7. Monitoring Component

This section describes the monitoring component of the watershed implementation plan. Criteria for judging results of implementation and water quality monitoring against prescribed milestones are identified. Finally, it provides for re-evaluation of implementation efforts, project milestones, restoration measures, and TMDLs if progress is less than expected.

7.1. Criteria for judging results of implementation and water quality monitoring against prescribed milestones

The stakeholders helped to select indicators that will be used to measure the current health of the watershed and to provide a way to measure progress toward meeting the watershed goals. Indicators are direct or indirect measurements of some valued component or quality in a system. Indicators are also extremely useful for assessing and communicating the status and trends of the health of a watershed. Indicators, however, do not tell us the cause of the problem. For example, we might use a thermometer to measure stream temperature. An elevated temperature might indicate a problem, but it does not specifically tell us what the problem is, where it is, or what caused it. Our stakeholder group identified the indicators that will be used to quantify existing conditions in the watershed.

Indicators are selected, refined, added to, and modified throughout the watershed planning and implementation process. As we completed the characterization phase and developed goals and management objectives, we shifted our indicators from those that assess current conditions to those that quantitatively measure progress toward meeting our goals. For example, in the Codorus Creek watershed, the goal is to reduce sediment loadings to meet water quality standards and support all beneficial uses. Table 7-1 shows indicators that may be used and related target values for measuring progress toward reducing the sediment load.

Table 7-1. Environmental Indicators Used to Identify Relationships Between Pollutant Sources and Watershed Conditions

Issue	Indicator	Target Value	Use
Sediment	Pebble counts (% fines <2mm)	<20%	Pebble count provides an indication of the type and distribution of streambed material. Too many fines can interfere with fish spawning and degrade the habitat for aquatic invertebrates.
	Stream Channel Stability	No significant risk of bank erosion	Channel stability uses a qualitative measurement with associated mathematical values to reflect stream conditions (Rosgen 1996).
	Total Suspended Solids (TSS)	Monthly average concentration <40 mg/L	Suspended solids can adversely affect stream ecosystems by filling pools, clogging fish gills, and limiting sunlight penetration and transparency of the water column critical to aquatic flora.
	Turbidity	<25 NTU	Turbidity measures the clarity of water and can also be used as an indirect measurement of the concentration of suspended matter.

7.1.1. Selected Quantitative Indicators

In developing the Codorus WIP, we conducted watershed assessments and analyses to quantify source loads, characterize impacts, and estimate the load reductions needed to meet our goals and objectives. Sometimes the source loads and load reductions will be expressed in slightly different terms, such as the number of miles of eroded banks and the miles of vegetated buffers needed to address the problem. Regardless of the approach, the important point to remember is that quantification is the key to remediation. If we can't somehow measure the problems we're facing, it will be almost impossible to know whether we're making any headway in addressing them.

For watershed planning purposes, indicators need to be quantitative so that the effectiveness of management measures can be predicted. For example, one of the goals identified by stakeholders is "restore aquatic habitat to meet designated uses". We believe the habitat has been degraded because of elevated levels of sediment entering the Codorus Creek, and indicators for sediment loading will be used to measure progress toward achieving that goal.

Where TMDLs exists, important indicators have already been defined and we have incorporated them when selecting appropriate management actions to implement the load reductions cited in the TMDL. Where no TMDL exists, selected indicators are linked to our water quality restoration or protection goals, such as pollutant concentrations or other parameters of concern (e.g., channel instability, eroding banks, channel flow, flow cycles). The indicators selected will consider the impacts, impairments, or parameters of concern in the Codorus Creek and the types and pathways of watershed stressor sources that contribute to those impacts.

7.1.2. Monitoring: Pre- and Post-Construction

Monitoring is conducted to measure success, and success in the field of natural stream channel restoration can be two-fold in purpose: 1) to meet permit conditions and measure the success of a project's specific objectives, and 2) to measure the performance of natural stream channel designs over the long term. Monitoring also provides baseline conditions and a measurement of change over pre-construction conditions.

A natural channel develops a particular form over a long period of time. It makes continual adjustments in width and depth as it experiences a wide range of storms and low flow events. Monitoring for short periods of time (only one or two years) implies that stability is established or should be established the day the channel is built. Therefore, monitoring over a period of at least three years is recommended to provide time for the stream channel to become more fully established.

In measuring project success, objectives expressed in terms of measurable stream conditions provide the basis for monitoring the success of the project. Define monitoring parameters to match your objectives and make sure your objectives are both achievable and measurable.

It's important to build monitoring components into the assessment phase of your project. Establish pre-construction monitoring components and locations. Monitor the poorest sections early on -- aim to document before and after construction and those conditions at the worst sections of impacted stream reaches.

Remember that the three main objectives of natural stream channel design are sediment transport, habitat restoration, and bank and channel stabilization. Determine ways to monitor for each of these three objectives, keeping in mind that there will be varying degrees to which these objectives are sought. Identify your MAIN objectives and plan to monitor accordingly.

Remember also that the reference site establishes baseline conditions to provide an accurate basis for measuring change.

Our monitoring plan includes pre-construction, as-builts, and post-construction monitoring to show whether the project was successful in meeting stated objectives. The plan should define monitoring parameters, sampling frequency, sampling locations and analytical procedures. Documentation on structures (their size, length, slope, rock size, etc.) should be part of your monitoring strategy. It's a good idea to involve the project designer in the selection of monitoring parameters.

Reference worksheet:

- Morph Chart (Appendix I) includes a column for as-builts.
- Field Survey Procedures for Characterization of River
- Morphology (Appendix I)

We're taking an adaptive management approach -- monitoring and evaluation teaches us new things in natural stream channel design. Unforeseen problems may require midcourse corrections either during or shortly after implementation.

We plan to use volunteers from watershed organizations, sportsman clubs, and senior volunteer organizations, such as the Environmental Alliance for Senior Involvement (EASI) to assist with short and long term monitoring tasks.

Monitoring Recommendations

- Duration of monitoring period: minimum of three years

- As Built Surveys: As Built surveys, which are now required by DEP, should be done within 60 days post-construction. Following construction, an as-built site plan should show:
  1. Any field adjustments in plan -- additions/deletions

2. Post-construction cross-sections (monumented) and longitudinal profile
3. Elevations and placement of structures
4. Constructability -- discuss access to project, utilities, selection of equipment
5. Breakdown of costs (optional: materials, construction, design, construction management)
6. Photos: take at monitoring stations and cross-section areas, upstream and downstream of project.
   Reference documents: Morph Chart (Appendix I) and Field Procedures for Characterization of River Morphology (Appendix I)

- Frequency of monitoring: During first year post-construction, a minimum of two times/year plus several bankfull storm events (as-built plus one more time unless there is not a bankfull event). For 2-5 years postconstruction, a minimum of 1x/year plus several bankfull storm events.

- Monitoring reports: Long term monitoring reports should include comments on structures (erosion at structures, narrative on any tweaking done), survivorship or percent cover of riparian vegetation or wetlands (this is often specified in the 404 permit special condition), and an evaluation of whether goals/objectives have been met. Note any monitoring requirements as part of required permits.

- Monitoring components: Parameters should reflect those measures needed to meet the project's objectives. It's also important to consider the capability and dedication of people who will be involved in conducting the monitoring activities.

<u>Channel characteristics</u>

- Monumented cross-sections (required by DEP)
  - Longitudinal profile
  - Slope
  - Riffle/pool characteristics
- Pebble Count
  - Bed particle size distribution
- Pattern
  - Sinuosity, meander lengths, radius of curvature
- Bank stability (optional)
  - Bank pins
  - Scour chains for measuring aggrading or degrading streambed
  - BEHI (bank erodibility index)
  - Bank stability (Pfankuch Stability Rating)

<u>Biological characteristics</u>

- EPA's RBP (Rapid Biological Assessment Protocol) assessment form
- PA Modified RBP (Rapid Biological Assessment Protocol) assessment form
- Penn State University's AVStrEAMS (Appendix II)

Currently, the Citizen Volunteer Monitoring Program under DEP is developing monitoring guidance for natural stream channel restoration projects. For an update, contact CVMP at 717-772-5807.

7.1.3. Minimum NSCD Monitoring Criteria for Volunteer Groups

The as-builts and permanent cross sections need to be set-up by the designer/ consultant Reports must be submitted as specified in permit conditions or as required in grants. (Discussion with 105 permitters should take place before monitoring begins so that everyone understands what is needed to meet permit requirements.)

Reports should include the following:
- State permit number
- Project name, location, and county
- State objectives of the project and project completion date
- Project monitoring contact person with phone number
- Project map with structure locations and photo locations
- Label structures from upstream to down stream, and left to right is as you look down stream

Project walk through (minimum of once per year, few times per year better)
- Make notes of structures (i.e.; are all the rock there, rocks missing, etc)
- Note any erosion along stream and/or structures.
- Note vegetation (i.e.; well established, somewhat bare, etc.)
- Note anything out of the ordinary

Establish photo points (with designer/consultant):
- Take photos from same established points each visit (indicate location, date and time)
- Take extra photos in areas of concern (i.e.; new eroding area, bank failure, structure rock missing, etc)
- Label photos and include a brief explanation of content and details

Complete cross section information using the “Cross-section Measurement Procedure” attached (or similar methodology). A minimum of two cross-sections, one riffle and one pool, that has been located in an area of concern should be completed.

7.1.4. Optional Monitoring

The following monitoring protocols are considered to be optional and may be employed as needed:

- Water chemistry (depends on available resources, may include lab analysis, meters, field kits like EASI HACH method)
- Stream flow volume/discharge (EASI method) and/or staff gauge reading (USGS gauge or constructed staff gauge) during project inspection
- Bank profile using toe pin (useful if no cross section is present)
- Riparian vegetation analysis (Adopt-A-Buffer Toolkit: Monitoring and Maintaining Restoration Projects, Delaware Riverkeeper Network, PA or DEP Watershed Snapshot Riparian Zone Survey)
- Invasive plant identification (Adopt-A-Buffer-Toolkit or similar methodologies)

7.2. Selected Combination of Indicators

We'll use different types of indicators to reflect where we are in the watershed management process and the audience with which we are communicating. We'll first select environmental indicators to measure the current conditions in the watershed and help to identify the stressors and the sources of the pollutants. As we developed our management objectives and actually assembled our watershed plan, we'll add performance indicators, such as social and programmatic indicators, to help measure progress toward meeting our goals. Table 7-2 provides indicators used throughout the watershed plan development and implementation effort.

Table 7-2. Logical Model for Water Quality Improvements of Codorus Creek

SITUATION	INPUTS	OUTPUTS		OUTCOMES		
Water quality of Codorus Creek is not meeting its designated uses due to impairments by sediment and nutrients primarily from stream bank and channel erosion, and secondarily from upland sources.	What we invest	What we do	Whom we reach	Short-term Results	Mid-term Results	Long-term Results
	• Funding for restoration efforts • Agency partnerships • Local expertise • Volunteers	• Landowners • Resource managers • Water users	• Landowners adjacent to Codorus Creek and its tributaries	• Landowners learn benefits of riparian management, i.e., buffers, fencing, crossings, etc. • Landowners discuss options and benefits with neighbors and colleagues	• Landowners cooperate and allow restoration and assume maintenance responsibility • Landowners install additional BMPs including buffers, fencing, crossings, etc.	• Meet designated uses of Codorus Creek • Ensure social, economic and environmental sustainability

<u>The Audience</u>

Indicators provide a powerful means of communicating to various audiences about the status of the watershed, as well as demonstrating the progress being made toward meeting goals. Selected indicators will help to communicate these concepts to non-technical audiences. For example, using a pounds per day/year sediment loading rate to demonstrate reduction in sedimentation of the Codorus Creek won't mean much to most people. But using the number of fish and/or macroinvertebrates that have been reported because of the reduction of sediment inputs is easier to understand. Or being able to count the number of failing septic systems that have been located and repaired shows people how the sources of pathogens are being reduced.

Environmental Indicators

Environmental indicators are a direct measure of the environmental conditions that plan implementation seeks to achieve. The indicators will be directly related to the indicators selected for our management objectives. By definition, the indicators are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. Targets goals are defined by the values of the selected indicators. Frequently these targets reflect water quality standards for designated uses. In other cases, qualitative standards for water quality and habitat protection need to be interpreted to establish the criteria. For example, the indicator phosphorus is used to target reductions of the instream sediment concentration value or a total allowable load that is expected to protect the resource.

Programmatic Indicators

Programmatic indicators are indirect measures of resource protection or restoration (e.g., the number of management practices or the number of point source permits issued). These don’t necessarily indicate that we’re meeting our load reductions, but they do indicate actions intended to achieve a goal. When we developed the WIP, we looked for important programmatic actions that can be tracked over time. Programmatic indicators include measures such as recording the number of people attending workshops, the number of projects approved, the number of monitoring samples taken, and dollars spent.

Social Indicators

Social indicators measure changes in social or cultural practices, such as increased awareness on watershed issues, and behavior changes that lead to implementation of management measures and subsequent water quality improvements. Indicators may include the percent of landowners along the stream corridor that know what a watershed is or the number of homeowners that sign a pledge to reduce fertilizer use. Consider the methods you’ll use to collect this information, such as pre- and post-surveys, focus groups, and one-on-one interviews. Table 7-3 provides indicators that may be used to measure progress or performance. Regardless of the type of indicators and targets you develop, you should establish some means for tracking, storing (e.g., database), and reporting progress against these values.

Table 7-3. Performance Indicators Used to Develop Targets to Measure Progress in Meeting Watershed Goals

Environmental	Programmatic	Social
• Number (or percent) of stream miles that meet water quality	• Number of BMPs implemented in the watershed	• Participation rates public education and outreach programs

standards		about solving NPS problems
• Number (or percent) of stream miles that meet one or more designated uses	• Number of approved or certified management plans (e.g., E&S control, GP-3, NPDES, Conservation, Nutrient Management, Stormwater Management)	• Increase in the awareness, knowledge and actions designed to change social behavior patterns
• Number (or percent) of stream miles that meet one or more numeric water quality standards	• Number of ordinances developed and implemented to restore and protect watershed	• Participation rates in various watershed-related volunteer stewardship activities (e.g., assessments, monitoring, restoration, etc.)
• Demonstrated improvement in water quality parameters (e.g., pH, DO, TSS)	• Number of visits to watershed groups, agencies and nonprofit web sites	• Increase in participation at watershed stakeholder forums
• Demonstrated improvement in biological parameters (e.g., increase in numbers and diversity of macroinvertebrates)	• Number of municipalities implementing septic system management programs	• Increase in number of stakeholders practicing watershed stewardship
• Demonstrated improvement in physical parameters (e.g., channel miles stabilized, increased riparian habitat)	• Number of illicit stormwater discharges identified and corrected	• Increase in the number of stakeholders cleaning and inspecting septic systems every 3-5 years.
• Number (or percent) of stream miles removed from "threatened" list	• Number of permits issued	• Increase in participation of locally led watershed planning, restoration and protection initiatives
• Number (or percent) of stream miles removed from TMDL lists	• Number of public water systems with source water protection plans	
• Reduction in nonpoint source pollutant loadings	• Minimization in the amount of impervious surfaces to ≤10 of total watershed area	
• Reductions in frequencies of peak flows downstream of developing areas	• Increase in number of locally led watershed planning, restoration and protection initiatives	
• Increase in the number of acres of floodplains and wetlands restored or protected		
• Reduction in the amount of trash collected in stormwater systems and streams		

7.3. Codorus Creek Restoration Efficacy Program (CCREP)

The Codorus Creek Restoration Efficacy Program (CCREP) at Penn State York (PSY), in partnership with local watershed organizations and the Pennsylvania Department of Environmental Protection (PA DEP), is assessing the outcome of stream restoration efforts on aquatic ecosystem health and water quality in the Codorus Creek Watershed, York County in southcentral Pennsylvania. In addition to this research mission, the program is committed to educational outreach to promote public awareness of watershed issues in York County including why many of our streams require restoration, what stream restoration entails, and what benefits are expected locally and downstream to the Susquehanna River and Chesapeake Bay. This website, once completed, will provide an interface for learning about the Codorus Creek Watershed, restoration efforts initiated by local watershed organizations, current CCREP research and results, and ways you can get involved in helping your watershed.

For more information, the reader is referred to the follow web site:

http://www2.yk.psu.edu/~mph13/CCREP%20Index.htm#

7.4. Provisions for reevaluation of implementation efforts, project milestones, restoration measures and/or TMDLs if progress is less than expected

There are two primary reasons to evaluate our watershed program. First, we want to be able to prove, or demonstrate, that by implementing the management measures, we are achieving our water quality and other environmental goals. Second, we want to be able to continually improve our program in terms of efficiency and quality. This adaptive management process is built into our program before implementation so that we ask the right questions and use the answers to strengthen our program during implementation. Collecting information does no good if we don't use the information to improve our watershed program.

We developed an evaluation framework to use once we begin to implement our watershed plan. The framework was developed before implementation so that we can effectively identify what measures we want to evaluate and determine how we will obtain the information. We should recognize that we'll continue to build on the initial characterization, filling information gaps and refining the connections between sources, pollutants, and load reductions. We'll adapt our implementation efforts on the basis of new information collected, changes in the operational structure of our partnership, emerging technologies, and monitoring results.

7.4.1. Structure of Evaluate Framework

In general, we will evaluate three major parts of our watershed implementation program to be able to demonstrate progress and make improvements in our program. We need to structure our evaluation framework to consider all three components and developed indicators that will measure each. The components are inputs, outputs, and outcomes. When "filling in" these components, we'll work backward, starting with our desired outcomes (goals) and working toward identifying the specific inputs needed to achieve those outcomes.

1. **Inputs:** the process used to implement your program. This includes inputs to your program such as resources of time and technical expertise, organizational structure and management, and stakeholder participation. Evaluation questions are:
    a. Are the human and monetary resources allocated sufficient to carry out the tasks?
    b. Did stakeholders feel they were well represented in the process?

2. **<u>Outputs:</u>** the tasks conducted and the products developed. This includes the implementation activities such as installing management practices, developing brochures, holding workshops, preparing fact sheets, and so forth. Evaluation questions are:
   a. Are we meeting our implementation schedule?
   b. Are we meeting our milestones?
   c. Did we meet our milestones sooner than expected?
   d. Did we reach the appropriate target audiences with our I/E materials?

3. **<u>Outcomes:</u>** the results or outcomes seen from implementation efforts. This includes increased awareness and behavior changes among the watershed community, as well as environmental improvements such as water quality, habitat, and physical changes.

   Outcomes can be further broken down into short-term outcomes and long-term outcomes. Sample evaluation questions:
   a. Did the target audience increase its awareness of watershed issues?
   b. Did the behaviors of the target audience change as a result of implementing the watershed plan?
   c. Are we meeting our interim targets for pollutant load reductions?
   d. Are pollutant loads being reduced?

   Once we've determined the questions we want to answer, we set up the framework to collect the necessary information. One approach to setting up an evaluation framework is to use a logic model.

7.5. Logic Model Used to Develop an Evaluation Framework

Many programs use a logic model (Figure 7-1) to set up and evaluate their programs. The model is an important tool in the adaptive management process because it allows you to better document the results you find and helps you determine what worked and why. Logic models have been used for years in social programs and are now being used in the context of watershed management.

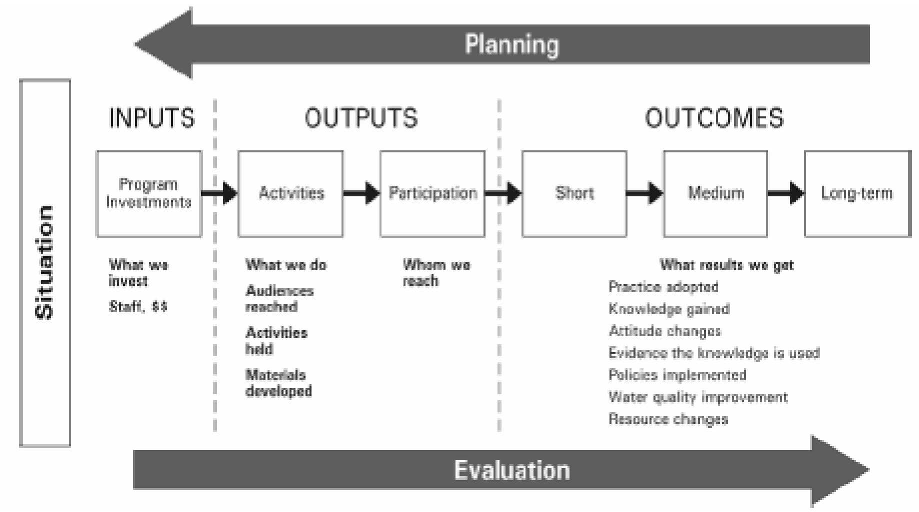

Figure 7-1. Logical Model Components

Basically, a logic model is a picture or visual representation of our program, showing the inputs needed to implement our program, the expected outputs to be performed, and the anticipated outcomes from implementing these activities. Using a logic model can help us to better document the outcomes, discover what works and why, and continually make changes to our program based on our evaluation results.

There are several benefits to using a logic model. First, the model puts all the information about our program in one place and can summarize a complex program in a simple picture. This is particularly helpful when communicating key activities to stakeholders. A logic model also shows the connections that link the inputs to results so that you can readily identify any gaps in the sequence. Finally, a logic model provides a "to do" list for evaluation, signaling what needs to be evaluated and when. The basic structure of a logic model includes stating our situation or problem, recording the inputs or resources needed, listing anticipated outputs from activities, and ultimately outlining the expected outcomes from the program. As we move from the inputs through the outputs and to the outcomes, there should be a direct link between the steps. These links are called "if...then" relationships. For example, if we invest the required staff time and resources (inputs), we'll be able to conduct the outlined activities (outputs). If we conduct those activities, we'll see the expected results (outcomes). Setting up a logic model this way can help us to identify gaps and revise some of the parameters as well as assist us with measuring and evaluating progress towards achieving implementation of management measures and watershed goals. Table 7-4 below lists the actual indicators that will be used to develop targets to track progress.

Table 7-4. Target Indicators Used To Track Implementation Progress

Concern: Little or no quality sportfish in streams due to heavy sedimentation Goal: Reduce sedimentation into streams to meet designated uses Objective: Install BMPs streamside and upland to reduce sedimentation by 25 percent		
Type of Indicator	Sample Indicators	Methods

Environmental (baseline conditions)	Turbidity, flow, suspended solids, channel stability	Direct water quality measurements, photographs, watershed assessments
Programmatic	# Stakeholders educated through outreach activities	Internet, e-mail, mailings, public forums, etc.
Programmatic	# Stakeholders educated through direct contact during assessments	Interviews , # signed landowner cooperator agreements
Social	# Stakeholder phone calls requesting information	E-mail, mail and phone records
Social	Increased public awareness and knowledge of watershed concerns and issues	Pre- and post-surveys, focus groups, locally led initiatives
Social	# Stakeholders requesting assistance to install BMPs	E-mail, mail and phone records
Social	# Stakeholders aware of financial and technical assistance available for BMP installation	# Requests for assistance, # signed landowner cooperator agreements, stakeholder $ leveraged
Programmatic	# BMPs installed	Tracking database
Environmental (measure implementation progress)	Channel stability, habitat quality & quantify, turbidity, flow, TSS	Direct water quality measurements, photographs, watershed assessments