikeways or have opportunities for signage and education. Points are deducted for projects situated on private land, out of public view or have restricted or prohibited access.
Habitat Creation: This factor evaluates whether the project is likely to create new terrestrial or aquatic habitat features or connect existing habitat features. Maximum points are awarded for projects that emphasize wetland, vernal pool, forest and in-stream habitat creation.
Other Community Benefits: This screening factor is a grab bag of sorts and rates projects with respect to any additional community benefits they may provide. For example points may be awarded for projects that enhance recreation, increase land prices, improve education/interpretation, provide open space, trails or greenways, or revitalize neighborhoods.

3. Run the spreadsheet to find projects with greatest aggregate score

Scores from individual projects are then entered into a spreadsheet database to compute their aggregate scores and identify priority projects based on highest total scores. An example of this approach is provided in Table 23, which summarizes the comparative ranking of 18 different restoration practices in a subwatershed. Based on the ranking, only projects with an aggregate score of 55 or higher were recommended for implementation.

4. Evaluate new project list to see if it meets subwatershed treatment criteria

The individual scores for the highest scoring projects should be double-checked to look for hidden "project killers." 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 be impossible to build. Examples of a project killer might be a site with an unwilling landowner or poor neighborhood acceptance. Based on the final adjustments, the team may add or drop projects accordingly.

5. Finalize project list and create subwatershed project map

A final project priority list is then created after the last adjustments are made. The priority list is normally accompanied by a subwatershed management map, and both are included in the draft subwatershed plan. A short report may be written to describe the subwatershed PER process, with an emphasis on the assumptions made with respect to choosing, scoring and weighting project ranking factors. A sample project map that can be generated is shown in Figure 24.

Table 23: Example Project Ranking System

Project ID	**Watershed Goals** (20 pts)	**Owner Coop.** (10 pts)	**Integration** (5 pts)	**Community Acceptance** (10 pts)	**Long-Term Maintenance** (20 pts)	**Cost** (20 pts)	**Subwatershed Area Treated** (15 pts)	**Access** (10 pts)	**Total** (out of 100) [2]
RR-1[1]	15	10	2	10	15	15	3	10	**80**
SC-1	20	2	5	10	15	10	12	5	**79**
MO-1	15	8	3	10	16	8	8	10	**78**
RR-3	15	7	5	10	15	15	3	5	**75**
SC-3	20	3	5	0	15	10	14	5	**74 (D)**[3]
RR-2	15	9	5	9	10	12	2	10	**73**
SC-2	20	0	4	5	14	9	7	10	**69 (D)**
SW-1	15	10	4	5	7	5	5	10	**61**
WF-1	10	10	4	6	10	12	3	3	**58**
WF-2	10	5	2	10	5	11	7	5	**55**
DP-1	10	5	4	8	10	5	6	6	**54**
MO-2	15	3	0	8	10	10	3	5	**49**
SR-2	5	9	5	10	10	1	2	5	**46**
SR-1	5	10	4	3	10	5	3	3	**43**
DP-2	10	1	2	7	5	6	4	0	**35**
SW-2	5	6	5	0	5	2	9	3	**35**
DP-3	5	3	0	4	5	5	6	5	**33**
SR-3	5	7	2	0	3	4	2	2	**26**

1. Project IDs are Storm Water Retrofits (SW); Stream Repair (SR); Discharge Prevention (DP); Watershed Forestry (WF); Riparian Reforestation (RR); Source Control (SC); Municipal Operations (MO).
2. Shaded projects were recommended for implementation due to the aggregate score of 55+.
3. "D" in score indicates project dropped due to poor landowner cooperation or neighborhood acceptance

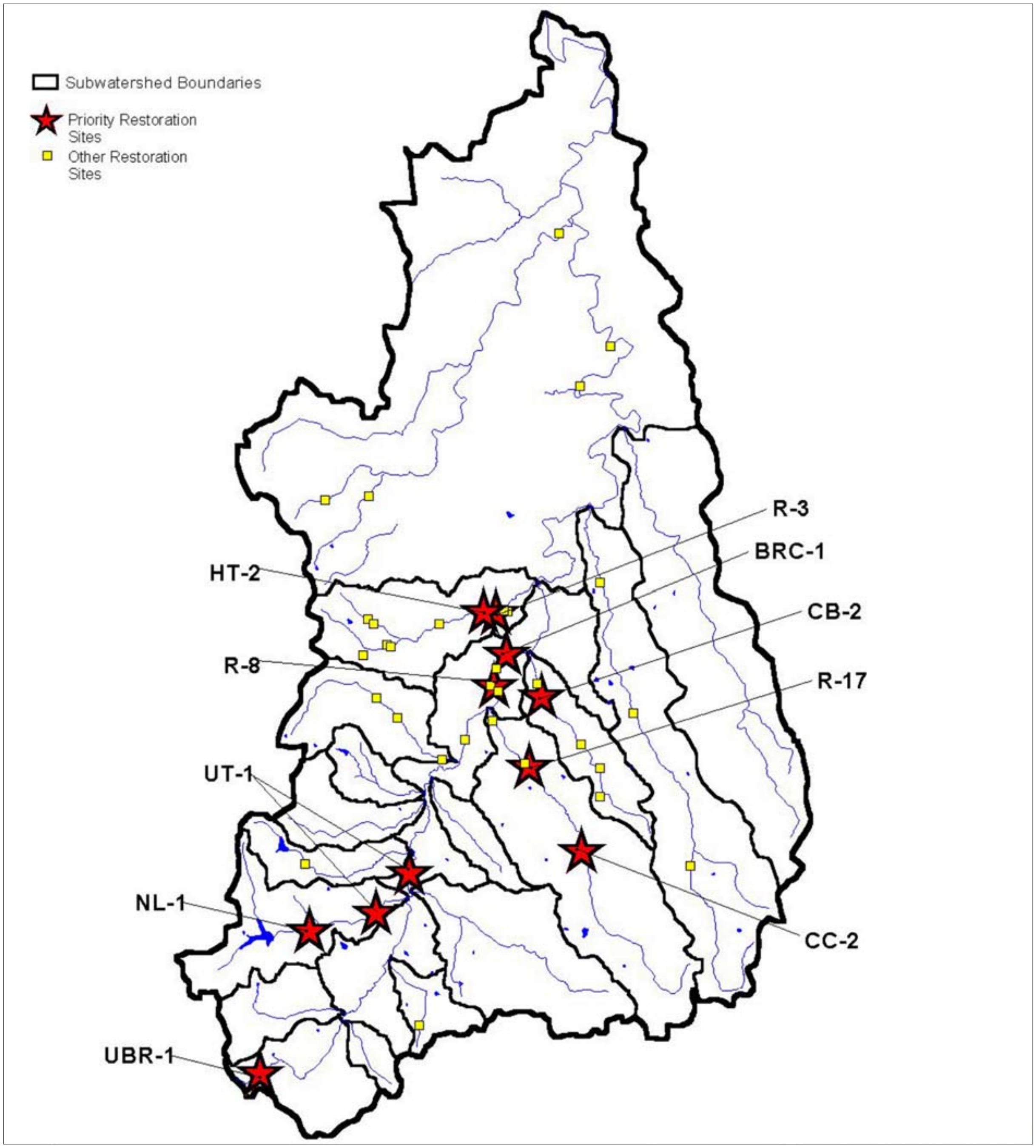


Figure 24: Big Rock Creek Priority Restoration Sites

The Big Rock Creek watershed plan identified 39 restoration projects, 10 of which were considered priorities. Priority restoration projects included riparian reforestation, stream repair, and storm water retrofits. (Source: Kitchell, 2003)

5.2 Neighborhood Consultation Meetings

Storm water 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 restoration 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 restoration projects, and are conducted in four tasks.

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 into PER

1. Define who is adjacent to the project

The core team should carefully consider how to define who is considered adjacent to each restoration project. In many cases, it is helpful to define specific boundaries of an "adjacent zone" of households or business that will be consulted. For example, the adjacent zone may consist of all homeowners within a particular neighborhood, all land owners within a thousand feet of the stream corridor, or all property owners that abut the project boundaries.

2. Notify every address within the boundary

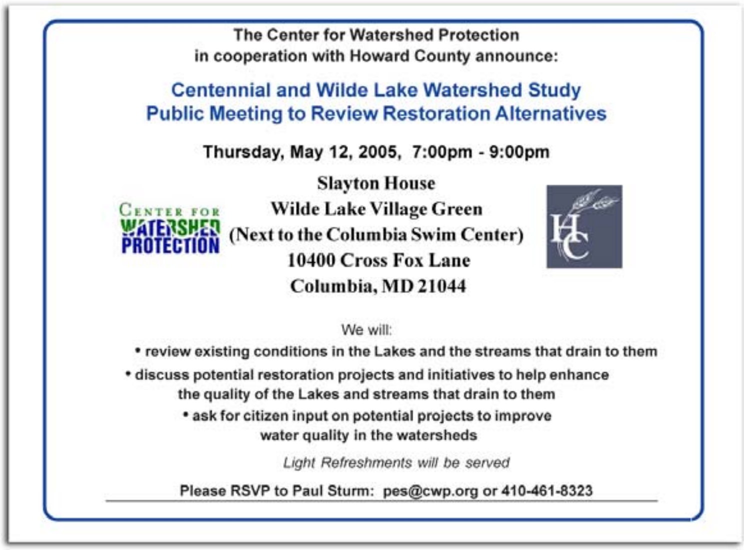
The goal is to notify everyone within the boundary about the proposed project and invite them to the neighborhood consultation meeting. Consequently, a combination of outreach techniques is needed to advertise neighborhood consultation meetings, including postcards or letters sent to affected homeowners and landowners (Figure 25), public displays, notices placed in community HOA newsletters, and posting of signs at proposed project locations.

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 exactly what is being proposed, what will happen during construction, and what the restoration project will look like when finished. Subwatershed maps, project renderings, and photos of similar restoration practices can all be used to show residents what the restoration product will look like. The meeting should also include a presentation on why restoration is needed and the planning process that led to the proposed project. Neighborhood meetings are also an excellent opportunity to educate residents about neighborhood pollution sources, stewardship practices and available municipal services. Most of all, the meeting should be structured to give adjacent residents the opportunity to voice their concerns, issues and questions about the project. Additional tips on conducting effective neighborhood consultation meetings can be found in Profile Sheet S-5.

4. Determine neighborhood acceptance and incorporate into PER

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 evaluation and 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, projects designs can be easily modified to satisfy neighborhood concerns, but if controversy continues, it may be necessary to drop the projects from further consideration.



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

Centennial and Wilde Lake Watershed Study
Public Meeting to Review Restoration Alternatives

Thursday, May 12, 2005, 7:00pm - 9:00pm

Slayton House
Wilde Lake Village Green
(Next to the Columbia Swim Center)
10400 Cross Fox Lane
Columbia, MD 21044

We will:

- review existing conditions in the Lakes and the streams that drain to them
- discuss potential restoration projects and initiatives to help enhance the quality of the Lakes and streams that drain to them
- ask for citizen input on potential projects to improve water quality in the watersheds

Light Refreshments will be served

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

Figure 25: Centennial and Wilde Lake Stakeholder Meeting Postcard Invitation

Neighborhood consultation meetings were held in the Centennial and Wilde Lake watersheds to educate stakeholders on recommended restoration projects and receive input on priority projects.

5.3 Draft Subwatershed Plan

The product of Step 5 is a short and concise subwatershed plan that recommends specific restoration projects and programs to be implemented, along with a subwatershed management map. Good subwatershed plans need not 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” for the recommended combination of restoration projects. The draft plan is synthesized directly from project evaluation and ranking (PER) and neighborhood consultation meetings (NCM). Five basic tasks are used to write an effective subwatershed plan:

- Draft an outline for the plan
- Define subwatershed objectives
- Identify early action commitments
- Develop project implementation matrix
- Prepare technical appendices supporting the plan

Additional tips on drafting a subwatershed plan can be found in Profile Sheet M-5.

1. Draft an outline for the plan

The main body of a good subwatershed plan should be no more than 20 to 40 pages long, with a matrix of key project recommendations and a subwatershed map showing their locations. The extensive supporting data produced in earlier steps should be consigned to technical appendices, preferably in a second volume. Table 24 recommends a standard table of contents for a subwatershed plan that organizes restoration information into a relatively condensed format. The core team should carefully review the draft plan outline to make sure it only contains the most essential information needed to make good restoration decisions.

2. Define subwatershed objectives

The core team brainstorms together to define the specific restoration objectives that the plan is expected to accomplish. The team should try to define objectives that are clear, time-based and measurable.

3. Identify early action commitments

This task identifies early action commitments that can be completed within the first year of the plan. Early action consists of two groups of commitments. The first group is an initial set of restoration projects that can be implemented within the next 12 months. These projects are generally low cost, involve restoration partners, and require relatively minor design and permitting. Examples include reforestation projects, changes in municipal operations, neighborhood stewardship and pollution prevention practices. The second group consists of priority restoration projects will undergo final design and permitting in the first year (with actual construction occurring in subsequent years). The team should identify a handful of priority storage retrofit, stream repair and other more complex projects to begin the process of final design and permitting.

Table 24: Standard Table of Contents for a Subwatershed Plan

Body of Report

1. Executive Plan Summary (5 pages)
    - List of early action items
    - Project implementation matrix
    - Subwatershed project map
    - One year and five year implementation budget

2. Review of Watershed Goals and Objectives (one page)

3. Subwatershed Restoration Strategy (5 to 10 pages)
    - Key problems and impairments impacts discovered during USA and USSR surveys
    - List of subwatershed restoration objectives
    - Review of restoration practices to be used
    - Selection of indicators to measure progress
    - Long term sentinel or performance monitoring plan
    - Implementation funding strategy and sources

4. Partners and Stakeholders Involved in the Planning Process (3 pages)
    - List of participants
    - Key outcomes of stakeholder and neighborhood meetings

5. Implementation Strategy for Priority Restoration Projects (10 to 25 pages)
    - Brief summary of each priority project, including description, cost, funding source, proposed phasing for design and construction, etc. This is the longer version of the project implementation matrix contained in the executive summary.

Technical Appendices

A. Memo outlining elements of Initial Subwatershed Strategy
B. Summary table of Subwatershed Restoration Inventory
C. Memo outlining methods for Project Evaluation and Ranking
D. Memo outlining findings of Subwatershed Treatment Analysis
E. Summaries of Subwatershed Stakeholder and Neighborhood Consultation Meetings

4. Develop project implementation strategy

The "guts" of a subwatershed plan is the project implementation strategy that outlines the proposed year-by-year phasing of design, construction, and monitoring of priority restoration projects. The strategy is often expressed in matrix format that contains detailed project information on where each project will be constructed, who will manage the project, when design will start, how long it will take to get to construction, and how much it will cost to design and build. The matrix should identify early action items in the first year, followed by annual summaries for the next five years showing how the remaining restoration projects will be phased. The project implementation strategy allows the core team to estimate annual implementation budget over the first five to seven years of the plan.

5. Prepare technical appendices supporting the plan

The last task 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 these technical details. As shown in Table 24, many products and memos produced in earlier steps can be directly inserted as appendices with little or no modification. Figure 26 illustrates the size differences between the "guts" of the plan (left) that can be provided to watershed stakeholders and a larger plan that includes appendices consisting of memos produced during the restoration process (right).

Figure 26: Which watershed plan would you rather read?

D-5	Desktop Analysis **Project Evaluation and Ranking**	PER

Purpose

This method is used to determine which combination of projects in the restoration inventory should be priorities for implementation and involves a comprehensive evaluation and ranking of all restoration projects and programs identified for the subwatershed.

Scale	Value
Subwatershed-wide	Essential

Analysis Method

Five tasks are involved in project evaluation and ranking:

1. Choose project screening factors, weighting and scoring rules
2. Score individual project concept designs and enter into spreadsheet
3. Run the spreadsheet to find projects with greatest aggregate score
4. Evaluate new project list to see if it meets subwatershed treatment criteria
5. Finalize project list and create subwatershed project map

Product

It is often helpful to outline the results of the spreadsheet analysis and its underlying scoring assumptions as a technical appendix to the draft subwatershed plan.

Mapping Needs

A simple subwatershed map showing the location and treatment areas of individual projects can be helpful in the project ranking process.

Level of Effort/Cost

The evaluation and ranking process is fairly straightforward once the project screening factors are chosen - plan on one week for a typical subwatershed.

Tips for Ranking Restoration Projects

- One of the key decisions in project ranking is whether to evaluate restoration practices within the same group (e.g., storm water retrofits) or evaluate all seven groups of practices together. There are pros and cons to each approach. In general, it is preferable to assess all groups of restoration practices at the same time, as long as the ranking factors are compatible among the groups.

- Comparing riparian reforestation to source control programs may seem like comparing apples to oranges, however, because these projects are all directly related to stream health, project ranking can be relatively straight forward.

- Let stakeholders participate in the selection and weighting of project screening factors.

- The most important screening factor is the degree to which the project meets watershed goals, followed by the cost per treated area.

- If water quality improvement is the goal, consider ranking factors that estimate how the project reduces pollutant loads (e.g., pounds of phosphorus reduced).

D-5	Desktop Analysis **Project Evaluation and Ranking**	**PER**

Tips for Ranking Restoration Projects

- Ranking systems are inherently subjective and can be easily modified to reflect specific "hot buttons" within a particular community. The core team should document the rationale for selecting ranking factors and their corresponding weights.
- Putting all the candidate restoration sites on a single subwatershed map greatly assists the ranking process. Stakeholders can visibly assess individual project locations in relation to upstream and down stream conditions and proximity to other restoration projects.

Project prioritization is a delicate balance between opportunity and feasibility.

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.

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

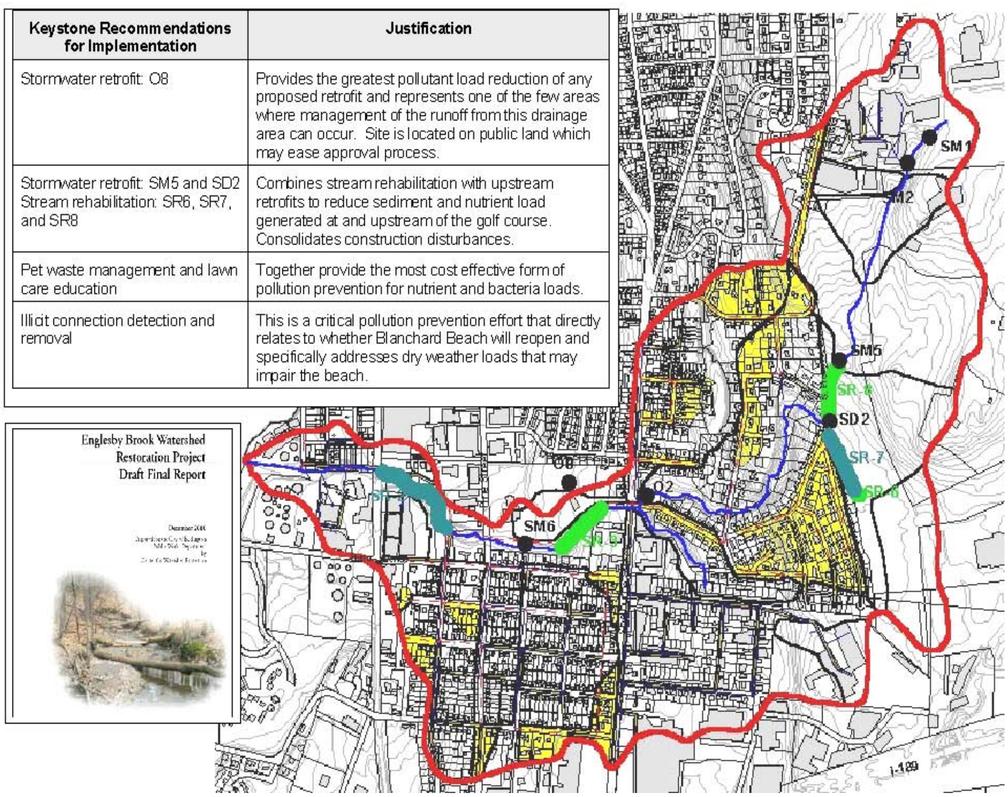
Tips for Drafting the Plan

- 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.

Chapter 6: Methods to Determine if Plan Meets Watershed Goals

STEP 6 AT-A-GLANCE			
No.	**ID**	**Name**	**How it Guides Restoration**
D-6	**STA**	**Subwatershed Treatment Analysis**	Evaluates whether the draft plan can achieve enough subwatershed treatment to meet goals and objectives and justify the community investment in restoration.
	1. Use Watershed Treatment Model or equivalent to estimate reductions in the pollutant of concern as a result of subwatershed treatment		
S-6	**EPR**	**External Plan Review**	Enable stakeholders to comment on the draft plan and request their support and endorsement to adopt the final 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		
M-6	**SIS**	**Subwatershed Implementation Strategy**	Decide how to navigate the plan through the local political and budget process and persuade key local decision-makers and partners to support plan adoption
	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		

This step is perhaps the most frequently overlooked one in the restoration process – determining whether or not the subwatershed plan can meet watershed goals and, if it does, how to ensure that support and funding will be available to implement it. Before proceeding with implementation, the degree of treatment should be estimated for the proposed combination of restoration projects to see if they are capable of meeting watershed goals (or whether more or fewer projects are needed). This step is known as a subwatershed treatment analysis (STA) and may involve the use of simple spreadsheet or more complex simulation models. Restoration projects may be re-prioritized or the subwatershed plan may need to be revised based on the STA. If the STA justifies the subwatershed plan, then the plan is sent out for external review and an implementation strategy is developed.

6.1 Subwatershed Treatment Analysis

It is important to clearly define the concept of subwatershed treatment at the outset. Treatment is defined as the proportion of the subwatershed area or stream corridor length that is effectively treated by restoration practices directly related to the primary restoration goal. In its simplest terms, treatment refers to the physical coverage of practices over the subwatershed. As an example, storm water retrofit treatment is defined as the fraction of subwatershed area (or impervious area) served if all proposed retrofits are built. Similarly, pollution source control treatment might be defined as the aggregate area of neighborhoods and individual hotspots targeted for pollution prevention practices.

The ability to predict the effect of subwatershed treatment depends on restoration goals and type of restoration practices proposed. Modeling works well in subwatersheds where flood or pollution reduction is the primary goal; but are less useful for assessing biological, habitat or community goals. Progress toward these goals can only be measured through sentinel monitoring.

While the extent of subwatershed treatment can be estimated for each kind of restoration practice, it is harder to model the collective impact of treatment on attaining specific watershed goals. Table 25 contrasts the ability to estimate the impact of subwatershed treatment for a range of restoration practices and watershed goals. As can be seen, models can estimate the impact of treatment for subwatershed hydrology and water quality. Fewer predictive models exist to estimate the impact of treatment if restoration goals are focused on improving habitat or aquatic biodiversity. In these situations, the relative prospects for success can be estimated simply by evaluating indirect metrics of subwatershed treatment.

When watershed restoration goals focus on hydrology or water quality, several models exist to estimate the treatment provided by restoration projects. This section describes two approaches to subwatershed treatment analysis:

- Spreadsheet Approach (Watershed Treatment Model)
- Simulation Model Approach (Various)

1. Spreadsheet Approach: The Watershed Treatment Model

The Watershed Treatment Model (WTM) developed by Caraco (2002) is a simple spreadsheet model that provides rapid, inexpensive and reasonably accurate estimates of subwatershed treatment for sediment, nutrients or bacteria. The WTM is an ideal tool for most subwatersheds, although more complex models may be warranted in some situations. The WTM spreadsheet (Version 3.1) is available for free download at http://www.stormwatercenter.net. A report documenting the assumptions incorporated into WTM and providing guidance for user input can be purchased electronically at http://www.cwp.org. The results and inputs from the WTM may be difficult to interpret without the accompanying documentation.

Table 25: Ability to Estimate Subwatershed Treatment				
Restoration Practice	Primary Restoration Goal			
	Hydrology	Water Quality	Biological	Community
Storm Water Retrofits	●	●	⦿	×
Stream Repairs	×	⦿	⦿	⦿
Riparian Management	×	○	⦿	⦿
Discharge Prevention	×	○	○	×
Watershed Forestry	⦿	⦿	⦿	⦿
Source Controls	×	⦿	×	⦿
Municipal Programs	×	⦿	×	⦿

Key
● Can be reliably modeled with WTM or simulation model
⦿ Inferred based on subwatershed treatment using WTM
○ Only determined by subwatershed monitoring
× Cannot be estimated or not applicable

The WTM quantifies the water quality benefits associated with a wide range of watershed restoration practices or "treatments." The WTM does not require expensive software and much of the needed input data should already have been gathered in preceding steps. The WTM can assess pollutant reduction or treatment for all restoration projects contained in the plan, or estimate pollutant reductions associated with a specific group of restoration practices (e.g., storm water retrofits). The WTM can also assess how pollutant loads change due to future growth in the subwatershed or widespread land cover change (e.g., converting turf to forest through watershed forestry).

The WTM has two basic components: pollutant sources and treatment options. The pollutant source component estimates subwatershed pollutant loads without any treatment. The treatment option component estimates how much the subwatershed load is reduced as a result of restoration practices or treatments. The WTM incorporates many simplifying assumptions that allow the user to assess various pollution sources and restoration practices that are not normally accounted for in more complex simulation models. Several caveats, however, should be kept in mind when applying the model.

The WTM:
- is not a predictive model (estimates annual load and not instantaneous concentrations)
- relies heavily on user input
- uses many defaults values (which can and should be overridden if local data is available)
- requires careful estimation of treatment and discount factors
- can currently only track sediment, nutrients, and bacteria

Pollutant Sources
The WTM predicts annual pollutant loads from primary and secondary sources of pollution. Primary sources include storm water runoff loads generated from general land use categories, as well as atmospheric deposition of pollutants over open water. Land cover data is input to WTM as the aggregate land acreage derived from the watershed-based GIS (Figure 27).

Secondary sources are pollutant sources dispersed through the subwatershed whose loading cannot be directly estimated from land use data. However, input data needed to estimate secondary sources can be derived from earlier steps of the restoration process.

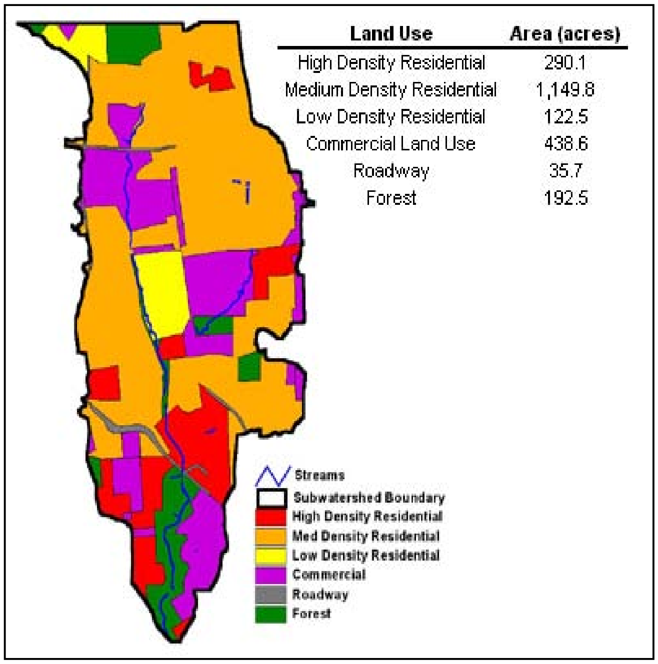
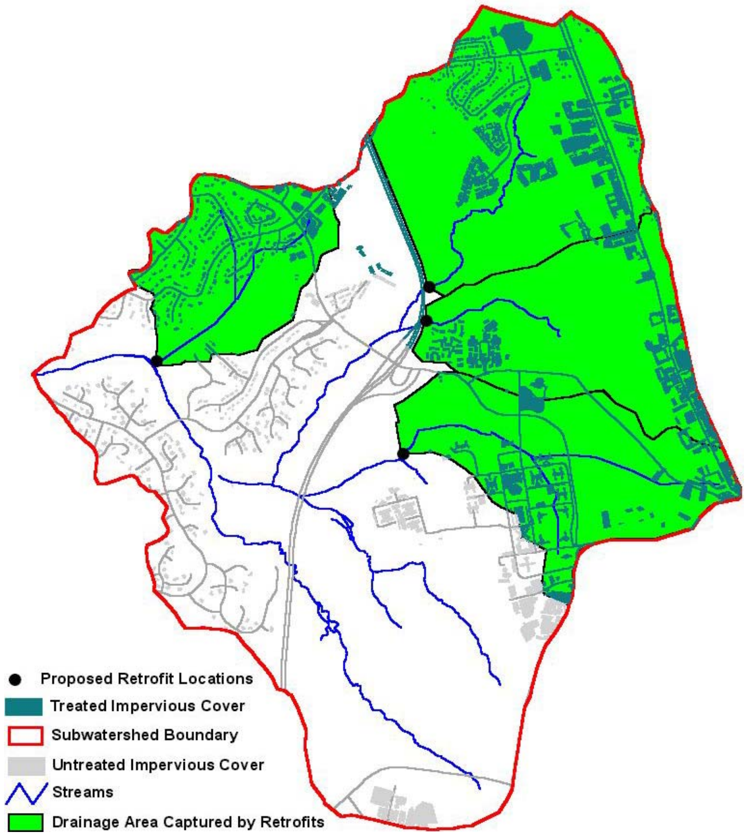


Figure 27: Land Use Data Derived From GIS

Treatment Options
The treatment component assesses the ability of current or proposed treatment options in a subwatershed to reduce the uncontrolled pollutant loads from primary and secondary sources (Table 26). A unique feature of the WTM is the inclusion of "treatability" and "discount" factors. The WTM assesses treatment achieved by applying a practice removal rate for the treatable load, and then adjusting, or discounting, the total treatment achieved to reflect the projected level of subwatershed implementation.

Treatability refers the fraction of a pollution source that can be treated by a practice. For storage retrofits, treatability is defined as the total contributing area treated by the practice as shown in Figure 28. For education programs, it may reflect the fraction of the population that can be reached. Discount factors are applied to potential load reductions to account for imperfect practice application and upkeep, inability of educational programs to reach all citizens, and inadequate funding to implement all practices, to name a few.

Reasonable estimates can be produced for restoration practices that are linked to the storm or sanitary sewer network (e.g., storm water retrofit ponds, on-site retrofits, discharge controls, street sweeping, storm drain inlet clean outs). Ballpark estimates can be derived for restoration practices that involve a major change in land cover or land use (e.g., watershed reforestation, elimination of a storm water hotspot, land reclamation, or impervious cover reduction) or construction of a large project (e.g., wetland restoration). Table 27 shows the range of restoration treatments that can potentially be assessed by the WTM, along with a general indication of the reliability of the estimate.



To reduce phosphorus loads, a community plans on retrofitting a 4.5 square mile subwatershed with four storm water ponds. The proposed storm water ponds will capture drainage from 1,375 acres, which includes 60% of the subwatershed's total impervious cover. The subwatershed was largely developed without any storm water management practices. The potential total phosphorus removal efficiency (E) for the ponds is initially estimated at 50%, based on national review of pollutant removal performance

Treatability and discount factors help determine the degree of subwatershed treatment:

***Treatability (T)** is the fraction of subwatershed impervious cover captured by storm water retrofits. The retrofit inventory indicates the four storm water ponds will capture drainage from 60% of the subwatershed's total impervious cover, which means T = 0.6.*

***The Capture Discount (D1)** is the fraction of the annual runoff volume treated by the practice. The retrofit ponds are designed to treat the runoff from a half-inch rainfall, which will captures roughly 70% of the annual runoff volume, which means D1 = 0.7.*

***The Design Discount (D2)** accounts for reductions in pollutant removal due to poor design or installation. The community has relatively good design and inspection requirements, but little prior retrofitting experience, so the design discount is modest D2 = 0.8*

***The Maintenance Discount (D3)** reflects the declining pollutant removal of the retrofits over time due to poor maintenance. Although the community will require regular maintenance for the retrofits, there is limited staff to ensure this occurs, so the maintenance discount is scored as D3 = 0.8*

Therefore, the subwatershed treatment efficiency for these retrofits is computed as:

(E) (T) (D1) (D2) (D3)

= (50%) (0.6) (0.7) (0.8) (0.8) = 26.7%
This means the proposed retrofits treatments are expected to reduce subwatershed phosphorus loads by 27%.

Figure 28: Retrofit Example Applications of Treatability and Discount Factors

Table 26: 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 • Sanitary Sewer Overflows • Combined Sewer Overflows • Illicit Connections	• Active Construction • Managed Turf • Channel Erosion • Hobby Farms/livestock • Marinas • NPDES dischargers

Table 27: Restoration Treatments Assessed by WTM, and Reliability of Estimate	
Storm Water Practices	**Reliability**
Storage Retrofits	●
On-Site Retrofits, including rooftop disconnection	●
Storm Water Treatment Practices for New Development	●
Stream Repair Practices	
Reduced Bank Erosion	◉
Riparian Management	
Riparian Reforestation	○
Floodplain Wetland Restoration	○
Discharge Prevention Practices	
Illicit Connection Removal	◉
Sanitary Sewer Overflow Abatement	●
Combined Sewer Overflows	◉
Marina Pumpouts	◉
Septic System Repair or Upgrades	◉
Improved Point Source Treatment	●
Watershed Forestry	
Soil Amendments/Land Reclamation	◉
Upland Reforestation	●
Impervious Cover Reduction	●
Pollution Source Control Practices	
Lawn Care Education	◉
Pet Waste Education	◉
Municipal Practices	
Street Sweeping	◉
Catch Basin Cleanouts	◉
Key ● *WTM provides reasonably accurate estimates of pollutant load reduction* ◉ *WTM provides indirect estimates of pollutant load reduction* ○ *Load reduction currently cannot be modeled in WTM*	

2. Simulation Models to Assess Subwatershed Treatment

Several useful simulation models are in the public domain, are reasonably well supported, and can be easily downloaded and used (see Table 28). A detailed discussion of their capabilities and limitations is beyond the scope of this manual, but for an excellent comparative review of watershed modeling tools, consult Shoemaker *et al.* (1997).

Most simulation models can produce reasonably accurate predictions of flow and pollutant loads, given precise input data on rainfall, land use and other subwatershed factors. Simulation models still have trouble directly estimating the impact of subwatershed treatment by many restoration practices. This is due to the fact that the change in hydrology and pollutant loadings attributable to restoration practices is poorly or indirectly understood (usually because of a lack of basic research on the performance of these practices). Consequently, even complex simulation models have a hard time predicting how restoration practices influence flows and pollutant loads at the subwatershed level (see Table 27). For example, the flow reduction or pollutant reduction benefits of stream restoration and riparian reforestation practices can only be inferred and not directly modeled at the present time. Few models can predict the impact of subwatershed treatment on biological indicators, such as fish and aquatic insects. Consequently, pre- and post-restoration monitoring is the only effective current strategy to evaluate treatment in subwatersheds where habitat and biological goals drive the restoration process.

Table 28: Other Models That Can Be Used For Subwatershed Treatment Analysis
SLAMM Source Loading and Assessment Management Model www.eng.ua/edu/~rpitt/SLAMMDETPOND/winSlamm/WINSLAMM.shtml • Continuous simulation of urban hydrology and water quality that takes a source area approach ideal for subwatersheds. Various SWT scenarios can be directly evaluated.
SWMM5 Storm Water Management Model www.epa.gov/ednnrmrl/swmm/index.htm • Continuous simulation of storm water hydrology and water quality, as well as sewers and combined sewer overflows. Can address most SWT scenarios.
HSPF Hydrologic Simulation Program-Fortran www.water.usgs.gov/software/surface_water.html • Continuous simulation of hydrology and water quality, with an emphasis on watershed land use. Analysis of SWT is cumbersome.
P8 Program for Predicting Polluting Particle Passage through Pits, Puddles and Ponds http://wwwalker.net/p8/ • Continuous or single event simulation of hydrology and water quality, that relies on NRCS curve number methods. Good capability to deal with structural SWT but not designed to assess soluble pollutants.
DR3M-QUAL Distributed Rainfall, Runoff and Routing Model www.water.usgs.gov/software/surface_water.html • Continuous or single event simulation of surface runoff and water quality designed for subwatersheds. Cannot simulate subsurface flow or sewers.
HMS and HEC-RAS Hydrologic Modeling System and River Assessment System HEC Hydrologic Engineering Center http://www.hec.usace.army.mil/ • Storm event simulation of surface runoff and channel hydraulics for flood management assessment. Cannot assess water quality. SWT restricted to flood reduction options.
Note: The models listed here are in the public domain and are supported to some degree by the sponsoring agency

6.2 External Plan Review

External review is an important ingredient of a restoration 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 restoration plan. While it may seem redundant to have yet another round of stakeholder involvement, it is inevitable that some important stakeholders slipped through the cracks that still want to provide input to the final plan. Their input is not merely editorial; stakeholders and partners are asked to endorse the plan and possibly even commit to specific early action projects. The goal of external plan review is to solidify support for restoration and identify and resolve any implementation issues that may arise. Successful external plan review helps demonstrate a broad community consensus for restoration, which is often essential to attract the political support needed to get reliable funding.

Four common tasks are involved in external plan review:

- Choose audience for external review
- Develop condensed plan summary
- Operate multiple processes to get plan feedback
- Provide timely revisions to plan

Each task is briefly reviewed below, and further tips in soliciting effective external plan review are provided in Profile Sheet S-6.

1. Choose audience for external review

The first task is to make strategic choices about who will be asked to provide external review, and what specific portions of the plan they will look at. While the plan should be distributed as widely as possible, each individual partner or stakeholder has different preferences or concerns about plan review. Some may want to comment on the technical details, others may want to revisit goals and objectives, and yet others are concerned about how the plan will impact them. Someone almost always finds something missing from the plan, and word-smithing and credit-mongering are also inevitable. In this task, the team targets the most critical partners and stakeholders that will influence implementation, and matches them to a specific review role that will hopefully lead to their ultimate endorsement of the plan. This approach, termed "segmented review" keeps the focus on the plan implementation.

2. Develop a condensed plan summary

The draft subwatershed plan produced in Step 5 is normally the basis for external plan review. Keep in mind, however, that thick restoration plans are intimidating to review, costly to distribute and require a lot of staff time to finalize, so the team should look for ways the plan can be decomposed to allow for segmented review, as described above (Figure 29). For example, some reviewers may just be sent the executive summary and project implementation matrix, others may receive the full plan (without the technical appendices) and others may get the full plan and supporting appendices. Some technical reviewers may be asked to focus their review only on the supporting technical material. All reviewers should be given the opportunity to access the entire plan and supporting documents, preferably by downloading them from the project website.

3. Operate multiple processes to solicit external feedback

The core team should consider several different processes to solicit external feedback on the plan, which can involve stakeholder meetings, written and verbal comments on hard copies of the plan, individual briefings with key partners, and website comments. By providing multiple review processes, the core team can meet the unique needs and preferences of the review audience. Some tips on effective methods to guide stakeholders through external plan review are provided in Profile Sheet S-6.

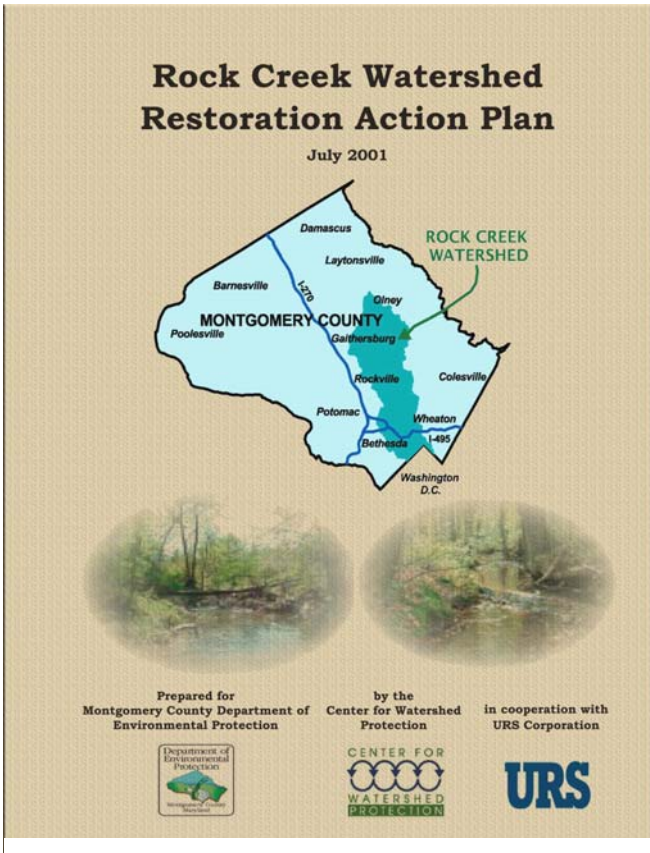


Figure 29: External Plan Review Example

The Rock Creek Watershed Restoration Action Plan, a 16-page condensed plan summary, was distributed to watershed stakeholders for external review (Cappiella, 2001).

4. Provide timely revisions to reflect feedback

Most subwatershed plans attract many comments of all kinds, and the real trick is to learn which ones are really worth addressing. As a general rule, the team should always respond to comments and commentators that most influence implementation and partner support for plan adoption. Each comment should be documented, as well as the manner with which it was dealt. Not all comments can be addressed in the final plan, but the team should notify the reviewer that they were treated seriously in either case. Reviewers should also be asked whether they want to be acknowledged in the final plan, and whether they are willing to formally endorse the plan. Once all comments are addressed, the plan can be finalized, and is ready to be formally adopted in Step 7.

6.3 Subwatershed Implementation Strategy

The decision in Step 6 is to agree on a strategy get the plan adopted, funded and implemented over time. The strategy requires a keen grasp of the local political landscape, partnership structure, and agency budgets. Communities that encounter problems during implementation often have not done enough homework on how to navigate the plan through the local political and budget process. The core team should consult closely with key advisors who understand local politics and the budgetary process. Key advisors include agency heads, staff to local elected officials, budget experts, major partners and others that have experience navigating through the local political and bureaucratic system. While every community will have a unique implementation strategy, most include six common elements:

- Investigate funding available for implementation
- Schedule realistic implementation time frame
- Establish restoration partnership structure
- Decide on early action commitments
- Determine minimum local budget needs
- Learn the local budget process and begin briefings
- More guidance on these important decisions is provided in Profile Sheet M-6.

1. Investigate funding strategies for implementation

The ultimate financing for restoration should be a diverse mix of local, state, federal and private funds, with the majority coming from local capital and operating budgets. The team should investigate both existing and new local funding sources, and look for supplemental state and federal grant funds as well. The funding strategy should ensure that year-to-year funding is available to support coordination and design, and that long-term funding is lined up for project construction.

2. Schedule realistic implementation time-frame

The next key decision is to agree on a proposed schedule for implementation. In most subwatersheds, the team will phase implementation over a five to seven year period. The team should consider whether they want to shoot for a long-term agreement to cover the entire period or split implementation into two or three shorter phases. The minimum goal for the first phase should always be enough funding to fully support all work through Step 7, construction of early action projects, and at least some additional restoration projects and monitoring. A sample implementation schedule is shown in Figure 30.

3. Establish restoration partnership structure

It is often a good idea to convene a core meeting of principals to determine if a formal multi-agency or multi-jurisdictional partnership would strengthen the chances of plan adoption. Clearly, some partners are more important than others, particularly if they can leverage multiple resources and funding sources. The existence of a restoration partnership is frequently an important selection factor for state and federal grant awards, and can persuade local authorities that the total restoration investment is being shared equitably among all parties.

4. Decide on early action commitments

Nothing promotes implementation better than implementation itself. The team should review the plan to find early action commitments that can be implemented in the first year of the plan that can show funders and elected officials that immediate progress is being made in restoration, and the plan will not sit on a shelf.

5. Learn the local budgetary process and begin briefings

The team should review the annual local budget process to determine how operating and capital funds can be accessed. Many communities cannot obligate operating funds beyond the fiscal year, although capital projects can be sequenced over multiple years. Local budget experts should be consulted to schedule the timing of budget briefings, and whether formal or informal action by elected officials is needed to adopt the plan and obligate funds.

Draft Appoquinimink Implementation Plan

Table E-5. Implementation Costs and Schedule

Recommendation	APCS Goal	Responsible Parties	Planning Level Costs* Short-term (year 1)	Mid-term (years 2-4)	Long-term (year 5+)*
1. Build capacity of watershed organization and coordinator	1,2,4,5	ARA	$15,000	$15,000 (@ $5,000/yr)	$5,000+
2. Hire part-time ESC/SWM inspector	4	NCC; M	$15,000	$45,000	$15,000+
3. Adopt local environmental protection ordinances†	10,13,14	M; T	$20,000-$60,000	--	--
4. Enhance stormwater criteria	10,13,14	M, NCC	$20,000	--	--
5. Adopt more stringent design standards for ESC practices	10	M, NCC	$20,000	--	--
6. Actively pursue land conservation	8	ARA; DDA; Land Trust	$5000 (identification)	Unknown	
7. Illicit discharge detection and elimination	11	ARA, M, NCC	$2400 (@ $400/site investigation) $1300 establish hotline	$4500 (@ $1500 annual hotline costs)	$1500+
8. Develop education program	1-3,10, 11	ARA	$15,000	$30,000 (@ $10,000/year)	$10,000+
9. Evaluate municipal programs/practices	--	NCCD; ARA; DelDOT; M	$15,000	--	--
10. Implement priority stream restoration	--	ARA; DNREC; NCC, M;	$10,000 (design of priority projects) $35,000 (repair DV-ER-4)	$260,000 (install DP-ER2/ -ER1;& DR-ER2/3) $6000 buffer (all projects)	$130,000 (install remaining)
11. Install priority stormwater retrofits	11,12	ARA; DNREC; NCC, M; DelDOT;	$25,000 (implement small demo project (DV-20 and DP-23 raingardens)	$25,000 (design & engineering) $475,000 (construct A1-2; DP-1; DP-8)	$820,000 (construct DV-2, DV-5)
12. Implement priority pollution prevention	1, 2, 11	ARA	Part of education program		
13. Monitoring and project tracking	3, 12, 23	DNREC; ARA; USGS	$6000 (10 bug stations @ $600/station) $500 (2 baseflow sites in high nuturient areas $20/sample/month) ††	$1200 (bugs year 2,4) $1500 (baseflow)	$6000+ (bugs) $500+ (baseflow)
14. Secure long-term funding	21	ARA; DNREC	Part of watershed group capacity funding		
Phase Totals			**$225,200**	**$873,200**	**$988,00**
Cumulative Total				**$1,098,400**	**$2,086,400**

* ARA=Appoquinimink River Association & watershed coordinator; DNREC=DE Dept of Natural Resources and Environmental Control; DelDOT= DE Dept of Transportation; DDA=DE Dept of Agriculture; NCC=New Castle County; M=Middletown; T=Townsend; USGS= US Geological Survey
** Light shading indicates ARA basic annual costs; darker shading indicates ARA lead in fundraising for short-term projects
† NCC and Odessa may also need to adopt/revise ordinances, however existing regulations for these jurisdictions were not evaluated as part of this work.
†† Baseflow monitoring costs are for analysis only. Note these costs do not include all recommended monitoring.

Figure 30: Appoquinimink Recommendation Matrix

An implementation schedule was developed upon completion of the Appoquinimink watershed plan. The schedule identified parties responsible for implementation, as well as estimated costs. (Source: Kitchell, 2005)

D-6	Desktop Analysis **Subwatershed Treatment Analysis**	**STA**

Purpose

Subwatershed treatment analysis examines the ability of the draft restoration plan to achieve levels of treatment needed to meet the watershed restoration goals. Often, the STA leads to revision of the draft plan by adding (or dropping) restoration projects.

Scale	Value
Subwatershed-wide	Helpful

Analysis Method

Two approaches can be used for subwatershed treatment analysis:

1. Spreadsheet Loading Models (Watershed Treatment Model)
2. Simulation Model

Product

The results of the STA can be summarized in charts, figures or tables that may be appended to the subwatershed plan. Remember that the product of the STA is a better combination of restoration projects and not a big thick report.

Mapping Needs

The WTM requires basic information on land use and land cover, as accurate estimates of the extent of subwatershed treatment collectively provided by the practices in the plan.

Other Data Needs

The WTM requires estimates of secondary pollutant sources, although in some cases default rates may be applied. Simulation models require a great deal more input data to operate, such as rainfall, soils, and pipe/channel dimensions. In addition, most simulation models require numerous model parameters to be estimated.

Level of Effort

A WTM can typically be performed on a subwatershed with one or two weeks of staff effort. Simulation modeling requires substantially more effort and cost, and may not produce results that are any more accurate than spreadsheet loading models.

Further Resources

- More details on the WTM are presented in Caraco (2002).
- Simulation Models described in Table 28 and Shoemaker *et al.* (1997).

Tips for Performing Useful Subwatershed Treatment Analysis

While subwatershed treatment analysis is helpful in forecasting the environmental benefits of restoration, modeling efforts can quickly expand in scope, cost and complexity, without necessarily producing any more useful management information. The following tips are recommended to strike an appropriate balance between thoroughness and speed, and primarily pertain to WTM modeling applications:

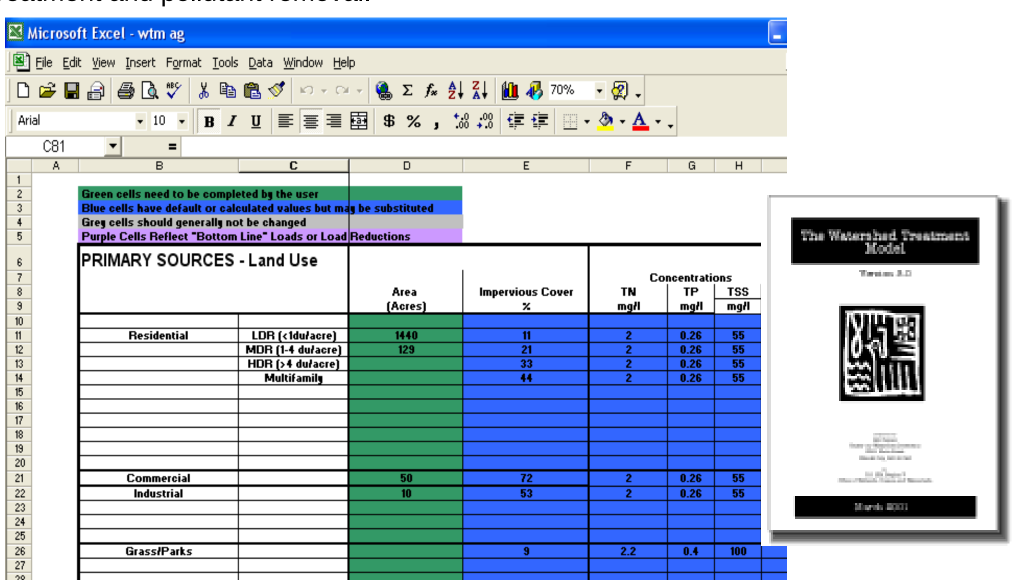
- Try to focus on just a few key pollutants of concern; not much extra information is produced when more than a handful of pollutants are analyzed.

- Phosphorus is often a good pollutant of concern, because there is usually quite a bit of available data on phosphorus loadings and removal rates. Phosphorus also behaves as an “average” pollutant since it is found in runoff as a composite of particulate and soluble forms.

D-6	Desktop Analysis **Subwatershed Treatment Analysis**	STA

Tips for Performing Useful Subwatershed Treatment Analysis

- If the subwatershed or its receiving water is listed by EPA or the state as not meeting water quality standards and is subject to a TMDL, then the listed pollutant(s) should automatically be selected as a pollutant of concern.
- Priority should always be given to acquiring the most recent and finest resolution land cover data available, since land cover is arguably the most important input parameter in subwatershed treatment analysis.
- Several good national and regional references exist to characterize regional storm water concentrations for different land uses and impervious cover, as well as expected removal rates from restoration practices. For example, Pitt *et al*. (2004) has produced a national storm water runoff quality database. Winer (2000) and ASCE (2004) have published average pollutant removal rates for a wide range of storm water and restoration practices.
- Pollutant loadings from secondary sources are much harder to quantify, but should never be neglected in subwatershed treatment analysis. Considerable detective work is needed to get decent estimates, and some degree of best professional judgment is almost always required.
- The precise degree of treatment and pollutant removal rates achieved by many types of restoration practices may be indirect, loosely defined or poorly understood. Many simplifying “ballpark” assumptions must be made in this accounting process. It’s OK to go out on a limb to come up with some initial estimates when deriving treatment and removal rates for a restoration practice, as long as the core team is conservative in its approach and documents all underlying assumptions.
- Some “discounts” should always be applied to removal rates to account for real world concerns about reduced practice performance due to bypass, poor installation and inadequate maintenance.
- It is usually a good idea to hire an independent expert to review the subwatershed treatment analysis. This person can check the realism of underlying technical assumptions about treatment and pollutant removal.



A sample WTM spreadsheet output

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.

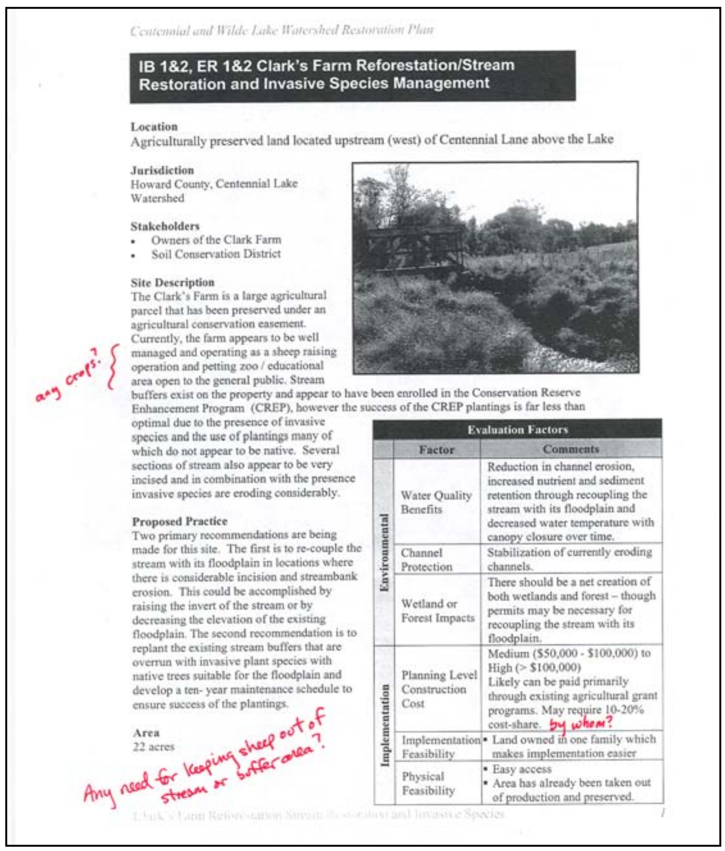
Level of Effort

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

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.

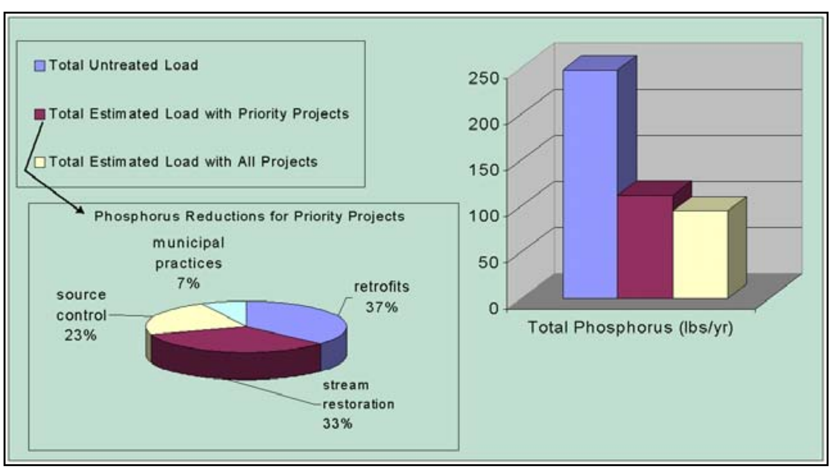
- The strategy should focus on how to pay for the delivery of multiple restoration projects in a relatively short time period. The future costs and staff effort needed to perform final design, permitting, construction, project management, monitoring, coordination and ongoing management will normally 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.

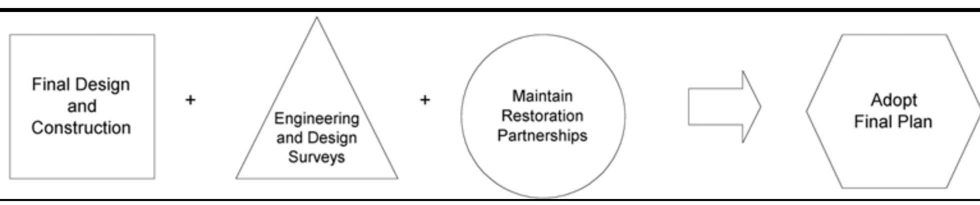
Real World Example

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).



Chapter 7: Methods to Implement the Plan

STEP 7: IMPLEMENT PLAN			
No.	**ID**	**Name**	**How it Guides Restoration**
D-7	**FDC**	**Final Design and Construction**	Assembles the final design, permit approvals, and bid package needed to construct individual restoration practices.
	1. Complete final design package 2. Assess permit needs and submit applications 3. Prepare planting plan 4. Prepare final cost estimates and bid documents 5. Secure easements and maintenance agreements 6. Conduct construction inspections 7. Accept project and enter into project tracking system		
F-7	**EDS**	**Engineering and Design Surveys**	Field surveys to acquire project data that directly supports final design, permitting and construction of individual restoration practices.
	1. Define nature and scope of pre-construction surveys 2. Define nature and scope of construction surveys 3. Incorporate surveys into final design and construction		
S-7	**MRP**	**Maintain Restoration Partnerships**	Organize stakeholders into a strong and broad coalition that can exert enough political force to get the plan adopted and funded.
	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		
M-7	**AFP**	**Adopt Final Plan**	Hammer out final implementation details and get elected officials to adopt the plan, and commit short- and long-term funds for implementation.
	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		



As the subwatershed 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 restoration projects and programs. Four methods are used to make sure restoration projects actually happen.

7.1 Final Design and Construction

The greatest expense in subwatershed restoration involves the final design, permitting and construction of individual restoration projects. The core restoration team should thoroughly assess all the tasks needed to actually make the restoration projects happen. Since many different projects and programs are typically applied in a subwatershed plan, the team should anticipate how to "deliver" restoration projects (i.e., how to sequence design, construction, inspection, maintenance and monitoring over time). In particular, the team should set a premium on getting the most accurate cost estimates possible, so that an overall implementation budget can be established and phased over time. Some surprises should always be expected during final design and construction, such as having projects drop out due to unforeseen feasibility and permit concerns.

Each type of restoration practice has its own unique considerations relating to design, permitting and construction. Table 29 summarizes common design and construction considerations associated with the seven types of restoration practices. The scope of final design depends on the size and complexity of the project, whether construction will be contracted, and whether any state or federal permits must be acquired. Six desktop tasks are involved in final design and construction of major restoration projects:

1. Complete final design package
2. Assess permit needs and submit applications
3. Prepare planting plan
4. Prepare final cost estimates and bid documents
5. Secure easements and maintenance agreements
6. Accept project and enter into project tracking system

Some of these tasks can be skipped for smaller restoration projects that are installed by volunteers and don't require many permits (e.g., early action projects). Further tips on managing the delivery of the design and construction of multiple restoration projects are offered in Profile Sheet D-7.

1. Complete final design package

The final design package should contain all the instructions needed to build an effective restoration practice, and provide enough information for plan reviewers to adequately review project impacts. The typical final design package contains the following information:

- Final engineering design for the project, including supporting computations, modeling and geotechnical data.
- Construction drawings and standard specifications that clearly illustrate how the project will be constructed (Figure 31).
- A sequence of construction, including any erosion and sediment control practices needed during construction, and boundaries that clearly define the limits of disturbance.
- A breakdown of the unit quantities of all the materials and activities needed to construct and maintain the project.

2. Assess project permit needs and submit applications

Designers should explore whether any permits are needed for individual restoration projects, which might involve wetland protection, forest conservation, fisheries, waterway construction, dam safety and many other concerns. When working in or near streams and wetlands, designers should arrange a pre-application field meeting with appropriate regulatory staff to get input on key permitting constraints and issues that need to be incorporated into the final design.

3. Prepare planting plan

Most restoration projects use some form of vegetation to stabilize the site and provide important restoration functions. In practice, planting failures are a recurring problem at many restoration projects. Consequently, designers should carefully specify how the site will be prepared, what species and planting methods will be used, and how vegetation will be maintained and managed during the first few critical years after it is established.

4. Prepare final cost estimate and bid documents

A final project cost estimate can be computed only when all construction, permitting and planting costs are fully known. The cost estimate data is then used to prepare the bid documents to select a construction contractor. While the exact nature of local bid documents varies considerably, communities should always consider ways to bundle contracts to cover both design and installation of multiple restoration projects.

5. Secure easements and maintenance agreements

Temporary or permanent easements are often needed for access and maintenance of the restoration project. In addition, restoration projects require maintenance and agreement must be secured as to who will be responsible for performing it in the future. All easements and maintenance agreements should be secured prior to breaking ground on the project.

6. Accept project and enter into project tracking system

The last task involves project acceptance, which is based on a final project inspection that may occur several month or even years after construction is completed. In some cases, an as-built drawing or record survey may be required to show final project dimensions and elevations. Once a project is accepted, project data is then entered into the subwatershed project tracking system (see Section 8.1) and any outstanding performance bonds are released.

Table 29: Common Design and Construction Considerations for Different Restoration Practices

Design and Construction Consideration	Restoration Practice						
	Storm-water Retrofits	Stream Repair	Riparian Reforest-ation	Discharge Prevention	Water-shed Forestry	Source Control	Municipal Opera-tions
Geotechnical analysis	●	⦿		⦿			
Structural analysis	●	⦿					
404 Wetland permit application	⦿	●	⦿				
401 Water quality certification	⦿	●					
Waterway construction permit	⦿	●	⦿		⦿		
Construction drawings	●	●	⦿		⦿		
Sequence of construction	●	●	⦿		⦿		
Standard specifications	●	●	⦿	⦿	⦿		
Onsite construction supervision	●	●	⦿		⦿		
Cut /fill estimates	●	⦿					
Construction/Installation windows	●	●	●		●		
Erosion and sediment control plan	●	●	⦿	⦿	⦿		
Maintenance schedule and agreement	●	⦿	⦿		⦿		⦿
Access/Maintenance easements	●	●	⦿	⦿	⦿		
Planting plans	●	●	●		●		
Floodplain modeling	⦿	⦿	⦿				
Sediment transport modeling		⦿					
Hydrologic modeling	●	⦿	⦿				
Hydraulic modeling	●	⦿	⦿				
Dam safety analysis	⦿						
Project tracking form	●	●	●	●	●	⦿	⦿
Cost estimates	●	●	●	●	●	●	●
Bid documents	●	●	●	⦿	●	⦿	⦿

Key: ● *survey normally required for the practice*
⦿ *survey may be required in some project situations*

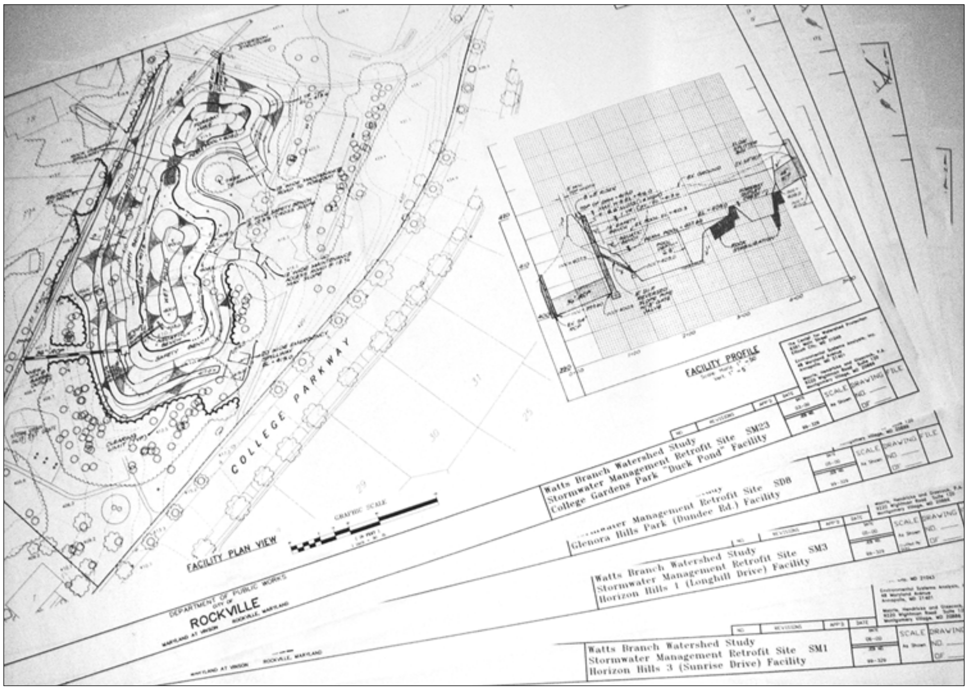


Figure 31: Watts Branch Duck Pond retrofit facility plan view

These final design plans were completed for storm water retrofit projects identified in the Watts Branch watershed plan.

7.2 Engineering and Design Surveys

At least one more round of field surveys may be needed at the project site to collect enough data to support final design, permitting and construction of restoration projects. The exact type and number of surveys depends on the restoration practice being designed and the condition of the project site. In general, storm water retrofits and stream repairs require the greatest number of engineering and design surveys. By contrast, few or no engineering and design surveys are needed for most reforestation, discharge prevention, source control and municipal practices. Two tasks are involved in scoping out the engineering and design surveys needed for individual restoration projects:

1. Define nature and scope of pre-construction surveys
2. Define nature and scope of construction surveys

Additional guidance on engineering and design surveys is provided in Profile Sheet F-7.

1. Define nature and scope of pre-construction surveys

As many as a half-dozen field surveys may be needed to support design and permitting, depending on the type of restoration practice and conditions at the project site. The un-shaded entries in Table 30 present common preconstruction field surveys that might be needed to support design for the seven different types of restoration practices. Pre-construction surveys fall into three major categories:

- *Field surveys required for environmental permitting*. Since many projects are located in or near streams, wetlands, and natural areas, a range of environmental permits may need to be secured. For example, if wetlands or forests are present in the stream corridor, wetland and/or forest stand delineations may be required as part of the permit application.

Methods for conducting these surveys are profiled in Table 20 (Chapter 4).

- *Topographic surveys.* Professional surveys may be needed to get the detailed topography needed to set design elevations, do cut/fill estimates or confirm ownership boundaries and easement locations. These surveys provide finer resolution of existing topography and typically involve at least one-foot contour elevations, and are tied into permanent benchmarks. Topographic surveys are normally only required for storage retrofits and stream repair projects.

- *Soil testing and geotechnical data:* Some testing of project soils is needed for most restoration practices. In some cases, simple soil tests or test pits are needed to establish soil quality and water conditions to develop planting plans. In other cases, detailed soil borings are needed to establish the engineering properties of project sub-soils needed to support final design (stability, load bearing strength, use for fill, infiltration rates, depth to water table, need for dewatering, etc.).

2. Define nature and scope of construction surveys

Construction surveys may entail pre-construction staking, an on-site preconstruction meeting, ongoing construction observations, construction inspections (including erosion and sediment control), resolution of the final construction punch-list, and final project documentation (through as-built drawings or record surveys). Experience has shown that designers, agencies and contractors need to interact closely and often during critical stages of construction to ensure project success. The shaded entries in Table 30 outline the types of construction surveys that may be needed for the seven different types of restoration practices. Once again, storm water retrofits and stream repairs normally require the greatest number of construction surveys, whereas most reforestation, discharge prevention, source control and municipal practices only require a few project inspections. Several different types of constructions surveys are often used to ensure proper installation of restoration practices.

- *Pre-construction staking/flagging.* These topographic surveys are used to stake project boundaries, and flag the limits of disturbance around wetlands, streams and tree save areas to prevent encroachment by construction equipment.

- *Pre-construction meetings.* Most projects begin with a preconstruction meeting at the site to review the design and sequence of construction together and agree on any field adjustments that are warranted. Pre-construction meetings ensure that the contractor, designer and agency fully understand all project requirements.

- *Construction inspections.* Inspections are needed to ensure that critical construction phases are installed properly, and that proper erosion controls are maintained at the site. Inspections are tied to contract payment or enforcement, and construction may be halted or payments withheld until the work is deemed satisfactory. A final inspection checks to see that all project criteria are met in regard to vegetative stabilization, plant survival, erosion control, slope stability, initial adjustment and other factors. Often, the inspector and contractor work up a final punch list on the final items that must be corrected to get the project accepted, and final payment released.

- *Construction observation.* These site visits are more collaborative and less contentious. The designer or engineer regularly meets the contractor to oversee construction, discuss proposed changes and make adjustments in the field, where needed.

- *As-built survey or record survey.* A final survey may be required to document the dimensions and locations of the project as it was actually built, compared to the original design. These as-built or record surveys are extremely useful in future project maintenance and performance monitoring.

Table 30: Common Field Surveys to Support Engineering and Design

Engineering and Design Surveys	Restoration Practice						
	Storm Water Retrofits	Stream Repair	Riparian Reforest-ation	Discharge Prevention	Watershed Forestry	Source Control	Municipal Operations
Geotechnical surveys/soil borings	●	⦿					
Wetland delineations	⦿	●	⦿		⦿		
Topographic surveys	●	●			⦿		
Tree surveys or forest delineation	⦿	●	⦿		⦿		
Utility marking	●	●	⦿	●			●
Soil borings	●						
Soil tests or sediment testing	⦿	⦿	●		●	⦿	⦿
Survey of invasive plant species		⦿	⦿		⦿		
Storm drain investigation (trunk)	⦿			●			
Fish sampling		⦿					
Dye testing				●			
Resident surveys						●	
Construction staking	●	●	⦿	⦿			
Construction inspection	●	●	⦿				
Construction observation	●	●	⦿	●	⦿		
As-built or record survey	●	●	●		⦿		
Monitoring of plant survival	⦿	●	●		●		

Key: ● *survey normally required for this practice*
⦿ *survey may be required in some project situations*
Note: Un-shaded entries indicate the types of preconstruction surveys that may be needed, while shaded entries indicate the construction surveys that may be needed.

7.3 Maintaining Restoration Partnerships

The purpose of stakeholder involvement in Step 7 is to build a strong and broad coalition in the community that can exert enough political force to get the plan adopted and funded. A restoration partnership is created when elected officials, senior agency heads and prospective partners are persuaded about restoration benefits and are motivated to act. Restoration partnerships are created through political interactions and not technical ones. Key players in the community need to be persuaded about watershed restoration -- its political and community benefits, the financial commitment to make it happen, and the breadth of partners that support it. Five ongoing tasks help create and maintain effective 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

1. Define expectations for the partnership

Many partners are needed for restoration, although each one brings something different to the table. Thus, the first task in creating partnerships is to define what each individual partner will provide or contribute, which may include one or more of the following:

- Political advocacy to adopt and implement the plan
- “Letterhead” support to provide legitimacy
- Volunteers for field work or early action projects
- Funding for restoration projects
- Participate in committees and decision-making
- Landowner approval or access for restoration projects
- Enhanced stewardship on private or public lands
- Greater visibility and media exposure
- Technical expertise and assistance in plan development
- Food and entertainment for volunteers
- Meeting venues

2. Define the benefits that partner will receive

While most prospective partners recognize the value of a healthier watershed, each is also motivated to act based on the perceived benefit to their organization. Consequently, the team should explore the range of benefits that might entice a partner to become more involved in restoration. Some examples of partner benefits include:

- Providing positive local media exposure
- Advertising their community involvement
- Putting their environmental values into action
- Promoting their related educational messages and programs
- Working with school children
- Providing recreational opportunities
- Receiving free technical assistance
- Networking and meeting new people
- Leveraging resources to build restoration projects
- Receiving financial support

The last partner benefit is particularly important – the most active partners tend to be the ones that receive at least some funding support. When partners are treated as volunteers working for nothing, that is usually what you get. Every new grant or contract should be viewed as a potential opportunity to financially involve partners and work more closely together.

3. Meet with individually partners to enlist their support

After the general expectations and benefits for the prospective partner have been defined, it is time for the team to meet with individual partners to discuss specifics and enlist their support. In some cases, the prospective partner may need more education about the restoration effort. Once the prospective partner is up to speed on restoration, the team should clearly outline the support requested and be explicit about any time and financial commitments. Similarly, the team should describe the expected benefits that may derive from the partnership, without over-promising. The team should also listen closely to the partner to hear what they need out of the deal. For example, funders and corporations, often have very specific requirements or policies that dictate their involvement. In some cases, the partnership can be sealed with a formal memorandum of agreement or simply a handshake. Don't be discouraged if great results are not achieved overnight -- partnerships evolve gradually over time based on trust and personal relationships.

4. Determine proper partner recognition

Once a partner has been recruited, they should be acknowledged constantly at meetings, websites, press releases, community events, educational materials and report covers. The team should always check with each prospective partner to find out their preferences as to how and where their name or logo will be used. Partners should also expect to get an advance look at all materials in which their name and logo are used – surprises are not a good thing in building partnerships.

5. Maintain partner relationships over time

Like any relationship, restoration partnerships require maintenance over time to ensure needs and responsibilities of both parties are being met. It is a good idea to have an occasional meeting to check in individual partners to see where they stand on the relationship. Additional tips on maintaining developing strong restoration partnerships are offered in Profile Sheet S-7.

7.4 Adopt Final Plan

There is no universal method to adopt the final plan since the local political process, partnership structure, and budgetary system is different in every community. Nevertheless, there are several recurring tasks that are frequently needed to adopt the final plan:

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

1. Decide which plan elements require adoption

The core team should have already made strategic choices regarding how to implement the plan in the preceding step. At this time, they should review the entire plan, and choose the specific plan elements to carry forward for formal adoption. The team may wish to consider some or all of the following actions:

- Endorse subwatershed objectives
- Acknowledge restoration partners
- Adopt the plan in principle
- Adopt the restoration project implementation matrix
- Commit to specific early action projects
- Adopt recommended subwatershed restoration strategy
- Authorize funding for next few years of project design and construction

2. Convert plan elements into legislative and budgetary language

In this task, the recommended plan elements are converted into legislative and budgetary language. Many instruments exist to adopt a plan, including formal votes to accept it, authorizing additional funding, authorizing the lead agency to engage in cost-sharing agreements or accept grants, or entering into a formal partnership.

3. Make persuasive case about restoration benefits

At this point, the benefits of a restoration plan needs to be marketed and the strength of the partners that support it. A few pages of talking points that concisely summarize the benefits of restoration are a helpful aid during the many briefings and meetings to come. The talking points should stress how the plan will address real impacts and problems in the subwatershed, and indicate how it contributes to meeting watershed goals. Any economic or community benefits associated with the plan should be prominently featured, such as community revitalization, increased public access, enhanced recreation, trails and greenways, environmental education, and higher land values. Lastly, the talking points should stress the diversity of partners that support the plan and any matching or leveraging of resources that they bring to the table. Elected officials are keenly interested in knowing the degree to which local agencies, regulators, local media, and constituent groups support its adoption.

4. Navigate the appropriate approval pathway

The last task is to navigate the plan through the local approval process, which may take considerable patience. Tips on working effectively with elected officials to adopt the plan are offered in the Profile Sheet S-7.

D-7	Desktop Analysis **Final Design and Construction**	FDC

Purpose

This method is used to assemble the final design package, secure any permits and approvals, and prepare a bid package that leads to effective construction of individual restoration projects. Final design steps vary according to the type of restoration practice and the size and complexity of the project site.

Scale	Value
Project site or stream reach	Essential

Analysis Method

The six tasks involved in final design and construction are:

1. Complete final design package
2. Assess permit needs and submit applications
3. Prepare planting plan
4. Prepare final cost estimates and bid documents
5. Secure easements and maintenance agreements
6. Accept project and enter into project tracking system

Guidance on specific design and construction tasks needed for each of the seven types of restoration practices is provided in Table 29.

Product

The product of final design is a package containing construction drawings, the sequence of construction, permit conditions, standard details, and bid forms to construct the restoration practice. Typically, storm water retrofit and stream repair projects require the most sophisticated design packages.

Mapping and Other Data Needs

The design and construction of restoration projects may require finer-scale topographic data, survey work and engineering field data. Table 30 summarizes the typical engineering and design surveys that may be needed to support design and permitting of restoration projects.

Level of Effort

Final design and permitting is usually estimated as a percentage of the planning level construction cost estimate for the individual project. This percentage frequently ranges from 5 to 20%, depending on the type of restoration practice and the sophistication of engineering analyses needed. In addition, up to 0.25 FTE is needed for plan review and contract administration.

Further Resources

More information on final design and permitting for each kind of restoration practice can be found in Manuals 3 through 8.

Tips for Final Design and Construction

Managing the delivery of multiple restoration projects through the local government contracting process can be a daunting task. The core team must deftly juggle a myriad of design, permitting and contracting issues – each of which can delay projects or increase construction costs. It is not uncommon for the entire process to extend from six months to two years.

D-7

Desktop Analysis

Final Design and Construction

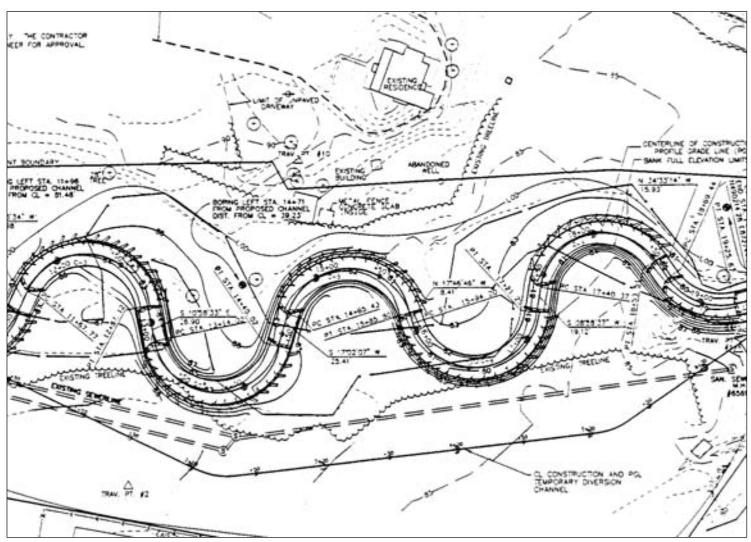
FDC

Tips for Final Design and Construction

Some tips for handling the large number of restoration projects expected in most subwatersheds are offered below.

- Retrofits and stream repair practices normally require the greatest effort in final design and permitting, followed by natural area restoration, discharge prevention and source control practices. Riparian management and watershed forestry require much less design and changed municipal operations require almost none.
- Each individual project should be carefully evaluated to determine what kind of environmental permits must be secured (and what supporting surveys will be needed). It is usually a good idea to host a pre-design meeting with permitting authorities in the field to clarify or resolve potential problems.
- The use of design/build contractors is increasing in many areas since it reduces the number of contracting steps and ensures continuity throughout the project.
- The contract bidding process can consume many months in most communities so it makes sense to lump multiple projects into a single bid package. Alternatively, communities can set up a "call contract" with one or more consultants to provide design and construction services over a multiple year period.
- Installation of most restoration practices requires specialized skills, knowledge, and past experience. Therefore, selection criteria in the bidding process should clearly emphasize contractor experience and current technical capability. Expect construction headaches if lowest cost is the only selection criterion.
- Something unexpected always seems to come up during construction, so contracts should include contingency provisions to help pay for them.

Final design can be quite complex for some stream repair and retrofit projects. These construction drawings show natural channel design in Maryland.



F-7

Field Assessment Method

Engineering and Design Surveys

EDS

Purpose

The purpose of engineering and design surveys is to acquire enough field data to directly support the final design, permitting and installation of a restoration practice. Depending on the type of restoration practice and conditions at the project site, as many as half a dozen field surveys may be needed. Common examples include geotechnical surveys, wetland delineations, topographic surveys, forest stand delineations, tree conservation surveys, utility marking, soil borings, soil fertility tests, invasive plants surveys, fish sampling, construction inspections and as-built construction drawings.

Scale	Value
Project site or stream reach	Essential

Basic Method

Two tasks are involved in selecting the engineering/design surveys needed for each individual restoration project:

1. Define nature and scope of pre-construction surveys
2. Define nature and scope of construction surveys

Information Provided for Restoration

Field surveys are often essential to project success, as they provide the needed data to secure environmental permits and assure that projects are properly installed and maintained over time. In general, storm water retrofit and stream repair practices normally require the greatest number of field surveys, but nearly all practices require construction observations, monitoring of plant survival, utility marking and as-built surveys.

Advanced Preparation

The number and type of engineering and design surveys are usually determined during the project concept design stage, taking into account earlier site inspections as part of the Candidate Project Investigation (F-4). It is always wise to consult with local and state permitting authorities to determine what surveys are needed for permit submittals.

Data Management & Reporting

The results of the field surveys are normally stored in the project design archives. Selected information, such as construction inspections, as-built survey, and plant survival monitoring should also be stored in a master database to track overall plan implementation at the subwatershed level (See profile sheet D-8).

Level of Effort/Cost

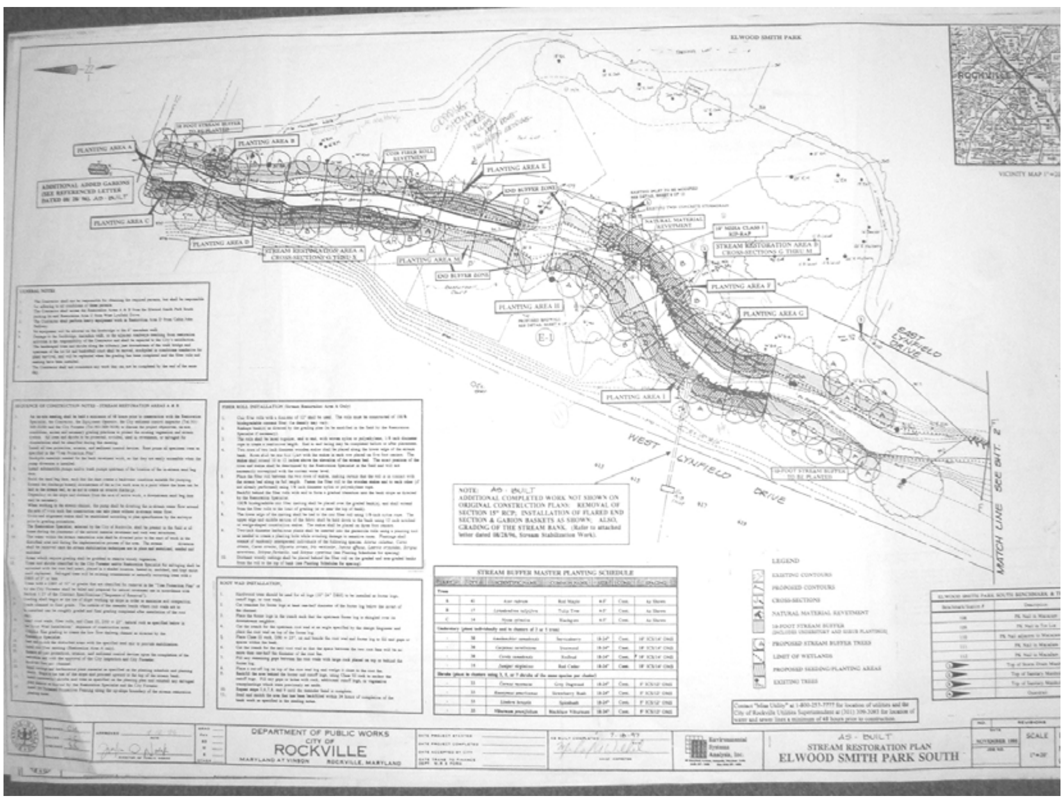
The cost for each type of engineering design survey varies, but can be quite high for some projects.

Tips for Supporting Better Design

- The cost and time needed to acquire environmental permits can be extremely high, and is the most frequent reason that restoration projects are delayed or even dropped. Be sure to allocate enough time and money for permitting activities in the design budget.

F-7	Field Assessment Method **Engineering and Design Surveys**	**EDS**

- Successful restoration projects involve a close collaboration among designers, agencies and contractors in the field. In this sense, it is important to distinguish between construction observation and construction inspection. Construction observation refers to the shared time in the field among all three partners to make changes to improve the design, and supervise practice installation. Construction inspection certifies that practices are installed and have a regulatory or contractual implication. Pre-construction meetings with the designer, contractor and any permitting authorities are also extremely helpful.



These as-built plans were approved for a stream restoration project constructed as part of the Watts Branch restoration plan.

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.

S-7

Stakeholder Involvement Methods

Maintain Restoration Partnerships

MRP

Level of Effort

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

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.

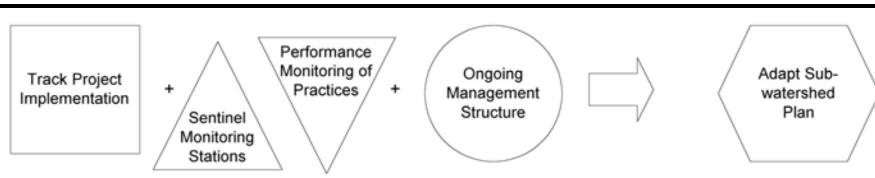
Watts Branch Watershed Study Projects Proposed CIP Implementation Schedule – Fiscal Years 2002-2012

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*		

Chapter 8: Methods to Measure Improvements Over Time

STEP 8 AT-A-GLANCE

No.	ID	Name	How it Guides Restoration
D-8	**TPI**	**Tracking Project Implementation**	Tracks essential data on the design, construction, and maintenance of all subwatershed restoration projects to improve future delivery of restoration practices.
	1. Determine key project management information to track 2. Continuously update individual project info in tracking system 3. Periodically report on status of subwatershed project implementation		
F-8a	**SMS**	**Sentinel Monitoring Stations**	Fixed subwatershed stations that sample long-term trends in selected aquatic indicators to measure progress made toward watershed goals
	1. Choose the right stream quality indicators 2. Locate representative fixed monitoring stations 3. Conduct annual sampling across all subwatersheds 4. Analyze indicator data for long-term trends		
F-8b	**PMP**	**Performance Monitoring of Practices**	Monitoring of the performance of individual restoration projects to determine whether they are working as designed and providing desired level of treatment in order to improve future designs.
	1. Inspect all restoration practices for physical and biological integrity 2. Monitor selected restoration practices to evaluate performance		
S-8	**OMS**	**Ongoing Management Structure**	Establish and sustain an ongoing management structure where stakeholders can advocate for restoration during the many years over which implementation occurs.
	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 support the organization 5. Launch and sustain the organization		
M-8	**ASP**	**Adapt Subwatershed Plan**	Decide whether the plan needs to be adapted or modified to respond to sentinel monitoring data, project experience, unforeseen funding opportunities or other information during the implementation phase
	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		



Implementation is by far the longest step in the subwatershed restoration process. The purpose of Step 8 is to sustain momentum and adapt the plan as more experience is gained in project implementation. Urban restoration is such a new field that each plan is basically its own subwatershed 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 restoration practices installed
- Adapt the plan to if the expected subwatershed improvements do not occur

8.1 Tracking Project Implementation

Managing the delivery of a large group of restoration projects within a subwatershed can be a complex enterprise. Therefore, it is a good idea to create a project tracking system to follow the status of individual projects from concept to completion. The project tracking system enables the core team to measure progress in implementation and interpret future changes in stream quality. Project tracking can also improve the delivery of future projects, and creates reports that can document progress for key funders and stakeholders. Three simple tasks are used to create a subwatershed project tracking system.

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

1. Determine key project management information to track

The project tracking system should account for all restoration practices installed in the subwatershed plan regardless of their type or size. Table 31 indicates some of the specific project management information to include in a tracking system. The tracking system should be designed so that the core team can quickly access information to:

- Determine actual project costs
- Track individual projects implementation status from design through construction
- Access design and permit information when needed
- Schedule construction and maintenance inspections
- Report on overall progress in subwatershed implementation

Table 31: Common Project Management Information to Include in Tracking Database
• Project Identification #
• Project Type
• Description
• GIS Coordinates
• Cost Share
• Total Design Cost
• Total Construction Cost
• Sponsoring Agency
• Subwatershed
• Property or Land Owner
• Property Owner Address & Phone #
• Location on Property
• Date Installed
• Final Design
• Permit File
• As-built Drawings
• Installer/Contractor Name & Phone #
• Installer/Contractor Phone #
• Inspection Schedule
• Initial Inspection Date
• Initial Inspection Comments
• Follow-up Inspection
• Follow-up Inspection Comments
• Next Inspection Date
• Maintenance Performed
• Digital Photographs
• Project archive file #

2. Continuously update project information into tracking system

Individual restoration projects should be entered into a master subwatershed spreadsheet, preferably linked to the watershed-based GIS. Information should be updated through each phase of project implementation – assessment, final design, permitting, construction, inspection, maintenance and any subsequent performance monitoring. It is recommended that one agency be designated to maintain the project tracking system, even if many different agencies and partners are involved in different phases of implementation. The tracking system should be updated several times per year to include new project information.

3. Periodically report on status of subwatershed project implementation

The tracking system should be reviewed at least once a year to make sure project data is current. If budget resources allow, a short report should be prepared that summarizes the status of subwatershed implementation, with an emphasis on project successes (and failures) that can be used to adjust and adapt future project implementation. More guidance on developing a project tracking system can be found in Profile Sheet D-8.

8.2 Sentinel Monitoring Stations

Sentinel monitoring stations are fixed, long-term stations that measure long-term trends in selected aquatic indicators over many years. They are often located at historic monitoring stations or at stations monitored during the Rapid Baseline Assessment (Step 2). Sentinel monitors measure key biological, physical, habitat or water quality indicators in stream health. Sentinel monitors should be installed at the onset of subwatershed implementation and maintained for at least five or 10 years. Trend monitoring is the best way to determine if stream conditions are improving and watershed goals are being met.

Four tasks are involved in establishing effective sentinel monitoring stations:

1. Choose the right stream quality indicators
2. Locate representative fixed monitoring stations
3. Conduct annual sampling across all subwatersheds
4. Analyze indicator data for long-term trends

1. Choose the right stream quality indicators

The indicator(s) that are measured at sentinel monitoring stations should be directly linked to watershed goals. In addition, the indicators should also be:

> *Repeatable*, with a consistent sampling method that produces comparable results over many years, even if different individuals or organizations measure the indicator, or sampling is interrupted due to budgetary problems.
>
> *Sensitive*, so that it reveals real changes in stream quality conditions over time, despite natural variation that tends to mask it.
>
> *Discrete*, so that only a single or a few indicator samples are needed every year to adequately characterize trends in stream conditions.
>
> *Relatively inexpensive*, so that communities can afford to sustain monitoring over the long term.

Obviously, not all indicators can meet all four of these selection criteria. Table 32 summarizes the range of potential indicators that can be used for sentinel monitoring, and compares how well they meet the four indicator selection criteria.

Table 32: Examples of Sentinel Monitors Indicators to Measure Progress Toward Goals	
Dry Weather Water Quality Indicators	
Fecal coliform (or other pathogen indicator)	●
Ammonia or phosphorus concentration	●
Benthic algal growth	○
Intra-gravel dissolved oxygen	○
Pesticide concentrations	○
Metal enrichment in bottom sediment	○
Turbidity	⦿
Biological Indicators	
Fish diversity (Fish IBI)	●
Aquatic insect diversity (Benthic IBI)	●
Single indicator species (e.g., trout, salmon, mussels)	●
Spawning or migration success	⦿
Riparian plant diversity	○
Pesticide levels in fish tissue	○
Physical and Hydrologic Indicators	
Stream habitat index (RBP or RSAT)	●
Riparian habitat index	⦿
Channel/Bank stability	⦿
Summer stream temperature	○
Average summer baseflow	○
Community Indicators	
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	

2. Locate representative fixed monitoring stations

Locating sentinel stations in a subwatershed requires careful planning since they are permanent sites where sampling will be repeated for many years. Factors to consider when locating representative monitoring stations were previously discussed in the Rapid Baseline Assessment (Section 2.2). Some additional data factors to consider when locating sentinel stations include:

Stations should be located at any prior RBA stations to take advantage of existing baseline data collected prior to implementation. Use of existing RBA stations helps reduce installation and rising costs for the station.

- At least two stations per subwatershed are generally needed to fully characterize conditions.

- Stations should be easy to find and gain access to. Sentinel stations will be visited dozens of times over many years so convenient, consistent and safe access is very important. Sentinel stations should be marked physically with rebar or signage, geo-referenced with a GPS unit, and photographed to facilitate subsequent surveys. Additionally, surveyed cross sections may also be valuable, particularly for measuring changes in stream geometry over time.

- Stations should be located in areas that will not change and will be secure from vandalism. Both the immediate area adjacent to the station and the upstream reach that should not change their basic characteristics in the future, except as a direct result of restoration practices (e.g., no local development, impoundments or crossings are anticipated that would interfere with the station's value to show long-term trends).

3. Conduct annual sampling across all subwatersheds

The sampling schedule at a sentinel station is determined by the aquatic indicator(s) 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 (Figure 32). In general, biological, habitat and stream geometry indicators are less influenced by year-to-year variation and may be skipped in some years if budgets are tight. Dry weather water quality, on the other hand, tends to be much more variable, and may require more samples each year, or strict sampling protocols to collect samples during the same season and flow conditions.

Figure 32: Fish Sampling
Annual fish shocking is conducted at sentinel stations that were established during the watershed planning process to assess fish diversity, an indicator of long-term trends in stream improvement.

4. Analyze indicator data for long-term trends

The last task in sentinel monitoring involves entering year-to-year indicator data into a common database so that long-term trends can be analyzed within the subwatershed. In most cases, sentinel monitoring will not produce enough samples to perform a rigorous statistical analysis, but means and ranges should be computed, and compared from year to year. The resulting charts and graphs are included in periodic reports and are used to track subwatershed improvement. Further guidance on sentinel monitoring can be found in Profile Sheet F-8a.

8.3 Performance Monitoring of Practices

The core team often has a keen interest in measuring whether the restoration projects they build are really working like they were designed to. As a result, they may want to invest in performance monitoring of restoration projects in order to improve future designs. Two approaches can be used to monitor the performance of restoration practices. The first approach is a relatively simple visual assessment of the structural or vegetative integrity of a group of restoration practices, whereas the second approach seeks to measure the pollution removal performance associated with a storm water retrofit or other restoration practice.

1. Systematically assess the integrity of groups of restoration practices
2. Monitor individual restoration practices to evaluate performance

Additional tips on how to monitor the performance of restoration practices can be found in Profile Sheet F-8b.

1. Systematically assess the integrity of groups of restoration practices

This monitoring approach inspects groups of projects to assess their function, longevity and survival over time. This systematic assessment looks at the physical or biological integrity of restoration practices to get performance information to improve future design and construction (Figure 33).

The specific factors evaluated in the field depend on the type of restoration practice being investigated. The shaded cells in Table 33 presents some examples of specific measures of project success or failure, based on the type of restoration practice. For example, reforestation projects might be inspected to evaluate tree survival or the spread of invasive species, whereas stream repairs projects may be assessed to see how structures and vegetation have adjusted over time and if they are still functioning properly. The systematic inspection of the biological and physical integrity of practices should not be confused with construction or maintenance inspections that are required as part of final design and construction in Step 7.

2. Monitor individual restoration practices to evaluate performance

The second monitoring approach relies on more intensive monitoring of individual restoration practices to assess their pollutant removal capability or impact on aquatic life. Performance monitoring is generally applied to larger restoration projects such as stream repairs, riparian reforestation and storage retrofits.

Pollutant Removal is determined by measuring the change in pollutant concentration or load as it passes through the practice. The sampling effort to get reliable estimates of pollutant removal is lengthy, complex and expensive. For example, at least 20 paired storm events may be needed to characterize pollutant removal performance of a storage retrofit, which may take more than a year, and cost upwards of a hundred thousand dollars. The experimental design needed to characterize pollutant removal of riparian reforestation, stream repair, source control, and discharge prevention and municipal practices is even more complex, which explains why the performance of these practices is so poorly understood. Guidance on monitoring design to determine pollutant removal of practices is provided in Burton and Pitt (2001) and ASCE (2004). It may be a good idea to partner with a local university or college to handle the monitoring effort.

Biological Response measures changes in the aquatic or terrestrial community before and after a restoration project or group of projects is installed. Most commonly, fish and/or aquatic insects are sampled below the project reach to track changes in the index of biotic integrity over time (Barbour *et al*, 1999). In other cases, trends in the vegetative community are tracked over time using vegetation inventory techniques (see Table 20 in Chapter 4).

The unshaded cells in Table 33 present some examples of specific measures to evaluate the pollutant removal or biological response of different types of restoration practices.

Table 33: Monitoring Measures to Test Performance of Restoration Practices	
Project Type	**Range of Methods to Evaluate Practice Performance**
Storm Water Retrofits	Inspection of hydraulic performance and physical integrity
	Assessment of aquatic or upland plant community
	Storm sampling of pollutant mass into and out of the retrofit
	Sampling of retrofit storm effluent quality
	Sampling of pollutant accumulation in bottom sediments
Stream Repair	Structural integrity of the repair practices
	Assessment of quality of in-stream habitat features created
	Changes in local fish and aquatic insect populations
	Sampling to confirm ability of fish to pass barriers and spawn
	Upstream/downstream sampling of sediment transport or nutrient uptake
Riparian Management	Tree survival or mortality
	Changes in forest canopy and structure over time
	Native vs. invasive species composition of the reforestation site
	Stream temperature due to canopy shading over headwater streams
	Surface and subsurface monitoring of riparian pollutant reduction
Discharge Prevention	Physical integrity of outfalls
	Before and after sampling of problem outfalls
	In-stream sampling of dry weather water quality indicators
Watershed Forestry	Same performance monitoring as riparian management
Source Control Practices	Before and after surveys of reported resident behaviors
	Before and after surveys of resident awareness/recall
	Before and after hotspot compliance investigations
Municipal Operations	Mass of sediments removed during sweeping/cleanout operations
	Nutrient, metal or oil content of removed sediments
	Before and after sampling of curb sediments

Shaded cells: examples of specific measures of project integrity, based on the type of restoration practice
Un-shaded cells: examples of specific measures to evaluate the pollutant removal or biological response of different types of restoration practices.

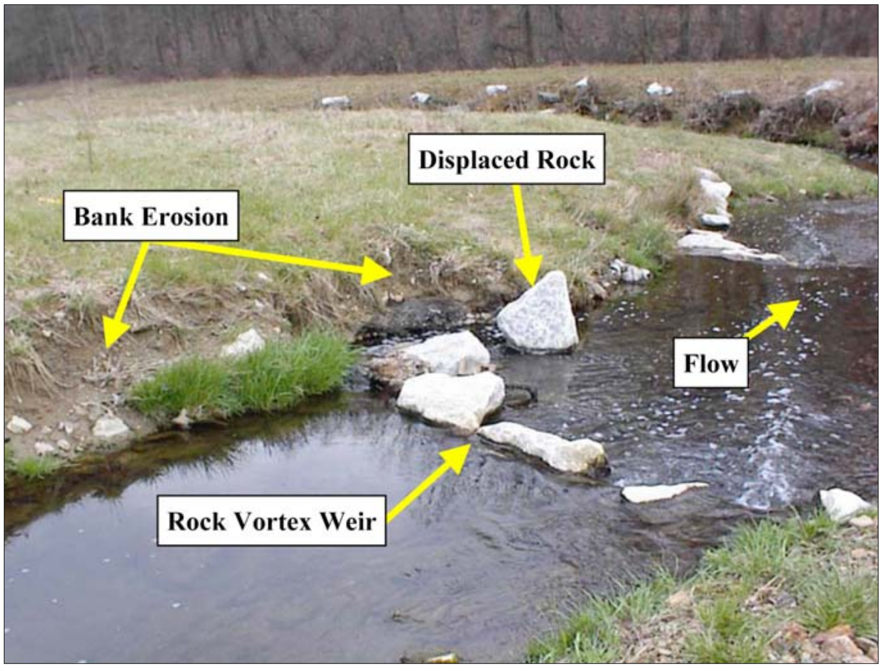


Figure 33: Example of Performance Monitoring of Stream Repair
Severe scouring and rock displacement was observed at this stream restoration project, inspected a few years after construction. The design specified a specific width between weir boulders, but didn't translate to the person on the front-end loader. The rocks were placed too close together, forcing water around the structure and scouring out the wing rocks.

8.4 Ongoing Management Structure

Full implementation of a subwatershed plan normally takes a minimum of five years, and often as many as ten. It can be hard to sustain momentum over such a long time frame without some kind of ongoing management structure. Thus, stakeholder involvement in Step 8 focuses on establishing and sustaining an ongoing management structure that can advocate for the plan and keep the public updated on restoration progress.

While each management structure is unique, the process of creating one can be distilled into four basic tasks:

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 organization

1. Review existing organizations and volunteer capacity

An ongoing management structure is hard to start from scratch, so the first task is to see if an existing organization is willing and capable to play the coordination role. The core team should review the capacity of any existing watershed group, community association, land trust, interagency committee or task force that is already working close to the watershed. Even if no group can be found to play the subwatershed coordination role, the team may still find individual volunteers with drive, expertise and commitment to help create a new management structure.

2. Choose the most important roles it could play

The second task is to work with the group to identify the roles it can play in the restoration effort. Ideally, the organization should be capable of handling the following ongoing functions:

- Maintain general interest in subwatershed restoration
- Advocate for greater funding and seek grant funds
- Administer stewardship and source control programs
- Coordinate agencies, partners and stakeholders
- Manage and track project implementation
- Handle ongoing public education and stewardship efforts
- Monitor and report trends in subwatershed indicators
- Revise and update the subwatershed plan

The organization may also choose to take on additional roles and functions, such as citizen monitoring, stream cleanups and tree plantings. The core team and the partners should work with the organization to decide on the most important functions needed to sustain restoration, particularly those that "fall between the cracks" of existing agencies and partners.

3. Agree on the organizational model to be used

Three models exist to create an ongoing management structure-- the local government-directed model, the watershed nonprofit organization model, and a hybrid model that blends both together (CWP, 1998). The choice of which organizational model is used depends on funding, decision-making authority, membership and whether a watershed organization currently exists. In most cases, the management structure is initially staffed by volunteers, but the goal is to ultimately shift to paid staff that can provide subwatershed coordination, whether they are housed in an agency or a watershed group.

4. Seek funding to launch the organization

Funding is almost always needed, regardless of which organizational model is selected. Funding sources may include grants from state and federal agencies and foundations, memberships, local appropriations, fee-for-service contracts, special events, and corporate giving. A diversity of funding sources is often needed to sustain a fledgling organization. Further guidance on how to create and sustain an ongoing management structure is provided in Profile Sheet S-8.

8.5 Adapt Subwatershed Plans

The management endpoint of Step 8 is fairly simple – how and when to adapt the plan if measurable improvements have not occurred in the indicators used to define subwatershed quality. An adaptive approach to subwatershed management is often most effective. While there is no universal sequence of steps to adapt restoration plans over time, four tasks should be considered when it comes time to revisit the plan.

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

Some practical tips in sustaining progress in plan implementation are provided in Profile Sheet M-8.

1. Reconvene stakeholders once a year

Stakeholders and partners should be continually engaged throughout plan implementation, with at least one meeting or event scheduled each year.

2. Evaluate long-term trends in aquatic indicators

Long-term trends in aquatic indicators measured at sentinel monitors should be analyzed to assess progress towards restoration goals. In addition, other monitoring data should be reviewed to see if any new habitat impacts or water quality threats have emerged since the plan was implemented. At least five years of data may be needed before any clear trends emerge. The management structure should share the resulting data with stakeholders, partners and the general public.

3. Assess the first round of implementation projects

The management structure should periodically analyze the project tracking system to look at progress made in delivering restoration projects. The review should look for ways to speed up project delivery, reduce costs, improve designs and generally find out what has worked and what has not. Any results from practice performance monitoring should also be included in the review. It may also be helpful to get a third party to conduct the review of the first round of implementation projects who can recommend management changes that might improve delivery of restoration projects in subsequent rounds.

4. Revise or expand restoration goals

Clements *et al.* (1996) recommends that watershed plans be re-assessed on a five to seven year cycle, specifically focusing on whether initial goals have been met and implementation is still on track. Much of the data needed for the assessment is produced in the previous two tasks. If goals are not attained, the management structure may choose revise or expand the plan to get further treatment, lower goals, or craft new goals to address new or unanticipated impacts. Additional tips on updating restoration plans can be found in Profile Sheet M-8.

D-8	Desktop Analysis **Tracking Project Implementation**	TPI

Purpose

The purpose of a project tracking system is to store essential data on the design, construction, maintenance and performance of individual restoration projects contained in the subwatershed plan. The tracking system typically uses a common spreadsheet or GIS format to keep the team apprised on project status and stream response and help improve the delivery of future restoration projects.

Scale	Value
Subwatershed-wide	Essential

Analysis Method

Three tasks are used to create a subwatershed 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 subwatershed project implementation

Product

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 restoration practices installed in the subwatershed, with an emphasis on both project successes and failures.

Mapping Needs

No major mapping needs are required for the database, although the geospatial coordinates of projects should be provided so that the location of projects can be mapped in the subwatershed.

Other Data Needs

Initial project information can be extracted from the project tracking file prepared during final design and construction (see Profile Sheet D-7). Subsequent project information is entered as the project is inspected, maintained and monitored; using a standard database.

Level of Effort

One to two weeks of staff effort are normally needed to design the overall project system and enter initial project information from archive files. Another week of staff effort is needed each year to maintain the tracking system and keep project data current. One week of staff time is typically needed to write up and distribute a summary report to stakeholders.

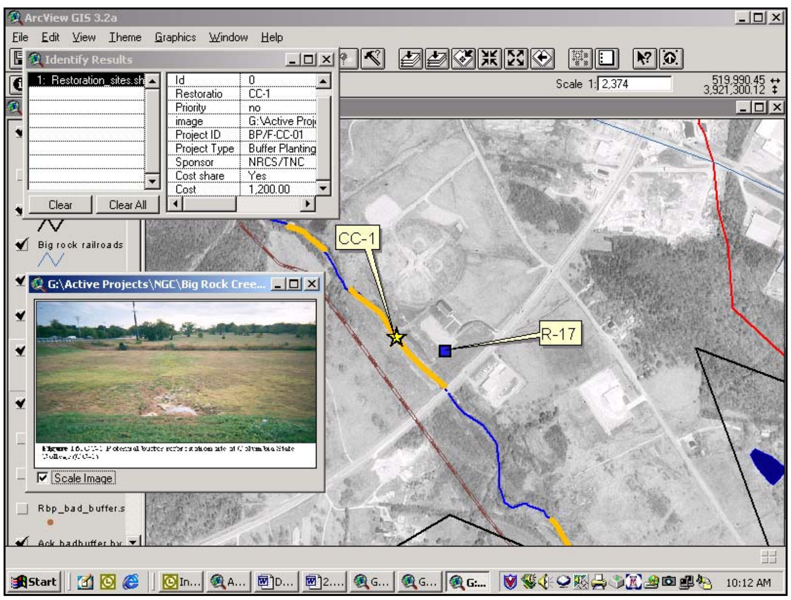
Tips for Designing a Project Tracking System

- Be sure to include digital photos of the project in the tracking system. Before and after project photos provide compelling information restoration projects, and are always handy when it comes to presenting reports on subwatershed implementation.

- The tracking system should be designed with an eye toward storing data that is needed to brief key managers and stakeholders. Data on project cost is particularly important for future budgeting, as is the ability to instantly show the current status of all projects in the plan.

D-8	Desktop Analysis **Tracking Project Implementation**	**TPI**

- Geo-spatial coordinates of each project should be recorded so that project implementation can be shown on subwatershed maps.
- Every piece of project information does not need to be stored on the project tracking system. Indeed, too much project information clutters the system and prevents managers from seeing the data that is truly important.
- More detailed project information should be stored in digital or hard copy project archive files in a pre-designated location where they can be easily accessed at a later date. Examples include design drawings, detailed cost estimates, engineering computations, as-built surveys and permit submittals.



Example of a GIS project tracking system

F-8a	Field Assessment Method **Sentinel Monitoring Stations**	SMS

Purpose

Sentinel monitors are fixed, long-term stations that sample long-term trends in selected aquatic indicators over many years to measure progress made toward attainment of watershed goals.

Scale	Value
Subwatershed-wide	Helpful

Basic Method

Four tasks are involved in establishing sentinel monitoring stations:

1. Choose the right stream quality indicators
2. Locate representative fixed monitoring stations
3. Conduct annual sampling across all subwatersheds
4. Analyze indicator data for long-term trends

Information Provided for Restoration

Long-term trend monitoring of aquatic indicators helps determine whether stream conditions are improving and watershed goals are being met. Reporting trends in aquatic indicators also helps maintain public interest in restoration during the many years it takes to see a biological or water quality response.

Advanced Preparation

Guidance on choosing the right indicators for sentinel stations is provided in Table 32. More tips on indicator sampling and data analysis can be found in the Rapid Baseline Assessment (Profile Sheet F-2).

Data Management & Reporting

Year-to-year data collected at sentinel monitoring stations should be organized in a spreadsheet and/or GIS system. Reports describing subwatershed implementation progress and indicator response to date should be prepared and distributed to stakeholders once every year or two.

Level of Effort/Cost

Variable, depending on the indicator(s) selected. Table 13 in Chapter 2 provides unit costs for some common indicators. The basic goal is to keep annual monitoring costs in the $2K to $10K range so that long term monitoring can be sustained.

Tips for Establishing Sentinel Monitoring Stations

Sentinel monitors are permanent stations that measure long-term changes in aquatic indicators that track key restoration goals. Most subwatersheds will only have one or two such stations, and deciding where to locate them is extremely important. Several tips are offered to improve the quality and management value of sentinel monitoring data:

- Sentinel stations should be located just above the confluence of a higher order stream so they capture the effect of upstream treatment (i.e., at the downstream end of a first order stream before it joins another first order stream to become a second order). Stations should be located just below the point of maximum subwatershed treatment or the stream reach where the greatest degree of aquatic improvement is expected.

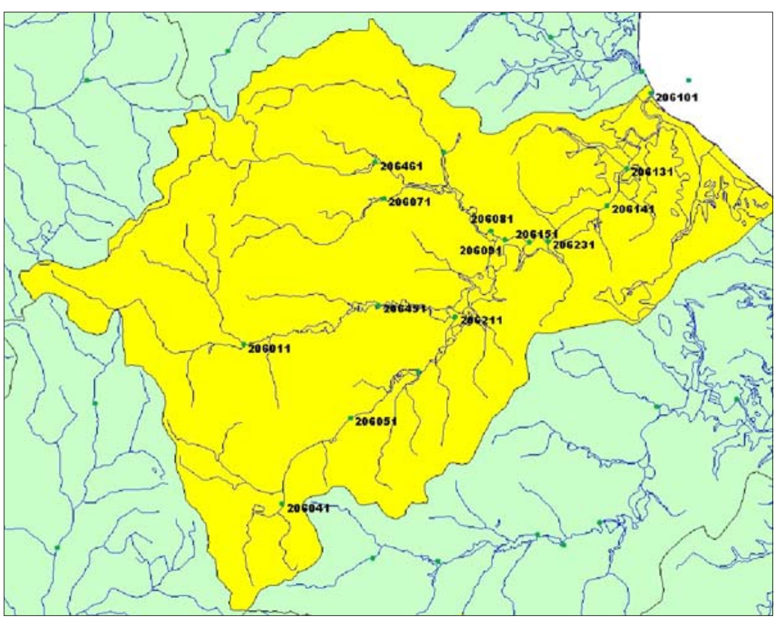
F-8a

Field Assessment Method
Sentinel Monitoring Stations

SMS

Tips for Establishing Sentinel Monitoring Stations

- Stations should be located in a manner so that indicator data are not unduly influenced by local factors, such as bridges, crossings, impoundments and upstream outfalls. Where possible, stream reaches above the station should have good riparian cover, and represent the best in-stream and riparian habitat in the subwatershed.
- Good access should be available to each station, and the site should be in public ownership or private easement so the land use at the station and upstream reach will remain relatively unchanged over a decade or more.
- The original cross-section of the stream should be benchmarked and geo-referenced so that it is easy to find the same area again when returning to the station over the years. An ideal station will have space available and power so that flow and storm water quality sampling equipment can be installed in the future, even if it is not considered now.
- Guidance is provided in Section 2.2 on the range of possible aquatic indicators that can be sampled at sentinel stations, along with their average unit costs.
- The monitoring plan should emphasize indicators that are relatively fast and inexpensive to collect, are sensitive and discriminating, and are repeatable and discrete (i.e., can be collected by different investigators a few times a year).
- Most communities will lack the resources to sustain monitoring year in and year out, so indicators should be robust enough to show trends in the event that future monitoring is infrequent or interrupted, or is handled by volunteers.



Numbered monitoring stations in the Murderkill watershed in Delaware

F-8b

Field Assessment Method
Performance Monitoring of Practices

PMP

Purpose

This method determines whether individual restoration practices are actually working as designed and are achieving their desired level of treatment with respect to biological, water quality or habitat improvement. Two basic levels of performance monitoring can be conducted. The first is a visual inspection of practice function or integrity, and the second is a much more sophisticated monitoring effort to assess pollutant removal or biological response attributable to the practice.

Scale	Value
Project site or stream reach	Helpful

Basic Method

Two approaches can be taken to monitor the performance of restoration practices:

1. Systematically assess the integrity of groups of restoration practices
2. Monitor individual restoration practices to evaluate performance

The range of potential methods for each of the seven groups of practices is provided in Table 33.

Information Provided for Restoration

Both types of performance monitoring provide specific information to improve the design of future restoration practices by identifying factors that improve or reduce performance or cause practice failure. This information can then be incorporated into subsequent designs in the subwatershed.

Advanced Preparation

Construction contracts should be written to provide one to three years of post-construction inspection and monitoring, depending on the type of restoration practice. If monitoring is geared to determine pollutant removal performance, significant planning is needed to establish the sampling protocol.

Data Management & Reporting

Performance monitoring data should be compiled and organized under the project tracking system. Any results that influence the success or failure of future restoration practices should immediately be disseminated to the design community.

Level of Effort/Cost

The visual assessment of project function is a relatively inexpensive field inspection using standard forms. Each inspection requires up to four hours including travel, and in some cases, multiple inspections are needed in the first few years. Intensive performance monitoring, on the other hand, can cost $40K to $120K per practice to collect enough data to reliably establish pollutant removal or biological response.

Further Resources

More detail on performance monitoring techniques for each group of restoration practices can be found in Manuals 3 through 9.

F-8b

Field Assessment Method

Performance Monitoring of Practices

PMP

Tips for Evaluating Performance of Restoration Practices

- Some degree of post-construction inspection and monitoring should always be stipulated as part of construction contracts
- Few communities can afford to intensively measure the performance of all restoration practices, but should try to focus resources to intensively monitor:
  - the largest restoration projects in the subwatershed
  - practices with the most innovative or risky design
  - individual practices that are being implemented on widespread basis in the subwatershed
- See if performance monitoring stations can be hardwired during project design, even if money is not currently available to instrument them. An example might be considering how sampling equipment could be installed within the inlet and outlet works of a storage retrofit in case grant dollars become available in the future.
- Establishing the pollutant removal performance of restoration practices is an extremely expensive and difficult enterprise. For example, a minimum of 15 to 20 paired storm event samples are needed to get a fair estimate of the pollutant removal performance of a storage retrofit. The experimental design needed to determine pollutant removal for source control, stream repair and riparian reforestation practices are even more complex.
- Experience has shown better results are achieved when efforts are focused on doing a very good job at a single site rather than a mediocre job at several sites.

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

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.

S-8

Stakeholder Involvement Methods

Ongoing Management Structure

OMS

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).

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.

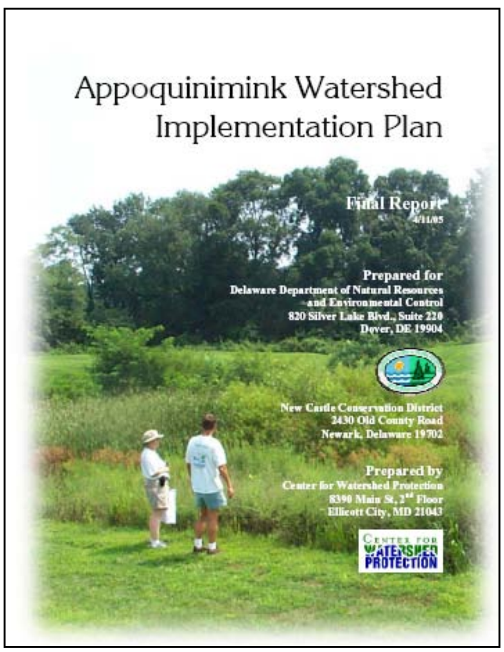
M-8	Management Methods to Get to Restoration Decisions **Adapt Subwatershed Plan**	**ASP**

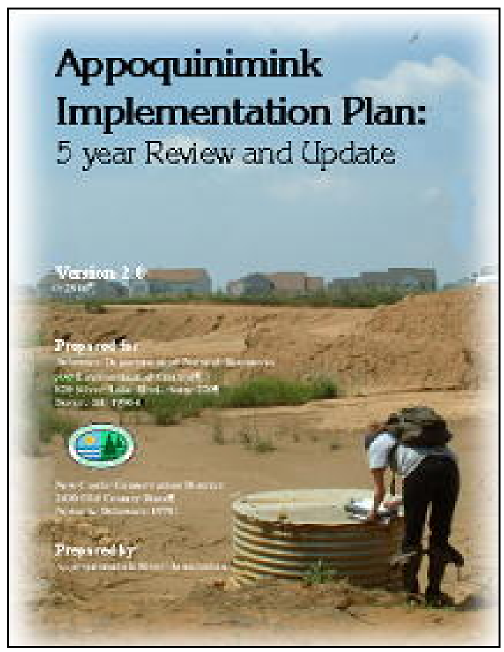
Tips for Sustaining Progress

- 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.





Chapter 9: Scoping and Budgeting a Restoration Plan

It is amazing how quickly the costs of restoration planning can add up. This chapter provides guidance on how to scope and budget a small watershed restoration plan given limited resources. As such, it is organized into four sections.

9.1 Scoping the Overall Plan
9.2 Restoration Budget Categories
9.3 Step-by-Step Budgeting Guidance
9.4 Phasing Plan Implementation

9.1 Scoping the Overall Plan

The core restoration team needs to make hard choices on the scope of the restoration plan given limited and uncertain budget resources. As an example, the total budget for a full-blown subwatershed plan following all eight steps and including project construction can easily exceed a million dollars. Even when funding is spread out over several years, it is certainly a hefty and often unaffordable investment for many communities. Therefore, most teams will really need to economize on the scope of work to get the maximum restoration information for the least cost. Four areas of the scope should be critically analyzed to find possible economies:

1. Establish a realistic overall budget and planning horizon
2. Analyze subwatershed factors that drive the scope of work
3. Decide which methods can be dropped or reduced in scope
4. Choose the methods that deserve greater investment

1. Establish a realistic overall budget and planning horizon

As noted earlier, the price tag is high for full implementation of the restoration plan. Ballpark budget estimates for the full cost to complete all four phases of restoration in a typical subwatershed are highlighted below:

- Community Watershed Analysis ($50,000)
- Prepare Draft Plan ($100,000)
- Adopt the Final Plan ($275,000)
- Implement the Plan ($1 to 3 million)

The team should develop an estimate of how much total funding will be needed for long-term implementation and then estimate what funding is realistically available over the short term (e.g., the next two years). These two numbers define the restoration planning horizon, which normally ranges from 5 to 7 years in most subwatersheds (see Section 9.4).

2. Estimate the subwatershed factors that will drive the scope

The scope of most restoration plans is directly related to four subwatershed factors:

1. Subwatershed area (square miles)
2. Number of stream miles
3. Estimated number of restoration projects
4. Number of existing stakeholders, partners and agencies that participate

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

3. Decide which methods can be dropped or reduced in scope

While most restoration 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 restoration process. The core team may consider dropping or deferring up to 12 methods, as shown below:

- D-1: Needs and Capabilities Assessment
- F-1: Existing Data Analysis
- S-1: Facilitate Stakeholder Consensus
- D-2: Comparative Subwatershed Analysis
- F-2: Rapid Baseline Assessment
- M-2: Priority Subwatershed List
- D-6: Subwatershed Treatment Analysis
- S-6: External Plan Review
- S-7: Maintain Restoration Partnership
- F-8a: Sentinel Monitoring Stations
- F-8b: Performance Monitoring of Practices
- M-8: Adapt Subwatershed Plan

Several optional methods occur at the front end of a restoration plan, and can be skipped if a community has already chosen its goals or has picked the subwatersheds it wants to work on first. Skipping these early methods can save as much as 10 to 15% of total planning costs. Some effort should always be devoted to the essential methods of finalizing watershed goals (FWG) and restoration education and outreach (REO), although the scope of each can be scaled back considerably. Other optional methods are performed at the back end of a restoration plan, and may be deferred until the draft plan has been adopted. Since these methods are not needed for several years, they may be deferred until they can be rolled into future capital budgets when the plan is finally adopted.

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 restoration decision. In particular, the team should resist the temptation to over-analyze, over-report, over-monitor or over-model.

4. Choose which methods that deserve greater investment

Just like regular investing, the scope should be analyzed to make sure funds are allocated properly. Three investment ratios can help allocate effort within a scope of work, the first two as shown in Figure 34. They include the ratio of funding allocated to:

1. Planning vs. implementation
2. Each of the four basic restoration methods
3. Key steps in the restoration planning process.

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 restoration 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 (pie chart on right in Figure 34) looks at how funding is allocated to the four types of restoration methods -- desktop analysis, field assessment, stakeholder involvement and restoration management. 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 restoration 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 restoration management methods is warranted if communities lack prior experience in restoration planning.

The third ratio looks at the relative funding allocated to each of the eight steps of restoration planning framework. For example, steps 4, 5 and 7 can consume as much as 75% of the total planning budget.

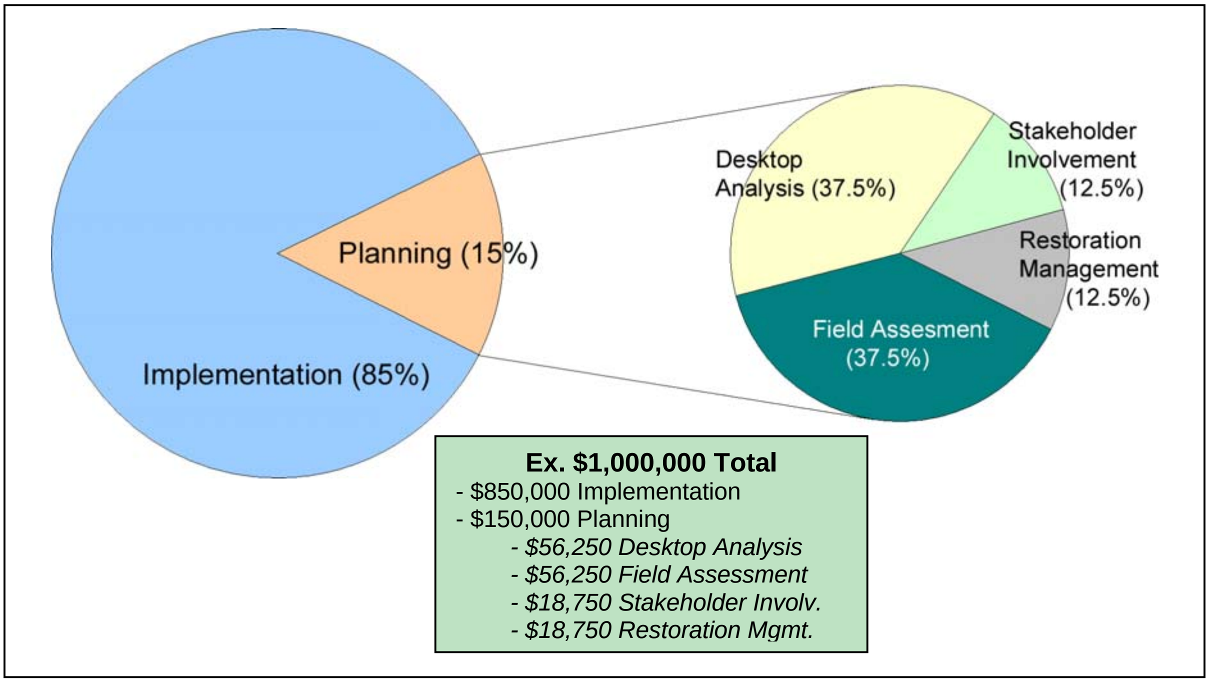


Figure 34: Allocating Planning and Implementation Budgets

The left pie chart demonstrates the ratio of Planning vs. Implementation and the right pie chart shows the recommended breakdown of the 15% planning budget with the four basic restoration methods.

Each of these steps involves extensive desktop analyses and field assessments to identify, investigate and design restoration projects. The team should review the scope to ensure adequate effort is devoted to these expensive but crucial steps.

9.2 Restoration Budget Categories

Four basic cost categories must be estimated separately to accurately budget restoration work plans -- staffing, direct costs, project management and project construction. Each cost category is described in greater detail in this section.

Staff Costs

A basic unit cost approach is used to estimate salary expenses, based on the size of the subwatershed and the time needed to complete each individual restoration method. Once staff hours are known, they are multiplied by an appropriate labor rate. Staff costs are normally the single largest line-item in restoration budgets. Four different types of labor can be employed in a restoration plan, each of which has a different effective hourly rate:

- Agency Staff
- Consultant Labor
- Watershed Group Staff
- Volunteers

In general, the restoration plan should include all four types of labor. The team should explore ways to substitute lower cost labor for higher cost labor, where feasible. The pros and cons of each of labor type are discussed below:

Agency Staff: Agency staff often directs many steps in restoration planning since they have ultimate authority for making most restoration decisions. The cost of agency labor is usually moderate, depending on whether the proposed staffing are new hires or existing personnel. The labor rate for agency staff is normally expressed as a fraction of full-time equivalent salary, and may not include all loaded benefits. In general, agency staff have moderate to high skills, although they may lack skills to perform detailed design and engineering methods. The downside of using agency labor is that staff often have competing duties and are frequently reassigned to handle other pressing priorities during the course of a restoration plan. Agency staff also has the reputation of being more process-driven than product-oriented, so they are not always the best labor type for time-sensitive methods.

Consultants: Experienced consultants have high skill levels, but come at the highest labor rate, which is fully loaded to include salary, benefits, overhead, and profit. Many restoration methods are ideally suited for consulting firms since they have the ability to quickly assemble multi-disciplinary teams to intensively work on products under tight deadlines. Indeed, specialized consultants are often needed to perform highly technical restoration methods involving design and engineering. The downside of employing consultant labor is that they only have authority to recommend ideas and not decide them. Consultants may also not be ideally suited to conduct stakeholder involvement, unless they are well-grounded in the community. Lastly, consultant labor can reduce the continuity of the restoration effort over the long run, since their participation normally ends the moment that the contract runs out.

Watershed Groups: Staff of watershed groups have a moderate to low labor cost, and are uniquely qualified to handle a range of restoration methods. Watershed groups are non-profit organizations that tend to have lower salary rates, benefits, and overhead than their for-profit counterparts. Watershed groups are particularly suited for many stakeholder involvement tasks, since they are a very low-cost outreach retailer. In addition, they can perform several field assessment methods with adequate training and supervision. Lastly, watershed groups are a desirable labor type since they can advocate for sustained plan implementation. Not every watershed group, however, is equipped to perform these functions. Some groups lack staff with requisite skills, have poor relationships with local governments, or lack the organizational capacity to effectively contract with government agencies.

Volunteers: The stakeholders that participate in the restoration process are volunteers that are donating their time and expertise. Agencies and watershed groups may also want to mobilize additional volunteers to perform selected restoration methods. Volunteers are certainly the lowest cost labor type, but most arrive with low skill levels and require additional training. Volunteers are never free, since a modest investment is needed to recruit, train and coordinate them. Still, the core team should explore ways to employ volunteers, particularly as technical advisors, to help out during field work, and support stakeholder management and outreach efforts. By extensively involving volunteers, the core team can powerfully demonstrate the depth of community support for restoration.

Direct Costs to Support Planning and Design

Seven subcategories of direct costs are generally needed to support restoration, including:

- Field equipment and supplies
- GIS hardware and software
- Direct outreach costs
- Subcontracts
- Local travel (car mileage)
- Printing and reproduction
- Postage and phone

Direct costs tend to be low for most steps in the restoration process, but are never zero. Each of the seven direct cost subcategories should be evaluated when budgeting for each step. By far and away, the greatest direct costs for restoration planning are associated with subcontracts needed to support final design and construction (FDC) and engineering and design surveys (EDS).

Project Management Costs

Project management costs include all costs incurred while managing the restoration effort as a whole that cannot be assigned to any specific method. The team should look for hidden costs in the work plan that deal with the following four project management areas:

Overall project management: A team leader should be designated to coordinate the many tasks, products and people involved in the restoration plan. The staff time required to effectively manage the delivery of a restoration plan is considerable, and requires frequent internal meetings, quality control review and team coordination. A common rule of thumb is that the budget for overall project management should be about 3 to 5% of the total labor cost for the plan.

Contract administration: Most restoration budgets include subcontracts to consultants and watershed groups that need to be administered. This involves staff time to process contracts through the system, monitor the work, review products, and ensure timely payment. To account for the cost of contract administration, a rule of thumb is often applied that they comprise about 3 to 5 % of total contract value.

GIS and data management: The budget should include overall costs to maintain and support the watershed-based GIS throughout each step of the restoration planning process. While many GIS housekeeping tasks are budgeted within individual methods, funds should be reserved to maintain, update and archive the system as a whole. No simple rules of thumb exist to cost out the data management function, but it should be accounted for during project startup.

Contingency costs: Not all restoration planning costs can be accurately projected in advance. Something unexpected always comes up, scopes expand, and methods exceed budgets. Contingency costs occur frequently in restoration planning since accurate costs are not fully known until the final steps of the process are completed. It is advisable to set aside 3 to 7% of the budget to account for contingencies. If contingency funds are not needed during the planning process, they can always be used to finance early action projects.

Construction Costs for Restoration Projects

The most difficult budget category to estimate are costs related to construction of restoration practices. Construction represents, by far, the largest share of the restoration budget. In the first few steps in the restoration process, virtually nothing is known about the true cost of construction of restoration practices. As the team proceeds through the eight-step framework, however, they progressively develop more accurate estimates of total construction costs. Some key steps where improved estimates are developed include:

Step 3: Estimate of number restoration projects to be investigated
Step 4: Initial planning level cost estimates for feasible projects
Step 5: First estimate of total cost for ranked projects
Step 6: Firmer estimate of total cost for recommended projects
Step 7: Final budget for full implementation of all projects

9.3 Step-by Step Budgeting Guide

This section presents unit cost information to estimate staff and direct costs for each step of the restoration process. The cost estimates reflect Center experience in preparing past restoration plans, and are based on the following general assumptions:

- 10 subwatersheds are analyzed in the first two steps
- Each subwatershed is 10 square miles in size and has 30 walkable stream miles
- 25 large and 50 small restoration projects are investigated in the field
- 15 large and 25 small restoration projects are recommended for final design and construction

The cost estimates also assume that the core team has:

- some prior experience in urban watershed restoration methods
- access to local GIS system that can support watershed analysis
- a trained GIS coordinator available
- most needed data layers can be acquired at nominal cost

A series of 14 tables is used to organize the unit cost information. The first eight tables present general estimates of staff hours and direct costs associated with each step of the restoration framework (Tables 34 to 41). Each table details underlying cost assumptions so that the user can adjust them based on subwatershed size and other scaling factors. The adjusted staffing hours and labor rates can then be inserted directly into the Restoration Planning Budgeting Worksheet, which is provided in Table 42.

Three additional tables provide detail on direct costs related to GIS software, field equipment and stakeholder outreach, respectively (Tables 43 to 45). Lastly, Tables 46 and 47 present planning level estimates on the unit cost to design and construct the seven groups of restoration practices.

Budgeting Step 1: Develop Watershed Restoration Goals

Table 34 presents the staff hours, direct costs, recommended labor types, and expected timeframe needed to complete Step 1. A mix of different labor types can be used in this initial step. The cost estimates assume analysis of 10 subwatersheds, participation by an initial group of 50 stakeholders, and coordination with up to 15 cooperating agencies and partners. Costs should be adjusted if the number of subwatersheds, stakeholders or agencies is higher or lower than these thresholds.

Budgeting Step 2: Screen Priority Subwatersheds

The staff hours and direct costs needed to complete Step 2 are provided in Table 35, along with recommended labor types and expected time frame. Costs for the CSA are extremely sensitive to the number of subwatersheds analyzed and metrics derived. The estimates shown in Table 35 assume 10 subwatersheds are analyzed and a dozen readily available or easy to derive metrics are chosen. The CSA is also where costs for creating the watershed-based GIS used in subsequent steps are normally incurred. GIS startup costs can balloon quickly; guidance is presented in the introduction and Table 43 on the costs associated with getting a GIS up and running.

If the core team elects to conduct an RBA, it will normally be the most expensive and time-consuming method in Step 2. The RBA cost assumptions here assume a single indicator measured twice at two subwatershed stations. The cost of an RBA increases even more rapidly if multiple indicators are sampled (or sampled more frequently) or more than ten subwatersheds are sampled.

The cost for restoration education and outreach (REO) is directly scaleable to the target number of stakeholders, and the number of meetings and briefings expected. In many cases, watershed groups or volunteers are an attractive and low cost labor source to handle REO. The staffing and direct costs shown in Table 35 for the REO are to produce and distribute restoration education materials using the least costly outreach techniques; direct costs can increase sharply when more expensive outreach techniques are used.

Table 34: Unit Costs for Step 1- Develop Watershed Restoration Goals									
No.	Method	Status	Staff Hours	Direct Costs	Labor Type				Timeframe
					A	C	W	V	
D-1	**NCA**	O	100	5 K	●	⦿	⦿		1 to 2 months
F-1	**EDA**	O	120	1 K	⦿	●	●		1 to 2 months
S-1	**FSC**	O	120	3 K	●	⦿	⦿		2 meetings
M-1	**FWG**	E	160	2 K	●	●	●	⦿	1 to 2 months
Key: O = Optional E = Essential A = Agency; C= Consultant W = Watershed Group V = Volunteers ● Primary labor source ⦿ Secondary labor source			*Budgeting Assumptions and Rules of Thumb:* **NCA:** direct costs include cost to acquire needed data layers for future watershed-based GIS and project website start-up. **EDA**: assumes one week to search for data generators, one week to analyze data, and one week to write up short memo. **FSC:** assumes one stakeholder meeting @ 32 hrs/meeting, 2K to hire professional facilitator, and 1 K for meeting expenses. **FWG**: one additional stakeholder meeting at 32 hours, and staff expense to get goals adopted.						

Table 35: Unit Costs for Step 2- Screen Priority Watersheds									
No.	Method	Status	Staff Hours	Direct Costs	Labor Type				Timeframe
					A	C	W	V	
D-2	**CSA**	O	150	6 K	●	●	⦿		1 month
F-2	**RBA**	O	80	5K/shed	⦿	●	●	⦿	6 to 9 months
S-2	**REO**	E	120	5 K	●	●	●	⦿	1 meeting 12 briefings
M-2	**PSL**	O	80	1 K	●	●	⦿		1 month
Key: O = Optional E = Essential A = Agency; C = Consultant W = Watershed Group V = Volunteers ● Primary labor source ⦿ Secondary labor source			*Budgeting Assumptions and Rules of Thumb:* **CSA**: Direct costs to set up watershed-based GIS: 6K **RBA**: Assumes two stations per subwatershed @ 2.5 K indicator monitoring for each station. Staff effort is one week to design and manage RBA and one week to analyze and report on data **REO**: Stakeholder meetings @ 32 hrs + 60 hrs to develop restoration education materials + 5K direct cost for outreach materials -- unit costs for outreach are provided in Table 45 **PSL**: assumes 2 days to select metrics, one additional meeting, and three days to document in memo.						

Budgeting Step 3: Evaluate Restoration Potential

The bulk of the cost for Step 3 is allocated for the Unified Stream Assessment (USA) and Unified Subwatershed and Site Reconnaissance (USSR). Staff costs for field surveys are directly scaleable to subwatershed stream miles (30 miles) and drainage area (10 square miles), respectively (Table 36). If a subwatershed is above or below these thresholds, then cost estimates should be adjusted accordingly using the rules of thumb shown in Table 36. Note that any type of labor can perform the field methods, so be sure to investigate opportunities to substitute lower cost agency, watershed group or volunteer labor. The cost estimates further assume that crews are trained and have some experience. If this is not the case, add 24 hours to the budget to train each new crew member.

Budgeting Step 4: Conduct Detailed Restoration Assessment

The unit costs to perform Step 4 are provided in Table 37. Once again, the budget is dominated by desktop and field investigations of candidate restoration projects. The total cost to perform both PCD and CPI is highly sensitive both to the number and size of restoration practices being investigated. Cost estimates should distinguish between large and small restoration projects. Projects with estimated construction costs exceeding $50K are classified as large, and projects under $50K are considered small. The cost estimates shown here assume 25 large and 50 small restoration projects are being investigated. The rules of thumb in Table 37 can be used to adjust the budget if the number of restoration projects significantly differs.

The budget for stakeholder meeting assumes two meetings will be held in the subwatershed, each of which requires 32 hours of staff support for preparation and follow-up. For budgeting purposes, the direct costs for recruiting and maintaining stakeholders are projected based on a unit cost of $50 per stakeholder invited.

Table 36: Unit Costs for Step 3- Evaluate Restoration Potential

No.	Method	Status	Staff Hours	Direct Costs	Labor Type				Timeframe
					A	C	W	V	
D-3	**DSA**	E	120	1 K	●	●	⦿		1 month
F-3a	**USA**	E	480	1 K	●	●	●	⦿	1 to 2 months
F-3b	**USSR**	E	208	0.5 K	●	●	●	⦿	1 to 2 months
S-3	**SIR**	E	40	2 K	●	●	●	⦿	
M-3	**ISS**	E	80	0.5 K	●	●	●		1 month

Key:
O = Optional
E = Essential
A = Agency; C = Consultant
W = Watershed Group
V = Volunteers
● Primary labor source
⦿ Secondary labor source

Budgeting Assumptions and Rules of Thumb:
DSA: One week for advance field preparation and two weeks for post-field data processing
USA: 3 person crew walks 2 stream miles/day, not including training
USSR: 2 person crew covers 2.5 square miles/day, not including training.
SIR: New stakeholder recruitment: $10/stakeholder
ISS: 40 hours to brainstorm strategy, and 40 hours to write-up and produce subwatershed management map

Table 37: Unit Costs for Step 4- Conduct Detailed Restoration Assessment

No.	Method	Status	Staff Hours	Direct Costs	Labor Type				Timeframe
					A	C	W	V	
D-4	**PCD**	E	400	2 K	⦿	●	⦿		2 to 3 months
F-4	**CPI**	E	200	1 K	●	●	⦿		2 to 3 months
S-4	**MSI**	E	64	6 K	●	●	●	⦿	2 meetings
M-4	**IRO**	E	80	1 K	⦿	●	⦿		1 month

Key:
O = Optional
E = Essential
A = Agency; C = Consultant
W = Watershed Group
V = Volunteers
● Primary labor source
⦿ Secondary labor source

Budgeting Assumptions and Rules of Thumb:
PCD: Assumes 25 larger restoration projects: 8 hrs per project
PCD: Assumes 50 smaller restoration projects: 4 hrs per project
CPI: Assumes 4 hrs @ 25 large restoration site visited; 2 hrs @ small site. See Table 55 for estimates for each type of restoration practice
MSI: 32 hours per meeting + direct outreach costs of $ 50 per individual stakeholder (assume 50) + subwatershed restoration website.
IRO: 80 hours to assemble inventory, and make ten copies

Budgeting Step 5: Assemble Projects into Plan

Table 38 summarizes the unit costs needed to complete Step 5. The costs for this step need not be high, but can rise sharply if the team elects to perform a complex project ranking effort, host a lot of consultation meetings, or produce a long, fancy, or highly polished plan. The cost estimates shown here are for a simple ranking system, two neighborhood consultation meetings, and a short plan that has relatively limited distribution. If the core team wishes to expand the scope of any of these three methods, they should increase the budget accordingly.

Budgeting Step 6: Determine if Plan Meets Watershed Goals

The costs to perform Step 6 methods are provided in Table 39. Costs are scaleable to the complexity of modeling (STA), the anticipated number of plan reviewers (EPR) and the number of partners and agencies involved in the SIS. The cost estimates shown in Table 39 assume a fairly modest level of effort devoted to each method. For example, the cost to perform the STA assumes simple WTM spreadsheet modeling of a single pollutant of concern. Likewise, a segmented plan review approach is utilized in EPR, consisting of limit hard copy and website plan distribution, a single stakeholder meeting and no major objections to the plan. The greatest staff effort in Step 6 is allocated to the subwatershed implementation strategy, including team meetings, partner briefings and plan revisions.

Table 38: Unit Costs for Step 5- Assemble Projects Into Plan

No.	Method	Status	Staff Hours	Direct Costs	Labor Type				Timeframe
					A	C	W	V	
D-5	**PER**	E	40	0.5 K	●	⦿	⦿		1 month
S-5	**NCM**	E	40	1 K	●	⦿	●		2 meetings
M-5	**DSP**	E	100	2 K	⦿	●	●		2 months

Key: O = Optional E = Essential A = Agency; C = Consultant W = Watershed Group V = Volunteers ● Primary labor source ⦿ Secondary labor source	*Budgeting Assumptions and Rules of Thumb:* **PER**: assumes 40 hours for simple spreadsheet ranking **NCM:** Two neighborhood consultation meetings with listening stations to handle 5 major projects each (20 hrs each + 1K for notification **DSP:** posting of plan on project website; limited distribution of 50 hard copies @ $20 each. Two weeks of staff time to write draft plan, + 20 hours to produce final draft.

Table 39: Unit Costs for Step 6- Determine if Plan Meets Watershed Goals									
No.	**Method**	**Status**	**Staff Hours**	**Direct Costs**	**Labor Type**				**Timeframe**
					A	**C**	**W**	**V**	
D-6	**STA**	O	60	2 K	⦿	●	⦿		1 month
S-6	**EPR**	O	80	1.5 K	●	⦿	⦿	⦿	1 meeting
M-6	**SIS**	E	120	0.5 K	●	⦿	⦿		2 months
Key: O = Optional E = Essential A = Agency; C= Consultant W = Watershed Group V = Volunteers ● Primary labor source ⦿ Secondary labor source			*Budgeting Assumptions and Rules of Thumb:* **STA**: Assumes WTM spreadsheet modeling of one pollutant of concern **EPR**: Assumes distribution of 50 copies of plan @ $5 per, website posting, one stakeholder meeting and no substantive objections to plan. **SIS:** Consists of one retreat, six partner briefings, and 40 hours to revise the plan						

Budgeting Step 7: Implement Plan

The unit costs to perform Step 7 are provided in Table 40, and are dominated by final design and construction and engineering and design surveys. The estimated budget for FDC and EDS is directly related to the number and size of restoration practices taken to the design stage. Once again, budgeting should distinguish between large and small restoration projects. The cost estimates shown assume 15 large and 25 small restoration projects go through design (reflecting the fact that about 40% of projects originally investigated are dropped due to poor feasibility).

If the number of projects departs significantly from these numbers, use the rules of thumb in Table 40 to adjust the budget. The hours shown for FDC and EDC are allocated for agency staff to do project plan review and manage the contracting process; whereas the direct costs are for consultant contracts for project design, permitting and survey services. It is further assumed that all design and survey work is bundled into a single contract to reduce contract administration expenses. Design costs are usually estimated as a direct proportion of estimated construction cost, which varies depending on the type of restoration practice being installed (see Table 46).

Staff costs to create restoration partnerships and navigate the plan to adoption are considerable; a total of six weeks has been assigned to accomplish these important tasks. The budget for these methods should be expanded if it is the first time a restoration plan is being done in a community.

Budgeting Step 8: Measure Improvements Over Time

The last step of the restoration process is hard to budget since it extends over a multi-year time frame. Annual unit costs to perform the methods involved in Step 8 are provided in Table 41, which need to be multiplied by the number of years of the planning horizon (normally 5 to 7). Note that the costs shown are only for ongoing project tracking, monitoring, reporting and coordination, and do not include the major plan revisions or adaptations that normally occur at the end of the planning horizon. Subwatershed monitoring is perhaps the greatest budget uncertainty in Step 8, as the costs for SMS and/or PMP can sharply increase the overall budget, particularly when they are carried out over many years. Similarly, the cost to support a part-time subwatershed coordinator and sustain an ongoing management structure can really add up over time. Table 41 outlines a baseline level of effort to support each method over the years.

Table 40: Unit Costs for Step 7- Implement the Restoration Plan

No.	Method	Status	Staff Hours	Direct Costs	Labor Type				Timeframe
					A	C	W	V	
D-7	**FDC**	E	480	150 K	⦿	●			6 to 12 months
F-7	**EDS**	E	80	90 K	⦿	●			2 to 3 months
S-7	**MRP**	O	120	0.5K	●		●		6 briefings
M-7	**AFP**	E	160	1 K	●	⦿	⦿		2 to 3 months

Key:
O = Optional E = Essential
A = Agency; C= Consultant
W = Watershed Group
V = Volunteers
● Primary labor
⦿ Secondary labor

Budgeting Assumptions and Rules of Thumb:
FDC: Assumes 16 hours of project management for each larger project, 10 hours for each smaller project. Direct contractors costs for design of 15 large restoration projects@ 7.5 K per project, and design of 25 smaller restoration projects@ 1.5 K per project
EDS: Contractor costs of 3.5 K for surveys needed for each large restoration site; 1.5 K for small sites
MRP: 6 partner briefings @ 6 hours/briefing + 80 hours aftercare
ADP: assumes 4 weeks of staff effort to navigate plan to adoption

Table 41: Unit Costs for Step 8- Measure Improvements Over Time

No.	Method	Status	Staff Hours	Direct Costs	Labor Type				Timeframe
					A	C	W	V	
D-8	**TPI**	E	120/yr	2 K	●	⦿	⦿		Multi-year
F-8a	**SMS**	O	120	15 K/shed/yr	⦿	●	⦿	⦿	Multi-year
F-8b	**PMP**	O	120	Variable	⦿	●	⦿		Multi-year
S-8	**OMS**	E	520/yr	15 K	●		●	⦿	4 mtgs/yr
M-8	**ASP**	O	80/yr	5 K	●		●		Ongoing

Key:
O = Optional E = Essential
A = Agency; C = Consultant
W = Watershed Group
V = Volunteers
● Primary labor source
⦿ Secondary labor source

Budgeting Assumptions and Rules of Thumb:
TPI: Annual maintenance of project tracking system + annual implementation progress report
SMS: Annual costs to conduct indicator monitoring at two stations in the subwatershed + 3 weeks initial effort to develop SMS sampling plan
PMP: Extremely variable, see Section 8.3
OMS: Subwatershed coordinator working ¼ time + 15 K in organizational support.
ASP: Convene one stakeholder meeting per year

Using the Budgeting Worksheet

The entire restoration budget can be calculated by completing the budget worksheet provided in Table 42. Be sure to make several copies of the worksheet, as several drafts are needed before the team arrives at a final budget. The team begins by estimating initial costs for each method and then carefully adjusting them based on the subwatershed scaling factors described earlier. Space is provided at the bottom of the budget worksheet to compute overall project management costs, which have not yet been considered. The first draft of the budget should then be scrutinized to look for cost saving strategies outlined in Section 9.1. Once the budget has been finalized, the team can put together a detailed scope of work or request for proposal if they are planning to outsource work to a consultant and/or watershed group.

Additional Details on Direct Costs

Tables 43 to 45 present more budgeting guidance on the range of options for direct costs associated with GIS software, field equipment and stakeholder outreach techniques.

Table 42: Budgeting Worksheet for Restoration Planning							
Task	**Restoration Planning Method**	**Est. Hours**	**Type**	**Labor Rate**	**Total Labor**	**Direct Costs**	**Total**
Step 1: Develop Watershed Restoration Goals							
D-1	Needs and Capabilities Assessment			$	$	$	$
F-1	Existing Data Analysis						
S-1	Facilitate Stakeholder Consensus						
M-1	Finalize Watershed Goals						
	Total for Step 1						
Step 2: Screen Priority Subwatersheds							
D-2	Comparative Subwatershed Analysis						
F-2	Rapid Baseline Assessment						
S-2	Restoration Education & Outreach						
M-2	Priority Subwatershed List						
	Total for Step 2						
Step 3: Evaluate Restoration Potential							
D-3	Detailed Subwatershed Analysis						
F-3a	Unified Stream Assessment						
F-3b	Unified Subwatershed and Site Recon						
S-3	Stakeholder Identification Recruitment						
D-3	Initial Subwatershed Strategy						
	Total for Step 3						
Step 4: Conduct Detailed Restoration Assessment							
D-4	Project Concept Design						
F-4	Candidate Project Investigations						
1. Retrofit Reconnaissance Inventory							
2. Stream Repair Investigation							
3. Urban Reforestation Site Assessment							
4. Discharge Prevention Investigation							
5. Hotspot Compliance Inspection							
6. Natural Area Remnant Analysis							
7. Source Control Plan							
8. Municipal Operations Analysis							
S-4	Managing Stakeholder Input						
M-4	Inventory of Restoration Opportunities						
	Total for Step 4						

Table 42: Budgeting Worksheet for Restoration Planning							
Task	**Restoration Planning Method**	**Est. Hours**	**Type**	**Labor Rate**	**Total Labor**	**Direct Costs**	**Total**
Step 5: Assemble Projects Into Plan							
D-5	Project Evaluation and Ranking						
S-5	Neighborhood Consultation Meetings						
M-5	Draft Subwatershed Plan						
	Total for Step 5						
Step 6: Determine if Plan Meets Watershed Goals							
D-6	Subwatershed Treatment Analysis						
S-6	External Plan Review						
M-6	Subwatershed Implementation Strategy						
	Total for Step 6						
Step 7: Implement the Restoration Plan							
D-7	Final Design Construction						
F-7	Engineering and Design Surveys						
S-7	Maintain Restoration Partnerships						
M-7	Adopt Final Plan						
	Total for Step 7						
Step 8: Measure Improvements over time							
D-8	Tracking Project Implementation						
F-8a	Sentinel Monitoring Stations						
F-8b	Performance Monitoring of Practice						
S-8	Ongoing Management Structure						
M-8	Adapt Subwatershed Plan						
	Total for Step 8						
Subtotal for Methods							$
Overall Project Management			__ % of Total Labor				
Contract Management			__ % of Total Contract				
GIS and Data Management			From NCA				
Contingency Costs			5% of subtotal				
Subtotal for Project Management							$
						GRAND TOTAL	
Notes:							

Table 43: Comparison of GIS Software Packages			
Software	**Cost**	**Function**	**Website**
ESRI ArcGIS	$1,500	Desktop GIS for Windows	www.esri.com
ESRI ArcExplorer	Free	Geographic data exploration software	
MapINFO Professional	$1,495	Business mapping software that lets you perform detailed and sophisticated data analysis to drive insightful decisions	www.mapinfo.com
IDRISI Kilimanjaro	$995	Geographic modeling technology that enables and supports environmental decision making with raster analytical functionality	www.clarklabs.org
ERDAS Imagine	$3,000 to $5,000	Image processing software	www.gis.leica-geosystems
GRASS	Free	An open-source free software GIS with raster, topological vector, image processing and graphics production functionality that operates on various platforms	grass.baylor.edu
Autodesk Map 3D	$4795	Connects CAD and GIS by providing powerful creation and editing tools for GIS professionals as well as the geospatial features that mapping and CAD technicians and civil engineers require	www.autodesk.com

Table 44: Unit Costs for Typical Subwatershed Field Assessment Equipment		
Equipment	**Unit Cost**	**Total Cost**
Waders (3 pairs)	$ 70.00	$210.00
GPS Unit (2)	150.00	300.00
Digital Camera (2)	200.00	400.00
Tape Measure (2)	15.00	30.00
Metal Clipboards (6)	10.00	60.00
Field Binders (10)	5.00	50.00
Street Maps (2)	40.00	80.00
Pry Bar (1)	25.00	25.00
First Aid Kits (2)	30.00	60.00
Backpacks (3)	15.00	45.00
Measuring Rod (1)	25.00	25.00
100 Pack Disposable Latex Gloves (2)	25.00	50.00
Water Quality Probes (2) – optional	400.00	800.00
Wide-mouth Sample Bottles (20)	5.00	100.00
Disposable Supplies* (1)	250.00	250.00
TOTAL		**$2475.00**
** Includes batteries, copies of field forms, pencils, papers, ice, etc.*		

Table 45: Unit Costs for Outreach Techniques		
Technique	**Unit**	**Unit Cost**
Overall residential outreach	Per year	$0.14 - $1.11
Designer for material layout	Per hour	$100 - $150
Coloring books	Per 1,000 produced	$0.45
Decals	Per 1,000 produced	$0.17
Magnets	Per 1,000 produced	$0.30
Posters (4 double-sided, color, 11x17)	Per 1,000 produced	$2.75
Printed materials (Flyers)	Per 1,000 produced	$0.60-$0.84
Printed materials (Tri-fold panel brochure)	Per 1,000 produced	$1.60 -$2.40
Stickers	Per 1,000 produced	$0.08
Tote bags	Per 1,000 produced	$3.50
Billboards	Per billboard/per month	$550 -$1,850
Exterior bus advertisements	Per bus/per month	$750 - $1,450
Tabletop display	Per display	$500-$800
Educational video	Per minute of video	$1,800
Movie theatre slides	Per month	$150 -$1,400
Newspaper ads in small local paper	Per advertisement	$260 -$450
Photo displays	Per display	$121
Public attitude phone survey	Per survey of 1,000	$15,000
Radio public service announcement *	Per announcement	$40-60
TV public service announcement *	Per announcement	$2,750 - $4,000
** Assumes free airtime* *Sources: Council of State Governments, 1998; MacPherson and Tonning, 2003; National Oceanic and Atmospheric Administration, 1988; Water Environment Research Federation, 2000; and Center for Watershed Protection, 1998.*		

Budgeting Individual Restoration Projects

Table 46 presents general planning estimates of the staff hours needed to investigate, design and manage the seven groups of restoration practices. Table 47 presents unit cost estimates for the construction of the seven groups of restoration practices that are used to derive initial cost estimates during project concept design. The construction cost data are based on a common unit of construction (e.g., impervious acres treated, linear feet of bank stabilization) and are presented as a range so that the team can select the most appropriate cost factor. In addition, the team should cross-check the unit cost data in Table 47 with any local or regional cost data to get the best construction estimates. Additional guidance on estimating the construction cost of restoration practices can be found in Manuals 3 through 9.

Table 46: Assessment and Design Costs for Seven Types of Restoration Practices

Restoration Practice	Unit Applied	CPI hrs	PCD Hrs	30% Design	FDC	Add'l Work	
						NCM?	EDS?
Storage Retrofit (large)	Site	4	8	40	15 to 25% of construction cost	Y	Y
On-site Retrofit (small)	Site	0.5	2	N/a	5 to 10% of construction cost	N	N
Stream Repair	Survey reach	4	6	24	15 to 20% of construction cost	?	Y
Reforestation	Planting site	2	6	N/a	16 hrs/acre	N	N
Discharge Prevention	Problem outfall	1	4	N/a	Varies	N	Y
Hotspot Compliance	Suspect business	2	6	N/a	16 hrs/site	N	N
Natural Area Remnant	Remnant	4	8	N/a	Varies	Y	Y
Source Control Plan	Sub shed	20	40	N/a	100 hrs	Y	N
Municipal Operations	Sub shed	20	40	N/a	100 hrs	N	N

Note: NCM= negotiated consultation meeting, EDS= Engineering and Design Survey, Y=yes, N=no, N/A= not applicable

Table 47: Estimated Costs for Common Restoration Practices

Restoration 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
Source Control	Neighborhood stewardship	$15 ($5 to 30)	Per household
	Hotspot pollution 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 catchbasin

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 instream 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

9.4 Phase Plan Implementation

A minimum of five years is usually needed to proceed through the eight steps and implement a restoration plan. From a planning standpoint, the restoration process consists of four distinct phases, as shown below:

1. Community Subwatershed Analysis
2. Draft Subwatershed Plan
3. Adopt the Final Plan
4. Implement the Plan

The section describes how to schedule work during each restoration phase. The exact schedule for completing each phase must reflect the planning horizon selected, the time frame and sequencing of individual restoration methods, funding availability and the anticipated difficulty in getting the plan adopted.

1. Community Subwatershed Analysis

This phase includes Steps 1 and 2 and produces agreement on watershed goals and priority subwatersheds to work on first. The minimum timeframe to complete a community subwatershed analysis ranges from 4 to 6 months, if an RBA is not needed. If a community elects to perform a RBA, this phase can easily stretch over a year, as shown in Table 48.

2. Draft Subwatershed Plan

The second phase consists of Steps 3 through 5 and culminates in a draft plan that recommends the best combination of restoration projects to be applied in the subwatershed. Most of the tasks are technical in nature, and with good project management, the phase can be completed within a year or less. Table 49 indicates the phasing of restoration methods. Note that the core team may need to adjust or extend its schedule to account for some field methods are restricted to certain seasons of the year.

3. Plan Adoption

The third phase includes Steps 6 and 7 and leads to the adoption and funding of the final restoration plan. It can take six months to a year to finalize the draft plan and navigate it through the local political and budgetary process. In the sample schedule shown in Table 50, the majority of time is devoted to final design and construction (FDC) and engineering and design surveys (EDS) needed to develop accurate estimates of construction costs. In some communities, FDC and EDS may be shifted into the plan implementation phase, which can help compress the schedule (and defer considerable expenses into future capital budgets). The plan adoption phase should always schedule some low cost, early action commitments to get implementation rolling.

4. Plan Implementation

The last and longest restoration phase involves plan implementation (Step 8). A minimum of five years is usually needed to design and construct all of the recommended restoration projects, which are normally handled in several annual batches". Table 51 indicates how project tracking, monitoring and plan adaptation are sequenced over a five-year time frame.

Table 48: Phasing of Restoration Methods - Phase 1: Community Subwatershed Analysis

Step	Method	Normal Time Frame	Months											
			1	2	3	4	5	6	7	8	9	10	11	12
1	**NCA**	1 to 2 months												
	EDA	1 to 2 months												
	FSC	2 months		⦿	⦿									
	FWG	1 to 2 months				●								
2	**CSA**	1 month												
	RBA	6 to 9 months												
	REO	3 to 6 months					⦿			⦿				
	PSL	1 month							●					●

Key:
● *Milestone where step is completed and restoration decision is made*
⦿ *Stakeholder meeting or interaction*

Table 49: Phasing of Restoration Methods - Phase 2: Prepare Draft Plan

Step	Method	Normal Time Frame	Month											
			1	2	3	4	5	6	7	8	9	10	11	12
3	**DSA**	1 to 2 months												
	USA	1 to 2 months												
	USSR	1 to 2 months		⦿	⦿									
	SIR	1month												
	ISS	1month				●								
4	**PCD**	2 to 4 months												
	CPI	2 to 3 months												
	MSI	2 months								⦿	⦿			
	IRO	1 month									●			
5	**PER**	1 month												
	NCM	2 months												
	DSP	2 month												●

Key:
● *Milestone where step is completed and restoration decision is made*
⦿ *Stakeholder meeting or interaction*

Table 50: Phasing of Restoration Methods - Phase 3: Plan Adoption														
Step	Method	Normal Time Frame	Months											
			13	14	15	16	17	18	19	20	21	22	23	24
6	**STA**	1 month												
	EPR	2 months		⦿										
	SIS	2 months			●									
7	**FDC**	6 to 9 months												
	EDS	3 to 6 months												
	MRP	3 months									⦿	⦿		
	AFP	3 months											●	
	Early Action Commitments											●	●	●

Key:
● Milestone where step is completed and restoration decision is made
⦿ Stakeholder meeting or interaction

Table 51: Phasing of Restoration Methods - Phase 4: Plan Implementation																					
Step	Batch	Year 3					Year 4					Year 5			Year 6			Year 7			
8	Batch 1								●												
	Batch 2											●									
	Batch 3															●					
	Batch 4																		●		
	TPI		●							●			●				●				●
	SMS																				●
	PMP																				
	OMS	⦿					⦿					⦿					⦿			⦿	
	ASP											⦿								⦿	●

Key:
● Milestone for a deliverable product
⦿ Stakeholder meeting or interaction

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Appendix A: GIS Data Needs and Sources

One of the most important questions to ask when beginning mapping for small watershed restoration is "what GIS data is available for my watershed?" Typical data you will need for restoration planning and sources are listed in Table A1. Data layers with national coverage are listed where applicable; however, state or local data layers should be used when available if they are more detailed or accurate. National sources listed generally provide data at a scale of 1:24,000 or finer. Internet sources of the data listed below are provided later in this appendix.

Table A1: Typical GIS Data Layers and Sources

Data Types	Commonly Used Layers	Source
Hydrogeomorphic Features		
Topography	• Digital Line Graphs (DLGs) • Digital Raster Graphics (DRGs) • Digital Elevation Models (DEMs) • National Elevation Database (NED)	• USGS Mapping • USGS Topographic Maps • USGS Mapping • USGS Mapping
Hydrology	• National Hydrography Dataset (NHD) • Digital Line Graphs	• USGS Mapping • USGS Mapping
Wetlands	• National Wetland Inventory (NWI)	• FWS
100-year floodplain	• Q3 Flood Data	• FEMA
Soils	• State Soil Geographic Database (STATSGO) • Soil Survey Geographic Database (SSURGO)	• NRCS STATSGO • NRCS SSURGO
Boundaries		
Watershed/subwatershed boundaries	• Hydrologic Unit Code (HUC) boundaries	• USGS Water Resources
Parcel boundaries	*Check with local GIS or planning department*	
Municipal boundaries	• Topologically Integrated Geographic Encoding and Referencing (TIGER)/Line files • Digital Line Graphs	• Census Bureau • USGS Mapping
Land Use and Land Cover		
Aerial photos	• Digital Orthophoto Quadrangles (DOQs) • Ikonos imagery	• USGS DOQs • Space Imaging
Land use/land cover	• National Land Cover data	• USGS National Land Cover Characterization
Zoning	*Check with local GIS or planning department*	
Roads	• Topologically Integrated Geographic Encoding and Referencing (TIGER)/Line files • Digital Line Graphs	• Census Bureau • USGS Mapping
Buildings Parking lots Driveways Sidewalks Turf cover Forest cover	*Check with local GIS or planning department*	
Utilities		
Sanitary sewer lines	*Check with local GIS, planning or public works department*	

Table A1 (continued): Typical GIS Data Layers and Sources		
Data Types	**Commonly Used Layers**	**Source**
Utilities		
Storm drain network		
Storm water practices		
Storm water outfalls		
Other utilities (electric, gas, phone)		
Point Sources and Hotspots		
National Pollutant Discharge Elimination System (NPDES) discharges	• Permit Compliance System (PCS)	• EPA BASINS
Hazardous waste/materials sites (CERCLA, RCRA)	• Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)	• EPA PCS
Erosion and sediment control (ESC) construction permits	*Check with local GIS, planning, environmental or public works department*	
Sanitary or combined sewer overflow occurrences		
Other potential hotspots (gas stations, under-ground storage tanks)		
Special Areas		
Historic sites	*Check with local GIS, planning, or natural heritage department*	
Conservation areas		
Rare, threatened or endangered (RTE) species habitat		
Stream Condition		
Monitoring stations	• 305(b) Water Quality Assessments • Storage and Retrieval (STORET)	• EPA Watershed Assessments • EPA STORET
Impaired stream segments	• 303(d) Listed Impaired Waters	• EPA Watershed Assessments

Data availability can be a huge limitation in using GIS mapping for urban watershed restoration. Some GIS data is available for free either online or from local sources such as county planning offices, which are a great data resource. Two important pieces of data that are typically difficult to find or expensive to purchase are recent aerial photos and impervious cover layers. If the cost of purchasing high-resolution aerial photography is prohibitive, you may wish to hold off on purchasing any photos until you have chosen priority subwatersheds for further assessment. Then you can purchase just the aerial photos for those subwatersheds. Or you can use inexpensive lower resolution photos from USGS (DOQs). Impervious cover layers may not exist for your watershed but can be digitized from aerial photos or estimated based on land use. Internet sources of GIS data are provided below. Sites that have free, downloadable GIS data are marked with an asterisk (*).

EPA Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)

http://www.epa.gov/waterscience/basins/b3webdwn.htm

Order software and EPA region data including point sources, hydrology, watershed boundaries.

EPA Permit Compliance System (PCS)
www.epa.gov/enviro/html/pcs/index.html
Query and download data on NPDES permits and other industrial discharges. Data is in tabular format but contains coordinates for input to GIS.

EPA STORET (STORage and RETreival)
http://www.epa.gov/storet/
Download water quality data in tabular format from existing monitoring sites for input into GIS.

EPA Surf Your Watershed
http://www.epa.gov/surf/
Online mapping tool used to obtain data about any specific watershed in the U.S

*EPA Watershed Assessments**
http://www.epa.gov/waters/data/downloads.html
Download EPA 305b assessment and 303d impaired stream layers.

*ESRI**
http://www.esri.com/data/download/index.html
Contains a wealth of technical resources for GIS software, downloadable data layers and a downloadable GIS viewing software called ArcExplorer.

Federal Geographic Data Committee's National Geospatial Data Clearinghouse
http://fgdc.ftw.nrcs.usda.gov/gateways.html
Search hundreds of spatial data servers for data and metadata and ordering information.

Federal Emergency Management Agency (FEMA)
http://www.msc.fema.gov/ordrinfo.shtml
Flood maps available for purchase.

*GIS Data Depot**
http://www.gisdatadepot.com
Contains national, state, or county-level GIS data for sale at a reasonable price or for free download in some cases.

Mapmart
www.mapmart.com
Contains national, state or county-level GIS data for sale at a reasonable price.

*National Atlas of the United States**
http://www.nationalatlas.gov/atlasftp.html
Contains various GIS layers from the US Department of the Interior.

*U.S. Fish and Wildlife Service (FWS) National Wetland Inventory (NWI)**
http://wetlands.fws.gov/downloads.htm
Download NWI GIS layers for the entire U.S. from the U.S. Fish and Wildlife Service.

Space Imaging
http://www.spaceimaging.com/products/ikonos/
Vendor for Ikonos satellite imagery – can be very expensive.

Terraserver
www.terraserver.com
Online mapping tool allows viewing of aerial photos and topographic quadrangles for locations across the U.S. Searchable by address, geographic coordinates and more.

*U.S. Census Bureau TIGER**
http://www.census.gov/geo/www/tiger/index.html
Download TIGER/Line files from 2000 and earlier by state. These files include municipal boundaries, roads, and other general data.

*USDA Natural Resources Conservation Service (NRCS) State of the Land**
http://www.nrcs.usda.gov/technical/land/aboutmaps/coverages.html
Download various Arc/Info coverages for the entire U.S. and individual states.

*USDA NRCS State Soil Geographic (STATSGO) Database**
http://www.ftw.nrcs.usda.gov/stat_data.html
Download soil layers for U.S. states.

*USDA NRCS Soil Survey Geographic (SSURGO) Database**
http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/
Download soil layers for U.S. counties.

USGS Digital Orthophoto Quadrangles (DOQs)
http://www.usgsquads.com/downloads/factsheets/usgs_doq.pdf
Fact sheet on DOQs that provides basic description and instructions for ordering.

*USGS Mapping**
http://edc.usgs.gov/geodata
Downloads and ordering information for DEMs, DLGs, NED and NHD.

USGS National Land Cover Characterization
http://landcover.usgs.gov/natllandcover.asp
Download land cover data by state

USGS Topographic Maps
http://topomaps.usgs.gov/drg/
Download or order DRGs, also contains basic info about topographic maps and USGS map symbols.

USGS Water Resources Maps and Info
http://water.usgs.gov/maps.html
Download HUS boundaries, stream ecoregions, landuse and more for the entire U.S.

Table A2 provides a comparison of the prices and functionality of various GIS software packages. Table A3 summarizes three levels of mapping sophistication, along with associated hardware and software costs and personnel needs.

Table A2: Comparison of GIS Software Packages

Software	Cost	Function	Website
ESRI ArcGIS	$1,500	Desktop GIS for Windows	www.esri.com
ESRI ArcExplorer	free	Geographic data exploration software	
MapINFO Professional	$1,495	Business mapping software that lets you perform detailed and sophisticated data analysis to drive insightful decisions	www.mapinfo.com
IDRISI Kilimanjaro	$995	Geographic modeling technology that enables and supports environmental decision making with raster analytical functionality	www.clarklabs.org
ERDAS Imagine	$3,000 to $5,000	Image processing software	www.gis.leica-geosystems
GRASS	Free	An open-source free software GIS with raster, topological vector, image processing and graphics production functionality that operates on various platforms	grass.baylor.edu
Autodesk Map 3D	$4795	connects CAD and GIS by providing powerful creation and editing tools for GIS professionals as well as the geospatial features that mapping and CAD technicians and civil engineers require	www.autodesk.com

Table A3: Comparison of Various GIS Options and Associated Costs/Benefits			
	Full GIS (e.g., networked GIS system such as Arc/INFO)	**Simplified GIS (e.g., ArcView)**	**Hand-Drawn Maps**
Training required	• Years of experience • Specialized skill that requires at least one FTE or contract services.	• Basic computer skills that can be supplemented with short courses, many of which are available on the internet. Allows for multiple staff to become proficient enough to complete analyses.	• Minimal training for basic map conceptualization, however, requires a cartographer for final map production.
Hardware expense	• Very Expensive • Can acquire necessary software and hardware from between $15,000 and $25,000. Plotters can add another $3,500 each minimum.	• Moderate • About $1,500 - $2,000 for base software package and $2,500 for special analysis extensions; normal PC acceptable – $1,500. Plotters can add another $3,500 each minimum.	• Inexpensive (requires acquisition of base mapping such as USGS 7.5 minute quadrangles and basic drafting tools – up to $500)
Data availability	• Data frequently originates at this level with GIS staff working with mapping contractors. Federal agencies also may have developed data that covers broader geographic regions, but can be modified.	• Much digital data is available as public domain information. Other data is available at fairly nominal rates through local/regional government entities, but this can get expensive as watershed area increases.	• Relies on pre-existing base mapping which may not be at a scale that is desirable or useful.
Ability to produce multiple maps	• High – maps are easily updated and annotated with pictures and other graphics	• High – maps are easily updated and annotated with pictures and other graphics	• Low – maps represent a snapshot in time and are time consuming to update
When to use	• Staff are skilled in GIS • Dedicated GIS department is in place or budgeted for that serves multiple local departments • Need to produce multiple, updateable, high quality maps	• Staff have basic computer skills • You rely on outside sources for the majority of your data layers • Want to produce multiple, updateable maps • A significant amount of the digital data needed are available	• Have limited staff and resources to use a GIS system • Are not confident that data layers can be obtained quickly • Feel that the basic maps described above are sufficient for your watershed plan • Only have a few subwatersheds to manage

Appendix B: Basic Theory of Watershed Stakeholders

While restoration 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 restoration plan. Ideally, the goals and vision for the watershed should be developed early in the restoration process, based on input from a broad group of stakeholders. Consequently, you need to know the key stakeholders in the watershed, and include them in virtually every step of the restoration process.

The term *stakeholder* is loosely defined as any agency, organization, or individual that is involved in or affected by the decisions made in a watershed plan. In theory, this definition includes just about everybody; in reality, it merely refers to those folks that actually show up to speak their mind.

Not all stakeholders are equal, however. In a literal sense, each has a different stake in the outcome of the plan, and is expected to perform a different role in the watershed restoration 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. 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. Effective watershed managers recognize the wide diversity in stakeholders, and structure their planning process to provide multiple options and opportunities for involvement.

Stakeholders usually fall into one of four distinct groups that interact to produce restoration plans, as shown in Figure B1. The four groups include the public, agencies, watershed partners and potential funders. Conceptually, stakeholder involvement can be viewed as a pyramid, with expanding levels of involvement. The base of the pyramid contains the greatest number of stakeholders, many of whom are initially unaware of watershed problems and their potential role in restoration. The awareness and involvement of stakeholders becomes progressively greater toward the top of the pyramid. Stakeholders found at the apex of the pyramid represent key decision-makers, and are generally considered the champions for restoration. The remainder of this appendix describes each of the four stakeholder groups in more detail.

Agency Stakeholders

Local government has primary responsibility for urban watershed restoration. In reality, these responsibilities are usually spread over a wide assortment of bureaus, departments, agencies and divisions that rarely coordinate much with each other. As a result, it is useful to think of all these individuals and units as occupying different levels of the stakeholder pyramid (Figure B2). The apex of the pyramid consists of the elected officials and the lead local restoration agency that are the champions of restoration, and who act to coordinate the actions of all other units of local government. Elected officials are critical stakeholders since they must vote to approve budgets for restoration plans.

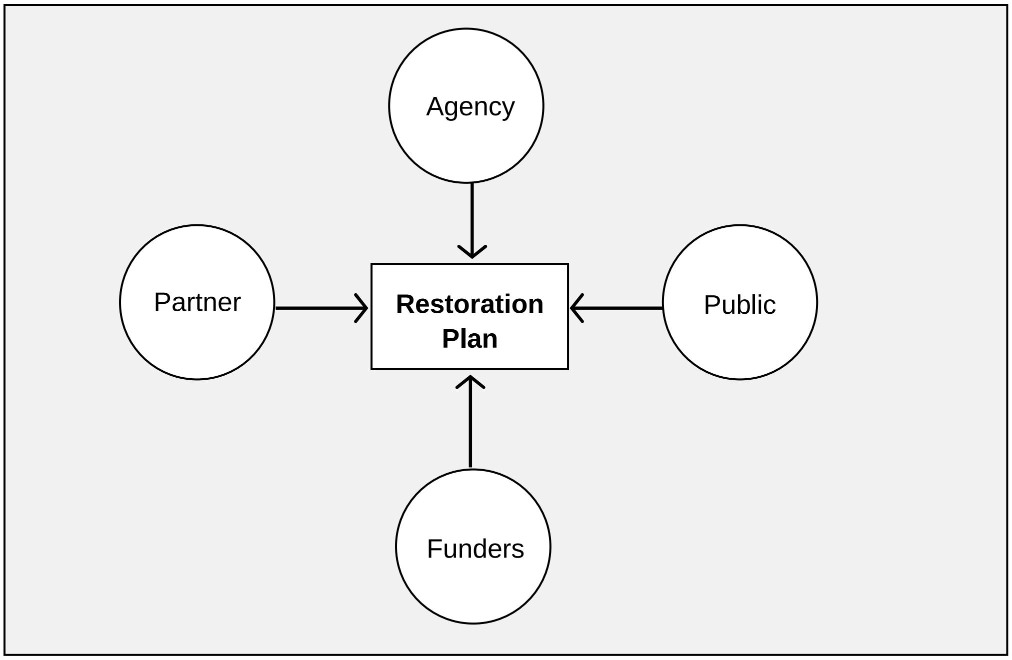

Figure B1: Four types of stakeholders involved in watershed restoration plans

The next tier consists of agencies that deal directly with local environmental issues or services, followed by agencies that own or control land where restoration practices may be constructed (e.g., schools, parks, etc.). The next rung is occupied by local agencies that may not initially perceive restoration as a core part of their mission. A good example is a local planning and zoning authority that can contribute to subwatershed restoration by adopting better development standards for infill and redevelopment.

The bottom of the pyramid consists of *state and federal* agencies that regulate water quality or protect natural resources. These agencies are critical, since they may need to approve permits for restoration practices or even approve the restoration plan itself (e.g., in the case of a TMDL). Some agencies can also lend staff expertise and provide monitoring and mapping data to support the restoration effort.

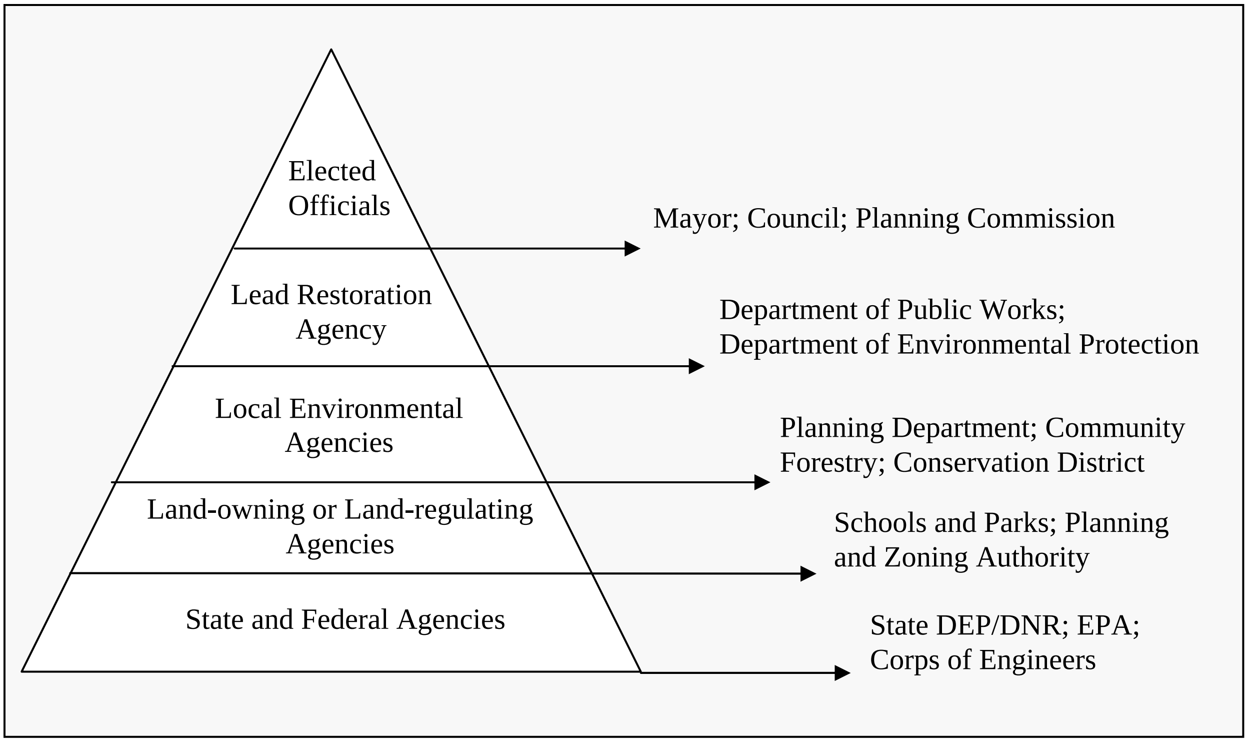

Figure B2: The Agency Stakeholder Pyramid
Dozens of local, state and even federal agency stakeholders need to be involved to coordinate effective local restoration planning.

The Public

The public is a major stakeholder in every watershed restoration effort; although as individuals, they may be unaware of this role. Indeed, watershed awareness and activism varies considerably among the public, and can be best understood in terms of a pyramid (Figure B3). The *general public* make up the bottom of the pyramid, and initially possess a low level of watershed awareness or involvement. Indeed, much of what they know about watersheds comes from the local paper or evening news. Increasing the awareness of the general public is important, given that the collective impact of their individual actions can improve or degrade watershed health.

The next level of the pyramid is occupied by the *receptive public*. As voters, they may support stronger local environmental initiatives, and might be willing to change daily behaviors to protect the watershed, such as installing rain barrels, planting trees or picking up after their pets. Education, outreach and direct municipal services may often be needed to improve personal stewardship among the receptive public.

The next subset is the *adjacent public*, which includes people that live near the stream corridor and will be positively or negatively affected by any restoration practices constructed within it. Since they have such a direct stake in the outcome of restoration, this group must be continuously informed as to how restoration practices will influence their neighborhood and property values.

The *activist public* occupies the next rung on the pyramid. This group consists of community leaders in neighborhood

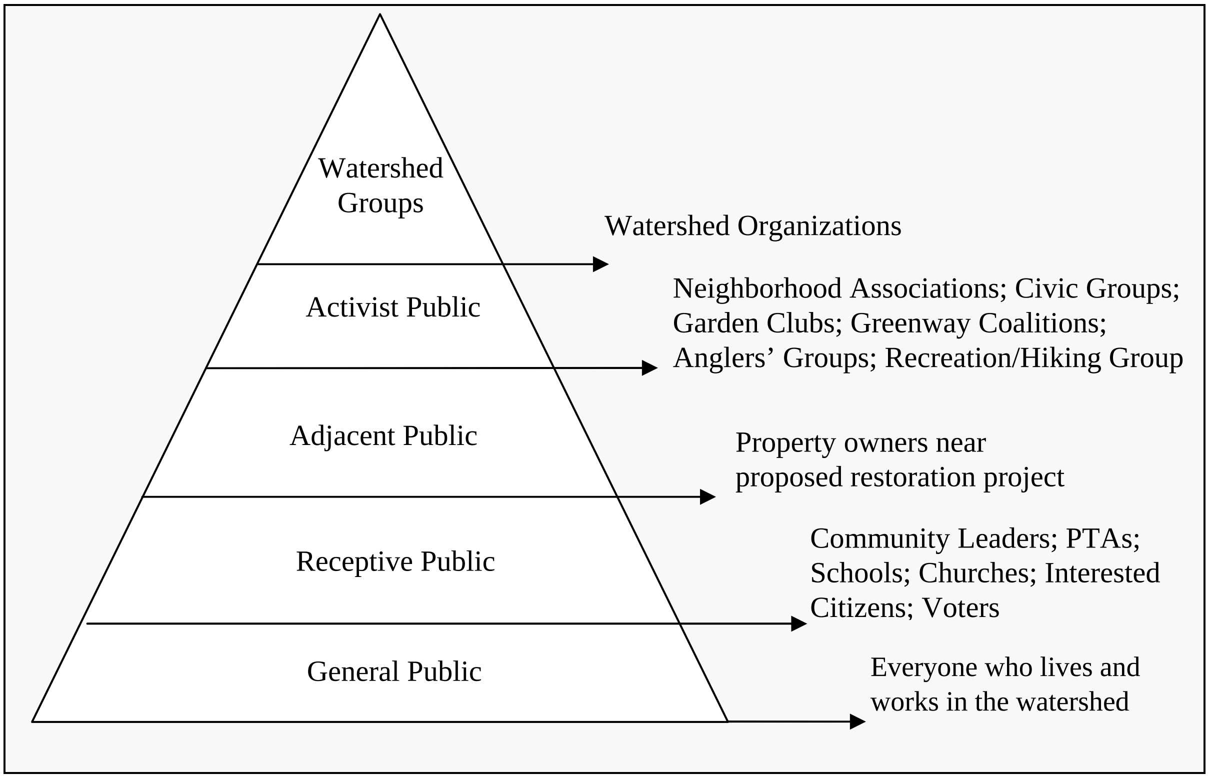

Figure B3: The Public Stakeholder Pyramid

Public stakeholders are not monolithic, but can be stratified on the basis of their awareness, stewardship activities, and interest in participating in the local watershed restoration process.

associations, civic groups, garden clubs, recreational enthusiasts, and the like. While watershed restoration may not be their main mission, the activist public often recognizes its potential benefits for the community. Enlisting the activist public in the restoration cause can be very important, given the strong influence they exert both in the community and on the local political process.

The apex of the pyramid is occupied by *watershed groups* that are organized to advocate for urban watersheds and help implement local restoration plans. Few subwatersheds possess such a group at the beginning of the restoration process, but they should always have one at the end.

Watershed Partners

The watershed partners stakeholder group consists of non-local government partners that are expected to perform many important roles in watershed restoration. Figure B4 depicts the diversity of watershed partners involved in local restoration.
Responsible parties include utilities whose activities or discharges are regulated by permit or ordinance. The goal is to align their pollution control efforts with the goals for watershed restoration.

Local media are also valuable watershed partners, since they have the best means to broadcast information about watershed restoration to the general public through local

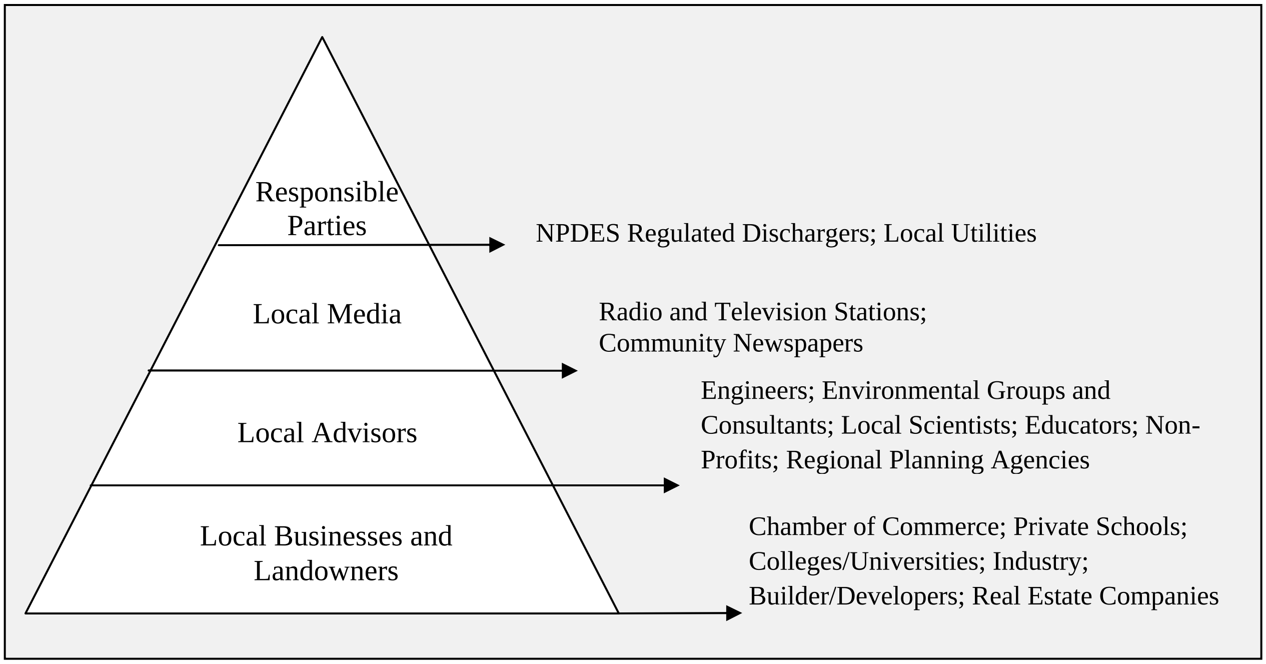

Figure B4: The Partner Stakeholder Pyramid
Many different partners comprise this diverse stakeholder group asked to perform many roles in watershed restoration, including implementing pollution controls, spreading the restoration message, providing expertise, and integrating restoration goals into their normal operations.

television, community newspaper and radio. Restoration requires a lot of expertise, and *local advisors* are the stakeholders that can bring it to the table. Examples of local advisors include engineers, environmental consultants, local scientists and educators. In addition, many non-profit organizations and regional planning agencies can contribute data and expertise to the watershed restoration effort.

Local businesses and landowners can be voluntary watershed partners, although they often start with a low level of awareness or may be suspicious of potential regulation. However, it is very important to enlist their cooperation to improve stewardship on the lands they own and the operations they control.

Funders

Funding partners are the stakeholders expected to finance watershed restoration at some point in the future. The diversity of funding stakeholders can also be viewed in terms of a pyramid (Figure B5). The top of the pyramid is occupied by *local government* who has the primary responsibility to finance restoration, especially during the early planning stages. The most common local revenue streams are operating budgets, capital budgets and storm water utilities. Most communities are already spending more money than they think on restoration activities, although these costs are frequently spread across many different agency budgets. Clearly, the agency heads, budget experts, and elected officials that control local purse strings are important individual stakeholders, and they need to be continuously educated on how restoration benefits the community and why the restoration investment is justified.

The next two levels on the funding pyramid are occupied by *state and federal funding sources*, which can provide grants, loans or direct technical services to supplement local restoration investments. State and federal funding stakeholders usually get many more funding requests than they can meet, so it is important to emphasize why the local watershed should be a top priority for

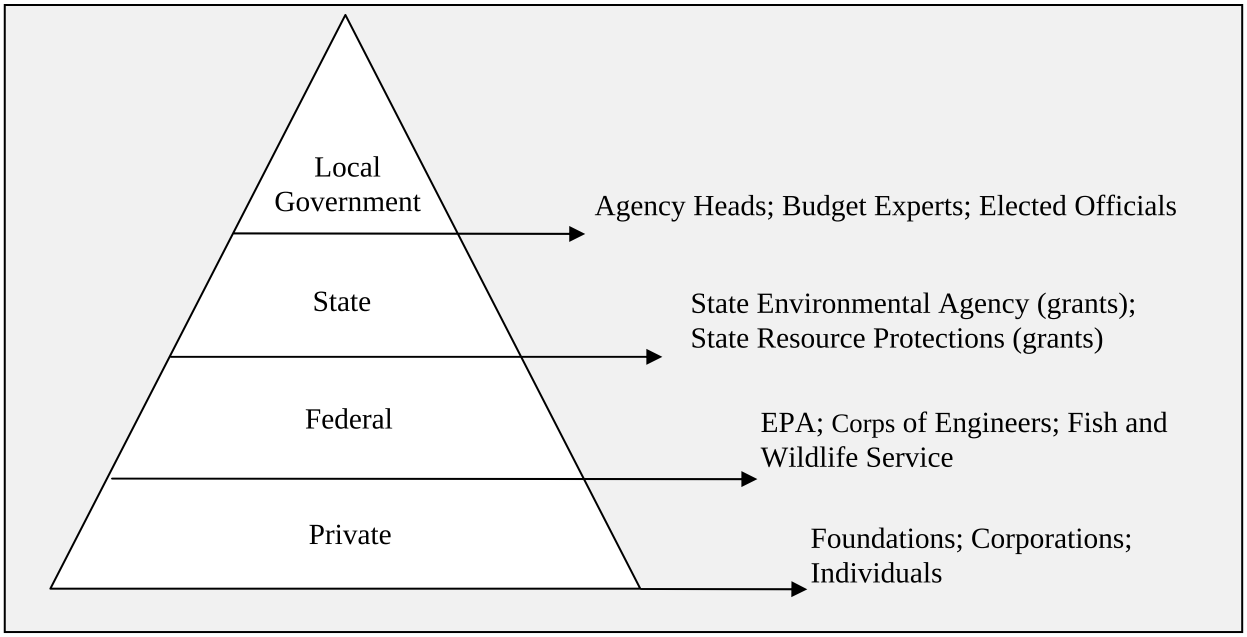

Figure B5: The Funder Stakeholder Pyramid

This group of stakeholders constitutes the major investors in local watershed restoration. Stakeholders near the top of the pyramid usually provide the greatest share of overall funding, but a targeted education strategy is always needed to cultivate each group of potential investors.

funding and to demonstrate the width and breadth of the local restoration partnership. The last rung of the pyramid is occupied by *private funding sources*. This diverse group of funders includes foundations, corporations, and individuals that can provide supplemental funding for selected restoration tasks. Private funding sources like to give to people, and see on-the-ground results at the community scale. Consequently, they tend to support grassroots watershed organizations rather than local governments. All funding stakeholders should be viewed as investors, and should be continuously updated about the costs of restoration and the benefits it provides to the community.

Appendix C: Needs and Capabilities Assessment (NCA)

Most communities already possess many of the ingredients needed for successful watershed restoration. With a little thought, you should be able to recognize regulations that mandate watershed restoration, local staff that can provide technical and programmatic assistance, and potential funding sources you can use to build an effective restoration 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 restoration, as well as identify potential resources you may not have considered.

The NCA is divided into five parts:

Part 1. Regulatory Forces Driving Watershed Restoration. This part examines federal and state "regulatory drivers" that influence watershed restoration 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, restoration experience, funding and mapping resources.

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

Part 5. Community Attitudes. This part identifies current community attitudes towards streams and watersheds. Community support can make or break restoration 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 endeavors.

Part 1. Regulatory Forces Driving Watershed Restoration

1.	**Does my community have a Phase I or II NPDES storm water permit?** *If so, local municipalities are required to meet a set of minimum management measures to reduce storm water impacts. These measures include implementing education and outreach, storm water 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.*	☐ Yes ☐ No ☐ Don't Know
3.	**Does your community have combined or sanitary sewer overflows?** *If yes, then your community would certainly benefit from storm water reduction activities. Alternatively, municipalities may be in the process of sewer separation and outfall modifications that might be linked with your stream and 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 Endangered Species Act (e.g., Pacific salmon, Barton Springs salamander).*	☐ Yes ☐ No ☐ Don't Know
6.	**Is your watershed within the jurisdiction of a regional or multi-state watershed agreement, a coastal management program, or a national estuary program?** *If so, look to MOUs and agreements, or 6217 and NEP program guidance to assist in establishing restoration goals or providing financial or technical support to restoration planning.*	☐ Yes ☐ No ☐ Don't Know
7.	**Is environmental protection/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 (e.g., forest conservation, storm water 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

Part 2: Local Agency Capacity

8.	**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
9.	***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
10.	**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
11.	**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
12.	**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
13.	**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
14.	**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.*	☐ Schools ☐ Parks ☐ Utility ☐ Golf course ☐ Municipality ☐ Don't Know

15.	**Are any green way or waterfront revitalization efforts planned or underway in your watershed?** *If so, these are great opportunities for you to slip in some restoration projects.*	☐ Yes ☐ No ☐ Don't Know
16.	**Have any inventories been conducted to identify natural area remnants, such as 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.*	☐ Yes ☐ No ☐ Don't Know
17.	**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
18.	**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
19.	**Do capital or operating budgets exist that can be used or leveraged for restoration purposes?** *Examine local capital and operating budgets to find line items and program areas that are related to watershed restoration.*	☐ Yes ☐ No ☐ Don't Know
20.	**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 h*ow the *municipal contracting process to develop restoration projects.*	☐ Yes ☐ No ☐ Don't Know
21.	**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 restoration. Review the project reports for previous grants.*	☐ Yes ☐ No ☐ Don't Know

Part 3: Your Local Agency Restoration Rolodex

22.	**What local 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!).*	☐ Don't Know Contact:
23.	**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:
24.	**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 restoration projects.*	☐ Yes ☐ No ☐ Don't Know Contacts:
25.	**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.*	☐ Yes ☐ No ☐ Don't Know Contacts:
26.	**Do you know which department handles storm water and flood plain management functions?** *These folks are critical partners in constructing storm water retrofit, stream restoration, and wetland enhancement projects.*	☐ Yes ☐ No ☐ Don't Know Contacts:
27.	**Do you know 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.*	☐ Yes ☐ No ☐ Don't Know Contacts:
28.	**Do you know 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.*	☐ Yes ☐ No ☐ Don't Know Contacts:

29.	**Who is responsible for environmental 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.*	☐ Yes ☐ No ☐ Don't Know Contacts:
30.	**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.*	☐ Yes ☐ No ☐ Don't Know Contacts:
31.	**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 ☐ No ☐ Don't Know Contacts:
32.	**Do you know the department that handles development review and land use planning?** *Watershed development can negatively impact stream quality, and there are many stages along the land development process where environmental safeguards can be applied. Get to know your local process and find out where your input is most valuable.*	☐ Yes ☐ No ☐ Don't Know Contacts:

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

33.	**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 *Contacts:*
34.	**Do any colleges or universities exist within 30 miles of your watershed?** *If so, consider all the free academic research and student labor you can direct towards your watershed.*	☐ Yes ☐ No ☐ Don't Know Contacts:
35.	**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 Contacts:
36.	**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 *Contacts:*
37.	**Do developable areas still exist in your watershed?** *If so, get to know your local homebuilders association. Let them take you out lunch. Open space design can be mutually beneficial to builders and environmentalists. In some cases, restoration or afforestation opportunities may present themselves.* *If not, keep your eye open for storm water retrofit and land reclamation opportunities. Opportunities for improving storm water treatment may also be found during redevelopment such as green rooftops.*	☐ Yes ☐ No ☐ Don't Know Contacts:
38.	**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 restoration effort.*	☐ Yes ☐ No ☐ Don't Know Contacts:
39.	**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 Contacts:

40.	**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 restoration progress over time. If not, you may consider building a case for gauge installation.*	☐ Yes ☐ No ☐ Don't Know Contacts:
41.	**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 Contacts:
42.	**Are any GIS mapping layers are 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

Part 5: Community Attitudes

43.	**What are the primary water quality 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 (air quality, economic growth, historic preservation, etc).*	☐ Yes ☐ No ☐ Don't Know
44.	**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 restoration activities than to link them to recreational amenities. Enlist hiking, biking, canoeing, and other recreational groups to your cause.* *If not, maybe you can work towards that goal.*	☐ Yes ☐ No ☐ Don't Know
45.	**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 restoration should contain a public component designed to engage and inform your local community.*	☐ Yes ☐ No ☐ Don't Know
46.	**Are elected officials or senior agency staff aware of the term *watershed restoration*?** *If framed in the right way, watershed restoration can be politically popular because it provides services to constituents in the neighborhoods and public areas.*	☐ Yes ☐ No ☐ Don't Know
47.	**Has the local press/media covered your watershed in the past year?** *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 general public and giving some recognition to supportive local officials and staff.*	☐ Yes ☐ No ☐ Don't Know

Other comments/notes:

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
13. Community Organization (presence/absence)	**Organizations exist and are active** Award points based on stakeholder assessment of organizational capacity	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.