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Handbook for Developing Watershed Plans to Restore and Protect Our Waters

Chapter 5. Gather Existing Data and Create an Inventory

March 2008

Handbook Road Map

5. Gather Existing Data and Create an Inventory

Chapter Highlights

- Determining data needs
- Identifying available data
- Locating the information
- Gathering and organizing necessary data
- Creating a data inventory

Read this chapter if...

- You're not sure where to look for data on your watershed
- You want to learn about the types of data you need to develop the watershed plan
- You want to know where to obtain maps of your watershed
- You want to know how to use GIS and remote sensing to help characterize your watershed
- You want to know how to create a data inventory

5.1 How Do I Characterize My Watershed?

Once you've formed partnerships, you'll begin to characterize the watershed to develop an understanding of the impacts seen in the watershed, identify possible causes and sources of the impacts, and subsequently quantify the pollutant loads. Characterizing the watershed, its problems, and pollutant sources provides the basis for developing effective management strategies to meet watershed goals.

Because it's rare for any watershed planning effort to require starting from scratch, the challenge is to understand and build on existing information. The characterization and analysis process is designed to help you focus the planning efforts strategically to address the most pressing needs and target your data collection and analyses to your specific watershed.

The next four chapters focus on the characterization process:

- Gather existing information and create a data inventory (chapter 5)
- Identify data gaps, and collect new data, if needed (chapter 6)
- Analyze data (chapter 7)
- Estimate pollutant loads (chapter 8)

Although these phases are presented sequentially, several iterations of gathering data, identifying gaps, and analyzing data might be needed within each phase. This chapter focuses on gathering existing information to create a data inventory.

Before You Start...

Before you start searching for and gathering data, revisit the conceptual model developed during the scoping process (chapter 4). The watershed problems, potential sources, and goals illustrated in the conceptual model will focus your data gathering, as well as the subsequent analyses.

Gathering and organizing data is a major part of developing a successful watershed plan. You'll gather data and conduct data analyses to characterize the condition of your watershed and its waterbodies, identify pollutant sources, and support quantification of the pollutant loads. Estimates of source loads are often a component missing from past and current planning efforts, and filling this gap is critical to successfully controlling sources, restoring watershed health, and meeting watershed and water quality goals. Without an understanding of where pollutants are coming from, it's almost impossible to understand their impact on watershed resources and to target your control efforts effectively. This section provides information on how to target your data-gathering efforts and explains what types of data and information are useful in developing a watershed plan.

5.2 Focus Your Data Gathering Efforts

Although the data-gathering and analysis phases of the watershed planning process are very important in estimating source loads, they can also be very challenging. The types and amount of data available vary by watershed, and there is often a variety of data, making it difficult to decide which data (and analyses) are necessary. You should decide which types of data and how much data you need to complete your watershed plan. To make these decisions easier, your data-gathering efforts should be guided by your earlier scoping efforts, during which you developed a conceptual model, identified preliminary watershed goals, and listed stakeholder concerns (chapter 4).

5.2.1 Build on Earlier Scoping Efforts

The conceptual model, discussed in section 4.3, is a graphic representation of the watershed processes and problems. The conceptual model allows you to visualize the pollutants causing impairment, their potential sources and pathways, and interactions between pollutants, related stressors, and impairments.

The information and links depicted in the conceptual model will help you to determine what information to collect for analysis and also prioritize the information. Data compilation can be an almost endless process; there's always something more to find out about your watershed. You should decide what you need and tailor your data-gathering efforts accordingly. It is often time-consuming to gather data and to analyze and make sense of them. You'll want to be careful not to spend your budget on compiling data and information that you don't need—data that will not help you understand the watershed problems and meet your goals. For example, if the primary concern in your watershed is elevated levels of bacteria posing human health risks and prohibiting recreational opportunities, you'll need to focus data collection and analysis on likely sources of bacteria loads to the streams, such as livestock operations, wildlife populations and their distribution, and septic systems. In addition, because bacteria are not typically related to other water quality parameters, you might not need to gather extra monitoring data. Alternatively, some water quality impairments are related to several parameters and affected by many factors, requiring more data and analyses to understand the dynamics of the problem. For example, excess nutrients can increase algal growth (chlorophyll a) and lead to processes that deplete dissolved oxygen, lower pH, and produce ammonia at potentially toxic levels. These parameters are interrelated: when evaluating one, you must often evaluate all of them. Therefore, identifying these types of relationships and interactions in your conceptual model is crucial to efficiently gathering data and conducting useful analyses.

5.2.2 Consider Stakeholder Goals and Concerns

Another factor that will focus your data gathering is the goals and concerns identified by the stakeholders during the initial phases of the watershed planning process. The conceptual model relates to the watershed goals identified with the stakeholders by identifying potential watershed sources causing the problems and, therefore, the sources that must be controlled to meet the goals. For example, if a perceived problem in the watershed is the degradation of fisheries, the conceptual model will identify possible causes of that problem (e.g., low dissolved oxygen) and the associated pollutant sources (e.g., increased nutrient inputs from fertilizer application and subsequent runoff). Similarly, if the stakeholders identified development pressures as a concern, you'll want to collect information on land use patterns, building permits, and current zoning practices. If they identified the protection of wetlands as a goal, you should identify the wetlands in the watershed and any current protection strategies in place.

Seek Out Local Data

Remember to check first for the availability of local data and ground-truth other datasets if possible. State and federal data can provide a broad set of information but might be coarse or out-of-date. Check for recent changes, especially changes in land use and land management that might not be reflected in available datasets. Consider the date when the data were originally generated and processed and compare the data with what you and the stakeholders know about the watershed.

5.3 Who Has the Data and What Types of Data Do You Need?

Building from the information provided by the stakeholders, you'll identify existing reports, plans, studies, and datasets from various sources that can be used to help characterize the

First, See What's Already Been Done

Much of the data you need for characterizing your watershed might have been partially compiled and summarized in existing reports, including

- TMDL reports
- Watershed Restoration Action Strategies
- Source Water Assessments
- CWA section 208 plans
- Clean Lake Plans (Clean Water Act section 314)

Although some of these plans might be outdated and represent historical conditions, they can provide a valuable starting point for gathering data and characterizing historical and current conditions in your watershed.

watershed. These sources include various local, state, tribal, and federal programs and organizations.

Many of the data types discussed in this section might already be summarized or available through existing programs, reports, and plans. For example, Total Maximum Daily Loads (TMDLs) completed for the watershed might include information on water quality, land use, and sources in the watershed. It's helpful to identify environmental studies that have already been conducted in your watershed because they might provide information on several different data types and guide you toward important stakeholders or sources of additional data. This section provides a variety of information that might help you identify existing plans and studies in your watershed. Another way to find them is an Internet search on your watershed or waterbodies—a broad search through a general browser or more specific searches through relevant state or federal environmental agencies' Web sites.

Before you begin to identify the types of data you need, it's helpful to understand the different data sources. The following descriptions are meant to familiarize you with these various sources and provide context for the discussions of specific data types in the subsequent sections.

5.3.1 Local Sources of Information

Identifying existing information at the local level is critical to supporting the development of a watershed plan that is based on local current or future planning efforts (e.g., information on zoning, development guidelines and restrictions, master planning, wastewater plans, transportation plans, future land use plans). This information not only will support the characterization of the watershed but also will identify any major changes expected to occur in the watershed (e.g., new development, addition of point sources, change from septic systems to city sewer). The sources for local information will depend on the kinds of land uses in your community (urban or rural).

To know what is available and how to get county-level information, it is necessary to become familiar with state-, county-, and city-level agencies. It's important to understand the authority and jurisdictions of the agencies in the watershed. This understanding facilitates the search for information and also provides valuable insight into the activities most likely to be implemented in the watershed. For example, it's important that the watershed plan identify control actions or management practices that people or agencies in the watershed have the authority and jurisdiction to implement. This will help you select the management strategies that you know can be adopted at the local level with existing

Navigating through Local Governments

Because local governments are organized differently, sometimes it's difficult to find the information you need. The best approach is to start with the local planning or environmental department and ask them to steer you in the right direction for other types of information. Local governments typically provide the following services:

- *County and city planning offices*: master plans, zoning ordinances
- *Environmental departments*: recycling policies, water quality monitoring program
- *Soil and water conservation districts*: agricultural land use information, topographic maps, soil surveys, erosion control information
- *Departments of economic development*: census data, tax records, demographic data
- *Water and sanitation department*: stormwater plans, maps of water intakes and sewer lines
- *Public health department*: septic system inventories, records of outbreaks of illness or ailments from poor water quality
- *Transportation department*: transportation master plans, permits, road and bridge construction information

authorities. Go to section 3.4.1 for a description of various local and regional programs and organizations.

Other "local" sources of watershed data include universities and environmental non-governmental organizations (NGOs). Although a university or NGO might not be located in or near your watershed, it might be active in the watershed and hold relevant local data.

Contact Your Local Stormwater Program

Be sure to check with your local stormwater management office, usually found in your city or county department of public works or planning office. They might already have developed a watershed plan for your area.

Universities can be important sources for demographic, climate, or spatial data. Many state climatology offices are associated with universities. In addition, university faculty or students regularly conduct environmental research related to their fields of study or expertise, sometimes providing data and information relevant to local watershed planning efforts (e.g., water quality, soils, land use changes). However, it might be difficult to identify any relevant studies and data without already knowing the specific project or contact. Universities have a variety of schools and departments, and no two are likely to be organized in the same way. Hopefully, if a university has conducted research in your watershed, one or more of the key stakeholders will be aware of it and can lead you in the right direction.

NGOs (e.g., Trout Unlimited, Izaak Walton League) often have information on stream conditions, habitat, and long-term changes in watershed characteristics (e.g., habitat, water quality). As with university information, it's difficult to identify NGOs active in your watershed and relevant data without already knowing they exist. Typically, if an NGO has an active interest in your watershed or has collected data, you or one of the involved stakeholders will know about it.

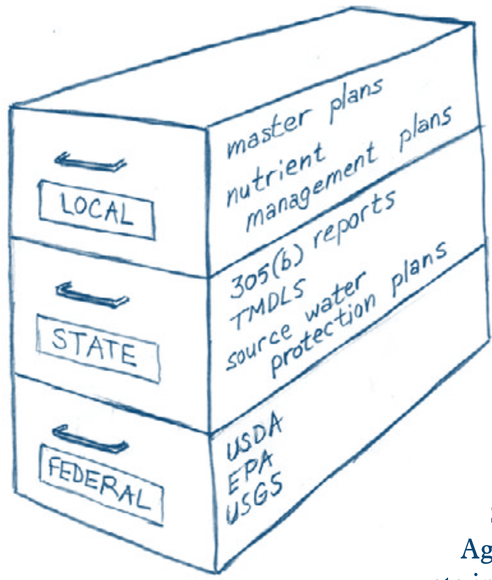
5.3.2 State Sources of Information

State environmental agencies routinely collect biological, hydrological, and water quality information for the waters in the state. State environmental agencies include several divisions and offices, many of which might be useful in characterizing your watershed and some of which might be irrelevant. Environmental agencies typically have a division or office dedicated to watershed or water quality issues. A variety of other offices deal with environmental issues (e.g., wastewater, mining, air quality) and will likely have information relevant to your watershed. It's useful to go to your state environmental agency's Web site to learn what types of offices work in your state and identify potential sources of relevant information.

In addition to state environmental agencies, several other state agencies might be useful in characterizing your watershed and potential sources. For example, the Division of Natural Resources or Department of Fish and Game can provide information on wildlife habitats and populations, and the Department of Agriculture can provide agricultural statistics for counties in your state. Go to section 3.4.2 for a description of various state programs and organizations.

Does Your State Have Its Own Watershed Guidance?

Before you start gathering data, check to see if your state has developed guidance or support materials for watershed planning. Whether comprehensive technical manuals or introductory brochures, these documents can provide information on available data sources, state and local government organizations, and various state-specific issues (e.g., laws, unique environmental conditions). For example, the *California Watershed Assessment Manual* (**http://cwam.ucdavis.edu**) was developed to help watershed groups, local agencies, and private landowners evaluate the condition of their watershed. The manual discusses the watershed assessment process and includes discussions of California-specific agencies, data types and sources, and environmental concerns. Check with your state environmental agency to see whether it has programmatic or technical documents on watershed planning.



5.3.3 Tribal Sources of Information

In watersheds that include tribal lands, tribal sources of watershed information can be important. Often, data and information for lands and waterbodies within reservation boundaries are limited at the state level and you must rely on tribal contacts for monitoring or anecdotal information.

Watershed characterization for tribal lands can be obtained from a variety of sources. First, search the Web to see if the specific tribe has a Web site with historical data or background information or reports. Go to section 3.4.3 for a description of various tribal programs and organizations.

5.3.4 Federal Sources of Information

Several federal agencies, including EPA, the U.S. Department of Agriculture (USDA), and the U.S. Geological Survey (USGS), generate information that will be useful in characterizing your watershed. With the various offices, divisions, and agencies in the federal government, there are likely several federal sources of every type of data used in watershed characterization. Go to section 3.4.4 for a description of various federal programs and organizations. The remainder of this chapter identifies these data types and their corresponding sources.

Types of Data Useful for Watershed Characterization

Physical and Natural Features

- Watershed boundaries
- Hydrology
- Topography
- Soils
- Climate
- Habitat
- Wildlife

Land Use and Population Characteristics

- Land use and land cover
- Existing management practices
- Demographics

Waterbody Conditions

- Water quality standards
- 305(b) report
- 303(d) list
- TMDL reports
- Source Water Assessments

Pollutant Sources

- Point sources
- Nonpoint sources

5.3.5 Data Types

In general, five broad categories of data are used to adequately characterize the watershed:

- Physical and natural features
- Land use and population characteristics
- Waterbody conditions
- Pollutant sources
- Waterbody monitoring data

Within these categories are dozens of reports and datasets that you can access to populate your data inventory. Table 5-1 identifies the types of data typically needed for watershed characterization and describes how the data might be used. Each data type is discussed in the following sections. Be careful not to collect existing information just because it's available. The data should help to link the impacts seen in the watershed to their sources and causes.

The data discussed in this section come in a variety of forms, including tabular data and databases, documents and reports, maps and aerial photographs, and geographic information system (GIS) data. Tabular data include water quality and flow monitoring data consisting of a series of numeric observations. Documents and reports include TMDLs or previous watershed studies that provide background information and summaries of watershed characteristics and conditions. They might address specific topics like fisheries habitats or particular pollutants, or they might cover a range of watershed

Table 5-1. Data Typically Used for Watershed Characterization

Data Type	Typical Uses of Data
Physical and Natural Features	
Watershed boundaries	• Provide geographic boundaries for evaluation and source control • Delineate drainage areas at desired scale
Hydrology	• Identify the locations of waterbodies • Identify the spatial relationship of waterbodies, including what segments are connected and how water flows through the watershed (e.g., delineate drainage areas contributing to wetlands)
Topography	• Derive slopes of stream segments and watershed areas (e.g., to identify unstable areas, to characterize segments and subwatersheds in watershed modeling) • Evaluate altitude changes (necessary when extrapolating precipitation from one area to another)
Soils	• Identify potential areas with higher erosion rates, poor drainage, or steep slopes • Use to delineate subwatersheds and develop input data for models
Climate	• Provide information about loading conditions when evaluated with instream data (e.g., elevated concentrations during storm events and high flow) • Drive simulation of rainfall-runoff processes in watershed models
Habitat	• Describe area's ability to support aquatic life, and identify areas at risk of impairment • Support defining stressors that could be contributing to impairment • Identify shading or lack of riparian cover • Support identification of potential conservation, protection, or restoration areas • Identify any in-stream flow alterations or stream fragmentation
Wildlife	• Identify special wildlife species to be protected • Identify potential sources of bacteria and nutrients
Land Use and Population Characteristics	
Land use and land cover	• Identify potential pollutant sources (e.g., land uses, pervious vs. impervious surfaces) • Provide basis for evaluation of sources, loading, and controls • Provide unit for simulation in watershed models
Existing land management practices	• Identify current control practices and potential targets for future management • Identify potential watershed pollutant sources
Waterbody and Watershed Conditions	
Water quality standards	• Identify protected uses of the waterbody and associated water quality standards
305(b) report	• Identify the status of designated use support in watershed waterbodies • Identify potential causes and sources of impairment
303(d) list	• Identify known pollutant impairments in the watershed • Identify geographic extent of impaired waterbody segments • Identify potential causes and sources of impairment
Existing TMDL reports	• Provide information on watershed characteristics, waterbody conditions, sources, and pollutant loads (for specific waterbodies and pollutants)
Source Water Assessments	• Identify water supply areas to be protected • Identify potential sources of contamination to the water supply

Table 5-1. Data Typically Used for Watershed Characterization (continued)

Data Type	Typical Uses of Data
Pollutant Sources	
Point sources	• Characterize potential point sources for quantifying loads
Nonpoint sources	• Characterize potential nonpoint sources for quantifying loads
Waterbody Monitoring Data	
Water quality and flow	• Characterize water quality and flow conditions throughout the watershed • Provide information on critical conditions, temporal trends, spatial variations, impairment magnitude, etc.
Biology	• Provide information on general health of the watershed, considering long-term effects
Geomorphology	• Describe river/stream pattern, profile, and dimension • Characterize drainage basin, channel/bank morphology • Classify river/stream type, based on morphology • Assess changes to morphology over time

topics. GIS data are available for a wide range of watershed characteristics, such as land use, locations of monitoring stations or flow gauges, vegetation, and population distribution.

Many of the data discussed below can be gathered, organized, and viewed using various tools. The two most popular tools, GIS and remote sensing, are specifically discussed in section 5.9 to provide guidance on how to use these tools, highlight their limitations, and identify the most common datasets.

Many of the datasets discussed in the following sections are provided as GIS data. GIS data can be critical in developing your watershed plan, but often they can be misinterpreted by first-time or novice users unfamiliar with the data types and their application. You might need to do some research or attend training to learn how to use GIS effectively before gathering the associated data—data that could be useless or misleading without the knowledge to use them properly. For more information on using GIS and what information to gather when compiling GIS data, go to section 5.9.1.

Web Sites for Downloading Watershed Coverages

- USGS 8-digit watersheds: **http://water.usgs.gov/GIS/huc.html**
- USDA Natural Resources Conservation Service 14-digit watersheds: **www.ncgc.nrcs.usda.gov/products/datasets/watershed**

5.4 Physical and Natural Features

This section discusses information on the physical and natural features of your watershed, including what data are available, why they are important, and where you can find them. Information on the physical and natural characteristics of your watershed will define your watershed boundary and provide a basic understanding of the watershed features that can influence watershed sources and pollutant loading.

5.4.1 Watershed Boundaries

Defining the geographic boundaries of your watershed planning effort is the first step in gathering and evaluating data. Up to this point, the watershed boundary might have been a theoretical boundary. You know for what watershed you are writing a plan, but you might not have documentation of its physical boundary and the waterbodies contained in it. Depending on the size of your watershed, its boundary might already have been delineated by a state or federal agency.

USGS Hydrologic Units

Major watersheds throughout the country were previously classified according to the USGS system into four levels—regions, subregions, accounting units, and cataloging units. The hydrologic units were nested within each other, from the smallest (cataloging units) to the largest (regions). 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. Although the nomenclature for hydrologic units has been revised based on an interagency effort (see section 4.4), the delineation of major watersheds and their hydrologic unit codes remain. There are 2,150 cataloging units (now called "subbasins") in the United States. GIS coverages of the cataloging units are available by EPA region in EPA's BASINS modeling system (**www.epa.gov/ost/basins**). The coverages can also be downloaded from USGS at **http://water.usgs.gov/GIS/huc.html**.

What's My HUC?

Although most watershed planning efforts focus on areas much smaller than an 8-digit hydrologic unit (subbasin), it's useful to know in what cataloging unit your watershed is included. Many databases (e.g., monitoring, GIS) are organized or referenced by HUC. To find your data and navigate through data repositories and search engines, it's necessary to know the HUC for your watershed.

If you don't know your HUC, visit EPA's "Surf Your Watershed" Web site (**http://cfpub.epa.gov/surf/locate/index.cfm**) to find it.

Most likely, your watershed is smaller than the USGS-designated cataloging units. (Most of the cataloging units in the nation are larger than 700 square miles.) It's important, however, to know what cataloging unit includes your watershed because many sources of data are organized or referenced by HUC.

NRCS Watershed Boundary Dataset

During the late 1970s the USDA's Natural Resources Conservation Service (NRCS) initiated a national program to further subdivide USGS's 8-digit cataloging units into smaller watersheds for water resources planning (figure 5-1). By the early 1980s this 11-digit hydrologic unit mapping was completed for most of the United States. During the 1980s several NRCS state offices starting mapping watersheds into subwatersheds by adding 2 or 3 digits to the 11-digit units. By the late 1980s and early 1990s, the advent of GIS made the mapping of digital hydrologic unit boundaries feasible. Through an interagency initiative in the early 1990s, NRCS used GIS to start delineating hydrologic units and subdividing them into smaller units for the entire United States.

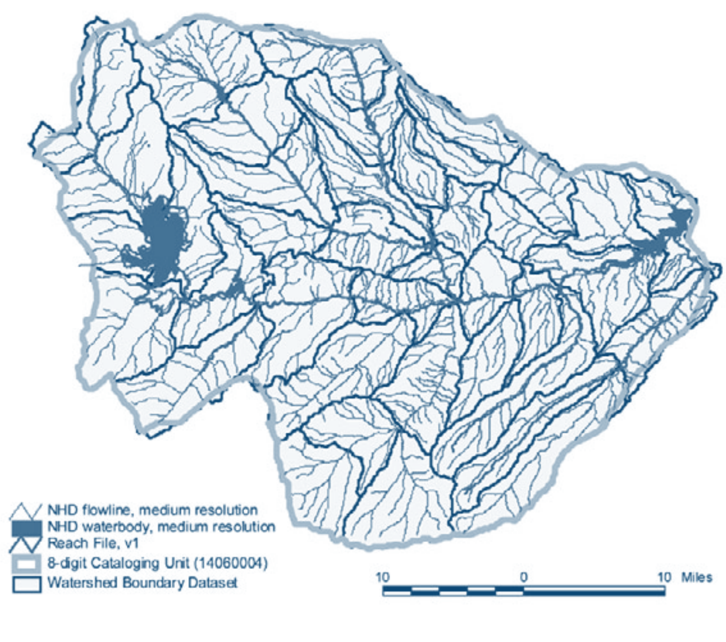


Figure 5-1. Example of NRCS Watershed Delineations Within a USGS 8-digit Cataloging Unit

A goal of this initiative is to provide the Watershed Boundary Dataset (WBD)—a hydrologically correct, seamless, and consistent national GIS database of watersheds at a scale of 1:24,000. The new levels are called watershed (fifth level, 10 digits [formerly 11 digits]) and subwatershed (sixth level, 12 digits [formerly 14 digits]). The size at the watershed level is typically 40,000 to 250,000 acres; at the subwatershed level, it is typically 10,000 to 40,000 acres, with some as small as 3,000 acres. An estimated 22,000 watersheds and 160,000 sub-watersheds will be mapped to the fifth and sixth levels.

GIS coverages of the WBD are publicly available through the Internet (**www.ncgc.nrcs.usda.gov/products/datasets/watershed**); however, because the mapping is ongoing, there is limited availability of the subwatershed coverage. As of January 2005, NRCS had completed the coverages for Alabama, Connecticut, Georgia, Illinois, Maryland, Massachusetts, Montana, Rhode Island, Utah, and Vermont. To check the status of the 12-digit subwatershed coverages and availability for your watershed, go to **www.ncgc.nrcs.usda.gov/products/datasets/watershed/status-maps.html**.

The WBD is also available through USGS's Elevation Derivatives for National Application (EDNA) database and interactive map (**http://edna.usgs.gov**). EDNA uses the USGS's National Elevation Dataset (NED) and National Hydrography Dataset (NHD) to derive and provide nationwide hydrologic data layers at a scale of 1:24,000. EDNA includes the WBD, as well as tools and data to delineate watersheds for any point in the United States.

Regional, State, and Site-specific Watershed Boundaries

In addition to the USGS and NRCS classification, many states have created their own watershed or planning unit delineations that break the USGS cataloging units into smaller watersheds. For example, California has delineated watersheds with a hierarchy of watershed designations that has six levels of increasing specificity. These state watersheds are generally much smaller than the national 8-digit HUCs and are better suited for local watershed planning activities.

An example of a regional dataset or tool for watershed delineation is the Digital Watershed Mapper (**www.iwr.msu.edu/dw**) from the Institute of Water Research at Michigan State University. The Digital Watershed Mapper delineates a watershed based on an address or a selected point on a map. It also provides land use, soils, and curve number coverages for the delineated watershed.

What If My Watershed Has Not Been Delineated?

If your state does not have watershed boundaries available or your watershed is not specified in the state coverages, you might have to create your own watershed boundary based on coverages of the stream network and elevation or topography, discussed in section 5.4.3. There are also tools available to delineate watersheds automatically. For example, BASINS includes an Automatic Watershed Delineation tool that segments watersheds into several hydrologically connected subwatersheds. (BASINS software is free from EPA and available for download at **www.epa.gov/ost/basins**.) The Automatic Watershed Delineation is used in ArcView and requires that the Spatial Analyst (version 1.1 or later) and Dialog Designer (version 3.1 or later) ArcView extensions be installed on your computer. The delineation process also requires a Digital Elevation Model (DEM) in ArcInfo grid format and optionally a stream network coverage (e.g., RF3 or NHD) in ArcView shape format. In addition, the National Hydrography Dataset (NHD) Web site provides several applications for using NHD data, including NHD Watershed, an ArcView (3.x) extension that enables users to delineate a watershed from any point on any NHD reach. The ArcView 3.x Spatial Analyst extension (version 2.0) is required to delineate watersheds from any point. Without Spatial Analyst, watershed delineation can be performed only upstream from an NHD reach confluence. Delineating watersheds using this tool also requires National Elevation Dataset (NED) data in the 8-digit HUC of interest. (NED data can be downloaded from USGS's Seamless Data Distribution System at **http://seamless.usgs.gov**.) In addition, 10-meter DEMs can be used in place of NED data, where they are available. (You can check the availability of 10-meter DEMs at **http://geography.usgs.gov/www/products/status.html**.)

5.4.2 Hydrology

Information on the hydrology of your watershed is necessary to visualize and document the waterbody network, including the locations of all the waterbodies and how they are connected to one another. When water flows through the stream network, it carries pollutant loads, and therefore the conditions of upstream segments can significantly affect the conditions of downstream segments. When evaluating source impacts on watershed conditions, it is crucial to understand the hydrologic network of the watershed. Not only is this information important for characterizing your watershed and evaluating sources and waterbody conditions, but it is also necessary input when modeling the watershed.

Web Sites for Downloading Waterbody Coverages

- USGS's NHD: **http://nhd.usgs.gov**
- EPA BASINS RF1 and RF3 by HUC: **www.horizon-systems.com/nhdplus**

Reach File

The EPA Reach Files are a series of national hydrologic databases that uniquely identify and interconnect the stream segments or "reaches" that compose the country's surface water drainage system. The three versions of the Reach File currently available are known as RF1, RF2, and RF3-Alpha, and they were created from increasingly detailed sets of digital hydrography data produced by USGS. RF1, at a scale of 1:500,000, contains only major waterbody features in the country, providing too broad a scale to be useful at the watershed planning level. RF2 and RF3 are at a scale of 1:100,000, a scale useful for watershed planning. However, RF3 has been superseded by USGS's National Hydrography Dataset (NHD), which provides more waterbody features (e.g., ponds, springs).

References documenting the content, production, and history of the Reach Files are available at **www.epa.gov/waters/doc/refs.html**. The GIS coverages of the Reach Files are available free for download through EPA's BASINS modeling system at **www.epa.gov/waterscience/basins/b3webdwn.htm**.

National Hydrography Dataset

The NHD is a comprehensive set of digital spatial data for the entire United States that contains information about surface water features such as lakes, ponds, streams, rivers, springs, and wells. In the NHD, surface water features are combined to form reaches, which provide the framework for linking water-related data to the NHD surface water drainage network. The NHD is based on USGS's Digital Line Graph (DLG) hydrography data, integrated with reach-related information from EPA's RF3. The NHD supersedes DLG and RF3 by incorporating them, not by replacing them.

Level of Detail in Maps

A map's scale is expressed as a ratio between a distance on the map and a distance on Earth. For example, a scale of 1:100,000 means that 1 unit of measure on the map represents 100,000 of the same units on Earth.

The full national coverage of the NHD is currently based on 1:100,000 scale data, but the NHD is designed so that it can incorporate higher-resolution data. It is also designed so that improvements and corrections to the dataset by individual users can be incorporated into the national dataset. A 1:24,000-scale NHD is being developed for many parts of the country. The 1:100,000-scale NHD is referred to as the "medium-resolution NHD"; finer scales, such as 1:24,000, are referred to as "high-resolution NHD" (figure 5-2). The attribute information for each waterbody feature is the same in medium- and high-resolution NHD; however, because of the finer scale, high-resolution NHD contains more waterbodies, including smaller-order streams and additional springs. To check the status of the 1:24,000 NHD and download coverages for

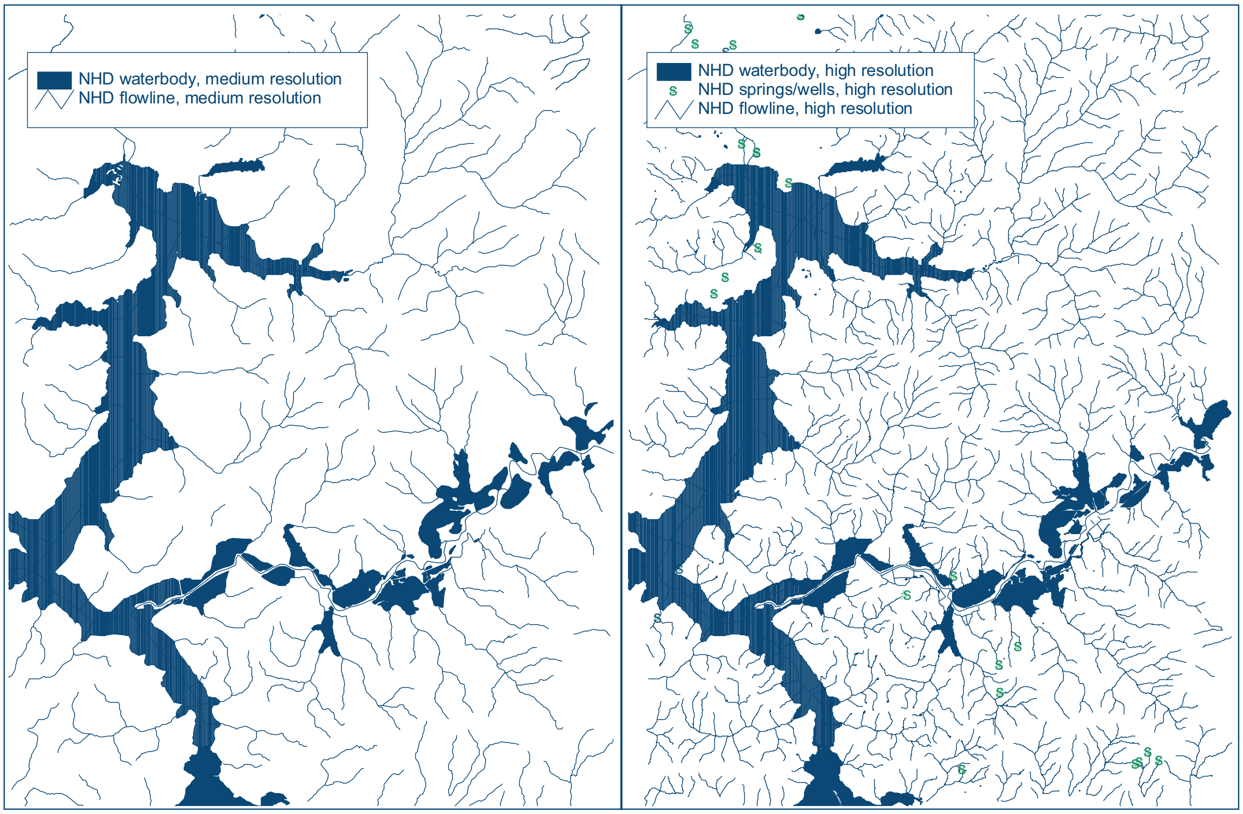


Figure 5-2. Examples of Medium-Resolution and High-Resolution NHD

your watershed at no cost, go to **http://nhd.usgs.gov**. This Web site also includes more information on the NHD, its contents, and related tools. Specifically, the Concepts and Contents technical reference (**http://nhd.usgs.gov/techref.html**) identifies and describes the contents and features of the NHD.

Sources of Digital Elevation Data

- USGS's EROS Data Center: **http://edc.usgs.gov/geodata**
- GIS Data Depot: **http://data.geocomm.com**

In addition, many state environmental agencies might have created state-specific hydrography coverage, whether based on NHD, aerial photos, or other sources. For example, the Utah Division of Water Quality has a coverage of waterbodies for the state that includes irrigation diversions and canals—features that might not be captured in the national datasets. Check your state environmental department's Web site to see if your watershed has already-created GIS coverages.

Floodplain Maps

To address flooding and control water quality, the Federal Emergency Management Agency (FEMA) requires municipalities to perform floodplain mapping and develop management plans to receive federal flood insurance. This information is also relevant to water quality protection and restoration activities because floodplains, when inundated, serve many functions and provide important habitats for a variety of fish and wildlife. Floodplains are important for spawning and rearing areas. Floodplain wetlands act as nutrient and sediment sinks, which can improve water quality in streams. They also provide storage that can decrease the magnitude of floods downstream, which can benefit fish and landowners in riparian areas.

In addition, streams that are actively connected to their floodplains are less prone to severe downcutting and erosion. Therefore, it's important to incorporate protection of these benefits of floodplain areas into your watershed management planning. Check with your local government planning office to see if floodplain maps are available, or search the FEMA map store at **www.store.msc.fema.gov**.

5.4.3 Topography

Characterizing the topography or natural features of the watershed can help to determine possible sources of pollution. For example, steep slopes might contribute more sediment loads to the waterbody than flat landscapes. Topographical information is also needed in many watershed models to route movement of runoff and loading across the land and to the waterbody. Digital elevation models (DEMs) are grid-based GIS coverages that represent elevation. They can be displayed in a GIS and are used for delineating watersheds and displaying topography. One DEM typically consists of thousands of grid cells that represent the topography of an area. DEMs are available with 10-meter, 30-meter, and 90-meter cell sizes. The smaller cell sizes represent smaller areas and provide more detailed and accurate topographic data. However, GIS coverages with small grid cell sizes often have large file sizes and can be difficult to work with over large areas. The 30-meter and 10-meter DEMs are appropriate for smaller watersheds, such as a single 8-digit cataloging unit or smaller.

Where to Get Topographic Maps

USGS has been the primary civilian mapping agency of the United States since 1879. The best-known USGS maps are the 1:24,000-scale topographic maps, also known as 7.5-minute quadrangles. More than 55,000 7.5-minute maps were made to cover the 48 conterminous states. This is the only uniform map series that covers the entire area of the United States in considerable detail. The 7.5-minute map series was completed in 1992. To order hard-copy USGS topographic maps, go to **http://topomaps.usgs.gov/ordering_maps.html**. USGS primary series topographic maps (1:24,000, 1:25,000, 1:63,360 scales) cost $6.00 per sheet, with a $5.00 handling fee for each order. They are also available through a variety of other sources, such as TopoZone (**www.topozone.com**). Electronic versions of topographic maps, called Digital Raster Graphics (DRGs), are also available (**http://topomaps.usgs.gov/drg**). USGS distributes DRGs on CDs, and there is a base charge of $45.00 per order, plus $5.00 shipping and $1.00 for each DRG quadrangle purchased.

5.4.4 Soils

Soils can be an important factor in determining the amount of erosion and stormwater runoff that occurs in your watershed. Soils have inherent characteristics that control how much water they retain, how stable they are, or how water is transmitted through them. Understanding the types of soils in your watershed and their characteristics helps to identify areas that are prone to erosion or are more likely to experience runoff.

Find Your Loca Soil and Water Conservation District

Local conservation districts can provide information on soils in your watershed and how they affect sources and pollutant delivery.

To see if your conservation district is online, visit **www.nrcs.usda.gov/partners/districts.html** or the National Association of Conservation Districts, **www.nacdnet.org/about/districts/websites**.

Historically, USDA and the local soil and water conservation districts have been instrumental in carefully mapping and classifying soils at the county level. Soils are also grouped into hydrologic soil groups according to their runoff potential. These datasets are essential to the development of input data for models that predict runoff and erosion and for the evaluation of land management techniques and alternatives.

NRCS is the principal source of soil data across the nation. You can access that information through the Soil Data Mart at **http://soildatamart.nrcs.usda.gov**. NRCS's Soil Data Mart includes more than 2,000 soil surveys with spatial and tabular information and another

800 soil surveys with tabular (soil attribute) data only. The spatial data on the Soil Data Mart are available for download at no charge and include the following:

- **State Soil Geographic (STATSGO) Database.** Soil maps for the STATSGO database are produced by generalizing the detailed soil survey data. The mapping scale for STATSGO is 1:250,000 (with the exception of Alaska, which is 1:1,000,000). The level of mapping is designed to be used for broad planning and management uses covering state, regional, and multistate areas.
  ↳ Go to **www.ncgc.nrcs.usda.gov/products/datasets/statsgo**.
- **Soil Survey Geographic (SSURGO) Database.** Mapping scales for SSURGO generally range from 1:12,000 to 1:63,360, making the soil maps the most detailed done by NRCS. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, township personnel, and county natural resource planners and managers. ↳ Go to **www.ncgc.nrcs.usda.gov/products/datasets/ssurgo**.

5.4.5 Climate

Local climatological data are often needed in a watershed characterization to help understand the local water budget for the region and also for modeling purposes. Current and historical climate data can be obtained from the National Climatic Data Center (NCDC), maintained by the National Oceanic and Atmospheric Administration (NOAA). ↳ The NCDC data are available online at **www.ncdc.noaa.gov/oa/ncdc.html** and include information such as precipitation, wind speed, temperature, and snow and ice cover at multiple stations throughout the United States. Stations within or near a watershed can be found in the NCDC database by using a variety of search tools, and data are provided (for a fee) in a raw format that can be read by a word processing or spreadsheet program. County-level stormwater management offices might also collect rain gage data.

Hourly or daily precipitation data, as well as temperature, evaporation, and wind speed, are necessary for simulating rainfall-runoff processes in watershed models. However, if weather data are being used only to generally characterize weather patterns in the watershed, daily or monthly averages are sufficient. Daily and monthly temperature and precipitation data are available online at no cost. The data are available by station through the regional climate centers and often through state climate offices. ↳ The Western Regional Climate Center provides a map of regional climate centers with links to their Web sites: **www.wrcc.dri.edu/rcc.html**. City or county stormwater management divisions might also collect rain gauge data.

Climatological data can be organized relatively easily to provide insight into wet and dry seasons, which can be important considerations in characterizing watershed problems and sources. Elevation can have an important impact on precipitation; therefore, in watersheds with significant differences in topography, it is recommended that data be presented from at least two locations (upper and lower).

5.4.6 Habitat

When characterizing your watershed, it's important to gather data not only to identify potential pollutant sources but also to identify areas for conservation, protection, and restoration. Maintaining high-quality wildlife and aquatic habitat is an important goal when developing watershed plans. High-quality, contiguous habitats and their buffers, as well as small pockets of critical habitat, help prevent water quality impairments and provide protection for both terrestrial and aquatic organisms. This section discusses information and programs available to help you identify and characterize critical habitats—terrestrial and aquatic—in your watershed.

National Wetlands Inventory

The National Wetlands Inventory (NWI), operated by the U.S. Fish and Wildlife Service (USFWS), provides information on the characteristics, extent, and status of the nation's wetlands and deepwater habitats and other wildlife habitats. The NWI has a new feature, *Wetlands Mapper*, that allows you to map wetland habitat data. Go to **www.nwi.fws.gov**. Identifying wetlands is crucial to protecting natural habitats in your watershed.

Wetland Assessments

Many programs use a wetland assessment or survey to serve as a baseline for future management activities. The survey might include global positioning system (GPS) coordinates of sample plots, a general plot description and condition assessment (land use impacts), canopy information or measurements, and digital pictures of sampling areas. In addition, the survey might document flora and fauna diversity observations. These datasets can be used to help characterize the watershed and identify wetland areas. In addition, State Wetland Conservation Plans are strategies for states to achieve no net loss and other wetland management goals by integrating regulatory and nonregulatory approaches to protecting wetlands. For more information on state wetland conservation planning activities, go to **www.epa.gov/owow/wetlands/facts/fact27.html**.

EPA's Web site for state, tribal, and local wetland initiatives (**www.epa.gov/owow/wetlands/initiative**) provides links to a variety of wetland information, including state/tribal regulatory programs; state/tribal watershed planning; local initiatives; and state, tribal, and local partners. The Web site also provides a link to the Association of State Wetland Managers' Web site, which provides links to state and local wetland programs. EPA also provides a link to wetland efforts throughout the EPA regions at **www.epa.gov/owow/wetlands/regions.html**.

National Wetlands Status and Trends Report

The Emergency Wetlands Resources Act of 1986 requires the USFWS to conduct status and trend studies of the nation's wetlands and report the results to Congress each decade. The report provides the most recent and comprehensive estimates of the current status and trends of wetlands on public and private lands in the United States. To download a copy of the most recent report, go to **http://wetlands.fws.gov**.

Natural Heritage Program

The NHP is a nonprofit program operated in every state under cooperative agreements with many state and federal agencies, such as the National Park Service, Forest Service, U.S. Department of Defense, and USFWS, to monitor the status of the state's rare, threatened, and endangered plants. State NHPs are part of a network established by The Nature Conservancy and currently coordinated by NatureServe, an international nonprofit organization. All NHP programs use a standard methodology for collecting, characterizing, and managing data, making it possible to combine data at various scales to address local, state, regional, and national issues. State NHP programs provide a variety of information, including statewide lists of tracked species and communities, plant atlases and maps, rare plant field guides, lists of rare plants (including rarity status, counties of occurrence, and flowering and fruiting times), synonyms for the scientific names of rare plants, and descriptions of how rare plants are treated under federal and state laws. Go to **www.natureserve.org/visitLocal/usa.jsp** to find local programs and datasets for your area.

Habitat Conservation Plans

Private landowners, corporations, state or local governments, and other non-federal landowners that wish to conduct activities on their land that might incidentally harm (or "take") wildlife listed as endangered or threatened must first obtain an incidental take permit from the USFWS. To obtain this permit, the applicant must develop a Habitat Conservation Plan (HCP), designed to offset any harmful effects the proposed activity might have on the species. HCPs describe the impacts expected from the proposed operations or activities (e.g., timber harvesting) and detail the measures to mitigate the impacts. HCPs can provide valuable information on critical habitat in your watershed and also identify stakeholders and current management measures to be integrated into the watershed planning process. ➥ Go to **http://endangered.fws.gov/hcp** for more information on the HCP program.

The Nature Conservancy

The Nature Conservancy (TNC) is a conservation organization working to protect ecologically important lands and waters for nature and people. TNC has numerous resources that you might find helpful when gathering habitat data. For example, TNC's Aquatic Ecosystem Classification Framework is an approach for establishing freshwater priorities across large geographic areas that uses all available data on species distributions as well as physical and geographic features. The approach allows consideration of higher levels of biological information—communities, ecosystems, and landscapes—in addition to rare and imperiled species. ➥ For more information, go to **www.nature.org/initiatives/freshwater/resources/art17010.html**. In addition, through the Sustainable Waters Program, TNC is demonstrating how water flows can be managed to meet human needs while sustaining ecosystem health. TNC works with local stakeholders to help bring their ecosystem-dependent needs and values to the decision tables, craft scientific approaches and tools to define the water needs of ecosystems, work with water managers to protect and restore natural patterns of water flow, and help to build alliances to push for new water policies that embrace environmental sustainability. ➥ For more information and resources on habitat conservation, go to **www.nature.org**.

5.4.7 Fish and Wildlife

Identifying the types of wildlife and their habitat requirements in your watershed can help to identify areas for protection and conservation in your watershed plan. Previous watershed reports might provide information on wildlife in your watershed. In addition, local and state fish and wildlife offices can provide you with information on wildlife species and distribution in their jurisdictions. ➥ Go to **http://offices.fws.gov/statelinks.html** for a list of and links to state and territorial fish and wildlife offices. The Nature Conservancy also has ecoregional plans and other reports that provide this kind of information. *Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity* provides information on freshwater species (➥ **www.natureserve.org/publications/riversOflife.jsp**). It's especially important to consider wildlife habitat in your watershed plan when endangered or threatened species occur in your watershed. ➥ To find out more about endangered species, go to **http://endangered.fws.gov**. That page also includes links to endangered species contacts in your area (➥ **http://endangered.fws.gov/contacts.html**).

Understanding the types of wildlife in your watershed can not only identify critical habitat areas to protect but sometimes also identify pollutant sources affecting water quality. For example, waterfowl can be a significant source of bacteria and nutrients to reservoirs and lakes. Although wildlife are an important component of the watershed ecology and should be protected, it's important to understand their impact on waterbody conditions when developing a watershed plan.

State Comprehensive Wildlife Conservation Strategies

State comprehensive wildlife conservation strategies (also known as wildlife action plans) assess the condition of each state's wildlife and habitats, identify the problems they face, and outline the actions that are needed to be conserve them over the long term before they become more rare and more costly to protect. State fish and wildlife agencies have developed these plans by working with a broad array of partners, including scientists, sportsmen, conservationists, and members of the community. There is a plan for each state and U.S. territory. Plans contain data on the distribution and abundance of wildlife; locations and relative conditions of habitats essential to species in need of conservation; and problems that might adversely affect species or their habitats and priority research and survey efforts. For more information on state wildlife action plans, go to **www.wildlifeactionplans.org**.

USGS GAP and Aquatic GAP

Gap analysis is a scientific method for identifying the degree to which native animal species and natural communities are represented in our present-day mix of conservation lands. The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of ordinary species (those not threatened with extinction or naturally rare) and their habitats to provide land managers, planners, scientists, and policy makers with the information they need to make better-informed decisions. GAP is coordinated by the Biological Resources Division of the U.S. Geological Survey (**http://gapanalysis.nbii.gov**). Aquatic GAP promotes conservation of biodiversity through information by providing conservation assessments of natural communities and native species.

The Aquatic GAP examines how well all aquatic species and their habitats are represented within places and managed for their long-term persistence, which species and habitat types are under-represented in aquatic biodiversity management areas or activities, and which species and habitat types are at risk. GIS models are used to predict aquatic biodiversity at the community and species levels. Examples of data and information collected include habitat cover and quality, fish species and macroinvertebrates associated with habitat types, water quality, and stream gradient. Aquatic GAP projects are completed or on-going in several states (NY at the watershed scale) and regions (e.g., Upper Tennessee River). For more information, go to **www.glsc.usgs.gov/main.php**.

5.4.8 Ecosystems

Ecosystem management requires that all aspects of a watershed (e.g., land, water, air, plants, and animals) be managed as a whole, not as separate and unrelated parts. Ecosystem management plans protect the viable populations of native species and the natural rhythms of the natural range of variability of the ecosystem. They allow public use of resources at levels that do not result in the degradation of the ecosystem. Successful, effective ecosystem management requires partnerships and interdisciplinary teamwork within the watershed.

There are a number of good resources for developing an ecosystem management plan. The following article provides relevant background information to help you protect ecosystems in your watershed:

- *Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation* R.F. Noss, E.T. LaRoe III, and J.M. Scott. U.S. Department of the Interior, National Biological Service (now called BRD). 1995. (**http://biology.usgs.gov/pubs/ecosys.htm**)

  This article provides estimates of declines of natural ecosystems in the United States, a rationale for ecosystem-level conservation, discusses decline and threat as criteria for conservation, and relates ecosystem losses to endangerment at species and population levels. Ecosystems are defined generally and at various spatial scales and include vegetation types, plant associations, natural communities, and habitats defined by ecologically relevant factors. Appendix B of the article includes a comprehensive list of at-risk ecosystems of the United States.

Another valuable resource is The Wildlands Project (**www.twp.org**). The Wildlands Project works toward restoring networks of wild landscapes with area-specific, native species. Its mission is to strengthen existing wilderness areas and create more sustainable ecosystems by creating a series of wilderness corridors that link larger areas. Development and human activity in these corridors are limited to lessen their impact on local wildlife. The project has done notable partnership work in Minnesota, where the Minnesota Ecosystems Recovery Project (MERP) is working toward the design and establishment of a comprehensive nature reserve system that includes core reserve areas; buffer zones with limited, sustainable human activities; and corridors that will allow migration of plant and animal species between core areas.

5.5 Land Use and Population Characteristics

This section discusses data and information for determining the distribution of land use and population in your watershed. Land uses are an important factor influencing the physical conditions of the watershed, as well as an indicator of the types of sources active in the watershed. Together with land use characteristics, population can help you to understand the potential growth of the area and possible changes in land uses and sources.

National Sources for Land Use and Land Cover Data

GIS coverages

MRLC/NLCD data: **www.mrlc.gov/index.asp**

USGS's LULC data: **http://edc.usgs.gov/geodata**

Survey-based land use data

U.S. Census of Agriculture: **www.agcensus.usda.gov**

National Resources Inventory: **www.nrcs.usda.gov/technical/NRI**

5.5.1 Land Use and Land Cover Data

Evaluating the land uses of a watershed is an important step in understanding the watershed conditions and source dynamics. Land use types (together with other physical features such as soils and topography) influence the hydrologic and physical nature of the watershed. In addition, land use distribution is often related to the activities in the watershed and, therefore, pollutant stressors and sources. Sources are often specific to certain land uses, providing a logical basis for identifying or evaluating sources. For example, sources of nutrients such as grazing livestock and fertilizer application associated with agricultural land uses would likely not contribute to loading from other land uses such as urban or forest land uses. Likewise, urban land uses typically have specific pollutants of concern (e.g., metals, oil and grease) different from those associated with rural land uses. Evaluating land use distribution and associated sources also facilitates identifying future implementation efforts because some management practices are most effective when applied to a certain land use.

This section discusses some of the most common sources of land use data. Typically, land use and land cover data are obtained from aerial photographs, satellite images, and ground surveys. Because in some areas land uses continually change, it's important to keep in mind the type and date of available land use data when reviewing the sources of land use data for use in developing your watershed plan.

What Is the MRLC?

Many of the land use datasets discussed in this section are products of the Multi-Resolution Land Characteristics (MRLC) consortium. Because of the escalating costs of acquiring satellite images, in 1992 several federal agencies agreed to operate as a consortium to acquire satellite-based remotely sensed data for their environmental monitoring programs. The original members of the MRLC consortium were USGS, EPA, NOAA, and the Forest Service. The National Aeronautics and Space Administration (NASA) and the Bureau of Land Management (BLM) joined the consortium later.

During the 1990s the MRLC created several mapping programs, including (1) the Coastal Change Analysis Project (C-CAP) administered by NOAA; (2) the Gap Analysis Project (GAP) directed by the Biological Resources Division of USGS; and (3) the National Land Cover Data (NLCD) project directed by USGS and EPA. The data developed by these projects are available publicly through download or by contacting the agencies involved.

For more information on the MRLC and its data products, go to **www.epa.gov/mrlc**.

National Land Cover Data

Satellite data from the early 1990s are available for the entire United States as part of the National Land Cover Data (NLCD) program, made available by the Multi-Resolution Land Characteristics Consortium (MRLC). The NLCD data are classified using a standard land use classification system and are available as 30-meter grid cell GIS coverages that can be displayed and queried in a GIS. The NLCD includes 21 land use classifications within the following broad categories:

- Water
- Developed
- Barren
- Natural Forested Upland (non-wet)
- Natural Shrubland
- Non-natural Woody
- Herbaceous Upland Natural/Semi-Natural Vegetation
- Herbaceous Planted/Cultivated
- Wetlands

Definitions of the land use classifications are included at **http://landcover.usgs.gov/classes.php**.

The NLCD data can be downloaded from the NLCD Web site at **www.epa.gov/mrlc/nlcd.html** or through USGS's Seamless Data Distribution Center (**http://seamless.usgs.gov**). The entire United States is being mapped using imagery acquired circa 2000 as part of the MRLC 2001 land use project. To check the status of NLCD 2001 and whether it is available for your watershed, go to **www.mrlc.gov/mrlc2k_nlcd_map.asp**.

Land Use and Land Cover Data

USGS's Land Use and Land Cover (LULC) data consist of historical land use and land cover classification data based primarily on the manual interpretation of 1970s and 1980s aerial photography. Secondary sources include land use maps and surveys. Along with the LULC files, associated

NLCD 1992 vs. NLCD 2001

NLCD 1992 was derived from the early to mid-1990s Landsat Thematic Mapper (TM) satellite data purchased under MRLC 92. The entire United States is being mapped through NLCD 2001 using imagery acquired circa 2000 from Landsat-7's enhanced TM (ETM). This project entails re-mapping the lower 48 states, as well as covering Hawaii and Alaska for the first time. Classification schemes for the two rounds of classification are similar but not identical. For a list and definitions of the classifications, go to **www.epa.gov/mrlc/classification.html**.

NLCD 2001 is a Landsat-based land cover database that has several independent data layers, thereby allowing users a wide variety of potential applications. Primary components in the database include

- Normalized imagery for three time periods
- Ancillary data, including a 30-m DEM, slope, aspect, and a positional index
- Per-pixel estimates of percentage of imperviousness and percentage of tree canopy
- 21 classes of land-cover data derived from the imagery, ancillary data, and derivatives using a decision tree
- Classification rules, confidence estimates, and metadata from the land cover classification

To check the status of NLCD 2001 and determine whether it is available for your watershed, go to **www.mrlc.gov/mrlc2k_nlcd_map.asp**.

maps that provide additional information on political units, hydrologic units, census county subdivisions, and federal and state land ownership are included. LULC includes 21 possible categories of cover type within the following Anderson Level I codes:

- Urban or Built-up
- Agricultural
- Rangeland
- Forest
- Water
- Wetland
- Barren
- Tundra
- Perennial Snow or Ice

LULC data are available for the conterminous United States and Hawaii, but coverage is not complete for all areas. The data are based on 1:100,000- and 1:250,000-scale USGS topographic quadrangles. The spatial resolution for all LULC files depends on the format and feature type—GIRAS (Geographic Information Retrieval and Analysis System) or CTG (Composite Theme Grid). Files in GIRAS format have a minimum polygon area of 10 acres with a minimum width of 660 feet (200 meters) for man-made features. Non-urban or natural features have a minimum polygon area of 40 acres (16 hectares) with a minimum width of 1,320 feet (400 meters). Files in CTG format have a resolution of 30 meters.

All LULC data are available for free by download at **http://edc.usgs.gov/geodata**.

State and County Land Use Databases

In addition to national coverages, several states and counties have statewide or local land use and land cover information available. Specialized local land use or land cover sets might include land parcel or land ownership, impervious surfaces, wetland or forest coverage, sewer areas, land use zoning, or future land use projections. For example, King County, Washington's GIS Center (**www.metrokc.gov/gis**) has an online database of available GIS data for the area, including 2001 Landsat land cover. Regional examples of land use datasets include land use data for southern California counties available from the San Diego Association of Governments (**www.sandag.cog.ca.us**) and Southern California Association of Governments (**www.scag.ca.gov/index.htm**). The Internet is an excellent tool for locating land use data available from local and regional agencies.

Many GIS Web sites, including Geography Network (**www.geographynetwork.com**), have links to local, state, and federal GIS sources and provide query engines to identify available GIS data by geographic location or content. In addition, states often have GIS groups as part of their environmental agencies and provide access to the data on the Internet. Examples of state GIS Web pages are included in section 5.9.

Survey-Based Data

In addition to GIS coverages and databases of land use distribution, there are several survey-based inventories of land use information. Two examples are the USDA's National Resources Inventory (NRI) and the USDA's Census of Agriculture. Be careful when using NRI and Census of Agriculture data to evaluate land use in your watershed because these inventories are built on a more gross scale than is typically needed for watershed planning. The NRI is based on data collected at thousands of sites across the country to evaluate state, regional, and national trends in resources. The Census of Agriculture includes county-level data on agriculture characteristics that might or might not reflect the characteristics of your watershed. If these data are evaluated for your watershed, they should be used to gain a general sense of the sources and conditions, not as hard facts on the watershed.

USDA National Resources Inventory

Survey-based land use data are available from the USDA's NRI (**www.nrcs.usda.gov/technical/NRI**). The NRI is a statistical survey of information on natural resources on non-federal land in the United States that captures data on land cover and land use, soil erosion, prime farmland soils, wetlands, habitat diversity, selected conservation practices, and related resource attributes. The NRI includes inventories such as highly erodible lands, land capabilities, and land uses.

With data collected during each survey from the same 800,000 sample sites in all 50 states, Puerto Rico, the U.S. Virgin Islands, and some Pacific Basin locations, the NRI is designed to assess conditions and long-term trends of soil, water, and related resources. Previously, data were collected every 5 years, with information available at each sampling point for 1982, 1987, 1992, and 1997. Since 2001 the NRI has been updated continually with annual releases of NRI data. The NRI provides information for addressing agricultural and environmental issues at the national, regional, and state levels.

NRI data are provided on a county or cataloging unit level. Therefore, at the smaller watershed level, they are likely useful mainly for providing "big picture" information on trends in land use over the years. However, NRI data are useful at the watershed level when evaluating the erodibility of agricultural land in your watershed. When developing watershed models, for example, the NRI can be an important source of information on site-specific soil characteristics for agricultural lands (e.g., cropland, pastureland) in your area. It's also important to note that the NRI data are provided as inventories and are not in GIS format.

USDA Census of Agriculture

Additional survey-based land use data are available from USDA's Census of Agriculture (**www.agcensus.usda.gov**). Prepared by the USDA's National Agricultural Statistics Service, the census includes comprehensive data on agricultural production and operator characteristics for each U.S. state and county, including area of farmland, cropland, and irrigated land; livestock and poultry numbers; and acres and types of crops harvested.

Unfortunately, Census of Agriculture information is provided at the county level—often a more gross scale than is useful for watershed planning. Moreover, the Census of Agriculture information is provided as inventories, not in GIS format, preventing you from isolating data for only your watershed. You must be careful about using county-level information to evaluate your watershed because farming practices can vary widely across a county.

Specialized Land Use Datasets

In addition to the national datasets discussed previously in this section, there are several specialized datasets on land use focusing on specific regions (e.g., coastal areas, forested areas) or on specific types of land uses (e.g., mineral areas).

The following are examples of these types of data. You can find more examples at the following MRLC Web site: **www.epa.gov/mrlc/data.html**.

The NOAA Coastal Services Center is developing a nationally standardized database of land cover within the coastal regions of the United States as part of the Coastal Change Analysis Program (C-CAP). C-CAP includes land cover and change data for the nation's coastal zone, designed to assist coastal resource managers in their decisionmaking processes. These land cover products inventory coastal intertidal habitats, wetlands, and adjacent uplands with the goal of monitoring changes in these habitats on a 1- to 5-year cycle. For more information on the C-CAP and related data, go to **www.csc.noaa.gov/crs/lca**.

Another type of specialized land use dataset is the BLM's Land and Mineral Use Records. The Land and Mineral Use Records Web site allows users to search, locate, and map the BLM's land and mineral use authorizations and mining claims on public lands throughout the United States. Land and mineral use authorizations include such things as oil and gas leases, right-of-ways, and mineral leases. To search the Land and Mineral Use Records, go to **www.geocommunicator.gov/GeoComm/landmin/home/index.shtm**.

5.5.2 Land Management Practices

Information on how the land is managed in a watershed is helpful to identify both current control practices and potential targets for future management. This information not only will support the characterization of the watershed but also will be important in identifying current watershed sources, future management efforts, and areas for additional management efforts.

> **Local Conservation Districts**
>
> Conservation districts are local units of government responsible for the soil and water conservation work within their boundaries. A district's role is to increase voluntary conservation practices among farmers, ranchers, and other land users. Depending on the location of the districts, their programs and available information vary. For example, districts in agricultural areas can provide assistance with erosion control, agriculture-related water quality projects, and nutrient and pesticide management plans. Districts in suburban or urban areas might focus on protection of streams from impacts of urban activities and erosion control for construction activities.
>
> Local conservation districts can be a good source of information on potential watershed sources, as well as restoration activities in your watershed. To see if your conservation district is online, visit **www.nrcs.usda.gov/partners/districts.html** or the National Association of Conservation Districts, **www.nacdnet.org/about/districts/websites**.

Nonpoint Source Projects

Under Clean Water Act section 319, states, territories, and tribes receive grant money to support a wide variety of activities, including implementation of best management practices (BMPs) to improve water quality. To find out if there are any current nonpoint source projects in your watershed, contact your state environmental department. EPA's Web site for nonpoint source pollution (**www.epa.gov/nps**) provides a variety of links, including section 319 information, publication and information resources, background on the state-EPA nonpoint source partnership, and outreach information. A list of state nonpoint source coordinators is available at **www.epa.gov/owow/nps/319hfunds.html**.

Local Ordinances

Local ordinances that establish construction-phase erosion and sediment control requirements, river corridors and wetland buffers, and other watershed protection provisions are often included as part of a watershed plan implementation strategy. Check to see what current ordinances are in place for your community through the planning or environmental department. For example, your locality might have a local wetland protection ordinance that protects wetlands by restricting or requiring a special permit for certain activities, such as dredging, filling, clearing, and paving, within wetland boundaries or buffers. CWP provides model ordinance language for wetland protection in *Adapting Watershed Tools to Protect Wetlands: Wetlands & Watersheds Article #3* (**www.cwp.org/wetlands/articles/WetlandsArticle3.pdf**). Also go to CWP's Stormwater Manager's Resource Center, which provides examples of real-world and model ordinances (**www.stormwatercenter.net/intro_ordinances.htm**) that can be used to guide future growth while safeguarding local natural resources. The intent is to provide language and ideas that communities and stormwater managers can incorporate when writing an ordinance for their local area. The Web site includes a sampling of ordinances from across the nation and can help watershed managers understand what ordinances might exist in their watershed. ↳ Other references for model ordinances are provided in appendix A.

Land and Water Conservation Measures

There are several ways that land can be conserved for water quality protection, habitat conservation, or water supply protection. For example, Purchase of Development Rights (PDR) is a voluntary land protection tool that pays landowners to protect their land from development. Through PDR a government agency, or private nonprofit organization, buys development rights (also known as a conservation easement) from landowners in exchange for limiting development on the land in the future. Transfer of Development Rights (TDRs) is a land use management technique that can support local comprehensive planning goals and facilitate watershed-based zoning proposals by transferring development potential from sensitive subwatersheds to subwatersheds designated for growth. The principle of TDRs puts to creative use the premise that ownership of land entails certain property rights and therefore individual rights can be bought and sold to accomplish various community planning objectives. TDRs allow developers to purchase the rights to an undeveloped piece of property in exchange for the right to increase the number of dwelling units on another site. The practice is often used to concentrate development density in certain land areas.

Under the USDA NRCS's Conservation Reserve Program, farmers convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. In addition, designation of conservation preserves and hydrologic reserves, as well as conservation tax credits (income tax deduction for conservation easements) are other tools that can be used to protect sensitive lands. Hydrologic reserves are undeveloped areas that are maintained to protect natural hydrology and provide habitat during drought periods.

Master Plans

Economic development plans for counties or multi-county regions often have significant impacts on water resources. The designation of future development areas, greenways, sewer service districts, and drinking water sources should address how water resources will be protected through watershed planning/management, antidegradation policy implementation, and other measures. Integrating watershed planning with economic development master planning builds efficiencies and effectiveness in both processes and ensures compatibility among activities that might have competing objectives. In addition, master planning studies might provide information on future land uses and growth projections. Contact your local government planning department to find out if your community has a master plan.

Stormwater Pollution Prevention Plans

Federal regulations require many industrial facilities and most construction sites disturbing more than 1 acre of land to obtain a stormwater permit. Each covered industrial facility or construction site is required to develop and implement a stormwater pollution prevention plan (SWPPP) that describes the activities that will be conducted to prevent stormwater pollution. If you're interested in how a certain industrial facility or construction site plans to control stormwater pollution, you can often obtain a copy of the SWPPP from your state environmental agency, EPA regional office, or local municipality. ↳ Additional information is available at **www.epa.gov/npdes/stormwater**.

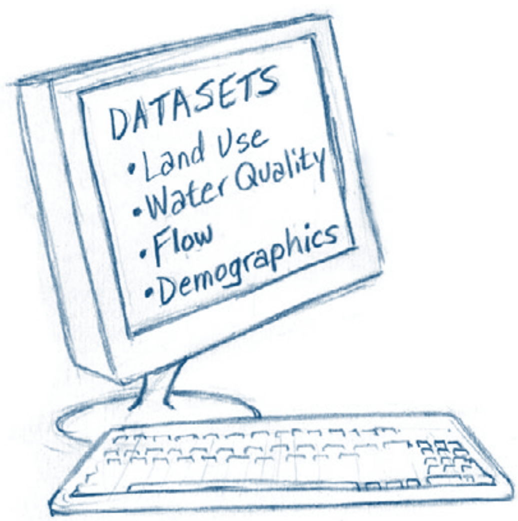
BLM Resource Management Plans

The BLM administers 262 million surface acres of America's public lands, primarily in 12 western states, and 700 million acres of mineral estate. The BLM's 162 resource management plans (RMPs) form the basis for every action and approved use on public lands throughout the country. The RMPs typically establish guidance, objectives, policies, and management actions for public lands administered by the BLM and might address a combination of the following issues:

- Air quality
- Cultural resources
- Grazing and rangeland
- Wildlife habitat
- Mineral and mining resources
- Recreation and off-highway vehicle use
- Special management designations
- Hazardous materials
- Soil and water resources
- Vegetation
- Lands and realty management
- Fisheries management
- Oil and gas resources
- Visual resource management
- Soil and water resources

An RMP in your watershed could provide information on potential sources, as well as general background information on watershed activities and conditions.

↳ The BLM's national planning Web site (Planning, Assessment, and Community Support Group) allows you to search for BLM management plans by state. Go to **www.blm.gov/planning/plans.html**.



5.5.3 Demographics

Demographic data include information on the people in the watershed, such as the number of persons or families, commuting patterns, household structure, age, gender, race, economic conditions, employment, and educational information. This information can be used to help design public outreach strategies, identify specific subpopulations to target during the implementation phase, or help determine future trends and needs of the populations.

Local governments usually collect demographic information on their communities through the planning or economic departments. The primary database for demographic, social, and economic data is the U.S. Census Bureau (↳ **www.census.gov/popest**). Within the database you can search county population estimates.

Population Statistics

Population can provide insight into the distribution of pollutant sources in a watershed and into future growth patterns. In developing areas, it's important to consider future growth when evaluating sources of impairment and identifying potential management options. GIS data for mapping human population are provided by the U.S. Census Bureau through the TIGER (Topologically Integrated Geographic Encoding and Referencing) program. Go to **www.esri.com/data/download/census2000_tigerline/index.html**. TIGER data consist of man-made features (such as roads and railroads) and political boundaries. Population data from the 2000 Census can be linked to the TIGER data to map population numbers and density for small areas (census blocks) and large areas like counties and states. Information from the 1990 Census includes data on household wastewater disposal methods (e.g., sewer, septic systems, other), but similar information was not collected as part of the 2000 Census. Cultural data are also available through many of the states' GIS Web sites.

Land Ownership

Many watersheds contain land owned by a variety of parties, including private citizens and federal, state, and county government agencies. Although information on land ownership in a watershed might not help to characterize the physical nature of the area, it can provide insight into sources of information for characterizing the watershed or identifying pollutant sources. It can also be very useful in identifying implementation opportunities. For example, federal parks can cover large expanses of land, comprising large portions of the watershed, and the managing agency (e.g., National Park Service, USDA Forest Service) can be a valuable source of information on watershed and waterbody characteristics and potential sources (e.g., wildlife populations). State and federal agencies owning and managing land in the watershed should also be contacted to identify any previous studies conducted in the watershed that might support watershed or instream characterization. Keep in mind that local county or city agencies often maintain parcel maps as GIS coverages.

GIS coverages of managed lands in the country are available through EPA's BASINS modeling system. To download data for your cataloging unit, go to **www.epa.gov/waterscience/basins/b3webdwn.htm**. Many states and counties also have coverages of land ownership by parcel or census block.

5.6 Waterbody and Watershed Conditions

Several sources can provide helpful information on the current condition of the waterbodies in your watershed, including whether they meet water quality standards and support designated uses. This section discusses where to find water quality standards for your waterbody, how to identify impaired waters and use support in your watershed, and how to find any TMDLs that have already been completed in your watershed. This information provides a general overview of the health of the waterbodies in your watershed and what uses should be supported.

5.6.1 Water Quality Standards

You'll need to obtain the current water quality standards for the waterbodies in your watershed to understand for what uses the waterbodies should be protected and to compare instream monitoring data with standards to evaluate impairment. You should also document the designated uses for the waterbodies and any relevant criteria for evaluating waterbody conditions. This information can be obtained from EPA's Web site at **www.epa.gov/wqsdatabase**. Tribal water quality standards can be found at **http://epa.gov/waterscience/tribes**.

5.6.2 Water Quality Reports

State water quality reports produced to meet federal requirements provide data on the status of waterbodies, designated uses, known impairments, and potential sources of the stressors. Local municipalities or counties may also produce individual reports on the status of water quality in their jurisdictions.

Biannual 305(b) State Water Quality Report

Under section 305(b) of the Clean Water Act, states are required to prepare a report describing the status of their water quality every 2 years. EPA compiles the data from the state reports, summarizes them, and transmits the summaries to Congress along with an analysis of the nationwide status of water quality. The 305(b) reports evaluate whether U.S. waters meet water quality standards, what progress has been made in maintaining and restoring water quality, and the extent of remaining problems. Check your state's report to see if your watershed has been monitored or assessed. If so, you should find information like the following:

- Status of use support with descriptions of significant water quality impairments
- Identification of problem parameters for impaired waters, along with potential sources of the stressors
- Priority for TMDL development

Go to **www.epa.gov/OWOW/305b** for information on your state's 305(b) report.

303(d) List of Impaired Waters

Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. Impaired waters are those which do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters.

Reviewing your state's 303(d) lists will help you identify any impaired waterbodies in your watershed. If there are impairments that have not been addressed through TMDLs, you might want to consider coordinating with your state's TMDL program to develop TMDLs concurrently with your watershed plan. The 303(d) list may identify the schedule for TMDL development, highlighting TMDLs already done, currently under way, or scheduled for coming years. The list may identify potential sources of the impairment and include notes on why the waterbody was listed—information that can guide your source assessment and search for information.

Integrating 303(d) and 305(b) Reports

Beginning with the 2002 305(b) and 303(d) reporting cycle, EPA had encouraged states to prepare a single integrated report that satisfies the reporting requirements of Sections 303(d) and 305(b). As part of EPA's guidance to states for preparing integrated reports, EPA recommends that states use the following five reporting categories to report on the water quality status of all waters in their states:

Category 1: All designated uses are supported, no use is threatened;

Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported;

Category 3: There is insufficient available data and/or information to make a designated use support determination;

Category 4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed;

Category 5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

In classifying the status of their waters, states may report each waterbody in one or more category (the latter, where there is more than one impairment in a waterbody). Waters assigned to categories 4 and 5 are impaired or threatened; however, waters assigned to Category 5 represent waters on a state's Section 303(d) list. A state's Section 303(d) list is comprised of waters impaired or threatened by a pollutant, and needing a TMDL. Similar to Category 5, waters in Category 4 are also impaired or threatened; however, other conditions exist that no longer require them to be included on a state's Section 303(d) list. These conditions, which are referred to as subcategories of Category 4 in EPA's Integrated Reporting Guidance, are described below:

Category 4a: TMDL has been completed;

Category 4b: TMDL is not needed because other required controls are expected to result in the attainment of an applicable WQS in a reasonable period of time (see Section 5.6.3 for additional details);

Category 4c: The non-attainment of any applicable WQS for the waterbody is the result of pollution and is not caused by a pollutant. Examples of circumstances where an impaired segment may be placed in Category 4c include waterbodies impaired solely due to lack of adequate flow or to stream channelization.

For additional information on EPA's five recommended reporting categories, go to EPA's *Integrated Reporting Guidance* at **www.epa.gov/owow/tmdl**.

5.6.3 Watershed-Related Reports

In addition to state or local water quality reports, there might be existing watershed-related studies produced for all or a portion of your watershed under various state, local, or federal programs. These studies might have a narrower focus than your watershed plan (e.g., source water, specific pollutant) or be out-of-date, but they can provide information on available data, potential pollutant sources, and historical water quality and watershed conditions. This section provides a few examples of current or recent programs that might provide relevant watershed information. This is not a comprehensive list of the programs or reports that could be available for a watershed, but it does highlight commonly used plans that can provide information relevant to watershed planning.

Existing TMDL Reports

If a TMDL has been developed for all or part of your watershed, the supporting documents can often provide much of the information needed to support watershed plan development, such as

- Descriptions of the stressors causing water quality impairment
- The extent (length of stream, area of watershed) and magnitude of the impairment
- Sources of impairment and relative contributions for parameters causing impairment

TMDLs Are a Starting Point

Do not limit your watershed planning effort strictly to the information provided in the TMDL. You'll need to review the TMDL and determine the following:

Pollutants and Sources. TMDLs are developed specifically to address the pollutants included on the state's 303(d) list. The watershed planning effort should consider all pollutants causing problems in the watershed.

Availability of Information. Since the TMDL was completed, has more information that would change or refine the source assessment become available?

Scale/Resolution. What was the scale of the TMDL source assessment? Does it fit the needs of the watershed plan? Generally, the resolution of your watershed plan will need to provide more detail for developing and implementing specific control strategies.

Resources Available. Was the TMDL completed with limited resources? Are there sufficient resources to refine the original source assessment?

- Loading targets for watershed and water quality protection
- Overall load allocations for point and nonpoint sources

To find a link to your state's TMDL program Web site, go to **www.epa.gov/owow/tmdl/links.html**.

In addition, the National TMDL Tracking System (NTTS) houses the 303(d) lists and tracks TMDL approvals. The NTTS stores information necessary to track the performance of state and regional TMDL programs and to ensure that TMDLs are being calculated at an adequate pace for waters currently listed as impaired. The database includes numerous Web-based reports. The NTTS is mapped to the NHD through the EPA WATERS (Watershed Assessment, Tracking & Environmental Result) system. Data files and GIS shapefiles with information on segments listed for one or more pollutants and listed waters for which TMDL loading reduction targets have been established are available for download at **www.epa.gov/waters/data/prog.html**.

Category 4b Rationales

Similar to a TMDL, a state's rationale for assigning an impaired water to Category 4b of the integrated report can also provide much of the information needed to support watershed management plans. Specifically, EPA's *Integrated Reporting Guidance* recommends that states include the following information in their rationales for assigning an impaired water to Category 4b:

- Identification of segment and statement of problem causing the impairment;
- Description of pollution controls and how they will achieve WQS;
- An estimate or projection of the time when WQS will be met;
- Schedule for implementing pollution controls;
- Monitoring plan to track effectiveness of pollution controls; and
- Commitment to revise pollution controls, as necessary.

In return, watershed-based management plans may also provide much of the information needed to support assigning an impaired waterbody to Category 4b.

For additional information on Category 4b, go to EPA's Integrated Reporting guidance for the 2006 and 2008 reporting cycles at **www.epa.gov/owow/tmdl**.

Source Water Assessments

The Safe Drinking Water Act (SDWA) Amendments of 1996 require states to develop and implement Source Water Assessment Programs (SWAPs) to analyze existing and potential threats to the quality of the public drinking water throughout the state. Every state is moving forward to implement assessments of its public water systems through the SWAPs. Assessments were required to be completed by 2003 for every public water system—from major metropolitan areas to the smallest towns, including schools, restaurants, and other public facilities that have wells or surface water supplies. (Assessments are not conducted for drinking water systems that have fewer than 15 service connections or that regularly serve fewer than 25 people because these are not considered public water systems.)

The SWAPs created by states differ because they are tailored to each state's water resources and drinking water priorities. However, each assessment must include four major elements:

- Delineating (or mapping) the source water assessment area
- Conducting an inventory of potential sources of contamination in the delineated area
- Determining the susceptibility of the water supply to those contamination sources
- Releasing the results of the determinations to the public

The assessments are available through the local utility in its annual consumer confidence reports. Many local water utilities provide this information online, and it can be found by searching the Internet. ➷ Go to EPA's Local Drinking Water Information Web page, **www.epa.gov/safewater/dwinfo/index.html**, to find links to many online water quality reports and specific information about local drinking water supplies, including information about the state's drinking water program and source water protection program. ➷ Go to **www.epa.gov/safewater/dwinfo/index.html** to find links to regional and state contacts for source water protection. ➷ Additional information about SWAPs is available at **http://cfpub.epa.gov/safewater/sourcewater/sourcewater.cfm?action=Assessments**.

Watershed Restoration Action Strategies

In 1998 EPA and USDA released the Clean Water Action Plan (USEPA and USDA 1998) as a means toward fulfilling the original goal of the Clean Water Act—fishable and swimmable waters for all Americans. A key component of the plan was the development of Watershed Restoration Action Strategies (WRASs) to comprehensively address watershed restoration, including a balance between discharge control for specific chemicals and prevention of broader, water-related problems such as wetland loss and habitat degradation. The plan proposed that states and tribes develop WRASs for those watersheds identified as having the greatest need for restoration.

The development and implementation of WRASs were a focus of EPA guidelines for awarding section 319 funds in Fiscal Years 1999 through 2001. Consequently, many states developed WRASs for priority watersheds, and some might continue to do so. If a WRAS has been completed for your watershed, it can be an important source of information about water quality conditions, available data, land uses and activities, threats to water quality, restoration priorities, key stakeholders, and sources of funding. ➷ Browse your state environmental agency's Web site to see if a WRAS is available for your watershed.

5.7 Pollutant Sources

Pollutants can be delivered to waterbodies from various point and nonpoint sources. Identifying and characterizing sources are critical to the successful development and implementation of a watershed plan and the control of pollutant loading to a stream. Characterizing and quantifying watershed pollutant sources can provide information on the relative magnitude and influence of each source and its impact on instream water quality conditions. Watershed-specific sources are typically identified and characterized through a combination of generation, collection, and evaluation of GIS data, instream data, and local information. However, some common types of pollutant sources might be contributing to watershed problems, and this section discusses information available to characterize them.

Who Is Subject to NPDES?

To find out more about NPDES and what discharges are subject to NPDES permitting requirements, go to EPA's NPDES Web page at **http://cfpub.epa.gov/npdes/index.cfm**.

5.7.1 Point Sources

The discharge of pollutants from point sources, such as pipes, outfalls, and conveyance channels is generally regulated through National Pollutant Discharge Elimination System (NPDES) permits. Check with state agencies for the most recent and accurate point source discharge information. Be sure to verify actual monitored discharges and future discharge projections or capacity because often not all of the water quality parameters that you might be interested in are monitored.

Permits

Existing dischargers that discharge into waterbodies from specific point sources should be identified. These include wastewater treatment plants, industrial facilities, and concentrated animal feeding operations. Generally point sources that discharge pollutants into waterbodies are required to have a permit under the NPDES program. Information on major facilities is stored in EPA's Permit Compliance System (PCS). PCS is an online database of information regarding permitted point sources throughout the United States (**www.epa.gov/enviro/html/pcs/index.html**). Data from major NPDES permits is included in PCS; PCS also includes information from certain minor NPDES permits as well. Included in the database is information about facility location, type of facility, receiving stream, design flow, and effluent pollutant limits. PCS also contains Discharge Monitoring Report data on effluent monitoring and recorded violations. Data are continuously added to the database so that the most recent point sources can be tracked. Geographic information is included with each point source so that data can be plotted and analyzed in a GIS.

Wastewater Permits

Many communities have a wastewater treatment plant that uses a series of processes to remove pollutants from water that has been used in homes, small businesses, industries, and other facilities before discharging it to a receiving waterbody. Generally facilities that discharge wastewater into waterbodies are required to have a permit under the NPDES program. Information about wastewater treatment facilities is available in EPA's "Envirofacts" data system for water (**http://oaspub.epa.gov/enviro/ef_home2.water**). Search for facilities in your area by entering your ZIP Code, city, or county. Envirofacts will display a list of permitted facilities in your area, including each facility's name, permit number, location, and discharge information.

Stormwater Permits

Federal regulations require certain municipalities, generally those in urban areas with separate stormwater sewer systems, to obtain municipal stormwater permits. These permits require each municipality to develop a stormwater management plan that describes how the municipality will prevent stormwater pollution. Copies of the permits are available from your state environmental agency or EPA regional office. The stormwater management plans written to comply with the requirements in the permit typically include activities to educate the public about stormwater impacts, control stormwater runoff from new developments and construction sites, control stormwater runoff from municipal operations, and identify and eliminate illicit discharges. Contact your local municipality's environmental agency or public works department to find out whether it addresses stormwater runoff. You should also be able to obtain a copy of the municipality's current stormwater management plan to see what activities are planned. Additional information is available at **www.epa.gov/npdes/stormwater**.

5.7.2 Nonpoint Sources

Nonpoint source pollution, unlike pollution from industrial facilities and treatment plants, typically comes from many diffuse sources, not specific pipes or conveyances. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground, carrying natural and man-made pollutants and finally depositing them into surface waters. Surface water runoff represents a major nonpoint source in both urban and rural areas. Runoff from urban watersheds can deliver a variety of pollutants from roadways and grassed areas, and rural stormwater runoff can transport significant pollutant loads from cropland, pastures, and livestock operations. Natural background sources like wildlife or geology (e.g., soils high in iron) can also contribute loadings and might be particularly important in forested or less-developed areas of the watershed. Additional nonpoint sources include on-site wastewater systems (septic tanks, cesspools) that are poorly installed, faulty, improperly located, or in close proximity to a stream and illicit discharges of residential and industrial wastes. This section discusses some common nonpoint sources characterized in watershed plans.

Local USDA Extension Offices

Extension offices are a valuable source of information on local agricultural practices and can provide information on types and distribution of livestock, crops, and management practices. The national Cooperative Extension System works in six major areas:

- 4-H youth development
- Agriculture
- Leadership development
- Natural resources
- Family and consumer sciences
- Community and economic development

Although the number of local extension offices has declined over the years and some county offices have consolidated into regional extension centers, approximately 2,900 extension offices remain nationwide.

To find your local extension office, go to **www.csrees.usda.gov/Extension/index.html**.

Livestock Sources

In watersheds with extensive agricultural operations, livestock can be a significant source of nutrients and bacteria and can increase erosion. If available, site-specific information on livestock population, distribution, and management should be used to characterize the potential effects from livestock activities. Local USDA officials are typically the best source of livestock information. If local information is not available, you can use the Census of Agriculture to find information about the number and type of animal units per county. The census is conducted every 5 years; the most recent census was conducted in 2002. Data from the census are available online at **www.agcensus.usda.gov**, and data can be analyzed at the county level in a GIS. You should consult local USDA officials to determine whether conditions in the watershed are accurately reflected in the census. You should also obtain local information on additional agricultural sources, such as land application of manure.

Cropland Sources

Depending on crop type and management, croplands are a potentially significant source of nutrients, sediment, and pesticides to watershed streams. Cropland can experience increased erosion, delivering sediment loads and attached pollutants to receiving waterbodies. Fertilizer and pesticide application to crops increases the availability of these pollutants to be delivered to waterbodies through surface runoff, erosion (attached to sediment), and ground water. If cropland is an important source of pollutants in your watershed, it's useful to determine the distribution of cropland as well as the types of crops grown. Land use coverages for your watershed can identify the areas of cropland in your watershed. For more information on the types of crops and their management, contact local extension offices or conservation districts. The USDA Census of Agriculture can also provide information on crop types and fertilizer and chemical applications. However, census data are presented at the county level and might not reflect the cropland characteristics in your watershed. The USDA's Spatial Analysis

Research Section has developed a coverage of the distribution of crop types (e.g., soybeans, corn, potatoes, cotton) called the Cropland Data Layer (**www.nass.usda.gov/research/Cropland/SARS1a.htm**). Currently, the Cropland Data Layer is available for Arkansas, Illinois, Indiana, Iowa, Mississippi, Missouri Boot Heel, Nebraska, North Dakota, and Wisconsin. Some states have data available annually since 1997, and some have only recent (2003–2004) data available. In addition, NRCS offices in agricultural regions often take annual aerial photos to track crop usage.

Literature values for pollutant generation by crop type are often used in modeling and other loading analyses to estimate loads from cropland sources. NRI data also provide information on cropland characteristics by county and cataloging unit.

Urban Sources

Impervious coverage information is typically used to characterize the density of and potential loading from urban areas. Impervious coverages are developed from direct photointerpretation and delineation or estimated by relating imperviousness to land use and land cover. Because urban or developed areas have high percentages of impervious area, they typically experience greater magnitudes of stormwater runoff than do more rural areas. Runoff from developed areas can wash off and transport pollutants, and urban pollutant loads can be a significant source when the watershed is predominantly developed, with little or no agricultural area. In addition to the larger areas of impervious surfaces, urban areas typically have pollutant sources unique to the urban and residential environment (e.g., pet wastes, lawn fertilizers, pollutants from car maintenance) that are often difficult to identify. These sources are usually collectively represented by the term *stormwater runoff*. Literature values of urban accumulation or stormwater loading rates can be used to characterize the urban land uses in source analyses and model applications.

Onsite Wastewater Systems

Individual and clustered wastewater systems provide appropriate treatment if they are designed, installed, operated, and maintained correctly. Malfunctioning systems, however, can contribute significant nutrient and bacteria loads to receiving waterbodies, particularly those in close proximity (less than 500 ft). Local agencies can provide estimates of the total number of septic systems in a specific area or county. For example, the Panhandle Health District in Idaho has an online searchable database of septic system permits, geographically identified by Census block. Also, county-level population, demographic, and housing information, including septic tank use, can be retrieved from the U.S. Census Bureau (↳ **http://quickfacts.census.gov**).

To evaluate septic systems as a source of pollutants, however, you'll want to know the distribution of malfunctioning systems. In some cases, local health departments can provide information on septic systems (e.g., location, frequency, malfunction rates), but in many watersheds the specific incidence and locations of poorly performing systems are unknown. Literature values and local or county statistical information can be used to estimate the number of failing septic systems in a watershed. ↳ For example, the National Small Flows Clearinghouse (NSFC 1993) surveyed approximately 3,500 local and state public health agencies about the status of onsite systems across the country (NSFC 1993) and provides the number of reported failing septic systems in the United States by county.

Local Knowledge Goes a Long Way

Having a local understanding of your watershed and the activities that take place there is critical to accurately identifying and characterizing sources. If you need help identifying sources, the information in this section should guide you in the right direction, but it's also very important to involve local experts that can help you through the process. Without input from local agencies (e.g., conservation districts), you might miss important sources that are unique to your area.

(Go to **www.nesc.wvu.edu/nsfc/nsfc_index.htm**.) Using the county-specific estimates from NSFC (1993), the number of failing septic systems in a county can be extrapolated to the watershed level based on county and watershed land use distribution. The number of malfunctioning systems can also be estimated by applying an appropriate failure rate, from literature or from local sanitation personnel, to the total number of septic systems in a watershed.

Silviculture Sources

Silviculture can be a significant source of sediment and other pollutants to a waterbody. The primary silviculture activities that cause increased pollutant loads are road construction and use, timber harvesting, site preparation, prescribed burning, and chemical applications. Without adequate controls, forestry operations can cause instream sediment concentrations and accumulation to increase because of accelerated erosion. Silviculture activities can also cause elevated nutrient concentrations as the result of prescribed burns and an increase in organic matter on the ground or in the water. Organic and inorganic chemical concentrations can increase because of harvesting and fertilizer and pesticide applications. Harvesting can also lead to instream accumulation of organic debris, which can lead to dissolved oxygen depletion. Other waterbody impacts include increased temperature from the removal of riparian vegetation and increased streamflow due to increased overland flow, reduced evapotranspiration, and runoff channeling.

The BLM administers millions of acres of commercial forests and woodlands in the western United States. For a list of BLM state offices, visit **www.blm.gov/nhp/directory/index.htm**. Local BLM personnel can help you identify areas of silvicultural activity in your watershed.

Wildlife Sources

Although wildlife inputs typically represent natural background sources of pollutants, they can be an important source of bacteria or nutrients in forested or less-developed areas of a watershed. In addition, animals that inhabit area waters (e.g., waterfowl) represent a direct source to receiving waters. Although wildlife sources are often uncontrollable, it's important to consider their potential impact on water quality and their importance relative to other pollutant sources when characterizing your watershed. State or local wildlife agencies (e.g., Department of Fish and Game) or relevant federal agencies (e.g., Forest Service) can be contacted for estimates of wildlife populations in your area. Go to **http://offices.fws.gov/statelinks.html** for links to state and territorial fish and wildlife offices.

Airborne Deposition of Pollutants

Watersheds downwind from sources of air emissions containing nitrogen, phosphorus, ammonia, mercury, or other metals can receive significant loads of these pollutants under certain conditions. Airborne pollution can fall to the ground in raindrops, in dust or simply due to gravity. As the pollution falls, it may end up in streams, lakes, or estuaries and can affect the water quality there. For example, studies show that 21% of the nitrogen pollution entering Chesapeake Bay comes from the air. In addition, much of the mercury linked to fish tissue contamination comes from the combustion of fuels and other material containing mercury compounds, transported downwind and deposited in distant watersheds. Dealing with these sources will require long-term actions to identify source areas/categories and determine appropriate load reduction management strategies. More information on air deposition of pollutants—including isopleth maps showing general areas of high loadings—can be found at **www.epa.gov/owow/airdeposition/** and **http://nadp.sws.uiuc.edu/**.

5.8 Waterbody Monitoring Data

A number of federal, state, local, and private entities monitor waterbodies across the nation. These data might represent specialized data collected to answer a specific question about waterbody conditions, or the data might be collected regularly as part of a fixed network of long-term monitoring to assess trends in water quality. Monitoring data, including chemical, physical, and biological data, are critical to characterizing your watershed. Without such data, it is difficult to evaluate the condition of the waterbodies in your watershed. The waterbody data

Identify the Weakest Link

Just as a chain is only as strong as its weakest link, a watershed characterization is only as good as the data it is based on. It's important to understand the quality and quantity of your instream monitoring data when using the data for watershed planning and associated decisions. Common factors that can affect the usefulness of data include the following:

- **Data quality:** Data quality represents a variety of aspects of the data, including accuracy, precision, and representativeness. For more information on data quality, go to section 6.2.2.
- **Spatial coverage:** The number of locations with relevant data can determine the detail of your watershed analysis. Without instream data collected throughout the watershed, you can't evaluate the spatial differences in water quality conditions or identify areas of greater impairment.
- **Temporal coverage:** Without watershed data covering a long time period or a variety of environmental conditions, it's difficult to understand the typical instream conditions of your waterbody. Because most instream data consist of occasional (e.g., monthly) grab samples, monitoring data often represent only a snapshot of the waterbody at the moment of sampling.

Often, data are limited and you don't have the luxury of daily samples collected over a 10-year period. If the amount of data is insufficient to continue with watershed plan development, it might be necessary to initiate additional monitoring (see chapter 6). Otherwise, having limited data should not stop the watershed planning process; the process can continue with an understanding that the data might not fully represent or characterize waterbody conditions and that future monitoring should be used to update the plan as necessary.

gathered and evaluated for the watershed characterization typically include flow, water quality (e.g., chemical concentrations), toxicity, and biological data. Other specialized datasets might also be available for your waterbodies, such as physical stream assessments or ground water studies, but this section discusses the most common sources of waterbody data available to the public.

Much of the nation's hydrology, water quality, and biological data resides in national datasets accessible on the Internet. Many of the databases include several datasets and analysis tools. The following sections describe the major databases that contain waterbody monitoring data.

5.8.1 Water Quality and Flow Data

This section discusses a variety national databases containing water quality and flow monitoring data.

STORET

STORET is EPA's database for the storage and retrieval of ground water and surface water quality data. In addition to holding chemical and physical data, STORET supports a variety of types of biomonitoring data on fish, benthic macroinvertebrates, and habitats. Currently, there are two versions of the STORET database. Legacy STORET contains historical data from the early 1900s through 1998, and new data are no longer input to the Legacy STORET database. Modernized STORET has data from 1999 to the present. New data are input into the Modernized STORET database as they become available. STORET data can be downloaded online from **www.epa.gov/STORET/index.html**.

STORET includes data for the following topics:

- Station descriptions
- Non-biological physical and chemical results ("regular results")
- Biological results
- Habitat results

Data can be queried through several search options, including geographic location, organization, and station ID. You can also browse STORET data using mapping tools available through STORET's main page.

National Listing of Fish Advisories

The NLFA database includes information describing state-, tribe-, and federally issued fish consumption advisories in the United States for the 50 states, the District of Columbia, and four U.S. territories. The information is provided to EPA by the states, tribes, and territories. The advisories recommend limiting or avoiding consumption of specific fish species or limiting or avoiding consumption of fish from specific waterbodies. The NLFA Web site lists 3,089 advisories in 48 states through the end of 2003. The Web site can generate national, regional, and state maps that summarize advisory information. Also included on the Web site are the name of each state contact, a phone number, a fax number, and an e-mail address. Go to **www.epa.gov/waterscience/fish/advisories**.

NWISWeb

The National Water Information System Web site (NWISWeb) is the USGS's online database for surface water and ground water flow and water quality data. The NWISWeb database provides access to water resources data collected by USGS at approximately 1.5 million sites in all 50 states, the District of Columbia, and Puerto Rico. Data are organized by several categories, such as surface water, ground water, real time, and flow. The data can be queried using information such as station name, location (latitude and longitude), or 8-digit HUC. Data can be downloaded online at **http://waterdata.usgs.gov/nwis**.

Beach Environmental Assessment, Communication, and Health Program Data

The BEACH Program appropriates funds to states for developing monitoring and notification programs that will provide a uniform system for protecting the users of marine waters. The BEACH Program can provide information on issues and concerns related to bacteria contamination at recreational beaches, provide monitoring data, and assist with educating the public regarding the risk of illness associated with increased levels of bacteria in recreational waters. If your watershed borders the coast or the Great Lakes, go to **www.epa.gov/beaches** for additional information.

Volunteer Monitoring Program Data

State, tribal, and local volunteer monitoring programs might also be good sources of water quality data. Many volunteer groups upload their data to STORET. Go to **www.epa.gov/owow/monitoring/volunteer** for more information.

WATERS

The WATERS information system uses EPA's standard mapping application to display water quality information about local waters. WATERS combines information about water quality goals from EPA's Water Quality Standards Database with information about impaired waters from EPA's TMDL database. Go to **www.epa.gov/waters**.

National Sediment Inventory

EPA completed the National Sediment Inventory (NSI) in response to the Water Resources Development Act of 1992 (WRDA), which directed EPA, in consultation with NOAA and the U.S. Army Corps of Engineers, to conduct a comprehensive program to assess the quality of aquatic sediments in the United States. EPA also submits to Congress a report on the findings of that program. The report identifies areas in the United States where the sediment might be contaminated at potentially harmful levels. The report also assesses changes in sediment contamination over time for areas in the United States with sufficient data. The first National Sediment Quality Survey report was released in 1997, and it was updated in 2004. Before releasing the update, EPA released the National Sediment Quality Survey Database, which has compiled information from 1980 to 1999 from more than 4.6 million analytical observations and 50,000 stations throughout the United States. The database contains information on

- Sediment chemistry, a measure of the chemical concentration of sediment-associated contaminants
- Tissue residue, a measure of chemical contaminants in the tissue of organisms
- Toxicity, a measure of the lethal and sublethal effects of contaminants in environmental media on various test organisms

↳ Go to **www.epa.gov/ost/cs/report/2004/index.htm** for more information on the NSI report. ↳ Go to **www.epa.gov/waterscience/cs/nsidbase.html** to download the associated sediment quality data.

5.8.2 Biological Data

Aquatic life (e.g., fish, insects, plants) are affected by all the environmental factors to which they are exposed over time and integrate the cumulative effects of pollution. Therefore, biological data provide information on disturbances and impacts that water chemistry measurements or toxicity tests might miss. This makes these data essential for determining not only the biological health but also the *overall* health of a waterbody.

Although there is no single source of biological data, many of the datasets already mentioned under the instream monitoring section include biological datasets. To learn more about the specific biological assessment programs of states and regions, visit ↳ EPA's Biological Indicators of Watershed Health Web site at **www.epa.gov/bioindicators/index.html**. This site provides links to state program Web sites, contacts, and relevant documents.

Biological community samples (fish, invertebrates, algae) are collected in the nation's streams and rivers as part of the USGS National Water-Quality Assessment (NAWQA) Program's ecological studies (↳ **http://water.usgs.gov/nawqa**). Data for thousands of fish and invertebrate samples are available for retrieval online, and algal community and instream habitat data will be released in summer 2005. ↳ Go to **http://infotrek.er.usgs.gov/traverse/f?p=136:13:0::NO:::**.

5.8.3 Geomorphological Data

Rivers and streams change in direct response to climate and human activities in the watershed. Increasing impervious surfaces like pavement, clearing forests and other vegetation, compacting soils with heavy equipment, and removing bank vegetation typically result in an adjustment in the pattern, profile, or dimensions of a river or stream. Assessments of river and stream geomorphology can help determine (1) the prior or "undisturbed" morphology of the channel; (2) current channel conditions; and (3) how the stream is evolving to accommodate changes in flow volumes/timing/duration, channel alteration, and so forth. This information is also helpful in analyzing the movement of sediment downstream from upland sources and channel banks.

Geomorphological studies focus on characterizing the drainage area, stream patterns (single/multiple channels, sinuosity, meander width), the longitudinal profile (gradient), channel dimensions (e.g., width/depth ratio relative to bankfull stage cross section, entrenchment), bank and channel material, riparian vegetation, channel evolution trends, and other features. Because of the fairly recent development and application of analytical tools to assess and classify rivers and streams and explore the relationships among variables affecting their physical conditions, geomorphological data are not available for many river systems. Guidance on conducting geomorphological assessments is available from the Federal Interagency Stream Corridor Restoration Working Group (**www.nrcs.usda.gov/technical/stream_restoration**), Wildland Hydrology (**www.wildlandhydrology.com**), and some state water resource and fish/wildlife agencies.

5.9 Selected Tools Used to Gather, Organize, and View Assessment Information

Although you can use various tools to help visually organize data, two of the most popular tools are GIS and remote sensing techniques, which help to collect and display land use data.

5.9.1 Geographic Information Systems

A GIS is a tool used to support data analysis by creating watershed maps and displaying a variety of spatial information that is helpful for characterizing a watershed; gaining insight into the local environmental, cultural, and political settings; and identifying potential pollutant sources. For example, application of fertilizer on cropland might be a source of nutrients to watershed streams, and GIS data can help in identifying the locations of cropland throughout the watershed and the proximity of cropland to affected streams. Using water quality data analysis in conjunction with GIS evaluations can provide a basis for evaluating water quality trends throughout the watershed. GIS provides the flexibility of evaluating data in different ways and combinations. Users can display only the data useful to their needs and can easily display a combination of spatial coverages. In addition, users can easily create their own watershed coverages to display specific information (e.g., average pollutant concentrations at different waterbody sites).

GIS also allows users to combine and display spatial data from a variety of sources. A wide range of sources for accessing and obtaining GIS data are available. The Internet provides a convenient source for much of the GIS data available from federal, state, and local agencies, as well as GIS organizations and companies. Browsing the Web sites of state and local environmental agencies or contacting the agencies directly can often lead to GIS sites and databases. Table 5-2 provides a selected list of several online GIS data sources.

Check State and Local GIS Data Sources

This section provides several examples of GIS data sources, primarily national, but additional state, local, or regional sources might exist and should be investigated. Several states maintain online databases of GIS data for the state; for example, California Spatial Information Library (**http://gis.ca.gov**), West Virginia Department of Environmental Protection Internet Mapping (**http://gis.wvdep.org**).

See table 5-2 for more information on locating state and local GIS data.

A GIS is very useful and allows for easy display and evaluation of a variety of watershed characteristics (e.g., soils, land use, streams). However, several aspects of GIS and related data can “trip up” GIS novices. This section discusses several topics that you should keep in mind when using GIS and gathering and evaluating GIS data.

Table 5-2. Sources of GIS Data Available on the Internet

GIS Distribution Source Description and Web Site
Federal Agencies and Consortiums
National Geospatial Data Clearinghouse. Sponsored by the Federal Geographic Data Committee (FGDC), the Clearinghouse offers a collection of more than 250 spatial data servers that can be searched through a single interface based on their descriptions or metadata. **www.fgdc.gov/dataandservices**
EPA's BASINS. BASINS is a multipurpose environmental analysis system that integrates a GIS, national watershed data, and environmental assessment and modeling tools. The BASINS GIS data include more than 35 standard coverages, including physical data (e.g., waterbodies, elevation, land use, soils), administrative and political data (e.g., jurisdictional boundaries), landmarks and features (e.g., roads, dams, cities), and other monitoring or environmental information (e.g., gauge sites, monitoring sites, point source facility locations, mine locations, Superfund sites). **www.epa.gov/OST/BASINS/b3webdwn.htm**
USGS's Earth Resources Observation Systems (EROS) Data Center. EROS Data Center is a data management, systems development, and research field center for the USGS National Mapping Division. The EROS Web site contains aerial, topographic, elevation, satellite, and land cover data and information. **http://edc.usgs.gov**
U.S. Census Bureau Topologically Integrated Geographic Encoding and Referencing (TIGER) System. The Census Bureau developed the TIGER system and digital database to support its mapping needs for the Decennial Census and other Bureau programs. **www.esri.com/data/download/census2000_tigerline/index.html** or **www.census.gov/geo/www/tiger**
Bureau of Land Management Geospatial Data Clearinghouse. BLM established the GeoSpatial Data Clearinghouse as part of the FGDC Geospatial Data Clearinghouse Network. BLM data can be searched through the FGDC Web site or the BLM clearinghouse Web site. The BLM Geospatial Data Clearinghouse contains only geospatial data held by the BLM, and it can be searched by state or by keyword (e.g., geology, minerals, vegetation, fire). **www.blm.gov/nstc/gis/GISsites.html** or **www.or.blm.gov/metaweb**
U.S. Department of the Interior, National Atlas of the United States, Map Layers Warehouse. The Atlas is a largely digital update of a large, bound collection of paper maps that was published in 1970. It provides high-quality, small-scale maps, as well as authoritative national geospatial and geostatistical datasets. Examples of digital geospatial data are soils, county boundaries, volcanoes, and watersheds; examples of geostatistical data are crime patterns, population distribution, and incidence of disease. **http://nationalatlas.gov/atlasftp.html**
Watershed Characterization System. WCS is an ArcView-based program that uses spatial and tabular data collected by EPA, USGS, USDA-NRCS, the Census Bureau, and NOAA. The tool can quickly characterize land use, soils, and climate for watersheds in the EPA Region 4 states. **www.epa.gov/athens/wwqtsc/html/wcs.html**
EnviroMapper for Water. EnviroMapper for Water provides a Web-based mapping connection to a wealth of water data. It can be used to view and map data such as the designated uses assigned to local waters by state agencies, waters that are impaired and do not support their assigned uses, beach closures, and location of dischargers. Water quality data include STORET data, National Estuary Program (NEP) study areas, and locations of nonpoint source projects. **www.epa.gov/waters/enviromapper**
State Sources
State GIS Clearinghouse Directory. The Directory provides a list of state GIS agencies, groups, and clearinghouses. **www.gisuser.com/content/view/2379**
GIS Organizations or Companies
ESRI. ESRI is a software, research and development, and consulting company dedicated to GIS. Its software includes ArcInfo, ArcGIS, and ArcView. **www.esri.com/data/download/index.html**
Geography Network. This global network of GIS users and providers supports the sharing of geographic information among data providers, service providers, and users around the world. www.geographynetwork.com, provided through **www.esri.com**
GIS Data Depot. GIS Data Depot is an online resource for GIS and geospatial data from The GeoCommunity, a GIS online portal and daily publication for GIS, CAD, mapping, and location-based industry professionals, enthusiasts, and students. **http://data.geocomm.com**
University of Arkansas Libraries and the Center for Advanced Spatial Technologies (CAST). Starting the Hunt: Guide to Mostly On-Line and Mostly Free U.S. Geospatial and Attribute Data, written by Stephan Pollard and sponsored by the University of Arkansas Libraries and CAST, provides a compilation of links to online GIS data, categorized into two broad classifications—State and Local Aggregations and National Aggregations. **www.cast.uark.edu** or **http://libinfo.uark.edu/GIS/us.asp** (direct link to data lists)

When You Can't Do It Yourself

Although the advent of GIS has made many aspects of watershed planning much easier, using GIS effectively requires a certain level of knowledge and practical experience. Sometimes it's not feasible for watershed planners to use GIS extensively, perhaps because they don't have the expertise or the required software. If this is the case, you can use a variety of online mapping applications to gain an understanding of the watershed and its characteristics and pollutant sources without doing the GIS work yourself. Many state, local, and university GIS programs or offices have online interactive mapping applications to display or query their GIS data. For example, the California Digital Conservation Atlas (**http://gis.ca.gov/ims.epl**) is an interactive map with coverages for a wide variety of natural resources-related information, including waterbodies, watershed boundaries, environmental hazards, available plans, and land use and cover. Another example is the Pennsylvania Department of Environmental Protection's eMapPA (**www.emappa.dep.state.pa.us/emappa/viewer.htm**), which is a mapping application that displays state permit information along with various statewide data layers. The mapping application displays information on general watershed features (e.g., streams, floodplains, roads) and a variety of permitted facilities (e.g., wastewater treatment plants, landfills, mines). Although you won't be able to customize the GIS data or add your own coverages (e.g., average nitrate concentrations at monitoring stations), these types of interactive maps allow you to view and evaluate general watershed GIS data without having to gather, store, and manipulate them.

Projections

The spatial representation of data in a GIS is tied to a mapping plane, and all data have an associated projection. Map projections are the means of representing a spherical Earth on a flat mapping plane, and the process of data projection transforms three-dimensional space into a two-dimensional map. Different map projections retain or distort shape, area, distance, and direction.

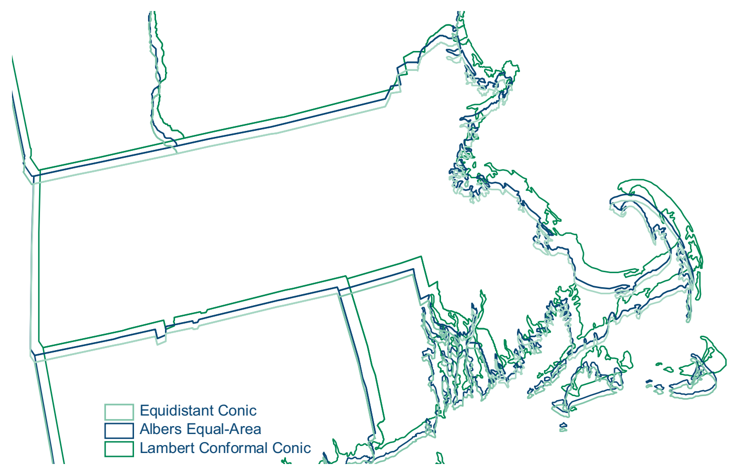


Figure 5-3. Example Map Projections

It is not possible for any one projection to retain more than one of these features over a large area of the earth. Because different projections result in different representations of the shape, area, distance, and direction of mapped objects, GIS data for the same watershed in different projections will not overlap correctly. As an example, figure 5-3 presents a map of Massachusetts in three different projections. Although centered around the same latitude and longitude, these representations obviously do not spatially represent the state in the same way.

Much of the GIS data available through the Internet is provided in decimal degrees—unprojected latitude and longitude. However, GIS data can be projected, and different sources of GIS data use different projections. As an example, EPA's BASINS and U.S. Census Bureau TIGER data are provided in decimal degrees, but many state GIS Web sites provide their GIS data in projections specific to the state (e.g., state plane) or its location in the country (e.g., Universal Transverse Mercator [UTM] zones). When gathering GIS data from a variety of sources, it's important to gather information on the different projections as well so that data can be "re-projected" into a common projection. Projection information is included in the GIS data's metadata (under "Spatial Reference Information").

Don't Forget the Metadata

When gathering GIS data, it's very important to obtain and review the associated metadata. Metadata are "data about data" and include the information needed to use the data properly. Metadata represent a set of characteristics about the data that are normally not contained within the data itself, such as

- Description of the data (e.g., creator, contact, distribution information, citation information)
- Information on how and when the data were created
- Spatial reference information (data projection)
- Definitions of the names and data items

Understanding the content and structure of the data is especially important when compiling and comparing data from various sources or agencies.

Scale

The map scale of GIS data specifies the amount of reduction between the real world and its graphic representation, usually expressed as a ratio of the unit of measure on the map to the same units on the ground (e.g., 1:20,000). Map scale determines how much area is included on paper maps; however, because the capabilities of GIS allow you to zoom in and zoom out to customize your map display, map scale does not determine the extent of the mapped information in a GIS. Scale, however, does affect what is included in the GIS data. The smaller a map's scale (the more ground area it covers on a paper map), the more generalized the map features. A road or stream that is sinuous on the ground might be represented by a fairly straight line in data with a small scale, and some features might not even be included in small-scale data. The scale of your GIS data is an important aspect to keep in mind when combining datasets for evaluating your watershed. The scale of your information influences the spatial detail of your analysis. For example, if you want to evaluate road crossings for streams in your watershed and you use data at a small scale, the data will likely not include many of the small roads and streams. Figure 5-4 presents maps of streams and roads obtained from datasets of different scales. Obviously, the smaller-scale dataset (1:500,000) has much coarser detail, while the larger-scale dataset provides a higher level of detail.

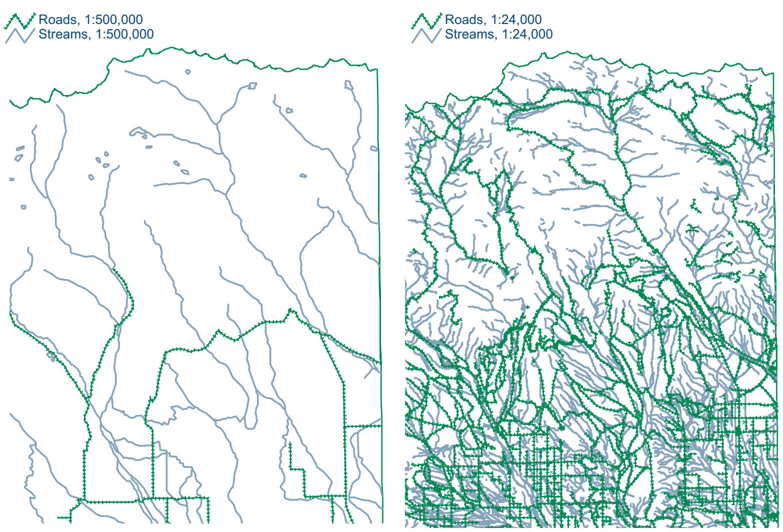


Figure 5-4. Example of GIS Datasets at Different Scales

Time Frame

It's very important to consider the date of the GIS data you are evaluating, especially when combining datasets. Because of the time and effort it takes to create GIS data, often there are not many versions (dates) of the same coverage available and you are limited to what is available. Sometimes, however, there are different sources of the same kinds of data from different periods. For example, USGS has a variety of land use datasets based on satellite images taken during different time frames. The LULC data are based on images taken during the 1970s and 1980s, while the NLCD data are based on images from the early 1990s and 2000. It is important to obtain the data that are most representative of the time period you want to evaluate. If you want to compare land use and water quality data, try to obtain land use data from the time your monitoring was conducted. For example, compare historical data collected in the 1970s with the LULC data and compare more recent monitoring data with the NLCD data from the 1990s.

If GIS data are significantly out-of-date, it might be necessary to ground-truth them to avoid undermining your analysis. For example, if the land use data represent watershed land uses 20 years ago, you might under- or overestimate certain types of sources when evaluating current loading conditions. If you have a small watershed and land ownership has not changed significantly (parcels are still comparable to historical land use divisions or aerial photos), you might be able to drive through your watershed and note any major land use changes.

Another factor to keep in mind is the date of creation versus the date of the original data on which the GIS coverage is based. For example, the NLCD 2001 data are still being developed; therefore, many datasets will be dated 2005 even though they are based on satellite images from 2001. Be sure to review the metadata to determine the dates of all of your GIS coverages.

The Importance of Training

Several nuances are associated with displaying, manipulating, and controlling GIS data. It is recommended that you have some training before you undertake significant GIS evaluations.

The availability and type of GIS training are highly specific to your location and needs. To find out more about GIS training and educational resources, visit **www.gis.com/education/index.html** or conduct an Internet search to research training opportunities in your area.

Organization, Storage, and Manipulation of Files

GIS data can come in a variety of formats and typically have several associated files needed to view and understand their content. For example, a standard shapefile includes the files (the main file [*.shp] and the index file [*.shx]) that control the display of the shapes and the file (dBASE file [*.dbf]) that contains feature attributes (e.g., area, name) for each shape in the file. Grid data require even more files to display. When dealing with data in different projections, it is necessary to "re-project" the data into a common projection, creating even more data files. In addition, GIS data that cover large areas or include highly detailed information (e.g., parcel-based land use) can have very large files. Because of the number and size of files, the organization of GIS files can become cumbersome and require considerable disk space on your computer. It is often helpful to organize data according to watershed topics (e.g., hydrology, land use, soils, stations) or by the source of the data (e.g., TIGER, EPA BASINS).

In addition, GIS data can be manipulated very easily to evaluate certain areas or certain data types, but doing so can lead to a number of extraneous files, as well as unintended changes to your original data files. You can delete or add records to GIS data files, but it's important to remember that when you do this, you are changing the original data files. If you want to isolate areas (e.g., subwatersheds) or records (e.g., certain monitoring stations), it is necessary to clip existing coverages to create new coverages.

Several other issues related to organizing, storing, and using GIS files can aggravate the new user; therefore, it's useful to rely on members of your watershed group that have experience in using GIS or contacts that can provide guidance to beginners.

5.9.2 Remote Sensing Techniques to Collect Land Use/Land Cover Information

Remote sensing refers to the collection of data and information about the physical world by detecting and measuring radiation, particles, and fields associated with objects located beyond the immediate vicinity of the sensor device(s). For example, photographs collected by an aircraft flying over an area of interest (e.g., aerial photography) represent a common form of remote sensing information. Satellites that orbit the earth are often used to collect similar images over larger areas, and these images are another example of remote sensing information. Remote sensing information is collected, transmitted, and processed as digital data that require sophisticated software and analysis tools. An excellent and wide-ranging review of remote sensing can be found at **http://rst.gsfc.nasa.gov/Homepage/Homepage.html**.

Using Land Use Data to Evaluate and Manage Stormwater in Anchorage

The Municipality of Anchorage (MOA), Alaska, created a complete land cover classification to provide the foundation for mapping inland areas according to their common surface hydrologic and gross pollutant generation potential. The "Storm Water Runoff" grid was derived in summer 2000 through analysis of IKONOS satellite imagery and other geographic datasets (especially land use, streets, drainage, coastland, and wetlands data). The GIS-based dataset was built to provide information for stormwater management applications.

The land cover data include five major classes—Impervious, Barren Pervious, Vegetated Pervious, Snow and Ice, and Water. These classes are further subdivided to reflect changes in perviousness due to different land development applications. For example, impervious surfaces are classified as street surface, directly connected impervious, and indirectly connected impervious, and vegetation classes are classified as landscaped or forested. Values for hydraulic connectedness (direct or indirect connection) are attributed to each mapped land parcel independently of the assessment of the pervious quality.

MOA uses the GIS coverage to support development and application of the Stormwater Management Model (SWMM) for stormwater management within the municipality. SWMM, based on MOA's land use coverage, also was modified and applied in the Chester Creek watershed to develop draft TMDLs for bacteria in the creek and two watershed lakes.

Remote sensing data products, especially land cover and elevation, provide fundamental geospatial data for watershed characterization. Remote sensing is a powerful tool for watershed characterization because the data are digital and therefore you can use the information analytically, especially in a GIS system. You can integrate remote sensing data with other types of data, such as digital elevation data, the stream network (e.g., NHD), and so forth. You can then use GIS to classify landscape and ecological attributes at detailed levels within a watershed. An example is identifying steeply forested lands and riparian buffers.

This section includes remote sensing principles and highlights some of the most readily available and useful datasets. The highlighted datasets have undergone extensive quality control, are low-cost or free, and can be used in a basic GIS platform, especially ArcView. Their use in ArcView includes being able to perform basic analytical functions, such as calculating land cover distribution statistics in watersheds, as well as integration with other data such as Census data.

Types of Remote Sensing

Remotely sensed data can be broadly placed into two basic categories: (1) aerial imagery, which includes images and data collected from an aircraft and involves placing a sensor or camera on a fixed-wing or rotary aircraft, and (2) space-based imagery, which includes images and data collected from space-borne satellites that orbit the earth continuously. Although air-based and space-based remote sensing involve the same general principles, there are important technical differences in the acquisition and application of imagery from these sources.

Aerial Imagery

Aerial images are collected using sensors placed onboard the aircraft. For example, a photographic sensor can be placed on the underside of an aircraft and used to collect color photos over an area of interest. In contrast, a much more sophisticated sensor, such as AVIRIS (Airborne Visible/Infrared Imaging Spectrometer), can be placed onboard an aircraft to collect hyperspectral data and thereby acquire much more than simple color photographic images. A simple photographic sensor collects standard color imagery that is composed of the red, blue, and green spectral regions of the visible light spectrum (e.g., what the human eye can detect). In contrast, AVIRIS collects 224 contiguous spectral channels (bands) with wavelengths from 400 to 2,500 nanometers, spanning both the visible and non-visible regions of the light spectra. Go to **http://aviris.jpl.nasa.gov** for more information about AVIRIS.

Most sensors used in remote sensing measure the radiance from the sun that is reflected by the earth's surface. Various land surface features absorb and reflect this radiance to varying degrees, which is what enables the recognition of various features on the ground. However, some sensors used in remote sensing emit a source of energy that is reflected from the surface of the earth or from the object toward which the energy is directed. Such sensors can be laser-based or radar-based (e.g., SAR, which is Synthetic Aperture Radar, detailed here: **www.sandia.gov/RADAR/sar.html**).

Light Detection and Ranging (LIDAR) uses the same principle as radar—using electromagnetic waves in the visible or near-visible spectrum to remotely investigate properties of a medium—and is used in topographic mapping. LIDAR technology is not dependent on atmospheric conditions like cloud cover, so it has several advantages over traditional photogrammetry for topographic mapping. LIDAR technology offers the opportunity to collect terrain data of steep slopes and shadowed areas (such as the Grand Canyon), and inaccessible areas (such as large mud flats and ocean jetties). These LIDAR applications are well suited for making digital elevation models (DEMs), creating topographic maps, and extracting automatic features. Applications are being established for forestry assessment of canopy attributes, and research continues for evaluating crown diameter, canopy closure, and forest biometrics. Go to **www.etl.noaa.gov/et2** for more information.

Hyperspectral vs. Multispectral Remote Sensing Information Products

Spectral sensors record data related to sunlight in the visible, near infrared, and shortwave infrared regions that strikes surfaces on the earth and is reflected back to the sensor. Multispectral sensors capture a few relatively broad spectral bands, whereas hyperspectral sensors capture hundreds of narrow spectral bands. Multispectral sensors are used on satellite systems like LANDSAT, and these systems provide the remote sensing information used to build the National Land Cover Data (NLCD).

Hyperspectral sensors are still at an experimental stage for use in orbiting satellites, so that virtually all the available hyperspectral data come from airborne sensors. Hyperspectral imagery provides data for a broad range of electromagnetic wavelengths with finer spectral resolutions than conventional multispectral systems. Substantial costs are associated with hyperspectral systems for collecting the raw imagery, processing large amounts of data, and ground-truthing the remote sensing information with conventional water quality or land cover data. After specific kinds of hyperspectral information have been regionalized to particular watershed areas, the costs can be substantially reduced. Hyperspectral data can be applied to develop enhanced gridded datasets for land covers. With suitable regional calibration, both hyperspectral and multispectral information can help to provide numeric estimates for such water quality parameters as chlorophyll a (or other measures of algal standing crop), turbidity, and nutrient levels for phosphorus or nitrogen.

Satellite Imagery

Like aircraft-based sensors, satellite sensors have unique operational limitations and characteristics that must be considered before using them as a remote sensing tool. These factors include the incidence of cloud cover, the frequency at which the satellite passes over a given spot, the ground resolution desired, and the amount of post-acquisition data processing required. Several kinds of imagery and data are collected from satellites. For example, commercial satellites like QuickBird, IKONOS, and SPOT typically acquire high-resolution imagery useful for basic mapping of land surfaces. In contrast, satellites like LANDSAT-5, LANDSAT-7 (currently off-line due to an irreparable malfunction), TERRA, AQUA, and Earth Observing-1 (EO-1) contain an array of on-board sensors that collect far more than simple photographic imagery. These spacecraft are designed to collect data for a broad scientific audience interested in a variety of disciplines—climatology, oceanography, geography, and forestry to name a few. Thus, the project objectives must be clearly defined before the acquisition of satellite-based data to ensure that the proper remote sensing data product is chosen. Satellite imagery is available from several different land-mapping satellites, including LANDSAT, IKONOS, and SPOT. However, acquiring new aerial photography and satellite imagery requires extensive knowledge of image processing, and the data can be expensive or cost-prohibitive for many projects.

Remote Sensing Datasets

The raw data from the satellite sensors are voluminous, and specialized knowledge and software are needed to process the data into meaningful information. The digital signals from the multiple sensors need to be combined and processed, for instance, to be converted into meaningful land cover classifications. Furthermore, the digital images need to be registered and projected into a coordinate system, such as a Lambert projection. This makes the use of the raw data expensive and time-consuming. Fortunately, you can access preprocessed "derived" products, such as land cover datasets, that are available for free or at low cost. The USGS maintains a Web site for "seamless" data products at **http://seamless.usgs.gov**. You can also purchase data for less than $100 per item from USGS's Earth Resources Observation and Science (EROS) data center (**http://edc.usgs.gov**). In addition to the land use datasets mentioned in section 5.7.1, several other datasets might be useful as part of the watershed characterization process:

- Landsat data
- Elevation
- Greenness
- "Nighttime Lights"
- Coastal and Great Lakes Shorelines

Landsat Data

The Landsat Orthorectified data collection consists of a global set of high-quality, relatively cloud-free orthorectified TM and ETM+ imagery from Landsats 4-5 and 7. This dataset was selected and generated through NASA's Commercial Remote Sensing Program as part of a cooperative effort between NASA and the commercial remote sensing community to provide users with access to quality-screened, high-resolution satellite images with global coverage over the earth's land masses. The data collection was compiled through a NASA contract with Earth Satellite Corporation (Rockville, Maryland) in association with NASA's Scientific Data Purchase program.

Specifically, the Landsat Orthorectified data collection consists of approximately 7,461 TM (Landsat 4-5) images and approximately 8,500 ETM+ (Landsat 7) images, which were selected to provide two full sets of global coverage over an approximate 10-year interval (circa 1990 and circa 2000). All selected images were cloud-free or contained minimal cloud cover. In addition, only images with a high-quality ranking with respect to the possible presence of errors such as missing scans or saturated bands were selected.

In addition to the NLCD datasets, the basic Landsat data can be obtained from the USGS EROS Data Center. Unlike the NLCD, the Landsat spectral data need to be processed before they can produce meaningful information such as land cover characteristics. The advantages of using the Landsat data include a wider temporal range, covering the 1990s to essentially current conditions. In addition, trained users can produce customized classification schemes that might be more meaningful at the local scale. For instance, BMP analyses might require cropping types to be broken down into finer classes than the standard NLCD classes. Landsat data combined with local ground-truthing can produce such custom land cover breakouts. The Landsat Orthorectified datasets have been preprocessed so that the images are cloud-free, joined images that are georeferenced.

Extra steps are required for using the Landsat data, including special software and training in interpreting the multispectral images. A good place for users to start is the Purdue Multispec system, which is available for free at **http://dynamo.ecn.purdue.edu/~biehl/MultiSpec**. This site also contains links to several training and user guides.

Elevation

The USGS National Elevation Dataset (NED), **http://ned.usgs.gov**, has been developed by merging the highest-resolution, best-quality elevation data available across the United States into a seamless raster format. The NED provides a tool for the precise delineation of small watershed units, which can then be overlain with other vector or gridded GIS data. For instance, custom watershed polygons can be delineated using vector data from the NHD.

In addition to the NED, the Elevation Derivatives for National Applications (EDNA) datasets can be used for watershed analyses. EDNA is a multilayered database that has been derived from a version the NED and hydrologically conditioned for improved hydrologic flow representation.

The seamless EDNA database provides 30-meter-resolution raster and vector data layers, including

- Aspect
- Contours
- Filled DEM
- Flow accumulation
- Flow direction
- Reach catchment seedpoints
- Reach catchments
- Shaded relief
- Sinks
- Slope
- Synthetic streamlines

EDNA data are available at **http://edna.usgs.gov**.

Greenness Maps

Greenness maps show the health and vigor of the vegetation. Generally, healthy vegetation is considered an indicator of favorable climatic and environmental conditions, whereas vegetation in poor condition is indicative of droughts and diminished productivity. You can use USGS greenness maps to evaluate the vegetation condition of a region. The availability of current and past greenness data can be quite useful in, for instance, correlating the health of vegetation in a watershed with ambient monitoring data.

The greenness maps are representations of the Normalized Difference Vegetation Index (NDVI). NDVI is computed daily from two spectral channels. The two channels are reflected sunlight in the red (RED) and near-infrared (NIR) regions of the electromagnetic spectrum. NDVI, which is the difference between near-infrared and red reflectance divided by the sum of near-infrared and red reflectance, is computed for each image pixel as follows:

$$NDVI = (NIR - RED) / (NIR + RED)$$

Greenness maps reflecting current conditions can be obtained for free from the USGS seamless data Web site (**http://seamless.usgs.gov**). In addition, historical greenness data can be purchased from the EROS data center for $55 per scene. Go to **http://edcwww.cr.usgs.gov/greenness**. A scene is quite large, covering about half the country.

"Nighttime Lights"

One problem with the NLCD is difficulties in distinguishing vegetated areas such as suburbs from, for instance, woodlands. *The Nighttime Lights of North America* map layer is an image showing lights from cities, towns, industrial sites, gas flares, and temporary events, such as fires. Most of the detected features are lights from cities and towns. This image can be quite effective in delineating urban-rural boundaries. The data can be accessed at **http://nationalatlas.gov/mld/nitelti.html**.

Remote Sensing Data for Coastal and Great Lakes Shorelines

Coastal area elevation data can be especially challenging because of the low relief. Fortunately, the NOAA Coastal Services Center (CSC) provides additional remote sensing products for coastal and Great Lakes shoreline areas. These data include more detailed elevation data using LIDAR plus specialized hyperspectral-derived imaging datasets. The CSC LIDAR and other datasets can be accessed at **www.csc.noaa.gov/crs**.

Table 5-3 provides a summary of sample costs for purchasing remote sensing products.

Table 5-3. Sample Costs for Purchasing Remote Sensing Products

Remote Sensing Product	Resolution	Cost
NLCD	30 m	Free
NED	30 m	Free
Greenness	1 km	Free; $55/scene for historical data
"Nighttime Lights"		Free
EDNA	30 m	Free
LIDAR	Varies	Free for selected coastal and Great Lakes shorelines
Landsat	14.25 m to 28.5 m	$30/scene to $60/scene
SPOT	Varies; maximum resolution is 2.5 m	$1,000 +
IKONOS	Varies; maximum resolution is 1 m	Varies

5.10 Create a Data Inventory

Once you've gathered current datasets and existing studies, you should document the available relevant data in a data inventory. A comprehensive data inventory provides an ongoing list of available monitoring and watershed data. The data inventory should be updated during the course of the watershed planning effort so that a complete summary is available to stakeholders.

It is often useful to organize the data inventory by data type, allowing you to document the different types with information that might not be relevant to all types. The most likely types of data to be gathered are tabular data (e.g., monitoring data), reports and anecdotal information, and GIS data. For each of the datasets, you should document the important characteristics to identify and summarize the data. It is often useful to create the lists in a spreadsheet, such as Microsoft Excel, or a database, such as Microsoft Access. Spreadsheets are easy to use, but you can't search or query the data as you can in a database. Creating the data inventory in a spreadsheet, or even in a word processing program (e.g., Microsoft Word), is adequate. However, if you have a large amount of data and would like to be able to query the data, for example, by keyword or content type, you should use a database program for the inventory. The following paragraphs identify the types of information that should be used to document and organize the gathered data. These lists provide guidelines to help you create your data inventory, but you can also tailor your data inventory according to your needs and the types of data and information you gather. You should also document data not used in the analysis and justify their exclusion.

Information to Be Summarized in the Data Inventory

- Type of data (e.g., monitored, geographic)
- Source of data (agency)
- Quality of data (QA/QC documentation, QAPP)
- Representativeness of data (number of samples)
- Spatial coverage (location of data collection)
- Temporal coverage (period of record)
- Data gaps

For all the tabular datasets, you should create a list documenting the following information:

- Type (e.g., water quality, flow)
- Source/agency
- Number of stations
- Start date
- End date
- Number of samples/observations
- Parameters
- Frequency
- Known quality assurance issues related to the data
- Special comments (e.g., part of special study, ground water vs. surface water)

Once you begin to analyze your monitoring/tabular data (chapter 7), you'll identify more details about each dataset, including the type and amount of data at each station. For the data inventory, it's appropriate to document the general types and coverage of the datasets to provide an evolving list of the monitoring datasets available, where they came from, and what they include.

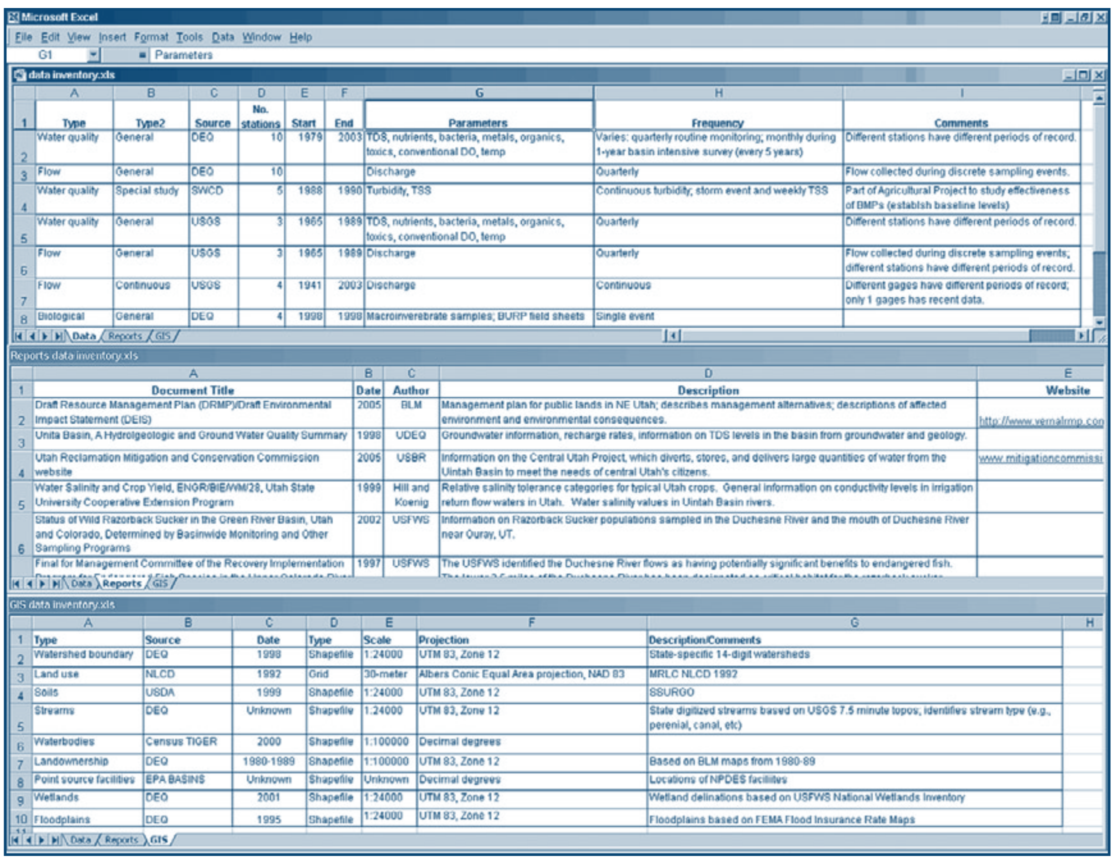
For all the reports and anecdotal information gathered for the watershed, you should include the following information in the data inventory:

- Document title
- Date
- Source/Author
- Description
- Web site (if available)

For the GIS data gathered, you should document the following information:

- Type (e.g., land use, soils, station locations)
- Source/agency
- Date (date or original data on which the coverage is based)
- Scale (e.g., 1:24,000)
- Projection (e.g., UTM, state plane)
- Description

Figure 5-5 provides an example of the fields in a data inventory.



Type	Type2	Source	No. stations	Start	End	Parameters	Frequency	Comments
Water quality	General	DEQ	10	1979	2003	TDS, nutrients, bacteria, metals, organics, toxics, conventional DO, temp	Varies: quarterly routine monitoring; monthly during 1-year basin intensive survey (every 5 years)	Different stations have different periods of record.
Flow	General	DEQ	10			Discharge	Quarterly	Flow collected during discrete sampling events.
Water quality	Special study	SWCD	5	1988	1990	Turbidity, TSS	Continuous turbidity; storm event and weekly TSS	Part of Agricultural Project to study effectiveness of BMPs (establsh baseline levels)
Water quality	General	USGS	3	1965	1989	TDS, nutrients, bacteria, metals, organics, toxics, conventional DO, temp	Quarterly	Different stations have different periods of record.
Flow	General	USGS	3	1965	1989	Discharge	Quarterly	Flow collected during discrete sampling events; different stations have different periods of record.
Flow	Continuous	USGS	4	1941	2003	Discharge	Continuous	Different gages have different periods of record; only 1 gages has recent data.
Biological	General	DEQ	4	1998	1998	Macroinverebrate samples; BURP field sheets	Single event	

Document Title	Date	Author	Description	Website
Draft Resource Management Plan (DRMP)/Draft Environmental Impact Statement (DEIS)	2005	BLM	Management plan for public lands in NE Utah; describes management alternatives; descriptions of affected environment and environmental consequences.	http://www.vernalrmp.con
Unita Basin, A Hydrolgeologic and Ground Water Quality Summary	1998	UDEQ	Groundwater information, recharge rates, information on TDS levels in the basin from groundwater and geology.	
Utah Reclamation Mitigation and Conservation Commission website	2005	USBR	Information on the Central Utah Project, which diverts, stores, and delivers large quantities of water from the Uintah Basin to meet the needs of central Utah's citizens.	www.mitigationcommissi
Water Salinity and Crop Yield, ENGR/BIE/WM/28, Utah State University Cooperative Extension Program	1999	Hill and Koenig	Relative salinity tolerance categories for typical Utah crops. General information on conductivity levels in irrigation return flow waters in Utah. Water salinity values in Uintah Basin rivers.	
Status of Wild Razorback Sucker in the Green River Basin, Utah and Colorado, Determined by Basinwide Monitoring and Other Sampling Programs	2002	USFWS	Information on Razorback Sucker populations sampled in the Duchesne River and the mouth of Duchesne River near Ouray, UT.	
Final for Management Committee of the Recovery Implementation	1997	USFWS	The USFWS identified the Duchesne River flows as having potentially significant benefits to endangered fish.	

Type	Source	Date	Type	Scale	Projection	Description/Comments
Watershed boundary	DEQ	1998	Shapefile	1:24000	UTM 83, Zone 12	State-specific 14-digit watersheds
Land use	NLCD	1992	Grid	30-meter	Albers Conic Equal Area projection, NAD 83	MRLC NLCD 1992
Soils	USDA	1999	Shapefile	1:24000	UTM 83, Zone 12	SSURGO
Streams	DEQ	Unknown	Shapefile	1:24000	UTM 83, Zone 12	State digitized streams based on USGS 7.5 minute topos; identifies stream type (e.g., perenial, canal, etc)
Waterbodies	Census TIGER	2000	Shapefile	1:100000	Decimal degrees	
Landownership	DEQ	1980-1989	Shapefile	1:100000	UTM 83, Zone 12	Based on BLM maps from 1980-89
Point source facilities	EPA BASINS	Unknown	Shapefile	Unknown	Decimal degrees	Locations of NPDES facilites
Wetlands	DEQ	2001	Shapefile	1:24000	UTM 83, Zone 12	Wetland delinations based on USFWS National Wetlands Inventory
Floodplains	DEQ	1995	Shapefile	1:24000	UTM 83, Zone 12	Floodplains based on FEMA Flood Insurance Rate Maps

Figure 5-5. Example Fields in a Data Inventory

For all the data types, it's also useful to document the physical location of the files. For example, if the dataset is electronic, provide the name of the file and the file path or location on your computer or network. Another option is to provide a numbering system for the filing cabinets or location of the hard copy reports you gather.

The data inventory will also be used to help identify any relevant gaps, especially those that could hinder data analysis. The data inventory can be used to identify obvious, broad gaps, such as a lack of water quality or flow data for the watershed. The identification of data gaps is an iterative process, however, and more specific data needs will be identified during the next phase of the characterization process (chapter 6). For example, a long period of record of water quality monitoring data might indicate sufficient water quality data for analysis of the waterbody. When you begin data analysis, however, it might become apparent that the data are not adequate for evaluating seasonal trends or other relationships and patterns.

The characterization process involves many steps. Once you've created the data inventory, you'll move on to the next phase in characterization: identify gaps and collect new data. As you review the data, however, you might realize that you need to gather additional existing information. You'll have to go back, add additional information to your data inventory, and then proceed forward.