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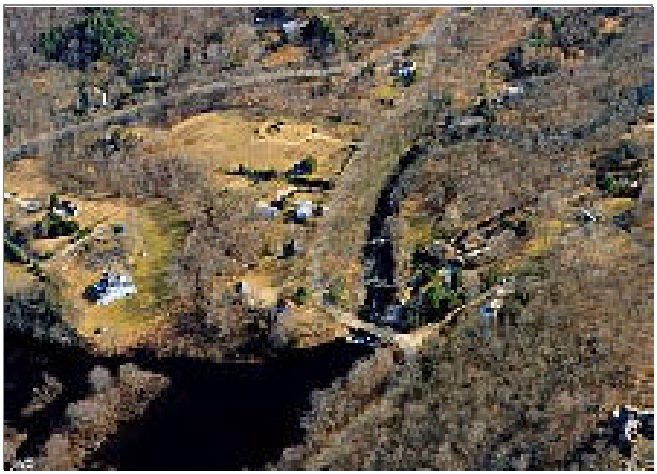
Overview To Watershed Assessment:

Tools For Local Stakeholders



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Introduction

The Watershed Framework

The Watershed Management Framework is being used increasingly to improve the receiving water quality of the nation's rivers and streams and the uses of its waterways. Using the watershed unit, rather than governmental boundaries as has been the case, provides for comprehensive, sensible water resource decisions and strategies, and addresses more effectively the full range of stakeholder concerns.

The "watershed approach" has long originated at the local watershed level, because of its practicality in problem solving among people, jurisdictions, and industries sharing a water resource. Now this approach is receiving a great deal of focus in the United States associated with the United States Environmental Protection Agency's (EPA) more formal development of the watershed approach. With rivers frequently serving as jurisdictional boundaries, water management concerns are best handled at the watershed, rather than jurisdictional, level. Working at the watershed level appropriately involves those most knowledgeable about the specifics of the river and its watershed: the interested governments, industries, citizens, and a full range of other interested stakeholders.

Various catalysts might lend impetus to the formation of a watershed organization: a single or compound water pollution issue, accelerated growth, or the proposal of a large industry or other project. The partnership formed by the watershed organization provides for one of the most critical elements to address water management: coordination of data from varying sources on a different geographic basis—the watershed.

Overview To Watershed Assessment

The watershed approach fosters the coordinated implementation of programs to control point source discharges, reduce polluted runoff, and protect drinking water sources and other sensitive natural resources such as wetlands. A watershed approach also highlights cost-effective opportunities to go beyond reducing chemical pollutant concentration, and instead to think about ways to enhance the overall health of the aquatic ecosystem and preserve biodiversity. The watershed approach also fosters greater interest from the public and provides a foundation for partnerships among federal, state, tribal, and local public and private watershed stakeholders.

Definition Of Assessment

The assessment phase is one of the first elements of effective water resources management. This document provides a set of "tools" to support these watershed-level frameworks to conduct the assessment phase. Assessment refers to a focused or comprehensive overview of key conditions and trends representing a baseline status. The assessment generates recommendations for management alternatives, a comprehensive plan, and a means of implementation.

In the case of water quality, it is essential for the assessment to include all available monitoring data. However, while the term 'assessment' can mean water quality monitoring, an environmental assessment report for a watershed should include all related material, especially land uses, soils and topography. The assessment should coordinate all relevant datasets and maps, which must be analyzed, organized and displayed so as to be most useful to later interpretation and management.

This effort requires intimate knowledge of the environmental conditions in the watershed, and will rely on the mix of agencies and institutions that must play a part in achieving coordinated and comprehensive solutions to today's complex pollution problems. Federal agencies can provide technical and, in some cases, financial assistance to facilitate watershed management. State and tribal leadership can bring all levels of government, the private sector and the public together to make the watershed approach work. But a watershed-up level approach reflects those most interested and affected in the watershed, who are best able to identify relevant data and interpret it in the context of the specific watershed.

Watershed assessment focuses on the overall watershed management program. It is critical in identifying pollutants of concern and the relative role of point and nonpoint pollutant sources, strategizing pollution prevention and control measures, and tracking progress and making adjustments towards meeting watershed goals and objectives.

Coordinating Data

Federal water quality monitoring and assessments are important aspects of many EPA programs authorized under the Clean Water Act, including the National Pollution Discharge Elimination System (NPDES), §106 State/Tribal Water Quality Program Management grants, § 305(b) Water Quality Inventory reports, and §300j-13 Source Water Protection under the Safe Drinking Water Act. The United States Geological Survey (USGS) also conducts instream chemical monitoring through its National Ambient Water Quality Assessment (NAWQA). However, due to the different program objectives, results from these programs are typically difficult to compare. Watershed-based assessment provides an excellent opportunity for coordinating information from existing and new federal programs.

At the state and local levels, information about pollution sources and impacts in a receiving water is collected and maintained by different organizations and agencies with little or no communication among them. For example, point source monitoring data may be maintained by the permit compliance branch of a state regulatory agency, biological monitoring data may be maintained by the fisheries division of the same state regulatory agency, and storm water outfall monitoring data may be gathered by the municipality. Sharing of collected, watershed-specific data among local and regional decision makers maximizes its usefulness and allows targeting of limited local dollars to collect any monitoring data necessary to fill in the gaps.

Watershed assessments do not necessarily require extensive additional resources if existing efforts are expanded to include a data coordination role. A useful watershed assessment report can be generated through better organization of existing information, supplemented with changes in existing monitoring procedures where necessary. The preliminary data review will identify if any additional water quality sampling, monitoring, and assessment is necessary to develop management strategies.

Purpose Of The Assessment

A watershed-based assessment provides a comprehensive evaluation of conditions and trends in the entire watershed. Watershed-based analysis can then be used to address the following objectives:

1. Characterize conditions and trends in water quality and watershed health;
2. Determine causes of existing and future water quality and watershed health problems;

3. Aid in the development, prioritization, and implementation of an overall watershed management program to prevent or correct the identified problems;
4. Establish a baseline and assess progress of overall watershed management activities or effectiveness of pollution prevention and control practices;
5. Support documentation of compliance with permit conditions and/or water quality standards and criteria;
6. Increase ecological and stakeholder benefits with minimal additional effort;
7. Provide data to calibrate and verify watershed/water body models;
8. Educate and inform the public; and
9. Refine the existing monitoring program.

The Watershed Partnership

Watershed partnerships should include all affected governments, and can be most effective through inclusion of representatives of municipal utilities, industries, business groups (such as the local Chamber of Commerce) and conservation advocacy organizations. Through such partnerships, resources are shared, roles are clarified, and cost effective practical solutions are put in place. As a result, a better informed and more involved constituency can make a commitment to lasting environmental improvements in their own community. While the goals, resources, and characteristics of the partnership will vary from watershed to watershed, this document outlines the typical roles and responsibilities of key watershed stakeholders and the strengths each brings to the partnership.

Purpose Of The Guide

This document describes the key steps to develop and implement watershed assessment plans. The term watershed assessment used here includes a variety of data collection, mapping and water sampling methods to characterize the environmental health of a watershed (see Table 1, page 10, for examples).

This document provides essential tools for local watershed stakeholders in overall assessment principles and structure. The second half is the *Resources* section, which contains essential reference material that will support the organization in proven techniques, so as to get a rapid start on devising the plan. The *References* section includes Web sites and electronic mapping (GIS) file availability, as well as extensive sources for paper map products fundamental to understanding a watershed. The Web-based version of this document is an electronic “portal” to all types of necessary material for an individual watershed assessment.

Roles and Responsibilities

Watershed assessment is inherently intergovernmental and interjurisdictional, because watershed boundaries do not correspond to political boundaries. Initiating a watershed assessment presumes a watershed coordinating group (or task force, commission, etc.) reflecting the appropriate balance of stakeholder concerns in the watershed. A coordinated assessment effort should encourage all stakeholders to become involved in the planning and implementation process, with the representatives of the stakeholders joining to form a watershed-based assessment team. Ensuring the appropriate participation of these various stakeholders at the outset will make efficient use of resources and avoid later obstacles.

The coordinator or coordinating group will serve as a central information repository, a QA/QC coordinator, and a general organizational contact. The group will establish goals and objectives, provide access to necessary data, and manage the scope and coordination of analysis. Stakeholders can provide data, scientific expertise, manpower, and even financial backing for assessment efforts. See Table 1 for a suggested responsibilities matrix.

Specifically, the coordinating group should have the ability and resources to perform the following tasks:

- Establish the Watershed Assessment Plan goals and objectives;
- Provide existing data and access to information that will aid in implementing the assessment strategy;
- Provide technical oversight and scientific expertise reflecting their responsibilities;
- Maintain appropriate contact with elected officials and appointed boards; and
- Develop funding options.

Federal Government Agencies

U.S. EPA can provide assistance through guidance, training, technology transfer, database assistance (e.g., STORET, BASINS, etc.) and by providing information from special projects in the watershed such as TMDL development.

Access to extensive information can be accessed via EPA's "Surf Your Watershed" program. EPA developed this Internet capability to facilitate information sharing by watershed, county, or other geographic unit. "Surf Your Watershed" (at URL http://www.epa.gov/surf) allows users to access information on a watershed level, including data such as ambient water conditions, water column chemistry, biological integrity, bottom sediment characteristics, instream designated uses or impairments or special protection areas, instream flow data, point source discharge data (e.g., compliance monitoring data), and watershed land use data. The site's Index of Watershed Indicators compiles information on the condition and vulnerability of watersheds in the United States. Fifteen indicators, including assessed waters which meet designated uses, fish consumption advisories, and contaminated sediments, are combined into an overall index score for every watershed in the nation. The Index also allows users to learn more about other organizations in their watershed. Watershed managers at the state and local level may access EPA's STORET (STOrage and RETrieval) data system (at URL http://www.epa.gov/owow/STORET). Available in PC or LAN version, STORET is a national system that can store virtually all types of water quality and biological data, and allows for data sharing among organizations. To aid in data sharing, a specific set of quality control measures is required for any data entered into the system.

Another important database available from EPA's Office of Water is the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) geographic information system (GIS) application. BASINS includes some of the data and modeling tools required for planning level evaluation and modeling of watersheds. This system assists federal and state agencies in performing large-scale assessments of watersheds, identifying and prioritizing pollution sources and issues, evaluating impacts on water quality, developing total maximum daily loads (TMDLs), and predicting the effects of management scenarios. BASINS' databases and tools are directly integrated within an ArcView GIS environment.

(Users should be alert to the importance of checking for updates via BASIN's Web site to obtain current data.)

In the case of an interstate watershed assessment, a federal agency such as an EPA Regional Office can assist in facilitating proposal development among stakeholders. Finally, where the State/Tribe is not the permitting authority, U.S. EPA is responsible for approving all proposals affecting regulatory requirements.

States/Tribes

Due to the State's role in setting water quality standards and permit limitations, it is important that the State be involved to the greatest extent possible. The State can act as a lead coordinator, a partner, or as a technical resource to the local watershed group. (Some Native American Tribes hold certain environmental regulatory powers parallel to those of the State on Tribal lands, under PL638, and must be included in any watershed organization linked with those lands.)

North Carolina is a good example of the State acting as a lead coordinator. North Carolina has developed a plan where the State conducts comprehensive monitoring of waterways in all major watersheds on a five-year rotating basis. Where programs such as this exist, local watershed monitoring organizations can provide valuable assistance in expanding the State program. This is achieved by increasing the number of monitoring sites, or expanding the number of parameters to be monitored. Where local organizations participate in established State programs, these organizations should work closely with the State to ensure the new programs support the overall State effort.

In contrast, North Dakota and Nevada are examples of limited Statewide watershed assessment programs coordinated and implemented locally. While EPA and the State/Tribe are

available to provide technical guidance, the assessment programs are tailored to meet local resources, designated use goals, and local watershed management plans, if they exist. Another advantage of a locally driven assessment program is that those actually residing in or around the watershed are actively involved and therefore, more likely to support the assessment results. Finally, by maintaining a locally driven assessment plan, the assessment goals can better be linked to the overall goals of the local watershed management plan. Even with the organization and actual assessment being conducted by the local watershed team, it is important that EPA or the State/Tribe continue to provide guidance on assessment techniques and program design to ensure compatibility with federal and State water protection programs.

Finally, there are programs where both the State and local watershed organizations have played leading or supporting roles in leading the assessment effort. The State of Maryland, for example, has acted as lead agency in protecting major waterways, such as the Chesapeake Bay and major tributaries. The regional organization the Metropolitan Washington Council of Governments, has served to provide technical assistance and to coordinate intergovernmental activities in the Anacostia Watershed, with key involvement of the federal government because of the extensive federal lands. The conservation-oriented Audubon Naturalist Society, and area county governments have been the catalysts in volunteer monitoring of the headwaters of local streams and of the Anacostia River.

Local Governments

Local governments are critical to the assessment of watershed conditions because of their unique land use authority, and their understanding of pollutants of concern, local impacts, and historical and projected land use changes. Their land use authority is key in providing information on environmental requirements in the process of land development, and in developing potential strategies, like requiring storm water quality BMPs for new development. They are sources of information on environmental problem areas, BMP locations, community interests, and local initiatives. In addition, local governments may play a major role in monitoring subwatersheds and areas that go beyond those covered by the State. Local governments are good sources for current and future land use information. Many localities have GIS databases including forecasts for housing and employment, which forecasts will be much more accurate than assuming full build-out according to zoning and the comprehensive plan.

Watershed-based initiatives are often initiated by local governments, frequently to protect a drinking water supply. For example, in Northern Virginia, local governments with lands draining to the Occoquan Reservoir formed a Policy

Board to serve as a forum for discussion of changes and strategies within the basin. The Occoquan Basin Policy Board funds a technical assistance committee to examine nonpoint source control strategies (staffed by the Northern Virginia Planning District Commission) and retains an independent university-based monitoring lab. Significantly, the Policy Board includes not only the local governments and their water and wastewater utilities, but the Soil and Water Conservation Districts and citizen appointees.

Permitted Dischargers

Dischargers will have experience in point source and ambient water quality sampling techniques, as well as quality assurance and quality control procedures. Dischargers can also be a valuable resource in assessing existing ecosystem conditions because they are likely to be familiar with local habitat and water use. Finally, permitted dischargers can provide financial resources for instream monitoring (water column, aquatic biota, etc.) If approved by the regulating authority , an offset may be provided of limited reductions in currently required effluent monitoring, as guided by EPA Burden Reduction Guidance.

Drinking Water Utilities

Utilities and agencies charged with providing and monitoring drinking water have a strong interest and scientific expertise in watershed monitoring and management. Source water monitoring is essential to the “multi-barrier” approach to treatment of surface water. The multi-barrier approach uses source water protection as one of three techniques to assure drinking water quality. Utilities monitor drinking water intakes and often monitor at upstream stations. These assessment resources could be joined with others in the watershed for a more comprehensive picture of the contaminants of most concern for both drinking water and primary contact (swimming).

Other Interested Parties

Other stakeholders may represent key affected industries, environmental advocacy groups, and expert resources. In forming the watershed organization, the following constituencies should be identified and considered for inclusion:

- Environmental groups;
- Agricultural organizations such as the Soil Water Conservation districts or Farmers Cooperatives;
- Local businesses and business groups such as the Chamber of Commerce;
- Universities and research scientists; and
- Civic groups and concerned citizens.

Such stakeholders can contribute to the success of a watershed-based assessment program through their expertise, knowledge of local conditions, and involvement in the watershed. Volunteer monitoring programs can provide high quality data that is valuable in conducting a watershed assessment (See References entries on Volunteer Monitoring). Volunteers can receive technical training for monitoring, which covers sampling techniques and reliable quality assurance/quality control (QA/QC) measures.

Table 1. Potential Roles and Responsibilities for Watershed Assessments

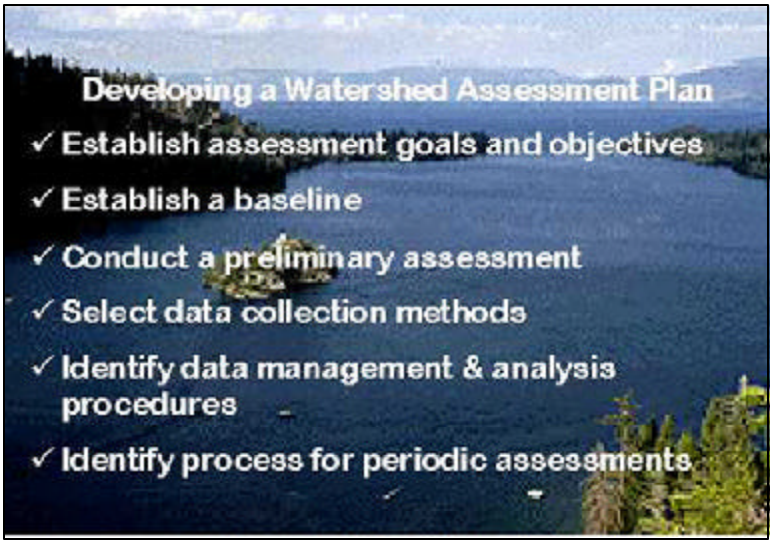
Office \ Task	Coordinate Assessment Plan	Provide data sources	Provide technical assistance in data collection and sampling	Analyze watershed data	Authorize changes in end-of-pipe monitoring	Conduct periodic evaluations of assessment plan	Manage and evaluate unified watershed data
Local	X	X	X			X	X
Regional	X		X	X		X	X
State	X	X	X	X	X	X	X
Federal		X	X	X	X	X	X
Permitted Dischargers		X	X				
Drinking Water Utilities		X	X				
Citizens	X	X	X				

Developing A Watershed Assessment Plan

There is no single, correct method for developing a watershed assessment plan. The process will be different for each watershed due to differences in critical challenges, natural resources, watershed conditions and trends, and relative impacts of various pollutant sources, all of which drive watershed goals and objectives. A generic Watershed Assessment outline is provided in Appendix A, but each assessment plan must be designed specifically for each watershed.

The process for developing a watershed assessment plan is outlined below. More information on each element of the process is presented below.

Establish Assessment Goals And Objectives



Before developing a watershed assessment plan, watershed stakeholders should agree on the purpose of the assessment effort, as guided by the established goals of the overall watershed program. Setting watershed assessment goals and objectives helps stakeholders understand the benefits and limitations of watershed

assessment activities. Implementing a multi-focused assessment will help achieve a successful and dynamic program.

In particular, watershed stakeholders should address the following questions in setting watershed assessment goals and objectives:

- Where are the known environmental problem areas and pollutants of concern?
- What are the major sources of impairment? Or is this a relatively unimpaired basin?
- What data/information is needed? By whom?
- What sources of information exist? What are the apparent gaps?
- What intensity of additional field monitoring, if any (water quality, biota, etc.) is required to meet the goals of a watershed management/protection plan?
- How will the assessment and management program be sustained over time? What will be the availability of future resources?
- Who is responsible for what? What regulatory authorities affect the plan and its findings?

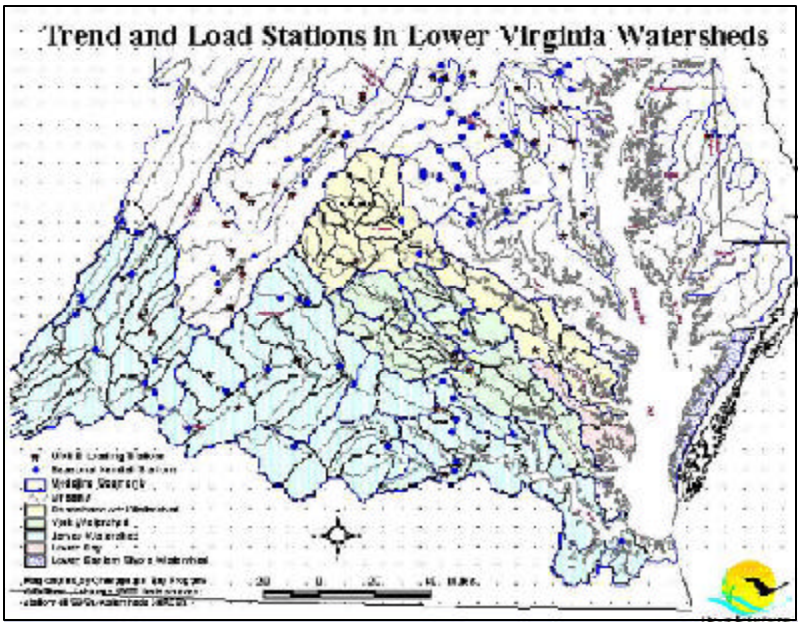
The goals and objectives of any watershed assessment plan must be clearly defined. Yet the needs for assessment data will change over time as human activity, pollution controls, or watershed management activities are implemented. Periodic review of the watershed assessment plan goals, objectives and protocols will ensure that the data collected is timely and relevant.

The generic scope for a Watershed Assessment at Appendix A can be focused toward potential impacts of anticipated activities, as well as on pristine areas to be protected. A comprehensive document will include a complete geographic grid.

Establish Baseline And Conduct Preliminary Assessment

Definition Of A Baseline

The next step in the development of an assessment plan is to establish a baseline of conditions within the watershed. A baseline is a “snapshot” of environmental and other relevant conditions at a point in time which will serve as a point of reference for management strategy priorities, and for future changes in the watershed. Watershed data collected prior to the implementation of proposed pollution controls and other management activities can be used to establish a baseline for determining the success of the overall watershed management plan, and to adjust the plan as time passes.



Data Coordination By Watershed Boundaries

Data coordination is one of the most useful tasks of the entire watershed assessment. Extensive regulatory requirements and local concerns demand that an enormous amount of data is collected under various programs—but rarely is this data organized by watershed. Indeed, the challenge of carving out datasets relevant to the watershed, and coordinating the data in comparable terms, may be one of the biggest efforts undertaken by the watershed organization, but the results will provide an unprecedented view of the watershed.

The organization and availability of data and maps can depend on the boundaries that delineate a community's watershed. Watersheds are organized by hydrologic units which are classified into four levels: regions, sub-regions, accounting units, and cataloging units. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system. Hydrologic units and codes for specific communities can be accessed electronically or through government agencies.

It is important to recognize that assessment activities include a broad range of existing data and information. Table 2 at the end of this section provides a summary of types of data that may be useful in watershed assessments. To reduce costs, watershed stakeholders should maximize the use of these existing resources and minimize duplication of monitoring and data collection efforts.

Many agencies are also good sources of historical information and data trends. Baseline analysis should include data records over a period of years, to assess areas of improvement or decline and trends in pollution sources (e.g., conversion of forested land to urban).

Readily accessible sources include a combination of federal, state and local data sources, such as:

- Existing assessments of water bodies (§ 305(b) reports)
- Impaired waters (§303(d) list)
- NPDES permit monitoring data
- Safe drinking water permits
- USGS topographic, hydrological and water quality sampling data
- Land use (existing actual land use via aerial photos; zoning and comprehensive plans; and land cover related to resource industries such as forestry and agriculture)
- Population and employment growth trends
- Soils (especially erodibility index) and subsurface geology
- Biological resources; rare, threatened, and endangered species

In addition, agencies such as the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Census, and state departments of fish and game maintain important background information (e.g., population growth, wetlands status, general land use trends). Statistical documents are also maintained in county, state and federal court houses. Local colleges and universities with departments pertaining to the physical environment often have abundant resources. Academic credentials of university staff can assist the watershed organization, and can be a low-cost research aid if the research goals of the watershed organization are reconciled with those of the academic institution. In addition, assessment data collected from similar watersheds should also be considered. For example, data associated with the Nationwide Urban Runoff Program (NURP) of the 1980's may be useful in predicting storm water pollutant loads from specific land uses. Likewise, accepted performance efficiency data for pollution controls from credible sources may substitute for duplicative monitoring of individual pollution controls.

Stakeholders should, therefore, invest significant time in the identification of existing sources of data before any additional monitoring is undertaken. A thorough effort at this stage can help identify data gaps and prevent duplication

of efforts and may also result in the identification of additional stakeholders.

Other useful resources (see Appendix D) are large-scale aerial photos, remote sensing data, satellite images, and historical photos. A rectified electronic base map with locational (preferably latitude/longitude) information is essential for proper integration of data by watershed, as well as for spatial analysis systems such as GIS.

Electronic Data And Geographic Information Systems (GIS)

The advent of the Internet and more powerful desktop computers offers an unprecedented resource for the watershed organization. Much of the data outlined above may be available electronically, and most government agencies maintain World Wide Web sites to provide easy access and assurance of current data. Ease of use, and widespread availability of computers with access to the Internet, means that electronic access is a tool within the reach of even the smallest watershed organization, in technical difficulty and affordability.

The use of GIS mapping resources, such as the USGS at the federal level, as well as state and regional GIS agencies, does not presume that the watershed organization possesses GIS software or trained personnel. Many of these mapping resources provide paper maps, and can sometimes produce specific combinations of data "layers" custom printed (and provided electronically) by some agencies. Most importantly, the advent of GIS has meant faster, cheaper, and more informative map creation—with provision for spatial analysis—by the agencies responsible for mapping. But the GIS tool is most appropriately used when spatial data is both analyzed and displayed electronically, for coordination and conversion of data by watershed.

Data Analysis

Once the baseline data set has been organized, the next step is to examine, analyze, and evaluate the data to determine watershed conditions. Stakeholders should use existing data to identify: areas not meeting water quality standards, areas showing other signs of impairment, significant water resources for protection, and likely or potential sources of impairment. The combination and organization of data should aid stakeholders in screening for priority areas for additional watershed assessment activities, and for targeting pollution control implementation.

Methods For Additional Field Data Collection

The analysis of the baseline dataset may determine that additional data and information is needed to better characterize watershed conditions and to meet the goals and objectives of the watershed assessment plan. With the objectives of the assessment plan clearly understood, specific details such as what parameters to monitor, monitoring station locations, and monitoring frequency can be developed (see References). In particular, data on biota is not typically collected on a systematic basis under the various Clean Water Act requirements, but rather by the U.S. Fish and Wildlife Service, and by State fisheries agencies. Similarly, most Clean Water Act requirements place an emphasis on ambient, or dry weather, water quality. Communities subject to the storm water rule (Municipal Separate Storm Sewer, or MS4) may already be conducting some wet weather monitoring.

The watershed organization can play a key role if it is determined that the desired additional monitoring data can be supported at the appropriate technical level. Assistance that can be provided by the coordinating body members includes:

- Identify data inadequacies
- Develop assessment strategies, such as coordinating volunteer monitoring programs with appropriate Quality Assurance\Quality Control (QA/QC)
- Collect comparable data, conduct sampling, analyze samples, and assess habitat conditions
- Interpret and evaluate monitoring results
- When appropriate, advise the permitting authority on possible substitutions of ambient monitoring for effluent discharge monitoring (in accordance with EPA Burden Reduction Guidance)

A field data collection plan must be prepared and possibly approved by reviewing authorities (see Appendices B and C). As in the original data collection effort, the types of field data collection, monitoring and sampling activities to be included in a watershed assessment should be determined using the assessment goals and objectives identified earlier in the process.

Water quality or biota field data collection methods must address how, where, when, and by whom samples should be taken (and who will pay the costs). EPA has established protocols for Quality Assurance\Quality Control (QA\QC) for all sampling and analysis. The data collection plan should also address safety measures.

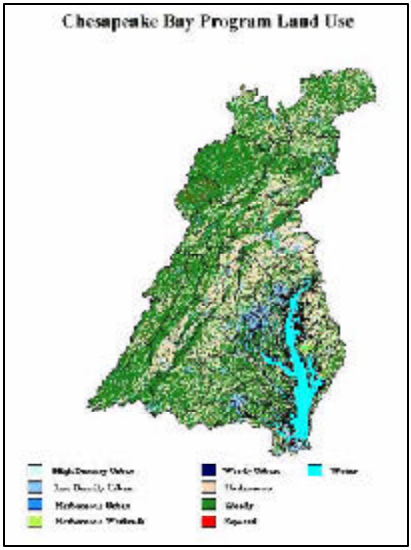
For example, to accurately document the impact of wet weather flows, monitoring and sampling strategies must reflect the unique characteristics of wet weather flows, including the altered flow regimes and storm event pollutant loadings which vary with watershed land cover conditions. Therefore, the baseline assessment should be designed to provide the necessary information about land cover and point sources to assess the relative contributions of pollutant sources. General information on water quality impairment can be used to determine the right mix of monitoring, in consultation with the state offices responsible for this monitoring. Table 2 at the end of this section provides a summary of the different types of monitoring.

Selecting the appropriate parameters to sample is one of the core decisions in developing a watershed monitoring plan. The plan should include a range of physical, biological, and chemical parameters to ensure that sampling will provide an accurate picture of the ecosystem. The goals and objectives of the assessment plan (e.g., baseline characterization, problem identification, monitoring compliance) will help determine parameters to use.

Recognizing that monitoring needs to encompass wet weather impacts allows for a wide variety of sampling parameters from which to choose. The parameters can be grouped as physical (e.g., flow hydrology, precipitation, channel morphology, turbidity), water quality (e.g., dissolved oxygen, BOD/COD, suspended solids, temperature, pH, conductivity, nutrients), health of the aquatic community (e.g., fish, macro invertebrates, aquatic habitats, sediment deposits), health of the terrestrial

community (e.g., waterfowl, reptiles, stream bank erosion, riparian habitat), aesthetics (e.g., trash, floatables, oil), human health (e.g., toxics, bacteria, metals), and indirect parameters (e.g., beach closures, fish advisories). Successful monitoring programs will combine biological and physical as well as chemical parameters to measure impacts of pollution, locate pollution sources, and track changes over time.

Generally, monitoring sites are selected using one of two approaches: probabilistic or tiered. Probabilistic approaches use a limited number of random samples to estimate trends within a larger geographic area. The use of random samples minimizes bias in sampling site location, and therefore, a greater representation is achieved. In watersheds where little is known about environmental conditions, probabilistic monitoring may be a good place to start. Several States are using this approach to broaden their knowledge of watersheds. For watersheds where more information exists about conditions, a tiered approach may be more useful in creating a base program to track long- term trends, target monitoring in specific regions for management purposes, and establish a random or spot check to identify unrecognized problem areas.



Sampling frequency will vary from watershed to watershed depending on the goals and objectives of the monitoring plan. When considering frequency, it is important to consider that sampling should be conducted during both dry and wet weather for a true watershed assessment. For wet weather monitoring, the number of sampling events per year should be sufficient to address seasonal variability, and must also provide an adequate number of observations for statistical analysis of the wet weather water quality impacts. The watershed assessment plan should also establish a minimum targeted rainfall event as well as a minimum antecedent dry period between rainfall events. In addition, the watershed monitoring plan must address implementation issues such as record keeping and reporting, scheduling, financial resources, and ongoing staff responsibility.

Quality assurance/quality control (QA/QC) procedures are essential to any watershed monitoring plan. They help assure data accuracy, continuity, and defensibility. Traditional QA/QC procedures such as documenting sample times, locations, and clarifying confounding factors are essential to ensure accurate data. Testing and certifying samplers for each type of sampling (e.g., different levels of certification ranging from debris identification to measuring vegetative overhang to subspecies macroinvertebrate identification), can help ensure the data is accurate. Standard operating procedures also ensure that the appropriate parameters are measured by approved methods.

Identify Data Management And Analysis Procedures

The watershed assessment plan should address data management including type of data base, methods for data analysis, quality assurance and quality control methods, modeling strategy (if appropriate), and how the data will be used to support the overall goals and objectives.

When developing a comprehensive watershed assessment plan, it is important that collected data be useful beyond the network of sampling stations. By ensuring compatible collection methods, comparable detection limits, uniform analytical methods, and common/compatible storage software, will increase the value of collected data for planning purposes, to enable comparisons to other watersheds, and also potentially for compliance purposes. Due to the statistical complexities of comparing different data, the statistical level of confidence at which the program objectives are achieved should be defined during the development of the monitoring program. While these issues will likely be encountered when acquiring information from outside agencies, using compatible monitoring protocols within the watershed can avoid these pitfalls as the watershed assessment progress.

Identify Process For Periodic Evaluation

Periodic review of the watershed assessment plan is essential to evaluate whether the plan is meeting its intended goals and objectives, and to effectively target monitoring resources. It also helps evaluate whether Best Management Practices or other wet weather controls are helping to meet the goals and objectives of the watershed management plan, such as improved water quality, species diversity, or wildlife habitat. Data needs may change over time, and periodic review can help identify targets for revising monitoring frequencies or locations.

In addition to reviewing watershed assessment data, periodic review includes review of monitoring and sampling protocols. Periodic review can help determine

which monitoring sites need continued base monitoring, which are targets for spot monitoring, and which should be targeted monitoring locations. Each monitoring point should be reviewed to determine whether parameters, sampling frequency, location and analytical procedures continue lead to data that meets the proposed goals objectives. Reviews should focus on measurable quantities, such as number of samples planned/analyzed, data confidence scores, or water quality in areas where BMPs have been implemented. As the watershed assessment progresses, monitoring sites may be covered by each of these monitoring methods, new locations can be determined, and results of the assessment can evaluated. If any component of the assessment does not meet overall goals and objectives, the component should be revised, and reviewed again.

Table 2. Summary of Data Typically Utilized for Watershed Assessments

Data Type	Description	Typical Parameters	Typical Assessment Frequency	Access to Existing Data
Base flow Water quality	water quality sampling during non-storm conditions	temperature, pH, conductivity, nutrients, bacteria, total suspended solids, turbidity, dissolved oxygen and alkalinity	periodic (monthly)	high
Storm flow Water quality	water quality sampling during and while a stream is affected by a storm event	temperature, pH, conductivity, nutrients, bacteria, total suspended solids, additional parameters can included metals, hydrocarbons, and pesticides	continuous (by event; 15-minute intervals or flow-weighted)	low to moderate
Aquatic biota	primarily aquatic fauna populations, including numbers, species diversity, and distribution	macro-invertebrates and fish	infrequent (seasonal to every three years)	low to moderate
Physical habitat	physical condition of a stream channel and its ability to support aquatic biota	wetted perimeter, bank stability, condition of substrate, sinousity bank condition, riparian area, embeddedness and large woody debris	infrequent (every three years)	low to moderate
Sediment	contaminants in stream and river sediment	particle size distribution, metals, PCBs, and pesticides	infrequent (every three years)	low to moderate
Ground water flow	ground water systems in connection with surface water bodies, indlucing unconfined aquifers, recharge, and discharge areas for regional confined aquifers; flow in these systems does not necesarily mimic surface topography	ground water levels, referred to as head	infrequent (seasonal to every few years)	moderate to high Data Type

Table 2. Summary of Data Typically Utilized for Watershed Assessments (Cont.)

Data Type	Description	Typical Parameters	Typical Assessment Frequency	Access to Existing Data
Ground water quality	water quality of the ground water systems described above	pH, conductivity, nutrients, pesticides, metals, bacteria	infrequent (seasonal to every few years)	moderate to high
Land cover characteristics	maps, remote sensing data, and surveys of land use/ land cover	existing and projected changes in land use and land cover levels of imperviousness	infrequent (every five years)	moderate to high
Precipitation	can include rainfall, rain on snow,	duration, intensity, and quantity	continuous (by event; 15-minute intervals or intensity-driven)	moderate to high
Geology	subsurface geologic conditions such as karst or carbonate substrate system; depth to groundwater			
Topography	contour and slope map by percent slope			
Location of permitted discharges and end-of-pipe water	conducted in support of an approved discharge permit	facility-specific, depends in part on the type of facility, size of operations, and the receiving stream	regular (bi-monthly)	high
Water intakes	public wells and surface water intakes	point data with drainage	infrequent	
Severed and ancyroid areas	areas served by sewer and septic	land area; linked to imperviousness; potential for septic pollution depending on density and soils	five years	
BMP performance monitoring	comparisons of upstream/downstream, before/ after, or inflow/outflow	land use, channel condition (see stream structure and physical habitat) and water quality (see storm flow water quality)	infrequent (by event)	moderate
Volunteer stream monitoring	conducted by trained volunteers, civic organizations, and school classes	physical stream condition, water quality, aquatic biota	periodic (monthly)	low to high

Appendix A

Generic Scope for Watershed Assessment

SECTION 1 - GOALS AND OBJECTIVES OF THE WATERSHED ASSESSMENT

1.1 Background
1.2 Purpose Of And Need For Action
1.3 Presenting Issues
1.4 Location Of The Watershed
1.5 Scope Of The Environmental Assessment Process
1.6 Organization Of This Environmental Assessment

SECTION 2 - AFFECTED ENVIRONMENT

2.1 Location, Activities and Uses, And History Of The Watershed
2.2 Topography And Drainage
2.3 Soils
2.4 Geology
2.5 Water Resources
- 2.5.1 Surface Water
  - 2.5.1.1 Hydrology And Flow Regime By Stream Order
  - 2.5.1.2 Surface Water Quality - Ambient (Dry Weather)
  - 2.5.1.3 Surface Water Quality - Wet Weather (Storm Water)
  - 2.5.1.4 Uses
- 2.5.2 Groundwater
  - 2.5.2.1 Abundance And Depth To Groundwater
  - 2.5.2.2 Uses
- 2.5.3 Floodplains

2.6 Climate, Precipitation, And Air Quality
2.7 Biological Resources
- 2.7.1 Vegetation
- 2.7.2 Terrestrial Wildlife
- 2.7.3 Aquatic Biota
- 2.7.4 Threatened and Endangered Species
- 2.7.5 Wetlands
- 2.7.6 Designated Resource Preservation Areas
- 2.7.7 Forest and Wildlife Corridor

2.8 Cultural And Historic Resources
2.9 Land Use
- 2.9.1 Actual Existing Land Use
- 2.9.2 Planned Land Use (Zoning and Comprehensive Plan)

2.10 Transportation
2.11 Aesthetics

SECTION 3 - REGULATORY AND PERMIT REQUIREMENTS

3.1 Relevant Federal, State, And Local Statutes, Regulations, And Guidelines
3.2 Permit Requirements

SECTION 4 - IDENTIFIED NEED FOR ADDITIONAL MONITORING DATA

SECTION 5 - REFERENCES

5.1 Literature Cited
5.2 Persons and Agencies Consulted
5.3 List of Preparers

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