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GAO

Report to the Chairman, Subcommittee on Water Resources and Environment, Committee on Transportation and Infrastructure, House of Representatives

June 2004

WATERSHED MANAGEMENT

Better Coordination of Data Collection Efforts Needed to Support Key Decisions

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GAO-04-382

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Highlights

Highlights of GAO-04-382, a report to the Chairman, Subcommittee on Water Resources and Environment, Committee on Transportation and Infrastructure, House of Representatives

Why GAO Did This Study

Reliable and complete data are needed to assess watersheds—areas that drain into a common body of water—and allocate limited cleanup resources. Historically, water officials have expressed concern about a lack of water data. At the same time, numerous organizations collect a variety of water data. To address a number of issues concerning the water data that various organization collect, the Chairman of the Subcommittee on Water Resources and Environment asked GAO to determine (1) the key entities that collect water data, the types of data they collect, how they store the data, and how entities can access the data; and (2) the extent that water quality and water quantity data collection efforts are coordinated.

What GAO Recommends

To enhance and clearly define authority for coordinating the collection of water data nationwide, the Congress should consider formally designating a lead organization for this purpose. Among its responsibilities, the organization would (1) support the development and continued operation of regional and state monitoring councils, (2) coordinate the development of an Internet-based clearinghouse to convey what entities are collecting what types of data, and (3) coordinate development of clear guidance on metadata standards so that data users can integrate data from various sources.

www.gao.gov/cgi-bin/getrpt?GAO-04-382.

To view the full product, including the scope and methodology, click on the link above. For more information, contact John B. Stephenson at (202) 512-3841 or stephensonj@gao.gov.

What GAO Found

At least 15 federal agencies collect a wide variety of water *quality* data. Most notably, the U.S. Geological Survey operates several large water quality monitoring programs across the nation. States also play a key role in water quality data collection to fulfill their responsibilities under the Clean Water Act. In addition, numerous local watershed groups, volunteer monitoring groups, industries, and academic groups collect water quality data. In contrast, collection of water *quantity* data is more centralized, with three federal agencies collecting the majority of data available nationwide.

While GAO found notable exceptions, officials in almost all of the federal and state agencies contacted said that coordination of water quality data was falling short of its potential. As illustrated below, key barriers frequently identified as impeding better coordination of water quality data collection include (1) the significantly different purposes for which groups collect data, (2) inconsistencies in groups' data collection protocols, (3) an unawareness by data collectors as to which entities collect what types of data, and (4) low priority for data coordination, as shown in a lack of support for councils that promote improved coordination. GAO concluded that designating a lead organization with sufficient authority and resources to coordinate data collection could help alleviate these problems and ensure that watershed managers have better information upon which to base critical decisions.

Data collectors strongly agree that coordinating water *quantity* data collection is considerably less problematic. Reasons include the fact that controversial water allocation decisions require accurate and complete water quantity data; that some of the technologies for measuring water quantity allow for immediate distribution of data; that water quantity data parameters are generally more consistent; and that coordination is simplified in that relatively fewer entities collect these data. Collectors of water quantity data generally agreed that an overall shortage of data was a more serious problem than a lack of coordination of the data that are collected.

Most Frequently Cited Barriers to Coordinating Water Quality Data Collection Efforts by 15 Federal Agencies

Source: GAO.

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Abbreviations

ASIWPCA	Association of State and Interstate Water Pollution Control Administrators
BPA	Bonneville Power Administration
CSREES	Cooperative State Research, Education, and Extension Service
EPA	Environmental Protection Agency
NOAA	National Oceanic and Atmospheric Administration
NWIS	National Water Information System
SNOTEL	Snowpack Telemetry
STORET	Storage and Retrieval System
TMDL	total maximum daily load
TVA	Tennessee Valley Authority

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United States General Accounting Office
Washington, D.C. 20548

June 7, 2004

The Honorable John J. Duncan, Jr.
Chairman, Subcommittee on
Water Resources and Environment
Committee on Transportation
and Infrastructure
House of Representatives

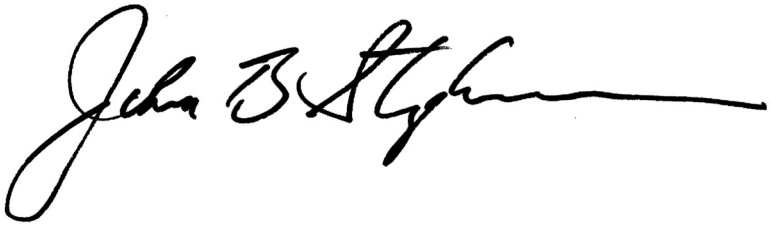
Dear Mr. Chairman:

In response to your request, this report discusses (1) the key entities that collect water quality and water quantity data, including the types of data they collect, how they store their data, and how entities can access the data; and (2) the extent to which these entities coordinate their water quality and water quantity data collection efforts. We include a matter for congressional consideration that the Congress considers formally designating a lead organization (either an existing water data coordinating entity or one of the federal agencies with broad water data collection responsibilities) to enhance and clearly define authority for coordinating the collection of water data nationwide. Among its responsibilities, the organization would (1) support the development and continued operation of regional and state monitoring councils, (2) coordinate the development of an Internet-based clearinghouse to convey what entities are collecting what types of data, and (3) coordinate development of clear guidance on metadata standards so that data users can integrate data from various sources.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. We will then send copies to others who are interested and make copies available to others who request them. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

Please call me or Steve Elstein on (202) 512-3841 if you or your staff have any questions. Key contributors to this report are listed in appendix VI.

Sincerely yours,



John B. Stephenson
Director, Natural Resources
and Environment

Executive Summary

Purpose

The availability of timely, reliable, and complete data about the nation's waters has significant environmental and financial implications. Water *quality* data, for example, are critical for determining which waters do not meet states' standards and must, therefore, be targeted for potentially expensive cleanup. Similarly, reliable and comprehensive data on the *quantity* of the nation's water resources are needed to support important—and increasingly contentious—decisions about how to allocate limited water resources among states and among a variety of competing uses. GAO and other organizations, however, have documented shortages in the data available to decision makers. Paradoxically, a large number of public and private organizations collect this kind of information—raising questions as to whether more efficient coordination of these data collection efforts can result in more data being made available for informed decision making.

The Chairman, the Subcommittee on Water Resources and Environment, House Committee on Transportation and Infrastructure, asked GAO to address a number of issues concerning the water data that various organizations collect and the degree to which their data collection efforts are coordinated with each other. Specifically, GAO was asked to determine (1) the key entities that collect water quality and water quantity data, including the types of data they collect, how they store their data, and how entities can access the data; and (2) the extent to which these entities coordinate their water quality and water quantity data collection efforts.

To respond to the Chairman's request, GAO surveyed key federal agencies that collect water quality and water quantity data. GAO also met with and obtained information from federal and state agencies, monitoring councils, localities, and other interested groups in Colorado, Mississippi, and Virginia. These states were chosen on the basis of the diversity of entities involved in the collection of data in these states, geographic diversity, and their experiences in coordinating water data. GAO also met with and obtained information from key national organizations interested in water monitoring and coordination of monitoring efforts. (See ch. 1 for a detailed description of GAO's scope and methodology.)

Background

Under the Clean Water Act, states have primary responsibility for implementing programs to manage water quality. This responsibility includes establishing water quality standards, monitoring and assessing the quality of their waters, and developing and implementing cleanup plans for waters that do not meet standards (impaired waters). Given the

environmental consequences and financial expense at stake in determining which waters are targeted for cleanup, it is particularly important that such water quality determinations and cleanup strategies be supported by complete and accurate data. In arriving at these determinations, state agencies responsible for water quality programs can use data collected by other state agencies, federal agencies, volunteer groups, and others. While states' collection of water quality data is critical to meeting the objectives of the Clean Water Act, other organizations also rely heavily on water quality data for a variety of purposes. The Army Corps of Engineers, for example, uses water quality data to, among other purposes, regulate water projects for flood control, navigation, and hydropower and process permits under Section 404 of the Act for the discharge of dredge and fill materials into navigable waters.

A number of entities also regulate the *quantity* of available water supplies to meet a variety of needs. Among other things, water quantity data are needed to help make water quality determinations. The quantity of water flowing through a river, for example, affects the concentrations of regulated pollutants in that river. The importance of water quantity data, however, extends beyond their impacts on pollutant concentrations. Federal, state, local, tribal, and private organizations also rely heavily on water quantity data to fulfill critical responsibilities in ensuring an adequate water supply to meet a variety of competing needs. States govern the allocation and use of water in accordance with their own laws, and enter into interstate compacts with neighboring states regarding water supplies that cross their common borders. To fulfill these responsibilities, states need data on how much water is available for allocation (e.g., streamflow and snowpack data) and data on how much water is being consumed. For their part, federal agencies support states in their efforts to govern the allocation and use of water and also use these data themselves in managing resources on federal lands.

In making decisions regarding the nation's waters, many advocate the use of the watershed approach, which seeks to manage watersheds—areas that drain to a common waterway—rather than individual bodies of water that may be affected by similar pollutants or natural conditions. The key data available to support critical watershed management decisions, however, are often incomplete and unreliable. According to the best available data from the Environmental Protection Agency (EPA), for example, only about one-fifth of the nation's total rivers and stream miles have been assessed to

determine their compliance with states' water quality standards.[1] Of the river and stream miles that were assessed, 39 percent were found to be out of compliance with states' standards. More generally, GAO reported in March 2000[2] that few of the 50 states had a majority of the data they needed to make key water quality determinations, such as which of their waters do not meet state standards and what are their most significant sources of pollution.

Results in Brief

GAO identified 16 key federal agencies that collect water data.[3] Fifteen of those agencies are collectors of a wide variety of water *quality* data. Among the most notable is the U.S. Geological Survey, which operates several large water quality monitoring programs across the nation. States also play a key role in water quality data collection to fulfill their responsibilities under the Clean Water Act. In addition, hundreds of other organizations, including local watershed groups, volunteer monitoring groups, industries, and members of academia collect water quality data. In contrast to the large number of entities collecting water quality data, collection of water *quantity* data is considerably more centralized. Several key federal agencies—most notably Interior's U.S. Geological Survey, Agriculture's Natural Resources Conservation Service, and the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service—collect a majority of the water quantity data available nationwide. The Army Corps of Engineers also collects water quantity data and funds the collection of considerable amounts of additional data.

[1]Environmental Protection Agency, *National Water Quality Inventory: 2000 Report* (Washington, D.C.: August 2002).

[2]U.S. General Accounting Office, *Water Quality: Key EPA and State Decisions Limited by Inconsistent and Incomplete Data*, GAO/RCED-00-54 (Washington, D.C.: Mar. 15, 2000).

[3]While not an exhaustive list of federal agencies that collect water data, GAO identified the following agencies: Within the Department of Agriculture—Agricultural Research Service, Cooperative State Research, Education, and Extension Service, Forest Service, and Natural Resources Conservation Service. Within the Department of Commerce's National Oceanic and Atmospheric Administration—National Marine Fisheries Service, National Ocean Service, and National Weather Service. Within the Department of Defense—Army Corps of Engineers. Within the Department of Energy—Bonneville Power Administration. Environmental Protection Agency. Within the Department of the Interior—Bureau of Land Management, Bureau of Reclamation, Fish and Wildlife Service, U. S. Geological Survey, and National Park Service. Tennessee Valley Authority.

While GAO found instances where good coordination has decreased water quality information gaps and duplication of effort, for the most part, entities collecting water quality data are either not coordinating their efforts or have experienced difficulty in doing so. These entities have faced several key barriers: (1) data collected for different organizations are geared toward serving different purposes, (2) inconsistent methods ("protocols") are used to obtain samples and interpret their results, (3) data collectors are unaware as to which entities collect what types of data, and (4) low priority for data coordination, as shown in a lack of support for national and state councils that have been established to improve coordination. These difficulties have not only perpetuated gaps and duplication of effort but have also complicated efforts to synthesize data from different collection efforts in a way that would provide decision makers with a more comprehensive picture of an area's water quality. GAO is recommending that the Congress consider formally designating a lead organization, such as a council or an agency, with sufficient authority and resources to effectively coordinate data collection.

The federal and state officials GAO interviewed generally agreed that efforts to coordinate the collection of water quantity data have been comparatively successful, often reporting that their biggest concern is that the overall amount of water quantity data is in short supply. These officials cited several reasons for the relative success of water quantity coordination efforts: (1) data collection is more centralized among the smaller number of entities collecting data, (2) water managers have a more critical need for accurate and complete data to support critical and time-sensitive decisions, (3) some of the technologies for measuring water quantity allow for immediate distribution of data, and (4) the measures of water quantity are fewer in number and are taken by data collectors in a more consistent manner.

Principal Findings

Many Organizations Collect Water Quality and Water Quantity Data

Fifteen of the sixteen federal agencies GAO examined said that they collect at least some water quality data on a wide variety of data parameters. A few agencies, such as the U.S. Geological Survey and the Army Corps of Engineers, collect water quality data across the nation. Most others, however, collect or fund the collection of project-specific data that are limited in geographic scope and frequency. For example, the Agricultural

Research Service and the Cooperative State Research, Education, and Extension Service collect or fund the collection of data on a project-specific level primarily for research. State water quality agencies play a key role in collecting data needed to meet their responsibilities under the Clean Water Act. However, they vary considerably in the comprehensiveness of their monitoring programs; the types of data they collect to ascertain the health of their waters (i.e., whether their monitoring programs emphasize the gathering of physical, chemical, or biological data); and the extent to which their monitoring strategies target specific waters of interest or employ statistical sampling methods that allow inferences to be drawn about a larger number of waters. In addition, local groups, volunteer monitors, academic institutions, and private companies collect water quality data for a variety of projects.

Water quality data are stored in a variety of ways, and their accessibility to potential users depends largely on how they are stored. Specifically, extensive water quality data are stored in either of two large, Internet-accessible federal databases: EPA's Storage and Retrieval System (STORET) and the U.S. Geological Survey's National Water Information System (NWIS). Thirty-one states, for example, store at least some of their water quality data in the STORET database. A considerable amount of data, however, is not maintained in these centralized databases. According to the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA),[4] some states store their data in state databases, and a small number of agencies still use paper files as their predominant means for storing data. In addition, considerable water quality data have been generated by federal agencies and other organizations on specific projects, though these data are usually stored in internal databases that are only accessible by request. Officials associated with some of these projects told GAO that, unless potential users of the data were aware of these projects, they are not likely to request the data.

Fifteen of the sixteen federal agencies GAO examined reported that they collect at least some water quantity data. Most water quantity data available nationwide, however, are collected by a few primary agencies. The U.S. Geological Survey is the primary collector of streamgage[5] and

[4]ASIWPCA is an independent, nonpartisan organization of state and interstate water program managers.

[5]Streamgage data include measurements of depths, areas, velocities, and rates of flow in natural or artificial channels.

water use data, which are stored and accessed through NWIS. The Department of Agriculture's Natural Resources Conservation Service collects snowpack data through its Snow Survey and Water Supply Forecasting Program in 12 western states and Alaska. It stores these data in an extensive, automated system, and makes them available to the public through the Internet. In addition, the National Weather Service collects precipitation data at most major airports and from volunteers across the nation. It stores these data in the National Climatic Data Center of NOAA's National Environmental Satellite, Data, and Information Service and makes them available to the public via the Internet. In addition, the Army Corps of Engineers funds the collection of considerable water quantity data. Other federal agencies reported that they generally collect project-specific water quantity data that they store in internal databases, which they make available in a variety of ways depending on the agency. Additionally, some states collect water quantity data, such as streamgage data and precipitation data, often to fill in gaps in the data collected by federal agencies.

Improved Coordination of Water Quality Data Collection Can Help Watershed Managers Make More Informed Decisions

Officials in almost all of the 15 federal agencies GAO contacted that collect water quality data indicated that coordination was either not taking place or falling short of its potential, and that enhanced coordination could provide data users with better data about water quality conditions and a more complete picture of the health of watersheds. For example, Forest Service officials explained that enhanced coordination between the Forest Service and the states would help states obtain the data needed to identify and address waters that do not meet water quality standards. State environmental agencies we contacted generally agreed, acknowledging in particular that improved coordination among state monitoring efforts, and between states and other data-gathering entities, could be significantly improved.

Given the strong consensus on the need for better coordination, GAO asked federal and state officials, representatives of local governments and watershed groups, and others to explain the barriers that have impeded their efforts to coordinate water quality data collection. Among the most frequently cited problems were the following:

- Organizations often collect data to achieve very specific missions, which sometimes makes officials unwilling or unable to modify their data collection approaches to make the results more widely usable, and

which may even make officials reluctant to share data they have on hand.

- Data collectors often use different data collection procedures, resulting in incomparable definitions to measure the same or similar pollutants, different detection limits, inconsistent levels of quality assurance, and inconsistent collection of metadata.[6]

- Many collectors do not know who is collecting which types of data because they do not have a centralized clearinghouse on water quality data.

In addition, water quality officials also cited complications in the way data are managed as a factor that makes it difficult to use data from various sources. Federal and state agency officials explained that data are often stored using different formats in different databases, making integrating data extremely difficult.

As some of the officials noted, there are coordinating bodies at the national and state levels that address coordination issues. Among the most notable of these is the National Water Quality Monitoring Council. The council is co-chaired by EPA and the U.S. Geological Survey and includes representatives from federal, interstate, state, tribal, local, and municipal governments, watershed groups, volunteer monitoring groups, and the private sector. The officials noted, however, that the effectiveness of the council, and of many similar organizations at the state level, has been inhibited by a lack of authority to make key decisions, a shortage of funding to undertake key coordinating activities, and low priority attention from data collecting organizations.

Some have cited these difficulties in calling for a clearly designated water data coordinating body with both sufficient resources and authority. They differ, however, on the precise form this body would take. When asked what type of entity might best fulfill this role, an official with the U.S. Geological Survey said that, with clearly defined authority, the National Water Quality Monitoring Council could make greater progress in

[6]Metadata describe the content, quality, condition, and other characteristics of data. They provide data users with information about the data so that they can make informed decisions as to the quality of the data and the comparability of the data for their questions or purposes.

improving both data coordination and the availability of water information for decision making. On the other hand, officials from the Army Corps of Engineers suggested that it may be preferable to designate a lead federal agency to assume this role. The officials suggested that an appropriate lead agency would be one that already carries out or supports broad water data responsibilities. GAO concluded that it may be appropriate for the Congress to make the judgment call as to whether such a body should be designated and which body should fulfill this role.

Water Quantity Data Are Limited, but Efforts to Collect Them Are Generally Well-Coordinated

Numerous federal and state officials cited an overall lack of water quantity data as a major concern. Nonetheless, broad consensus emerged among the federal and state officials GAO interviewed that where water quantity data are being collected, coordination has been comparatively successful. The officials cited the following key factors that account for this greater success:

- Water quantity data collection is centralized among a smaller number of entities, which allows users and collectors to more easily identify data sources. Additionally, the entities have clearly defined roles in data collection that collectively serve a common purpose of predicting and measuring the nation's water availability and use. Together, these attributes help prevent overlap and facilitate coordination.

- The need for accurate and complete real-time data to support urgent and controversial water quantity management decisions, such as flood control and water allocation decisions, provides an impetus for groups to collaborate in generating adequate data. In some cases, agencies may face costly consequences if they make poor decisions, adding yet another incentive to obtain sufficient data through coordination.

- Advanced technologies, such as satellite and radio technology, allow data gathered in stream or in remote locations to be quickly disseminated to data users via the Internet. By making it easier to share and access data, the availability of these technologies encourages coordination.

- The general consistency in the way water quantity data are measured and analyzed makes it easier for data users to integrate data gathered from separate collection efforts. Because water quantity has been measured for so many years, the parameters that agencies measure and

the methods they use to measure them are well-developed and more uniformly used.

Matter for Congressional Consideration

To enhance and clearly define authority for coordinating the collection of water data nationwide, GAO recommends that the Congress consider formally designating a lead organization (either an existing water data coordinating entity or one of the federal agencies with broad water data collection responsibilities) for this purpose. Among its responsibilities, the organization would:

- Support the development and continued operation of regional and state monitoring councils.
- Coordinate the development of an Internet-based clearinghouse to convey what entities are collecting what types of data. As part of this effort, the organization could advance the development of a geospatial Internet-based query tool (portal) that would allow users access to information about water data available within a given watershed.
- Coordinate the development of clear guidance on metadata standards so that data users can integrate data from various sources.

Agency Comments and Our Evaluation

GAO provided a draft of this report to the Departments of Agriculture, Commerce, and the Interior; the Army Corps of Engineers; and EPA. The Departments of Commerce and the Interior, the Army Corps of Engineers, and EPA provided written comments, which are reprinted in appendixes II through V. The Department of Agriculture did not submit a formal letter, although an official with the Department's Natural Resources Conservation Service expressed general agreement with the report. All of the agencies provided technical comments and clarifications, which were incorporated as appropriate. GAO also provided the draft report to two nonfederal members of the National Water Quality Monitoring Council for their review.

The Army Corps of Engineers stated that it "agrees with the majority of the [draft report's] findings," noting in particular its agreement that better coordination of data collection is needed to improve decision making. The Corps commented, however, that the draft report should have more fully discussed the full range of water quality and water quantity data that is collected and maintained by the Corps. The draft report had discussed a

wide range of Corps data collection activities (both water quality and water quantity), but GAO supplemented those discussions with additional detail in response to the Corps' comment. The Corps also offered additional information about planned activities to use a comprehensive integrated watershed management approach. GAO also added information about these planned activities. The Corps' comments, and GAO's response, are discussed at the end of chapters 2, 3, and 4.

The Department of the Interior generally agreed with the report, stating that "GAO is commended on their comprehensive job in assembling information on a large complex subject…" Interior's letter also noted that "GAO has brought many of the most important perspectives of successes and challenges to light." Interior cautioned, however, that the designation of a lead water data organization would not necessarily remove all of the barriers that are currently limiting the coordination of data collection activities. GAO agrees, but still believes that the establishment of such a lead organization would be an important first step to enhance and clearly define authority needed to address many of these barriers. These and other issues, and GAO's responses, are discussed at the end of chapters 3 and 4.

EPA agreed on the need for reliable, comprehensive, and accessible data on water quality to effectively implement the watershed approach. EPA noted, however, that the report should further emphasize (1) the high cost of monitoring, (2) recent significant improvements to the STORET system, and (3) the emphasis placed on coordination and data sharing in EPA's "Elements of a State Monitoring and Assessment Program" guidance. We provided additional information on these issues in response to the EPA comment. These issues, and GAO's responses, are discussed at the end of chapters 2 and 3.

The Department of Commerce's National Oceanic and Atmospheric Administration suggested that GAO clarify that the report addresses freshwater rather than saltwater and that it eliminate references to watersheds since the report does not deal with the subject at great length. GAO added language clarifying that our study focused on freshwater but retained references to watersheds. As the letter requesting our study noted, the watershed approach has become increasingly important in efforts to manage the nation's waters and that approach depends heavily on the availability of complete and reliable data.

The two National Water Quality Monitoring Council members offered several clarifications and suggestions, which were incorporated as

appropriate. National Water Quality Monitoring Council officials noted that, since the reviewers' comments were not considered for endorsement by the council's membership, they should be viewed as informal suggestions to enhance the accuracy and completeness of the report.

GAO also verified specific information in the draft report with officials from BPA, TVA, states, industry, watershed groups, and volunteer monitoring groups and made modifications as necessary.

Introduction

The availability to decision makers of timely, reliable, and complete data about the nation's waters has significant environmental and financial implications. Water quality data, for example, are critical for determining which waters do not meet states' standards and must, therefore, be targeted for potentially expensive cleanup. Similarly, decision makers need reliable and comprehensive data on the *quantity* of the nation's water resources to support increasingly important—and contentious—decisions about how to allocate limited water resources among states and among a variety of competing uses.

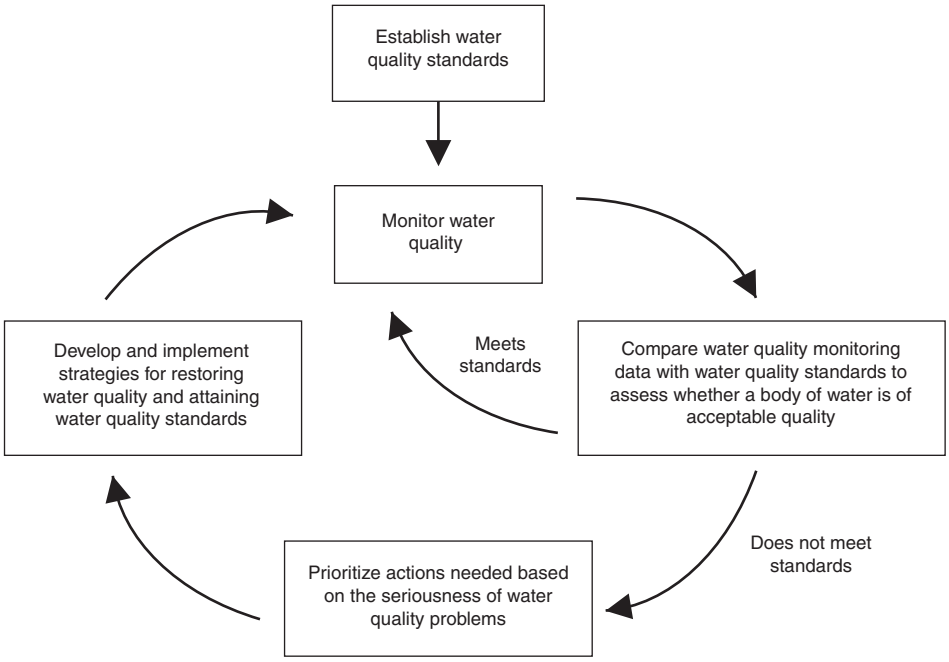
GAO and others, however, have documented shortages in the data available to make such decisions. At the same time, a large number of public and private organizations collect this kind of information—raising questions as to whether more efficient coordination of these data collection efforts can result in more data available for informed decision making.

Decision Makers Need Complete and Reliable Water Quality Data

Under the Clean Water Act, states have primary responsibility for implementing programs to manage water quality. Their key responsibilities include establishing water quality standards to achieve designated uses (the purposes for which a given body of water is intended to serve), assessing whether the quality of their waters meets states' water quality standards, and developing and implementing cleanup plans for waters that do not meet standards.

Monitoring information on water quality is the linchpin that allows states to perform these responsibilities. States generally monitor water quality directly, but frequently supplement these data with data collected by federal agencies, volunteer groups, and other entities. Monitoring data can include information about the presence of chemicals such as chlorine, physical characteristics such as temperature, and biological characteristics such as the health and abundance of fish and other aquatic species. Figure 1 shows how monitoring water quality is essential to identifying water quality problems and determining whether actions to restore water quality are successful.

Figure 1: Process of Water Quality Management



Source: GAO.

As shown in figure 1, states compare monitoring data with their water quality standards. If a state's assessment of a body of water indicates that it does not meet the standards—for example, if it has levels of chlorine that are too high to support aquatic life—then the body of water is considered as not supporting its intended use of aquatic life. In such cases, states are required, under section 303(d) of the act, to identify and list waters for which technology-based effluent limitations are not sufficient to meet water quality standards and for which pollutants need to be reduced. EPA must approve or disapprove the states' lists.

In developing their lists of impaired waters, states must use all existing and readily available water quality-related data to determine if a water body is impaired and identify the specific pollutant(s) causing impairment. Subsequently, states must develop a total maximum daily load (TMDL), as necessary, for each of the pollutants affecting each impaired body of water. TMDLs are used to restore water quality by identifying how much pollution

a body of water can receive and still meet standards and then reducing the amount of pollution entering the water to that level.

While states' use of water quality data is critical to meeting the objectives of the Clean Water Act, other organizations also rely heavily on water quality data for a variety of purposes. The Army Corps of Engineers, for example, uses these data for a variety of reasons, including regulating water projects and issuing permits under section 404 of the act for the discharge of dredge and fill materials into navigable waters. Federal land management agencies such as the Department of the Interior's Fish and Wildlife Service, National Park Service, and Bureau of Land Management and the Department of Agriculture's Forest Service rely upon these data to fulfill their responsibilities to protect and restore aquatic resources on federal lands. These agencies also use these data to fulfill their responsibilities under various laws, such as the protection of critical habitat for plants and animals under the Endangered Species Act. In addition to these federal agencies, numerous public and private organizations at the local level rely on water quality data to ensure that public health and environmental goals are protected.

Data Also Needed to Support Key Water Quantity Decisions

Federal, state, local, tribal, and private organizations also rely heavily on water quantity data to fulfill critical responsibilities in ensuring an adequate water supply to meet competing needs. States are primarily responsible for governing the allocation and use of water in accordance with the laws developed by their state and interstate compacts—agreements that address water allocation, quality, and other issues on bodies of water that cross state borders. Key state responsibilities in complying with these compacts and laws include administering water rights to various users, allocating water in accordance with these water rights, maintaining instream flow requirements for habitat purposes, and enforcing the decrees and water laws of the state. To fulfill these responsibilities, states need water availability data, such as streamflow and snowpack data, to quantify how much water is and will be available for allocation, and water use data, including withdrawal and return flow data, to determine how much water is being consumed. They obtain these data mostly through the efforts of others, such as federal agencies and municipalities, although a few states also conduct their own monitoring.

Federal agencies support states in their efforts to govern the allocation and use of water through many activities. Agencies, such as the Department of the Interior, assist states in developing, implementing, and enforcing

interstate compacts; the U.S. Geological Survey, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service, and Natural Resources Conservation Service, among others, collect and share information such as surface water, rainfall, and snowpack data, which help forecast water supply; and the Army Corps of Engineers and Bureau of Reclamation construct, operate, and maintain dams, reservoirs, and water distribution facilities to help meet the needs of water users, among other activities.

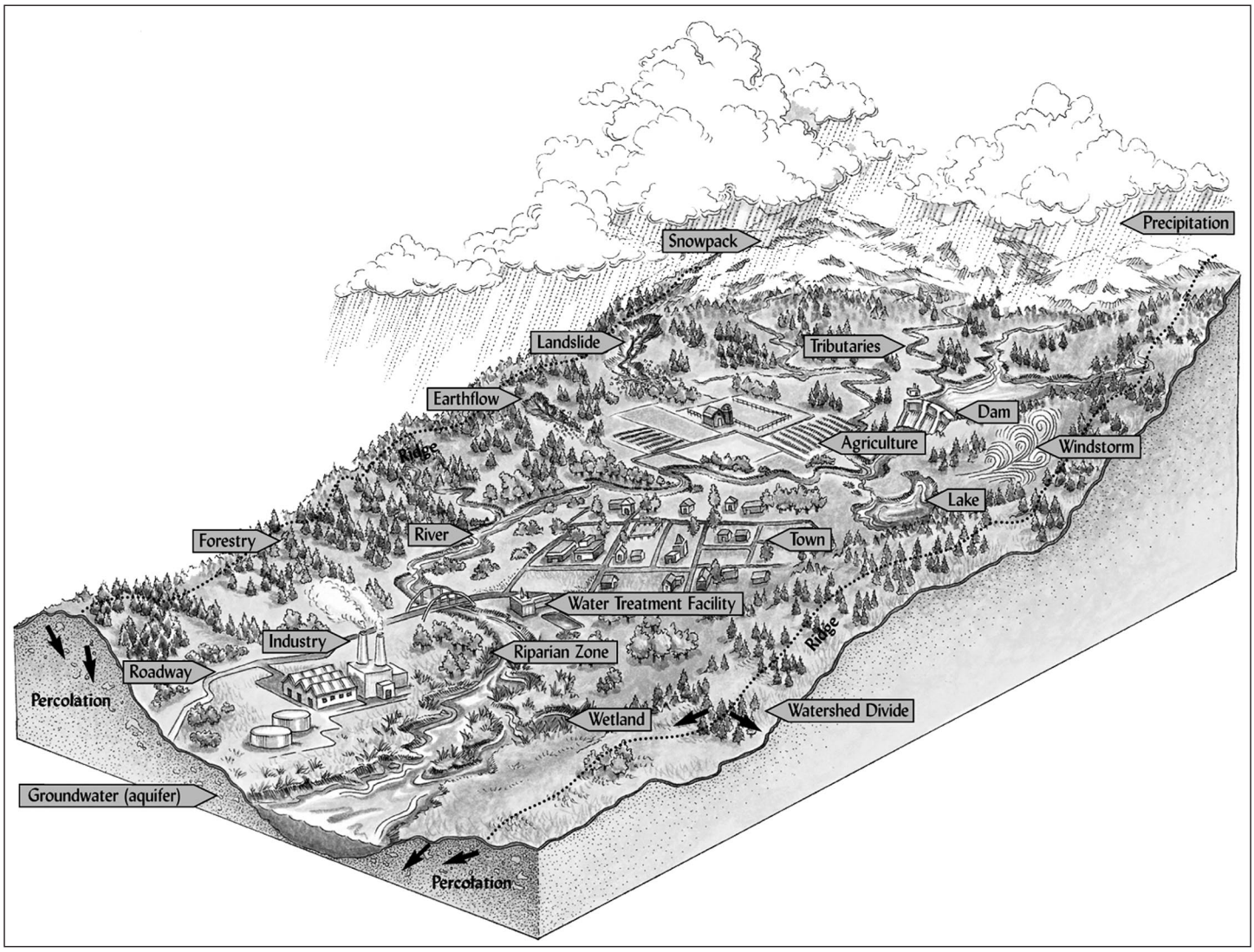
Federal agencies also need data to support their own varying objectives on federal lands. Agencies responsible for managing natural resources—such as the Forest Service, Bureau of Land Management, Fish and Wildlife Service, and National Park Service—construct and/or maintain water storage and distribution facilities on their lands to provide water for uses such as visitor services, recreation, habitat, and flood control. These agencies also often collect water data or conduct water resources investigations in support of their own responsibilities, such as collection of supplemental streamgage information to assess habitat and recreational conditions. Additionally, numerous federal natural resources management agencies may become involved (e.g., by geography or other factors) in some aspect(s) of tribal water interests. Federal natural resources management agency policies generally include provisions to protect and support tribal water interests, in cooperation with the Bureau of Indian Affairs and the tribes.

Other agencies needing water quantity data include local, regional, and interstate water authorities, as well as private firms that own and operate water resources systems. Scientists and recreational water users are also heavy users of water quantity data. These groups use data to, among other things, evaluate current water supplies and plan for future supplies; forecast floods and droughts; operate reservoirs for hydropower, flood control, or water supplies; navigate rivers and streams; and safely fish, canoe, kayak, or raft.

Data Needed to Support the Watershed Approach

Concerns over both water quality and water quantity often come together at the "watershed" level. As illustrated in figure 2, a watershed is an area that drains to a common waterway, such as a stream, lake, estuary, wetland, or ocean. Watersheds come in all shapes and sizes, and often cross county, state, and national boundaries. Depending on its scale, a watershed may refer to large or small river basins, sub-basins, tributary basins, or smaller hydrological units or drainage areas.

Figure 2: Representation of a Typical Watershed



Source: EPA.

Many federal agencies have long supported a watershed approach as the best way to manage the nation's water resources. Army Corps of Engineers officials, for example, noted that the agency has been working in the watershed context and engaged in watershed-level planning and management for many years. They noted further that watershed analysis has been the "cornerstone" of planning and environmental review efforts for major Corps projects. Also, in a December 2002 memorandum, the EPA Assistant Administrator for Water reaffirmed the agency's commitment to the watershed approach, noting that by focusing multistakeholder efforts within hydrologically defined boundaries to protect and restore our aquatic resources and ecosystems, the watershed approach "offers the most cost-effective opportunity to tackle today's challenges" in meeting the nation's water needs.[1] As the memorandum notes, the value in this approach is in taking a holistic approach to the water resource in a way that brings in the full range of federal, state, local, and private parties with a stake in the resource.

Importantly, the watershed approach also allows for the identification and prioritization of problems affecting the resource and steps to address them. This is important because different watersheds may be affected by significantly different natural conditions and pollution problems. Moreover, even where watersheds are affected by similar pollutants, the causes of their pollution problems—and the steps needed to deal with them—can be quite different. For example, in the case of two watersheds affected by excessive levels of nitrogen, one may need to reduce discharges from wastewater treatment plants and other "point" sources, while the other may need to address nitrogen sources emanating from agricultural use. Moreover, water officials must also consider water availability issues, since the amount of water flowing through the watershed affects the ability of the watershed to assimilate the pollutant. These critical determinations, however, can only be made and defended if reliable and comprehensive data are available on the quality and quantity of the water resource and on the ecological and other factors that affect them.

[1]Mehan III, G. Tracy, EPA Assistant Administrator for Water, *Committing EPA's Water Program to Advancing the Watershed Approach.* Memorandum to EPA Office Directors and Regional Water Decision Directors. (Washington, D.C.: 2002).

Can Critical Data Shortages Be Addressed through Enhanced Coordination?

Unfortunately, the key data needed to support critical water management decisions are often incomplete and unreliable. According to the best available data from EPA, only about one-fifth of the nation's total rivers and stream miles have been assessed to determine their compliance with states' water quality standards.[2] More generally, we reported in March 2000 that few of the 50 states had a majority of the data they need to make key water quality determinations, such as which of their waters do not meet state standards and what are their most significant sources of pollution.[3]

This apparent shortage of such data, however, belies the fact that numerous organizations do in fact collect this kind of information. Many federal agencies as well as a wide variety of other organizations at the regional, state, and local levels collect water quality and/or water quantity data. Consequently, questions have been raised as to whether better coordination among these numerous organizations in their data collection activities can provide decision makers with more of the vital information they need to make informed and defensible decisions on critical water-related issues.

Objectives, Scope, and Methodology

The Chairman of the Subcommittee on Water Resources and Environment, House Committee on Transportation and Infrastructure, asked GAO to address a number of issues concerning the water data that various organizations collect, and the degree to which their data collection efforts are coordinated with each other. Specifically, we were asked to determine (1) the key entities that collect water quality and water quantity data, including the types of data they collect, how they store their data, and how entities can access the data; and (2) the extent to which these entities coordinate their water quality and water quantity data collection efforts.

[2]Environmental Protection Agency, *National Water Quality Inventory: 2000 Report* (Washington, D.C.: August 2002).

[3]GAO/RCED-00-54.

To address the first objective, we identified and surveyed key federal agencies that collect water quality and/or water quantity data: the Department of Agriculture's Agricultural Research Service, Cooperative State Research, Education and Extension Service, Natural Resources Conservation Service, and Forest Service; the Department of Commerce's National Oceanic and Atmospheric Administration's National Marine Fisheries Service, National Weather Service, and National Ocean Service; the Department of Defense's Army Corps of Engineers; the Environmental Protection Agency; the Department of Energy's Bonneville Power Administration; the Department of the Interior's Bureau of Land Management, Bureau of Reclamation, Fish and Wildlife Service, U.S. Geological Survey, and National Park Service; and the Tennessee Valley Authority. Though not an exhaustive list of all federal agencies collecting water data, these key agencies were identified through discussions with federal water officials, identification of member agencies on the National Water Quality Monitoring Council,[4] and EPA's Guide to Federal Water Quality Programs and Information. As appropriate, we obtained separate information from different units within an agency. In each case, we obtained information on the types of data being collected, the methods in which the agencies store the data they collect, and the manner in which the data could be accessed by other parties.[5]

To obtain insights on data collection by states, local governments, and other organizations, we conducted site visits to three states—Colorado, Mississippi, and Virginia. The states were chosen on the basis of the diversity of entities involved in the collection of data in these states, geographic diversity, and their experiences in coordinating watershed data. During these site visits, we interviewed representatives of federal, state, and local agencies; watershed management groups; and members of academia, industry, environmental organizations, and volunteer monitoring groups.

[4]The National Water Quality Monitoring Council was created in 1997 and has representatives from federal, interstate, state, tribal, local and municipal governments; watershed groups; the volunteer monitoring community; universities; and the private sector. The purpose of the council is to provide a national forum to coordinate consistent and scientifically defensible water quality monitoring methods and strategies. This council's activities, including its role in coordinating water data collection, are discussed in greater detail in chapter 3.

[5]This report focuses largely on freshwater.

We also used the survey of federal agencies and the site visits to address the second objective to determine the extent to which data collectors coordinate their data collection efforts. Specifically, a number of questions in our federal agency survey addressed the extent to which data collection activities were coordinated with other federal agencies, as well as other entities. We also sought opinions on the most useful steps that could be taken to improve coordination. We supplemented these contacts by interviewing members of federal and state coordinating organizations, most notably the National Water Quality Monitoring Council and its state counterparts in Colorado, Maryland, and Virginia. In these instances, we sought information about past and ongoing efforts to coordinate data collection, seeking in particular to better understand the barriers these groups face in their coordination efforts. We also sought information about data coordination from other key organizations with particular knowledge about this issue, such as the Association of State and Interstate Water Pollution Control Administrators and the Advisory Committee on Water Information.

As agreed with the Chairman's office, in addressing the second objective, we also sought information on efforts to allow for the integration of data from separate collection efforts, so that direct comparisons can be made in a way that maximizes the usefulness of these data. This inquiry addressed, for example, the steps that agencies have taken or attempted to take to allow data users to integrate data from their agency with data from other sources. We examined this issue in our interviews with the full range of data users and data collectors contacted during our study. We also interviewed database managers from the key agencies that manage and store water data (most notably EPA and the U.S. Geological Survey) to identify current barriers to data integration and the steps needed to achieve better integration.

We conducted our work from March 2003 through May 2004 in accordance with generally accepted government auditing standards. GAO contacts and staff acknowledgments are listed in appendix VI.

Many Organizations Collect Water Quality and Water Quantity Data

Hundreds of entities collect water quality data, while fewer entities collect most of the available water quantity data. For water *quality* data, at least 15 federal agencies collect a wide variety of these data on a nationwide, regional, or project-specific basis. At the state level, multiple state agencies collect water quality data, including environmental, agricultural, conservation, health, and forestry agencies, and use these data to comply with federal regulations and to restore and protect water bodies. In addition, many local governments, volunteer monitoring groups, industries, members of academia, and others collect water quality data. Some water quality data are stored in two large national databases operated by the Environmental Protection Agency (EPA) and the U.S. Geological Survey; these databases are available through the Internet. However, many data collectors store their water quality data on a project-specific basis, such as in a database for a single research project, and these data generally are available, by request, only to those who know about the agency's projects.

While many entities collect water quality data, a small number of key federal agencies are responsible for collecting the largest share of the water *quantity* data collected nationwide. The U.S. Geological Survey collects streamgage data nationwide, NOAA's National Weather Service collects precipitation data at over 10,000 locations nationwide, and the Department of Agriculture's Natural Resources Conservation Service maintains an extensive automated system to collect snowpack data. These three agencies store their water quantity data in national databases that are accessible through the Internet. In addition, the Army Corps of Engineers funds the collection of considerable amounts of water quantity data. Other federal agencies, such as the Fish and Wildlife Service, also collect water quantity data, but generally on a project-specific basis with data available by request only. Some state agencies also collect water quantity data to better understand water availability and water use.

Water Quality Data Collection

At least 15 federal agencies, as well as state agencies, local governments, volunteer monitoring groups, industry groups, members of academia and others, collect water quality data. These data generally provide information on chemical, physical, or biological conditions of waters. The scope of the data collected varies widely—from national programs, such as the U.S. Geological Survey's National Water Quality Assessment Program, to site-specific research projects, such as the Department of Agriculture's testing of the effects of agricultural practices on water quality. Different entities also vary in how they store data and allow others to access them. In some cases, water quality data are stored in databases that are accessible via the

Internet. In many cases, however, water quality data are stored on a project-specific basis and can be accessed only by request.

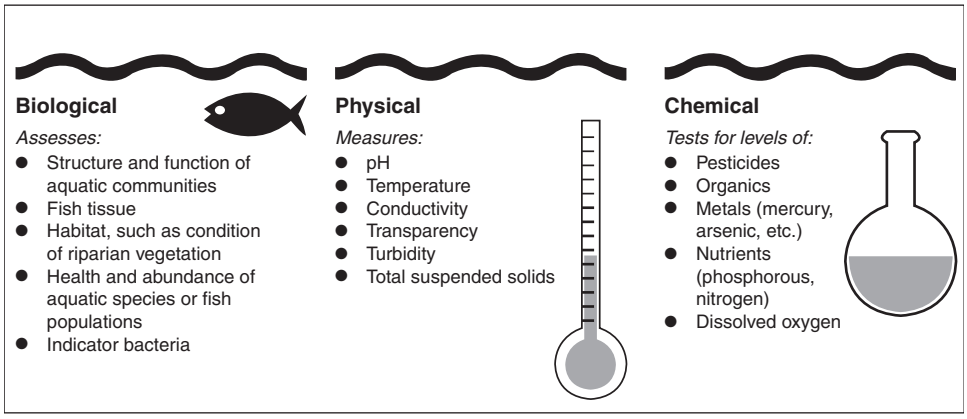
Water Quality Monitoring Measures the Biological, Chemical, and Physical Conditions of Water

The Clean Water Act establishes goals for attaining water quality, as measured by the biological, chemical, and physical conditions of waters. EPA guidelines discuss the different types of monitoring tests in each of these areas—each of which yields data about particular aspects of bodies of water.

- *Biological monitoring* measures the health of aquatic communities and includes a variety of techniques, such as assessing species' health and abundance.
- *Physical monitoring* tests the physical characteristics of bodies of water, such as temperature and the amount of suspended solids in the water.
- *Chemical monitoring* tests for chemicals that may be present, such as chlorine or ammonia, and metals, such as mercury.

These monitoring types and the parameters they measure are described in figure 3.

Figure 3: Monitoring Types and the Parameters They Measure



Source: GAO.

Federal Water Quality Data Collection

A number of federal agencies and subagencies collect, or fund the collection of, considerable amounts of water quality data. GAO surveyed the following 15 key federal agencies that collect water quality data on a wide variety of parameters:

- Department of Agriculture
  - Agricultural Research Service
  - Cooperative State Research, Education, and Extension Service
  - Forest Service
  - Natural Resources Conservation Service
- Department of Commerce
  - National Oceanic and Atmospheric Administration
  - National Marine Fisheries Service
  - National Ocean Service
- Department of Defense
  - Army Corps of Engineers
- Department of Energy
  - Bonneville Power Administration
- Environmental Protection Agency
- Department of the Interior
  - Bureau of Land Management
  - Bureau of Reclamation
  - Fish and Wildlife Service
  - U.S. Geological Survey

- National Park Service

- Tennessee Valley Authority

We asked officials from these agencies to report on the specific chemical, physical, and biological parameters—as listed in figure 3—that their agencies collect. Each of the agencies reported that they collect data on all, or almost all, of the listed parameters shown in figure 3.[1]

Although these parameters are collected widely across the agencies, we found that the geographical scope of agency data collection for each of these parameters varies considerably. The U.S. Geological Survey operates several large national programs, including the National Stream Quality Accounting Network and the National Water Quality Assessment Programs. These programs describe and provide an understanding of water quality in major river basins and aquifer systems, as well as in small watersheds, and cover about two-thirds of the land area of the conterminous United States. Many federal and state agencies and local groups rely upon data collected by the U.S. Geological Survey for watershed management activities.

The Army Corps of Engineers also collects water quality data on a broad geographical scale at many of its approximately 700 water projects. These projects primarily are operated to facilitate navigation, reduce flood or storm damages, provide water supply storage, or generate hydropower. In addition, the Corps also collects a considerable amount of water quality data for planning and design purposes, generally to understand impacts of projects in advance of their implementation. For example, before entering into a dredging cycle, the Corps collects short-term data to understand what pollutants will be released into a water body. Similarly, the Corps collects specific water quality data in response to Section 404 permit requests. In general, the Corps collects water quality data to address environmental issues, such as sediment and water quality for fish and wildlife.

Most of the agencies we surveyed collect project-specific data in defined geographic regions. For example, the Tennessee Valley Authority (TVA)

[1]Some agencies do not collect all of the listed parameters themselves, but provide funding to others to collect the data. For example, the Bonneville Power Administration, Natural Resources Conservation Service, and Cooperative State Research, Education, and Extension Service do not collect all of their water quality data themselves but instead provide funding to other entities that collect data.

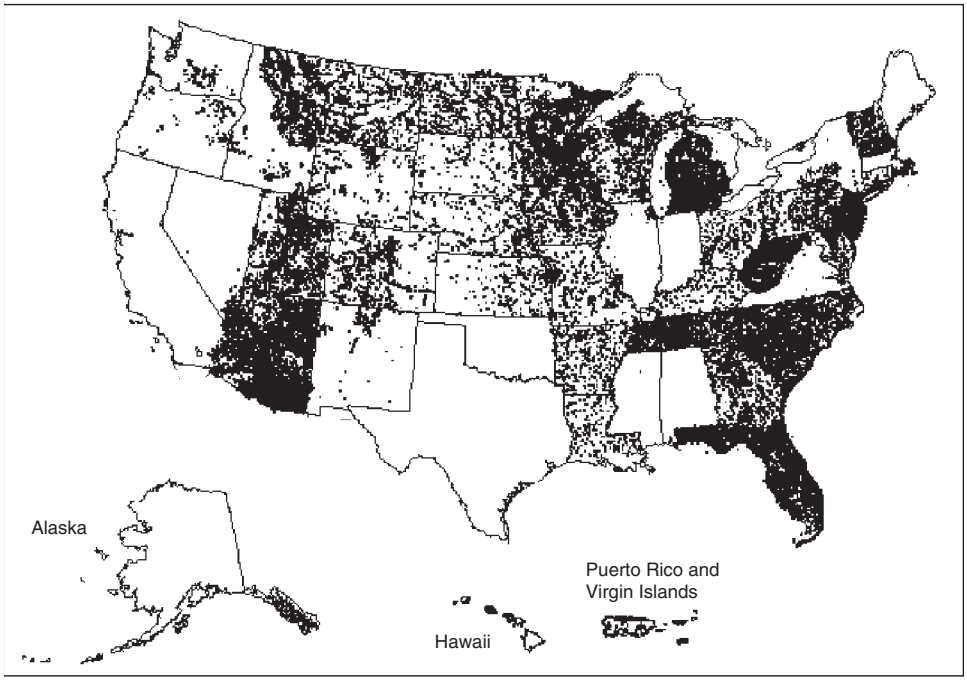
collects water quality data to evaluate ecological health in reservoirs throughout the Tennessee Valley, an area that includes almost all of Tennessee and parts of Mississippi, Kentucky, Alabama, Georgia, North Carolina, and Virginia. In addition, the Department of Energy's Bonneville Power Administration (BPA) collects water quality data in conjunction with some of the hundreds of fish and wildlife projects it funds each year throughout the Pacific Northwest, including Oregon, Washington, Idaho, and western Montana, as well as small portions of Wyoming, Nevada, Utah, California, and eastern Montana.

Agencies also collect data at varying frequencies. For example, a Bureau of Land Management official surveyed the agency's field offices and found that most collect chemical, physical, and biological data annually. In contrast, other agencies, such as the U.S. Geological Survey and National Park Service, reported that they collect water quality data on a continuous or otherwise more frequent basis.

Federal Water Quality Data Storage

There are two national databases for water quality data: EPA's Storage and Retrieval System (STORET) and U.S. Geological Survey's National Water Information System (NWIS). According to EPA officials, STORET contains biological, physical, and chemical data collected by over 120 organizations, including federal, state, and local agencies, American Indian tribes, volunteer groups, and academics. EPA officials reported that, as of January 2004, STORET contains approximately 18 million monitoring results collected from over 146,000 sites. Figure 4 depicts STORET's monitoring coverage. Officials from five of the agencies we surveyed said they store at least some data in STORET. For example, the National Park Service uses STORET to store all of its data, while several other agencies, such as the Bureau of Land Management and the Bureau of Reclamation, store small amounts of data in STORET.

Figure 4: STORET's Monitoring Coverage



Source: EPA.

The U.S. Geological Survey collects and analyzes chemical, physical, and biological properties of water and disseminates the data through NWIS to the public, state and local governments, public and private utilities, and other federal agencies involved with managing their water resources. The U.S. Geological Survey established NWIS in 1975 and made it available to the public through the Internet in July 2001. According to NWIS database managers, as of September 2003, NWIS was accessed about 16 million times a month. Unlike STORET, which contains data from multiple entities collected using a variety of data collection methods, NWIS contains only data collected by U.S. Geological Survey scientists or under U.S. Geological Survey approved data collection methods that pass a quality control check. According to officials from the Army Corps of Engineers and Bureau of Land Management, some of their agencies' data are available through NWIS. In addition, some water quality data collected by the Army Corps of Engineers are stored in district offices in individual project files for which the data were collected. Many of these data are accessible upon request.

While several federal agencies store at least some of their data in STORET and NWIS, officials in ten of the agencies we surveyed said that all or most of their water quality data are stored in databases that are specific to the project or program for which the data are collected. For example, officials from the Agricultural Research Service said that their data, collected through experiments conducted on farms and ranches to determine how agricultural practices affect water quality and verify the efficacy of best management practices, are stored in numerous, internal project-specific databases. In addition, according to an official from the National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service, the agency stores the data used to assess the health of marine and coastal ecosystems in internal program-specific databases.

Federal Water Quality Data Accessibility

Data stored in STORET and NWIS are publicly available through the Internet. Users can search STORET and NWIS by geographic area, such as state or county, and by water quality parameters, such as chlorine or dissolved oxygen. Data within STORET become available on the Internet when users upload their data into the central version of the database. The availability of NWIS data varies depending on the type of data that users are trying to access. For example, some water quality data, such as real-time data that are gathered from gages in streams, may become available in NWIS every 4 hours. In other cases, it can take an average of 4 months for data to be processed, checked for quality, and made available through the NWIS Web site.

Many federal agency officials we interviewed said that their data are available by request and/or through agency publications. However, several officials said that, most of the time, it would be difficult for the public to know that data are available because agencies do not always publicize information about individual projects. For example, the Cooperative State Research, Education, and Extension Service (CSREES) provides funding to collect water quality data in support of research and education objectives identified by individual investigators, but CSREES has no centralized database to store the data collected by researchers. Therefore, according to a CSREES official, potential data users would have to know about CSREES-funded projects in order to access the data. Similarly, officials from NOAA's National Marine Fisheries Service said that the public would have difficulty accessing the data that are stored in project-specific databases, because there is no automated access through the NOAA's National Marine Fisheries Service Web site.

State Water Quality Data Collection

To address their considerable water quality management responsibilities, various state agencies (such as departments of the environment, health, fish and game, and conservation) collect and use water quality data to comply with federal requirements and to restore and protect water bodies. According to a study conducted by the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA),[2] 40 state and 2 interstate agencies with specific responsibilities for monitoring and/or assessing water quality spent a total of roughly $112 million on water quality monitoring in 2002.[3]

States vary in the types of data they collect, with some states collecting primarily chemical and physical data, while others focus on biological monitoring. For example, state agency officials we interviewed in Virginia, Mississippi, and Colorado said that their state focuses primarily on collecting chemical data parameters while, as we reported in January 2002, Illinois, Maine, and Ohio rely primarily on biological monitoring.[4] States also vary in the extent to which their monitoring strategies target specific waters of interest or employ statistical sampling methods that allow inferences to be drawn about a larger number of waters. According to ASIWPCA, states tend to use traditional monitoring approaches, such as fixed stations—long-term, sometimes permanent, sampling sites—and special studies, which usually focus on a specific water quality problem.

Recently, states have also adopted the following types of monitoring strategies to supplement these approaches:

- The *rotating basin* strategy identifies basins, sub-basins or watersheds within an area that are sampled sequentially. Usually, a state monitors about one-fifth of its basins each year. After 4 or 5 years, the state has sampled all, and it repeats the sampling sequence.

[2]Association of State and Interstate Water Pollution Control Administrators, *Water Quality Monitoring Programs 2002: A Survey Report of the Status and Future of State Ambient Water Quality Monitoring Programs* (Washington, D.C.: 2003).

[3]The states and interstate agencies estimated their total resource need at $211 million, meaning they faced a shortfall of $99 million for water quality monitoring in 2002.

[4]U.S. General Accounting Office, *Water Quality: Inconsistent State Approaches Complicate Nation's Efforts to Identify Its Most Polluted Waters*, GAO-02-186 (Washington, D.C.: Jan. 11, 2002).

- The *targeted monitoring* strategy targets certain sites for concentrated monitoring based on a list of consideration and information needs, such as determining the effects of runoff from septic tanks or storm water or assessing current conditions in streams flowing to sensitive areas. The results of targeted monitoring can provide a good picture about water, identify sources of water impairment, and determine if management actions are improving water quality. However, the information gathered is location-specific and cannot be extended to other areas except through mathematical modeling.

- *Probabilistic monitoring* uses a sampling approach to provide comprehensive assessments of water quality conditions throughout an area. Sites are randomly selected from all of the waters in a watershed, and the results of monitoring are used to estimate water quality conditions in the larger area with known confidence. Probabilistic monitoring cannot provide information on specific sites unless the sites were included in the random selection. In addition, probabilistic sampling typically does not incorporate seasonal or other variation.

- A *tiered monitoring* strategy structures states' monitoring programs so that the less expensive and most expedient monitoring techniques can be used first, followed by more expensive and time-consuming studies, if the initial studies demonstrate that more monitoring is warranted. The tiered approach may combine the techniques described above. For example, one tier may be a rotating basin probabilistic approach for gathering information on waters statewide, while a second tier may focus on monitoring trends on large rivers and urban streams.

In March 2003, EPA issued guidance, "Elements of a State Water Monitoring and Assessment Program,"[5] that recommends 10 basic elements of a state water-monitoring program and serves as a tool to help EPA and the states determine whether a monitoring program meets the requirements of the Clean Water Act. The elements include (1) developing a monitoring program strategy, (2) using an integrated monitoring design, and (3) using accessible electronic data systems. According to the guidance document, EPA believes that state monitoring programs can be upgraded to include all ten elements within ten years. According to EPA officials, states should develop a monitoring strategy by the end of fiscal year 2004 and should

[5]Environmental Protection Agency, *Elements of a State Water Monitoring and Assessment Program* (Washington, D.C.: March 2003).

begin implementing the strategy in fiscal year 2005. EPA officials stated that they are working with states to implement the guidance in order to reduce inconsistencies and variations in state monitoring programs.

State Data Storage

After collecting data using the various monitoring strategies, states must store the data so that they can be readily retrieved for analysis and evaluation. According to an EPA official, as of March 2004, 31 states use STORET to store at least some of their data, and EPA is trying to have the remaining states and other federal agencies store their water quality data in STORET as well. ASIWPCA reports that state agencies are increasingly storing water quality data in national and statewide electronic databases, but a small number of agencies still use paper files as their predominant means for storing data.

Our site visits confirm that states differ in how their data are stored. Of the states we visited, only Colorado uses STORET to store water quality data. Officials in Virginia and Mississippi reported that they used STORET through 1998, when EPA introduced a modernized version of STORET. Officials in both states said that since they could not easily put data in or retrieve data from the modernized STORET, both states' Departments of Environmental Quality developed state databases to better meet their needs. In addition, Virginia Department of Environmental Quality officials said that some of their data exists only in paper files.

Accessibility of State Water Quality Data

As states' data storage practices vary, so does the accessibility of their data. According to an ASIWPCA survey, water quality information is primarily available to the public in published reports and other printed materials as well as in electronic formats such as CD-ROMs. The survey also showed that, as their resources permit, states are moving toward making their data available via the Internet.

Our site visits similarly revealed that the accessibility of data largely depends on the storage method the state uses. For example, Colorado's water quality data are accessible through STORET. Since Virginia's database is internal and is not Internet-accessible, data users must request data or access the data through publications. In Mississippi, the public can access water quality data through publications or by request from the Mississippi Department of Environmental Quality, though officials report that the state agency is moving toward developing a system that will be publicly accessible via the Internet.

Water Quality Data Collection by Local Governments, Volunteer Monitoring Groups, and Others

Local governments, volunteer monitoring groups, and others also collect water quality data for a variety of purposes, including monitoring the health of streams, lakes, and rivers, developing pollution reduction strategies, and conducting research.

Local Governments

Local government agencies, such as water management districts, also participate in monitoring projects, often to understand and address recognized water quality problems. Local agencies may limit their data collection to particular geographic locations (e.g., a sewage treatment district or particular town lake) or may collect data for specific parameters, such as pH or dissolved oxygen. For example, according to a Thornton, Colorado, city official we interviewed during one of our site visits, the cities of Northglenn, Thornton, and Westminster, Colorado, were prompted to start the Clear Creek Watershed Group in 1981 after city officials found that excessive nutrients were causing odor and taste problems in the cities' water supply. Similarly, a Fort Collins, Colorado, official explained that he helped to initiate a coordinated, regional watershed monitoring effort among some major municipal water providers because the quality of water entering water treatment plants was deteriorating.

Local governments may also work with federal agencies to collect water quality data. For example, according to a National Park Service official, the agency worked with the city of Las Vegas to collect data on the treatment and disposal of wastewater at nearby Lake Mead. The Army Corps of Engineers partnered with the District of Columbia to conduct wetlands restoration of the Anacostia River, providing monitoring data and technical and project management expertise. In addition, U.S. Geological Survey officials noted that local governments participate in its Cooperative Water Program.

Volunteer Groups

According to the volunteer monitoring representative of the National Water Quality Monitoring Council (the National Council),[6] an estimated 800 to 1,200 volunteer monitoring groups across the nation collect monitoring data with varying levels of technical expertise and financial resources. Volunteer monitoring groups collect data for a variety of parameters. For example, volunteers for the Virginia Save Our Streams organization primarily collect biological data through in-stream monitoring. Volunteers for another group, the Alliance for the Chesapeake Bay, collect streamside physical and chemical data, such as temperature, pH, and dissolved oxygen.

States use volunteer monitoring groups' data in a variety of ways. According to the volunteer monitoring representative of the National Council, states' use of volunteer monitoring data varies along a continuum; some states use volunteer monitoring data for educational purposes, others use the data as a "red flag" to indicate areas where additional state monitoring is needed, and still others use the data to decide whether waters should be identified as impaired. For example, according to the volunteer monitoring representative, Rhode Island uses volunteer monitoring data to make decisions regarding which lakes are impaired. In Virginia, officials from the Department of Environmental Quality explained that the state uses volunteer monitoring data to assess the general conditions of waters, but not to decide on impairments. According to Mississippi Department of Environmental Quality officials, volunteer-collected turbidity data led to a state investigation that found that a farmer caused the pollution because he was clearing land too close to the edge of the river.

Other Groups

Finally, we identified the following entities that also collect water quality data:

- *Universities.* Fifty-four Water Resources Research Institutes are located at land grant universities throughout the United States. According to an official from one of the institutes, the Virginia Water

[6]The National Water Quality Monitoring Council was created in 1997 and has representatives from federal, interstate, state, tribal, local, and municipal governments; watershed and environmental groups; the volunteer monitoring community; universities; and the private sector. The purpose of the council is to provide a national forum to coordinate consistent and scientifically defensible water quality monitoring methods and strategies. This council's activities, including its role in coordinating water data collection, are discussed in greater detail in chapter 3.

Resources Research Center, the Center has collected water quality data to develop several total maximum daily load (TMDL) reports.

- *Industries.* Industries collect water quality data to ensure that they are in compliance with permitted discharge levels, water quality standards, and TMDLs as well as research for improvements. For example, according to Weyerhaeuser officials, the company collects sediment data at some sites to determine their compliance with water quality standards.

- *Interstate commissions.* Several interstate commissions, such as the Susquehanna River Basin Commission and the Ohio River Valley Sanitation Commission, conduct water quality monitoring programs for a number of purposes, such as identifying problems that threaten the quality of water resources of multiple states and monitoring trends in water quality over time.

Water Quantity Data Collection

As with water quality data, at least 15 federal agencies, as well as some state agencies, collect water quantity data. However, a small number of key federal agencies collect a large share of these data, which are often stored in nationwide databases and accessed widely by a variety of users. The other federal agencies generally collect project-specific water quantity data that are available in a variety of ways, depending on the agency.

Water Quantity Monitoring Measures Water Availability and Water Use

Water quantity data are used to measure both the availability of water in lakes, rivers, streams, and other water bodies, as well as the amount of water that is removed from streams for a variety of purposes, such as drinking water or agriculture.

Water availability is measured by a number of data parameters, including streamflow, precipitation, and snowpack. In many cases, entities combine their data with others' to measure or estimate the amount of water available for use.

Water use refers to all in-stream and out-of-stream uses of water for human purposes from any water source. Water use is measured by parameters such as: (1) *withdrawal*, which is water removed from the ground or diverted from a surface-water source; (2) *consumptive use*, or the quantity of water that is not available for immediate reuse because it has been

evaporated, transpired, or incorporated into products, plant tissue, or animal tissue; and (3) *return flow*, which is irrigation water that is not consumed by evapotranspiration and that returns to its source or another body of water.

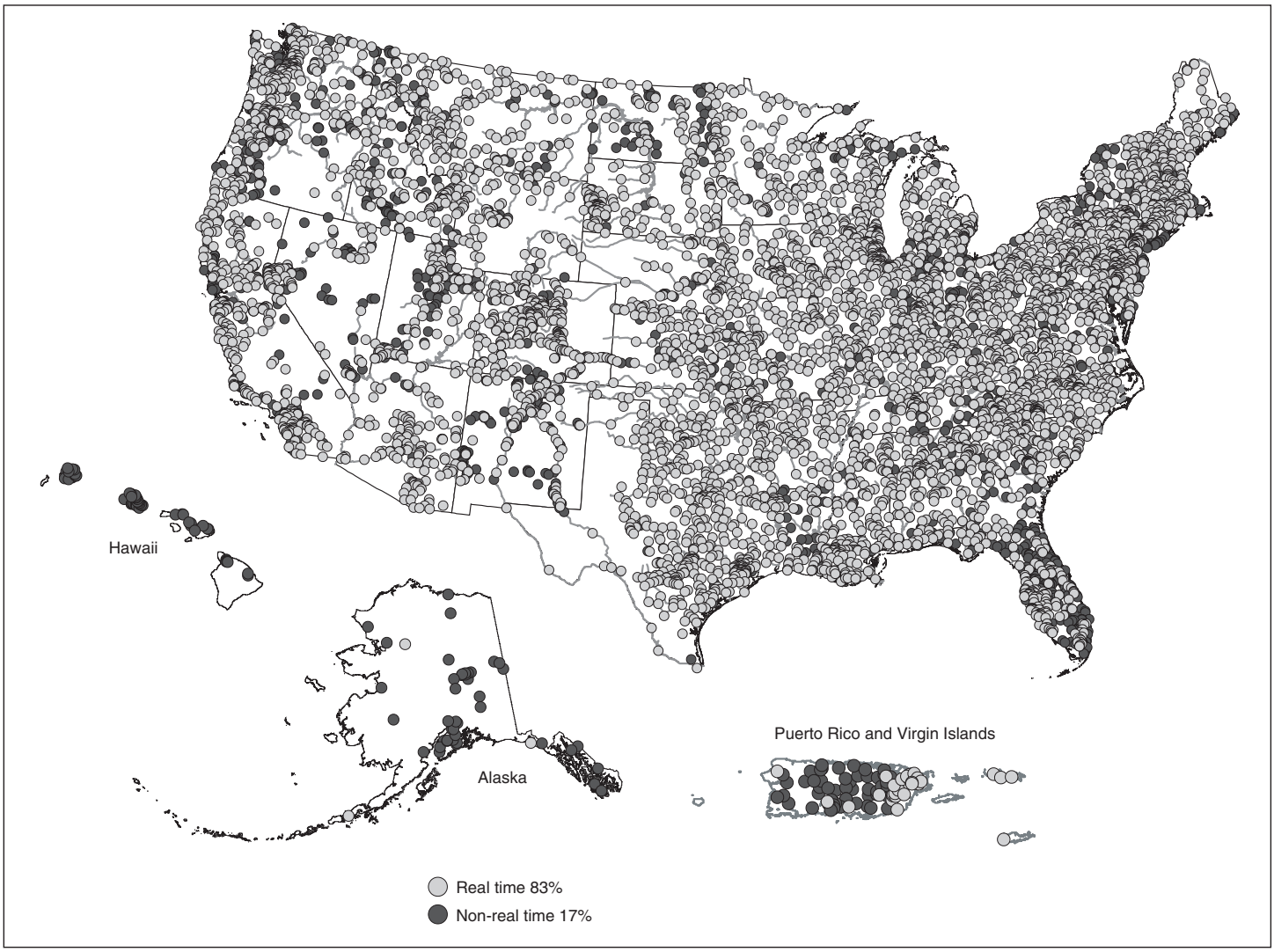
Federal Water Quantity Data Collection

Fifteen federal agencies collect, or fund the collection of, water quantity data, including water availability data and water use data. Most of the agencies reported that they collect at least some water availability and water use data. However, we found that the frequency and geographical scope of water quantity data collection varies widely. Three entities, the U.S. Geological Survey, NOAA's National Weather Service, and the Natural Resources Conservation Service, collect large amounts of data and store the data in national databases that are accessible through the Internet. In addition, the Army Corps of Engineers collects water quantity data and funds the collection of considerable amounts of additional data. Most of the other agencies collect limited water quantity data on a project-specific basis and store the data in internal, project-specific databases. These data are available in a variety of ways, depending on the agency.

The U.S. Geological Survey's Water Availability and Water Use Data

The U.S. Geological Survey is the federal agency primarily responsible for collecting, analyzing, and sharing data on water availability and use. In particular, the U.S. Geological Survey is the main collector of streamflow data, which measures the volume of water flowing through a stream using streamgages. Under the National Streamflow Information Program, the U.S. Geological Survey collects data through its national streamgage network, which continuously measures the level and flow of rivers and streams at 7000 stations nationwide (see fig. 5). It makes these data available to the public via the Internet. The U.S. Geological Survey is also a major collector of water use data under its National Water Use Information Program. Under this program, the U.S. Geological Survey compiles extensive national water use data collected from states every 5 years to establish long-term water use trends.

Figure 5: The U.S. Geological Survey's Nationwide Streamgage Network



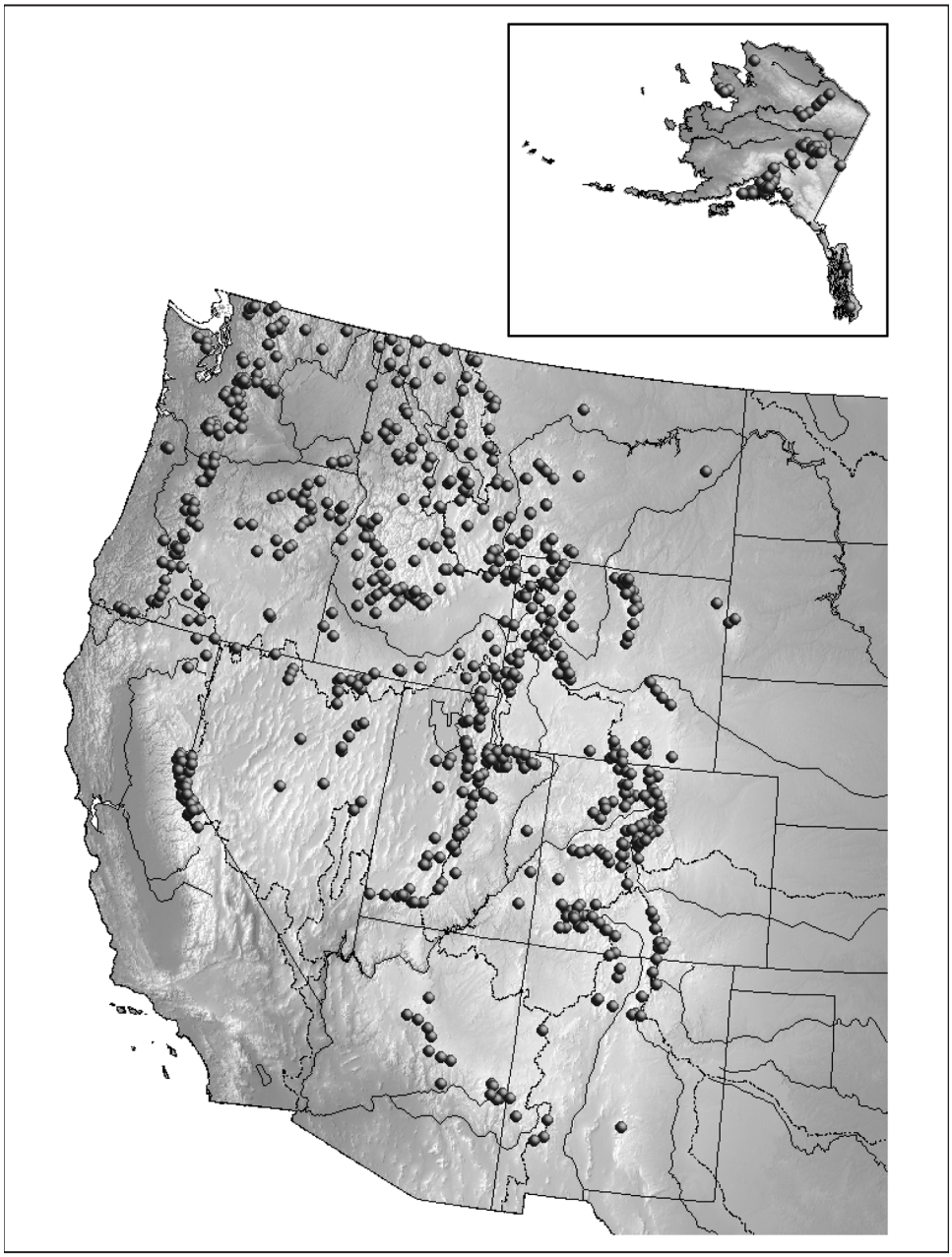
Source: U.S. Geological Survey.

The Natural Resources Conservation Service's Snowpack Data

Snowpack data is another key element in determining water availability because it helps western states forecast and manage future water supply. The Natural Resources Conservation Service is the key collector and provider of snowpack data through its Snow Survey and Water Supply Forecasting Program. As figure 6 shows, the Natural Resources Conservation Service collects snowpack data from over 700 automated

SNOTEL (SNOwpack TELemetry) stations in 12 western states and Alaska. In addition, the Natural Resources Conservation Service collects snowpack data at over 900 manually sampled sites in the western states. Snowpack data is also collected in Vermont, New Hampshire, Pennsylvania, and Minnesota through its Soil Climate and Analysis Network. The snowpack water equivalent and depth are used to estimate annual water availability, spring runoff, and summer streamflows. Individuals, organizations, and state and federal agencies use these forecasts for decisions relating to agricultural production, fish and wildlife management, municipal and industrial water supply, urban development, flood control, recreation, power generation, and water quality management.

Figure 6: SNOTEL's Site Locations

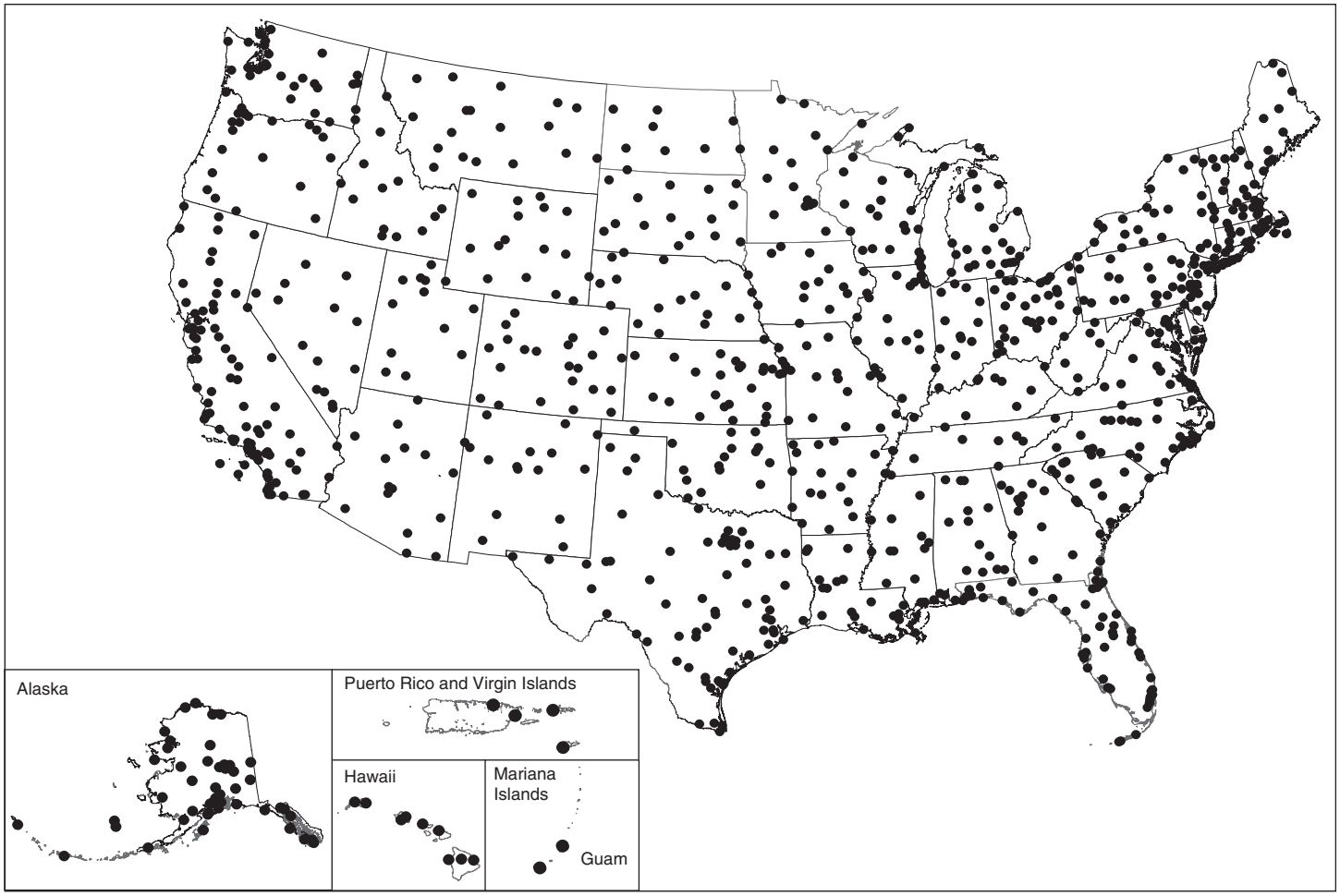


Source: Natural Resources Conservation Service.

NOAA's National Weather Service Precipitation Data

Precipitation data are also important in determining how much water will be available for use, as well as in predicting floods. The National Weather Service collects most of this data through the Automated Surface Observer System, a joint effort of the National Weather Service, the Federal Aviation Administration, and the Department of Defense. Data in the Automated Surface Observer System are collected across the nation at major airports and other areas, as shown in figure 7. The National Weather Service also collects precipitation data through the Volunteer Cooperative Weather Observation Network. Under this program, volunteers collect data at 11,400 weather stations in rural and urban areas to provide data for weather forecasts and drought and flood warnings. According to an official from the National Weather Service, precipitation data are used by weather centers to make more accurate weather forecasts, which can result in significant savings from flood damage. In addition, the National Weather Service and the Natural Resources Conservation Service combine their data, together with the U.S. Geological Survey's streamgage data, to forecast water supplies and floods.

Figure 7: Automated Surface Observer System Sites as of February 2004



Source: National Weather Service.

Army Corps of Engineers

In partnership with the U.S. Geological Survey, the Army Corps of Engineers funds approximately 15 percent of the U.S. Geological Survey National Streamflow Information Program. This provides funding, at least in part, for about 2,160 of the approximate 7,200 stations. The Army Corps of Engineers also collects some water quantity data for various parameters in association with its water management projects. For example, the Army Corps of Engineers keeps track of rainfall amounts, reservoir storage, and inflow and outflow as part of operating specific projects. In addition, the Army Corps of Engineers collects stage[7] data to monitor flood control efforts. Moreover, according to officials from the Army Corps of Engineers, the agency contributes to the analysis of water data by developing water resources software models that are used worldwide.

Other Agencies

Eleven other federal agencies we surveyed also collect water quantity data, though mostly on a site-specific basis.[8] For example, the National Park Service collects site-specific data to, among other things, characterize hydrologic conditions within park units. In addition, TVA collects water quantity data, such as flow and storage volumes, in order to help decide how much water should be released from its dams.

Storage and Accessibility of Federal Water Quantity Data

Streamflow, snowpack, and precipitation data are easily accessible through three large federal databases operated by the U.S. Geological Survey, Natural Resources Conservation Service, and the National Weather Service. The U.S. Geological Survey updates streamflow data continuously and makes these data available through NWIS. Through its SNOTEL system, the Natural Resources Conservation Service operates and maintains an extensive, automated system to collect snowpack data in the western United States. The National Weather Service stores precipitation data in the National Climatic Data Center and makes the data available through NOAA's National Environmental Satellite, Data, and Information Service.

According to the Army Corps of Engineers, its data are stored in a number of databases, including internal databases as well as the U.S. Geological Survey's NWIS. According to the Corps, most of these data are available through their district or division Web pages, though some data are not available for security reasons.

[7]Stage is a measure of the height of a water surface.

[8]Some of these agencies reported that they provide funding to others, such as contractors or academics, to collect water quantity data rather than collecting the data themselves.

Most of the other 11 agencies we contacted that collect water quantity data store their data in internal databases, and the data are made available to the public in a variety of ways. For example, BPA stores its water quantity data in internal, project-specific databases and makes them available via the Internet and/or through publications. The Agricultural Research Service stores its water data in numerous databases, largely on a project-specific basis and makes them available via the Internet, by specific request, and/or through publications. The Fish and Wildlife Service stores its water quantity data in project-specific databases at the agency's field offices and makes the data available on request.

State Water Quantity Data Collection

Many states also collect at least some water quantity data to manage their water resources, although the extent of their data collection varies. States need water availability data to forecast how much water can be used for a variety of purposes, such as agricultural or residential use, and often obtain these data from federal agencies. According to a U.S. Geological Survey official, the agency operates the core streamgaging network in most states through its Cooperative Water Program. Under this program, the U.S. Geological Survey enters into agreements with participating states to operate in-stream gages and to share the data collected from them. Officials in Mississippi, for example, said that the state contracts with the U.S. Geological Survey to collect its streamgage data. However, there are a few states that collect significant amounts of streamgage data. A U.S. Geological Survey official in Virginia explained that the U.S. Geological Survey and the Commonwealth of Virginia have historically worked together to operate a unified network of streamgages with uniform quality assurance protocols. In addition, Colorado officials said that the state operates a satellite monitoring system for collecting streamgage data, which is also coordinated with U.S. Geological Survey streamgage data collection efforts in the state. According to the U.S. Geological Survey, only one other state—Nebraska—collects a large share of its state's streamgage data.

In addition to streamgage data, states also require some precipitation data. An official from the National Weather Service said that while some states rely exclusively on the National Weather Service's precipitation data, other states collect some of their own precipitation data to fill in data gaps. For example, New Jersey relies on university researchers, funded by the state Department of Transportation, to collect precipitation data that supplements National Weather Service data.

States need water use data to support the operation of water supply utilities and water districts. In 2002, the National Research Council reported that more than 20 states maintain comprehensive site-specific water use databases, which were most commonly developed to support regulatory programs that register or permit water withdrawals.[9] In many cases, these data are developed through cooperative projects between state water agencies and the U.S. Geological Survey while, in the remaining states, data are collected only for a subset of water use categories or areas within the states. Furthermore, some states have no state-level programs for water use data collection. As we noted in July 2003,[10] state water managers place a high value on water quantity data collected under federal programs to support the states' ability to complete specific water management activities. For example, 37 states reported that federal agencies' data are important to their ability to determine the amount of available surface water. In addition, state water managers reported that data collected under federal programs may be more credible and consistent than the state data.

Agency Comments and Our Evaluation

The Army Corps of Engineers and EPA offered comments on a draft of this report that were germane to the material in this chapter. The Corps commented that the draft report should more fully discuss the range of water quality and water quantity data that the Corps collects and maintains. While the draft report had discussed a wide range of Corps data collection activities pertaining to both water quality and water quantity, we supplemented those discussions with additional detail in response to the Corps' comment. EPA commented that the report should further emphasize the high cost of monitoring. To reflect this perspective, we included information from ASIWPCA that 40 states and 2 interstate agencies spent a total of roughly $112 million on water quality monitoring in 2002 and estimated their total resource need at $211 million.

[9]National Research Council, *Estimating Water Use in the United States* (Washington, D.C.: National Academy Press, 2002).

[10]U.S. General Accounting Office, *Freshwater Supply: States' Views of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages*, GAO-03-514 (Washington, D.C.: July 9, 2003).

Improved Coordination of Water Quality Data Collection Can Help Watershed Managers Make More Informed Decisions

Despite the vast array of organizations collecting water quality data, we and others have documented a considerable shortage of these data. This shortage has impaired our understanding of the state of the nation's waters and complicated decision making on such critical issues as which waters should be targeted for cleanup and how such cleanups can best be achieved.

Better coordination among the numerous groups collecting data can help to close the gap between the availability of data and the much larger need for information. However, we found a number of barriers to achieving this goal. Specifically, organizations (1) collect data for disparate missions, (2) often use inconsistent data collection protocols, (3) are often unaware of data collected by others, and (4) often assign data coordination a low priority. These difficulties have not only perpetuated gaps and duplication of effort among data collectors but have also contributed to an "apples and oranges" problem in which the data that are collected cannot be easily synthesized to tell a more complete story. Taken together, the difficulties in coordinating data collection and in synthesizing available data have impeded our understanding of water quality issues and, in particular, have impeded the ability of watershed managers to make well-informed decisions.

Coordination Needed to Enable Monitoring Programs to Make Better Use of Available Resources

The shortage of reliable and complete water quality data, and its consequences for informed decision making, has been consistently documented by GAO and others. For example, our March 2000 report, *Water Quality: Key EPA and State Decisions Limited by Inconsistent and Incomplete Data*,[1] concluded that data gaps limit states' abilities to carry out key management and regulatory responsibilities and activities on water quality. The data gaps were cited as particularly serious for nonpoint sources,[2] which are widely accepted as contributing to the majority of the nation's water quality problems. Only six states reported that they had a majority of the data needed to assess whether their waters meet water quality standards. A vast majority of the states reported that they had less than half the data they needed to (1) identify nonpoint sources that result in waters not meeting standards and (2) develop total maximum daily loads (TMDLs) for those waters. Similar findings and conclusions have been documented by the National Research Council of the National Academies of Sciences,[3] and the lack of data states have to make assessments has been acknowledged by the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) and other organizations.

As we reported in March 2000, states overwhelmingly cited funding shortages as a primary constraint on efforts to monitor their waters. Forty-five states indicated that a lack of resources was a key limitation to making more progress on water quality issues, with a number of states noting specifically that state-imposed staffing constraints and shortages in lab funding have exacerbated the problem by limiting the number of samples that could be taken and analyzed. In the 4 years since that report was issued, there has been widespread acknowledgment of the need to (1) improve monitoring programs to allow better informed decisions about which waters to target for cleanup, (2) pursue watershed management strategies, and (3) make other key decisions. Nonetheless, the funding constraints impeding monitoring programs at that time are still present and, in many respects, have deteriorated further.

[1]GAO/RCED-00-54.

[2]Nonpoint sources of pollution are diffuse sources that include a variety of land-based activities, such as timber harvesting, agriculture, and urban development.

[3]National Research Council, *Assessing the TMDL Approach to Water Quality Management* (Washington, D.C.: July 2001).

In this context, both analysts and practitioners in the water quality community strongly support the concept of coordinating efforts to collect water quality data to make the most use of limited resources. Among the benefits cited, effective coordination improves the coverage of monitoring stations by more efficiently and strategically locating the monitoring stations of different groups. Similarly, as we found during our site visits, mutual understanding of different groups' monitoring needs and resources has sometimes resulted in modifying monitoring procedures so that individual monitoring stations could meet the data needs of a greater number of users.

Efforts to Coordinate Data Collection Have Thus Far Had Limited Success

Nonetheless, while we found some notable exceptions, officials in 14 of the 15 federal agencies we contacted told us that coordination was either not taking place or falling short of its potential. In addition, the officials noted that enhanced coordination could provide data users with better data about water quality conditions and a more complete picture of the health of watersheds. Among the array of examples cited are the following:

- An official from the Army Corps of Engineers pointed out that without mutual interest among agencies, water quality data collection efforts are very poorly coordinated. The official also noted that some agencies give a low priority to coordinating data collection within their own agencies. The official explained that other potential users of the data may have difficulty finding the correct points of contact to receive data and believes that enhanced coordination would bring more data into the hands of data users.

- Forest Service officials explained that enhanced coordination would help to minimize information gaps. They noted that there are over 2,500 listed segments of impaired waters on national forest system lands. According to the officials, the states are almost always deprived of data needed to develop TMDLs, and coordination between the Forest Service and the states could help minimize those data gaps and speed recovery of impaired waters.

The officials we interviewed from the state environmental agencies agreed, acknowledging in particular that coordination among state monitoring efforts, and between states and other data-gathering entities, could be significantly improved. For example:

- According to officials from the Mississippi Department of Environmental Quality, if federal agencies notified states when they begin monitoring projects and shared their results, the state could assess more waters and possibly reduce duplication of effort. For example, the officials noted an instance in which the Fish and Wildlife Service paid the U.S. Geological Survey to operate streamgages in Mississippi, but the Fish and Wildlife Service did not alert the state that data were being collected.

- According to officials from the Virginia Department of Environmental Quality, the state generally has to solicit data from federal agencies because the agencies do not readily share data with the state. Furthermore, better coordination with volunteer groups could significantly increase the percent of assessed waters in the state.

- According to an official from the Illinois Environmental Protection Agency, many groups in the state collect water quality data, but coordination is needed to develop mutually agreed upon quality assurance project plans and to modify data collection procedures to allow data sharing.

ASIWPCA's Executive Director also cited the need for greater coordination. She noted opportunities to enhance monitoring programs through, among other things, (1) better coordinating monitoring efforts among all levels of government; (2) integrating multiple objectives with single monitoring efforts; (3) incorporating state-of-the-art approaches to link data systems and improve reporting; (4) creating statewide monitoring councils; (5) creating public/private monitoring partnerships; (6) establishing volunteer monitoring corps to increase the total number of waters monitored; and (7) eliminating duplicative monitoring between and among the various state and federal agencies.[4]

Several Key Barriers Limit Effective Coordination of Water Quality Data Collection

Given the strong consensus on the need for coordination—but the difficulty often encountered in achieving it—we asked federal and state officials, representatives of local governments and watershed groups, and others who have tried to coordinate data collection to explain the barriers

[4]The Environmental Forum, *Sample Problem* (September/October 2002; vol. 19, no. 5, p. 26).

that have impeded their efforts. As figure 8 shows, the most frequently cited problems were the following:

- Organizations often collect data to achieve specific missions, which sometimes affects their willingness and ability to modify their approaches toward data collection to make the results more widely usable, and which may even make organizations reluctant to share data they have already collected.

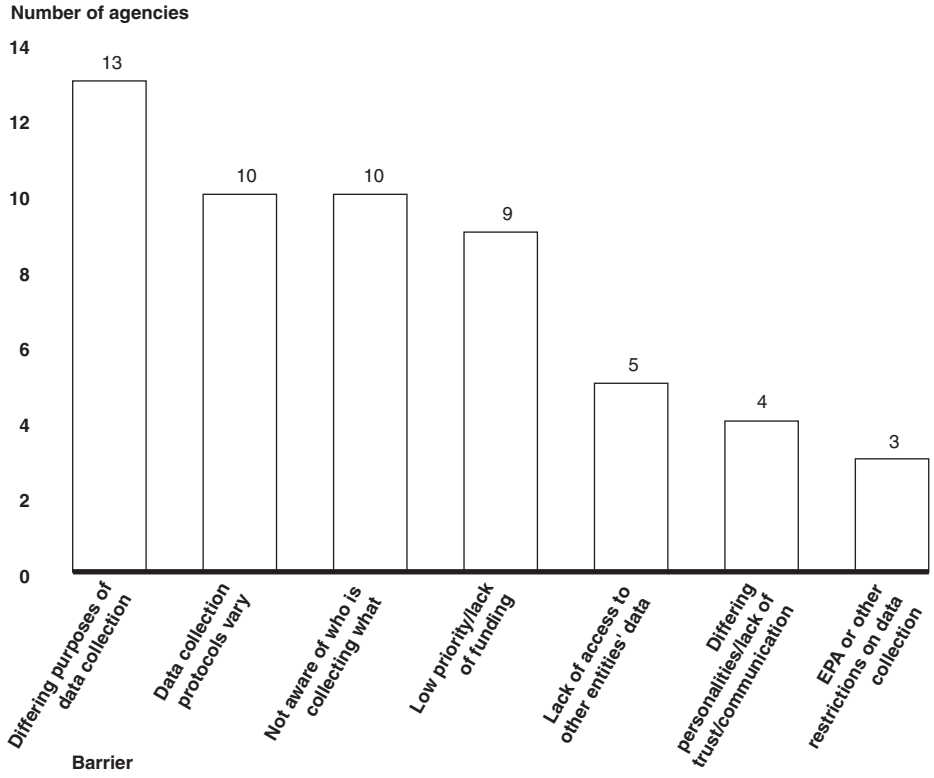
- Groups' data collection protocols often vary, resulting in incomparable definitions to measure the same or similar pollutants, different detection limits, inconsistent levels of quality assurance, and inconsistent collection of metadata.[5]

- Without a centralized clearinghouse on water quality data, many collectors are simply unaware of the data being collected by, or available from, other organizations.

- Data coordination is often assigned a low priority, as shown in a lack of support for national and state monitoring councils, which were established specifically to improve data coordination.

[5]Metadata describe the content, quality, condition, and other characteristics of data. They provide data users with information about the data so that they can make informed decisions as to the quality of the data and the comparability of the data for their questions or purposes.

Figure 8: Most Frequently Cited Barriers to Coordinating Water Quality Data Collection Efforts by 15 Federal Agencies



Source: GAO.

Organizations Collect Data for Disparate Missions

The very nature of the organizations collecting water quality data varies widely—some are public, others are private; some are national, others are statewide or local; some are specifically charged with the responsibility, others do so voluntarily. As we were frequently told, these variations often lead to different data needs and priorities, which may affect the organizations' ability—and willingness—to coordinate data collection strategies and to share available data.

The disparate missions among the organizations that collect data were cited by 13 of the 15 federal agencies as a significant barrier to improved coordination. Even within the community of federal agencies, significant diversity in agency missions can lead to vastly different priorities regarding

which data to collect and how to collect and analyze them. For example, the Environmental Protection Agency's (EPA) primary interest in water quality data arises from its responsibility to ensure that waters are in compliance with states' water quality standards. Accordingly, its monitoring approach (and those of the states that conduct monitoring programs to meet EPA requirements) generally focuses on determining whether certain thresholds are achieved or exceeded. The degree to which measurements are on one side or the other of these thresholds is generally of less consequence. On the other hand, the U.S. Geological Survey's monitoring program is oriented toward obtaining precise measurements of water quality and then tracking changes in these values over time. Accordingly, its monitoring techniques allow for collecting specific measurements—and those techniques tend to be more expensive. For example, the U.S. Geological Survey may use relatively expensive meters to measure water quality parameters such as temperature, dissolved oxygen, pH, and conductivity. These meters require more calibration and maintenance to ensure accuracy than the test kits used by others seeking to determine compliance with state water quality standards.

State officials have also emphasized how differing missions can affect the ability to coordinate monitoring strategies and share data. An ASIWPCA survey found that state officials identified conflicting state and federal data needs as among the top barriers to the effectiveness of their ambient monitoring program.

Finally, some organizations have little incentive to share data, while others may have strong disincentives to do so. According to some federal agency officials we interviewed, academicians who collect research data and plan to publish their results may see little benefit in disclosing their findings early. Similarly, industry officials told us that they were often unwilling to share their water quality data with states in situations in which they believed the data could be unfairly used against them in a regulatory setting.

Organizations Often Use Inconsistent Data Collection Protocols

When organizations differ in their overall approaches toward monitoring, the varying procedures they use to monitor may result in data that cannot be easily compared. A number of such varying procedures were cited in our interviews with federal officials and during our site visits.

Different Names or Definitions Are Used for Measuring the Same or Similar Parameters

According to several federal officials, different organizations sometimes use different names or definitions to measure the same or similar parameters. For example, turbidity, transparency, and total suspended solids are used to determine the extent to which water bodies are affected by sediment. However, they are each measured differently, and, consequently, the data arising from measures of these parameters cannot be synthesized.

Data collection methods for measuring even the same parameter can vary widely. Turbidity, which is a measure of the cloudiness of water, for example, can be measured using a meter, called a nephelometer, which provides a turbidity reading in nephelometric turbidity units, or it can be measured with a turbidity tube, which provides results in Jackson turbidity units. These two measures, however, cannot be used interchangeably. To address incomparable methods, the National Water Quality Monitoring Council has produced a National Environmental Methods Index Web site (www.nemi.gov). This index, which provides a compendium of methods to support monitoring programs, allows for the rapid comparison of methods and aims to ensure that data collectors more actively consider analytical methods when planning and implementing monitoring programs.

Different Detection Limits

Detection limits are the smallest concentration of a given parameter that can be measured. Data collectors may measure pollutants using different detection limits, which can limit the usefulness of their data to other groups. A Virginia monitoring manual noted, for example, that a test kit may have a high detection limit for total phosphorus and, therefore, might not be useful for the state if typical total phosphorus concentrations are lower. Different entities also report detection limits differently. For example, according to officials from the Army Corps of Engineers, some entities report pollutant concentrations that are below detection levels as zero; others report them as less than a certain detection limit; and still others report the measurements as the detection limit itself. These different methods for reporting similar findings make it difficult for data users to understand and use the data.

Different Quality Assurance Methods

Data collectors vary widely in the Quality Assurance and Quality Control methods they use to assure that their data meet minimal standards, and this variation may preclude wider use of data, according to federal and state officials we spoke with. For example, according to officials from the Virginia Department of Environmental Quality, they could not use data on pH levels collected by the Forest Service because the Service's methodology did not meet EPA requirements for quality assurance.

However, if the monitoring had originally been conducted using EPA's approved method, the state could have used the data and probably would have added more waters to Virginia's impaired waters list. In another instance, an official from the Army Corps of Engineers in Mississippi noted that the U.S. Geological Survey has rigorous quality assurance and quality control procedures, which results in a lag time between when the measurement was taken and when the data are accessible to the Army Corps of Engineers and the public. The official explained that, because of delays in receiving data, the Army Corps of Engineers is not always able to make optimum use of the data.

Variations in quality assurance and quality control are of even greater concern when it comes to volunteer monitoring data. For example, according to officials from the Mississippi Department of Environmental Quality, data collected by Adopt-A-Stream volunteers, one of the volunteer organizations in Mississippi, are not used by the state because they are not of sufficient quality to use in identifying waters that do not meet standards, and because the state believes it has little control over volunteers. However, the data could potentially be used to target future monitoring. To address this concern, EPA's Volunteer Monitor's Guide to Quality Assurance Project Plans outlines steps that a volunteer program needs to take to document the field, lab, analytical, and data management procedures of its monitoring program.[6] According to EPA officials, many volunteer programs develop such documentation in the form of Quality Assurance Project Plans, which are then submitted to the state water quality agency or the EPA regional office for review and approval. The officials noted that programs with approved plans are much more likely to have their data used.

[6]Environmental Protection Agency, *The Volunteer Monitor's Guide to Quality Assurance Project Plans* (Washington, D.C.: September 1996).

Different Metadata Standards

Metadata allow data users to understand characteristics about data collected by others, such as the methodology used to collect the data, and thus, determine whether these data are useful for their purposes. Officials from 9 of the 11 federal agencies we surveyed that use data to make watershed management decisions noted that a lack of metadata and/or inconsistency in metadata is a barrier to coordinating data collection efforts and data sharing.[7] For example, according to an official from the Cooperative State Research, Education, and Extension Service (CSREES), without metadata, the reliability of data is suspect and, therefore, should not be used to make watershed management decisions. Similarly, according to officials from the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service, data users need to know as much information as possible about the data that were collected so that data are not misinterpreted.

To address this concern, the Methods and Data Comparability Board of the National Water Quality Monitoring Council is developing water quality data elements that specify the metadata needed so data users can understand and use data from other sources. According to some watershed officials, however, the list of metadata that was originally suggested contained too many metadata fields and will need to be made more manageable to be useful.

Determining appropriate metadata standards is not an easy task. First, officials from several federal agencies explained that collecting and recording metadata can be expensive. An official from NOAA's National Marine Fisheries Service, for example, explained that the collection and storage of metadata requires additional staff and resources that may not be available. Second, as some federal agency officials noted, data collectors that are monitoring water quality for a project-specific need may not be aware that the data they are gathering may be useful to others, so they may not be willing to collect metadata.

[7]The federal agencies we interviewed that use data to make watershed management decisions include the EPA, Bureau of Land Management, Bureau of Reclamation, National Park Service, Fish and Wildlife Service, Natural Resources Conservation Service, Forest Service, Army Corps of Engineers, Bonneville Power Administration (BPA), Tennessee Valley Authority (TVA), and NOAA's National Ocean Service.

Organizations Are Often Unaware of Data Collected by Other Groups

As representatives of many groups indicated, coordinating data collection is difficult because they lack information about the data that other groups may be collecting. Of the 15 federal agencies we surveyed, 10 cited the lack of awareness of other groups' data collection activities as a barrier to coordination. For example, an official from the Agricultural Research Service in Mississippi noted that even though he tries to identify other data collectors within the state, he is consistently surprised to find out that there are additional entities collecting water quality data. An official from the Bureau of Land Management explained that, because watershed boundaries do not coincide with political boundaries, it exacerbates the difficulty of identifying what entities are collecting data within the watershed.

In addition to a lack of knowledge among data collectors about other entities that collect data, we also found a significant gap in knowledge about what data are collected within agencies. Many respondents to our survey could not provide completed information on the type of data their agency collects, frequency of data collection, and geographic areas of data collection. For example, over one-third of the agencies we surveyed were not able to provide complete information about their water quality data because there are no central water quality databases within the agencies.

Most of the federal officials citing unawareness of others' data collection efforts said that a clearinghouse to disseminate that information would go a long way toward addressing the problem. According to federal officials, clearinghouses can take various forms. For example, a clearinghouse might be similar to a phone directory, providing an index of data collectors and the type of data being collected. Or, a clearinghouse might provide an Internet "portal"—an access point from which data users can obtain information and access to data from multiple sources.

Data Coordination Is Often Assigned a Low Priority

Efforts to coordinate data collection activities are a low priority, as demonstrated by a lack of support accorded to federal and state monitoring councils that were formed to help coordinate the data collection efforts of their members and enhance data sharing and use. For example, the National Water Quality Monitoring Council (National Council) was established to implement a nationwide strategy to improve water quality monitoring, assessment, and reporting. This council is co-chaired by EPA and the U.S. Geological Survey and includes representatives from federal, interstate, state, tribal, local, and municipal governments, volunteer monitoring groups, and the private sector.[8] According to its charter, the National Council aims, among other things, to improve institutional coordination and collaboration, comparability of collected data, quality assurance and control, and storage systems that preserve data for future use. The National Council reports to the Advisory Committee on Water Information, which advises the federal government, through the U.S. Geological Survey and the Water Information Coordination Program.[9]

Most of the respondents to our federal survey that were aware of the National Council and its efforts often cited the National Council as a positive influence in promoting better coordination among data collectors. However, almost all of these officials also noted that both a lack of funding and dedicated time among National Council participants has limited the council's effectiveness. Several members of the National Council noted that participation on the council is voluntary and thus, as one member noted, "not part of a member's job description."

Council members we interviewed also agree that the National Council lacks authority. The Office of Management and Budget memorandum that established the National Council does not stipulate that federal agencies *must* cooperate. For example, even though the Army Corps of Engineers participated in the National Council when it was first established, the

[8]According to its terms of reference, National Council membership cannot exceed 35 member organizations, allowing for representatives from 10 federal agencies and 10 states (1 state from each of the 10 federal regions). Other organizations that participate on the National Council represent the following interests: Native Americans, agriculture, environmental interest groups, industry, local agencies and municipalities, river-basin commissions, and/or associations, universities, and volunteer monitoring groups.

[9]The Water Information Coordination Program, established by a December 1991 Office of Management and Budget memorandum, was created to ensure coordination of water information programs and designated the U.S. Geological Survey as the lead agency.

agency has opted out of participating in the National Council for the past several years.

The lack of priority for coordination at the national level is also prevalent at the state level. First, although the National Council and EPA have encouraged states to form councils to coordinate monitoring among the entities active in each state, as of September 2003, only seven state monitoring councils and three regional councils were active.[10] Second, even where such councils have been active, they have generally experienced difficulty in making progress. During interviews with monitoring council members in Colorado and Virginia—the two states we visited that have active coordinating councils—officials reported that their councils were making less progress than anticipated. According to members of the Colorado Water Quality Monitoring Council, the council has struggled, in part because participants must volunteer their own time and its efforts are limited by time and resources. Similarly, a Virginia Water Monitoring Council member told us that while Virginia's council has made some progress (such as sponsoring workshops, conferences, and annual meetings), the ability of the council to address water issues could be increased if the energy expended for fundraising was significantly reduced.

An EPA study of eight of the state and regional monitoring councils substantiated these comments.[11] EPA found that, although the councils have had some indirect effects, none has made a documented, "on-the ground" impact to water quality monitoring. The EPA study also identified many of the same problems we found during our site visits—a lack of funding, members pressed to balance their council participation with competing job demands, and the challenge of getting agency members to take off their "agency hats."

At the same time, according to EPA, state and regional monitoring councils can be effective in improving the availability of monitoring data if properly supported. For example, EPA officials and others have cited the Maryland Water Monitoring Council as a successful state council. The Maryland

[10]State councils are Maryland, Virginia, Oklahoma, Texas, Colorado, Kentucky, and Wisconsin. The regional councils are Chesapeake Bay, Lake Michigan, and New England. A state council was previously established in Montana but has since disbanded. According to EPA, three more states are considering forming state monitoring councils.

[11]Environmental Protection Agency, *Evaluation of State and Regional Water Quality Monitoring Councils* (Washington, D.C.: August 2003).

council has conducted monitoring design workshops and a stream monitoring roundtable to bring together organizations and individuals planning to monitor streams in Maryland, exchange information about the kinds of monitoring being planned, and prepare a geographically-referenced compilation of monitoring sites to ensure that everyone knows where monitoring is taking place. In addition, while the Colorado council has struggled, it has organized "data swaps" to allow monitoring organizations to share metadata and compare data collected by various groups.

As we previously noted, EPA issued guidance to the states in March 2003 that recommends 10 basic elements of a state water monitoring and assessment program. While EPA's guidance does not recommend coordinating data collection activities as one of the basic elements of state monitoring programs, it notes the importance of state monitoring program managers working with other state environmental managers and interested stakeholders as they develop their strategy. In addition, the guidance recommends that states identify required or likely sources of existing and available data and information and procedures for collecting or assembling it.

Coordinating Entity with Sufficient Resources and Authority Suggested as Potential Solution

Because currently established coordinating entities lack the resources, priority, and authority to make significant progress, some agency officials have suggested the need for a clearly designated coordinating body with both sufficient resources and authority. These agency officials differ in their suggestions about the structure of this coordinating body. For example, an official from the Advisory Committee on Water Information believes that, with enhanced authority, the Advisory Committee and its National Council could make significant progress toward improving the coordination of data collection efforts and increasing the amount of data watershed managers have available to make decisions. The official recognized that, while the coordinating entity will not be able to alter agency missions, it would be able to address such things as establishing a clearinghouse to identify who is collecting what type of data and developing clearly-defined and generally accepted government metadata standards for water data collection.

Officials from the Army Corps of Engineers provided a suggestion for an alternative structure for a coordinating body. The officials believe that the designation of one lead agency to define, locate, and integrate available data sources within a specified time frame would make data more easily

accessible, available in a useful format, and better enable local decision makers to make better informed decisions. The Corps officials explained that a lead agency could, for example, establish standards in cooperation with other agencies and establish a clearinghouse for data. The officials suggested that an appropriate lead agency would be one that already carries out and/or supports broad water data collection responsibilities.

Data Management Challenges Also Limit Data Availability

Water quality officials often noted that difficulties in data management are a factor inhibiting their ability to use water quality data to make watershed management decisions. These data management concerns commonly focused on two areas: (1) complexity of using EPA's storage and retrieval system (STORET) and (2) inability to integrate data from various sources to provide a more complete picture of water quality within watersheds.

Complexity of Using STORET

From 1965 until 1998, water quality data were stored in the original STORET Water Quality File, which is now called "legacy STORET." In 1999, EPA released "modernized STORET" to replace legacy STORET. This newer version contains data collected beginning in 1999, along with some older data that were transferred from legacy STORET. Some of the major changes between legacy STORET and modernized STORET include the following:

- Storing data in legacy STORET could only be accomplished by someone with a mainframe user ID and specialized training. In contrast, modernized STORET is installed on personal computers, and data can be entered on those personal computers without requiring access to an EPA computer. Local STORET users then choose if and when to upload their data into national STORET.

- Unlike legacy STORET, modernized STORET contains metadata on why the data were gathered; sampling and analytical methods used; the laboratory used to analyze the samples; the quality control checks used when sampling, handling the samples, and analyzing the data; and the personnel responsible for the data.

EPA considers STORET to be its main repository for water monitoring data and a cornerstone of its data management activities and water program integration efforts. And, according to EPA officials, the agency has worked hard to resolve a number of issues affecting the database's wider use.

Nonetheless, officials from many of the entities we interviewed suggested that further progress is needed before they can effectively use STORET. They cited the following difficulties: (1) uploading data to STORET, (2) retrieving data from STORET, and (3) dealing with the system's large number of data parameters. The last point in particular was cited by Forest Service officials, who noted that the large number of data parameters in the system made it cumbersome to use. Consequently, less than 5 percent of Forest Service data currently go into STORET, and the agency has yet to decide whether to consolidate their water quality data into STORET or expend resources to develop an in-house water quality module.

Officials in two of the three states we visited held similar views. Officials from the Virginia Department of Environmental Quality reported that they have not used STORET since it was updated because of difficulties in uploading and retrieving data, and the state has instead opted to develop its own data storage system. Mississippi Department of Environmental Quality officials similarly reported that they store their data in two state-run databases. Officials from both states noted that they would prefer to have their data in STORET, but would need additional assistance from EPA to do so. On the other hand, one of the states we visited, Colorado, noted success in using STORET to store its water quality data. In addition, officials from EPA's Denver office noted that other states, such as Utah, have also had success in using STORET.

Some local government and volunteer monitoring groups also have encountered challenges using STORET. For example, a watershed group in Colorado noted that, while their group recognizes that STORET is a valuable data management system and made the decision to use the system in 2000, the group had only a limited amount of data in STORET as of fall 2003 because of difficulties uploading their data. The group explained that unified federal support for the system is lacking, and therefore, limited funding has been made available to address the difficulties STORET users encounter. In addition, a volunteer monitoring group from Virginia reported that while they had tried to put their data into STORET, they had too much difficulty uploading data into the system, and that EPA's resources were, at the time, stretched too thinly to provide sufficient assistance. Moreover, officials from Big Dry Creek Watershed Association in Colorado reported that while they recognize the benefits to others of having their data in STORET, they do not perceive a benefit to their association that warrants spending the funding or time to do so.

Many of these issues were echoed by state and interstate agencies in a 2002 ASIWPCA survey. Most survey respondents, for example, indicated that EPA does not have sufficient resources to support the system. Some also noted that STORET is incompatible with their internal state systems and reporting needs, data retrieval is difficult, and a good deal of staff effort must be spent to manage incompatibilities.

EPA officials have acknowledged these problems, as well as concerns over insufficient training and technical support. Nonetheless, the agency has cited recent successes in dealing with STORET challenges, pointing to growth in the number of states and other organizations using the system. As of March 2004, over 120 organizations use STORET, including 31 states, four EPA offices, interstate organizations such as the Delaware River Basin Commission, federal agencies, American Indian tribes, watershed groups, and volunteer monitoring groups. According to EPA, over 7 million of the approximately 18 million monitoring results contained in STORET were added in 2003 alone. EPA officials noted that the agency has made efforts to encourage yet more states, federal agencies, and other groups to make greater use of the system by (1) working to make the system easier to use by, for example, releasing revised versions of STORET and a STORET Import Module which make data upload easier and (2) providing greater technical assistance. In addition, according to EPA, the agency developed a new STORET data warehouse in 2003 that has increased data retrieval speed by 200-fold. With the completion of the data warehouse, the agency plans to significantly increase customer outreach and support to better meet states' needs for the STORET system.

Agencies Face Difficulties Integrating Data from Separate Sources

Another key data management concern is that many different databases with different formats and purposes are used to store water quality data, often making it extremely challenging for data users to integrate data from various sources. According to several federal agency officials, entities that collect water quality data need to coordinate their efforts during the planning phases of data collection to agree on how to manage data. Without such agreement, data collected often either cannot be used by other entities or entities must commit resources to integrate data.

An EPA review of statewide watershed management approaches found data incompatibility affects states' ability to compile data at the basin and watershed level.[12] As a result, it can be difficult to obtain a complete picture of water quality problems and their sources. Furthermore, several states reported that federal and state data systems are often not compatible, and that more work is needed to build and manage databases across agencies that have standardized protocols, metadata reports, and georeferencing capabilities for mapping and modeling.

The most significant example of incompatible databases involves the U.S. Geological Survey's National Water Information System (NWIS) and EPA's STORET. Officials from the U.S. Geological Survey explained that different philosophies and different approaches to the database designs have led to databases with data models that are not compatible. NWIS contains only U.S. Geological Survey generated data or data the U.S. Geological Survey has reviewed and ensured that data quality is known and acceptable. In contrast, STORET accepts data of varying quality from any source, contains significant metadata, and allows the data owner to change or delete data.

According to an EPA official, NWIS was compatible with legacy STORET and, through an agreement with the U.S. Geological Survey at the time, NWIS data was regularly copied into legacy STORET. Furthermore, when EPA modernized STORET, the U.S. Geological Survey and EPA worked closely to ensure that modernized STORET and an expected modernized version of NWIS would remain compatible. However, NWIS was not modernized according to plan, and now the modernized STORET and NWIS are incompatible. Additionally, according to a U.S. Geological Survey official, for technical reasons the archived version of legacy STORET no longer contains NWIS data.

As a result, according to federal and state agency officials, integrating data from these two primary water quality databases takes time and a significant commitment of resources. For example, an official from New Jersey's Department of Environmental Protection explained that transferring data from NWIS into STORET—in order to form a more complete picture of water quality within the state—takes considerable time and effort from both state and U.S. Geological Survey staff. Similarly, an official from the

[12]Environmental Protection Agency, *A Review of Statewide Watershed Management Approaches* (Washington, D.C.: April 2002).

National Park Service explained that the incompatibility of NWIS and STORET makes it very difficult to retrieve data from NWIS and combine it with National Park Service data stored in STORET to create one useable database of park water quality. The official explained that, to effectively use U.S. Geological Survey data from specific contracted studies, the National Park Service often requests that raw data be put into STORET.

EPA and the U.S. Geological Survey have taken steps to address the issue of data incompatibility. In February 2003, EPA and the U.S. Geological Survey agreed to the following:

- Deliver data from NWIS and STORET in a common format to federal, state, and tribal organizations, as well as to the general public and scientific community.

- Ensure that the data from NWIS and STORET are documented to describe their quality so that users can determine the utility and comparability of the data.

- Their data systems will include metadata associated with each water-quality result as soon as possible.

- Recognize that much data exists for which available documentation is limited and yet these data are useful for certain purposes and, therefore, the agencies will not exclude such data from their systems because of these limitations.

- Facilitate and encourage the maximum use of metadata to enhance the usefulness of the information for multiple purposes.

- Work with the National Water Quality Monitoring Council to develop a geospatial Internet-based query tool (portal) for sharing data, especially relying on data from STORET and NWIS. Since data cannot be efficiently transported between the databases, the agreement between the agencies focuses on a data portal as an alternative to copying data into multiple databases. The agencies agreed to "strive to achieve these objectives as soon as is practicable within the constraints of available resources."

In addition to difficulties in integrating data from STORET and NWIS, some agency officials noted difficulty in integrating data within agencies. For example, according to EPA, the agency has historically stored water data

collected under the Superfund program in various databases. Noting the inconvenience of this practice, four EPA regions are working to consolidate Superfund data in STORET. In addition, according to the Army Corps of Engineers, much of its data as well as data from other agencies is stored using different formats in different databases, making integrating the data and analyzing the information for decision making extremely difficult and time consuming.

To address the difficulties integrating data, the Army Corps of Engineers believes using a Geographic Information System (GIS) as the foundation for managing water resources is the only viable solution to effectively integrate vast amounts of disparate data needed to effectively manage the nation's water resources. Thus, according to Corps officials, the agency is taking steps to standardize and integrate disparate data sets by developing an "Enterprise GIS" to support watershed analyses. The Corps envisions that the Enterprise GIS data, output from watershed modeling efforts, and many of the analytical tools would be Web-enabled to make them accessible to federal, state, and local governments. The Corps acknowledges, however, that the agency's implementation of Enterprise GIS at the national level has been slow, citing funding constraints.

Conclusions

The acute shortage of accurate and reliable water data has been documented by GAO, the National Academies of Science, and other organizations. The consequences of this shortage have been amplified in recent years as states and local communities have come under increased pressure to identify and address—in a scientifically sound and legally defensible manner—which of their waters do not meet standards and should, therefore, be targeted for cleanup. The consequences of inadequate water data have also been amplified by the nation's increased reliance on the watershed approach, a strategy whose success relies heavily on the availability of comprehensive and reliable information.

With this critical need in mind, some may find it perplexing that literally hundreds of organizations collect water quality data that are not being sufficiently brought to bear on critical decisions. Our findings suggest that improved coordination could go a long way toward alleviating this problem.

However, the national, regional, and state monitoring councils that exist to promote such coordination have frequently been impeded by a lack of authority to make key decisions, a shortage of funding to undertake key

coordinating activities, and low priority attention from data collecting organizations. Among the most notable of these is the National Water Quality Monitoring Council, which is co-chaired by EPA and U.S. Geological Survey, and which includes representatives from federal, interstate, state, tribal, local, and municipal governments, watershed groups, volunteer monitoring groups, and the private sector.

Some have cited these difficulties in calling for a clearly designated lead water data coordinating body at the national level; one with both sufficient resources and authority. They differ, however, on the precise form this body would take. One model would enhance the role of the National Water Quality Monitoring Council, as the nation's premier water data coordinating body. Another approach suggested by some would be to designate a lead federal agency to assume this role—one that already carries out and/or supports broad water data collection responsibilities. We believe that it is most appropriate for the Congress to exercise the judgment call as to whether and how such an effective coordinating body should be established.

Matter for Congressional Consideration

To enhance and clearly define authority for coordinating the collection of water data nationwide, we recommend that the Congress consider formally designating a lead organization (either an existing water data coordinating entity or one of the federal agencies with broad water data collection responsibilities) for this purpose. Among its responsibilities, the organization would:

- Support the development and continued operation of regional and state monitoring councils.
- Coordinate the development of an Internet-based clearinghouse to convey what entities are collecting what types of data. As part of this effort, the organization could advance the development of a geospatial Internet-based query tool (portal) that would allow users access to information about water data available within a given watershed.
- Coordinate the development of clear guidance on metadata standards so that data users can integrate data from various sources.

Agency Comments and Our Evaluation

The U.S. Army Corps of Engineers, the Department of the Interior, and the Environmental Protection Agency offered comments on a draft of this report that were particularly germane to the material in this chapter. The Corps offered additional information about planned activities to use a comprehensive integrated watershed management approach, which we included in finalizing the chapter.

The Department of the Interior cautioned that the designation of a lead water data organization would not necessarily remove all of the barriers that are currently limiting the coordination of data collection activities. Interior noted that while designating a lead organization or agency has value, resources are needed and some barriers, such as differing purposes for data collection and variation in data collection protocols, would remain. We agree and, accordingly, view Congress' designation of a lead organization as an important step toward addressing the challenges of coordinating data collection. We believe that such a step would enhance and more clearly define the authority needed to address many of these barriers.

Interior also stated that a crucial distinction between NWIS and other databases mentioned in the report, particularly STORET, is that NWIS serves not only as a data archive but also as a data processing system that applies quality control tests. In addition, Interior explained that establishing one large Federal database is neither feasible nor desirable. We agree with both points. Regarding the first point, we recognize that NWIS holds data that are consistently subjected to quality assurance and quality control, while STORET and other databases contain some data of varying or unknown quality. Regarding the second point, many federal agency officials and others noted that it would be neither realistic nor necessary to establish one database that contains all water data. Rather, they generally explained that an Internet-based tool that allows them to link to data sources in a particular geographic area would be both practical and sufficient.

EPA agreed on the need for reliable, comprehensive, and accessible data on water quality to effectively implement the watershed approach. EPA noted, however, that the report should further discuss recent significant improvements to the STORET system and the emphasis placed on coordination and data sharing in EPA's "Elements of a State Monitoring and Assessment Program" guidance. The draft report contained some

information on these issues, but we incorporated additional detail in response to EPA's comments.

Water Quantity Data Are Limited, but Efforts to Collect Them Are Generally Well-Coordinated

Many stakeholders use water quantity data to make decisions with important economic, environmental, and social implications. Among other things, water quantity data are needed to help make water quality determinations. The quantity of water flowing through a river, for example, affects the concentration of a regulated pollutant in that river. The importance of water quantity data, however, extends beyond their impacts on pollutant concentrations. Federal, state, local, tribal, and private organizations also rely heavily on water quantity data to fulfill critical responsibilities such as ensuring an adequate water supply to meet a variety of competing needs.

Officials at both the federal and state level most often reported that their biggest concern about water quantity data is the lack of data available to make these economically and socially important watershed management decisions. However, where data are available, there is broad consensus among federal and state data collectors we interviewed that, while not always flawless, the coordination of water quantity collection efforts is less complicated and more effective than the coordination of water quality data collection.

Water Quantity Data Are Needed for Decisions with Important Economic, Environmental, and Social Implications

As pressure on existing supplies continues to grow, water supply and management issues, and therefore water quantity data, are increasingly important. Much as debits, credits, and savings in a financial budget need to be quantified to maintain fiscal responsibility, the nation's water supply and use need to be comprehensively quantified within the water budget context to ensure adequate availability of water as water demands fluctuate regionally because of changes in climate, urban growth patterns, agricultural practices, and energy needs.

Scientific water quantity data make it possible to understand and protect water for many economically, environmentally, and socially important uses such as safe drinking water, habitat for fish and wildlife, rivers and streams for recreational activities, and water allocations among competing uses by industry, agriculture, and municipalities. A broad group of stakeholders use water quantity data to support decisions concerning these uses. These stakeholders—water managers, engineers, scientists, emergency managers, recreational water users, and utilities—use water quantity data to evaluate current water supplies and plan for future supplies; forecast floods and droughts; operate reservoirs for hydropower, flood control, or water supplies; make informed evaluations of the nation's water quality; navigate rivers and streams; and ensure safe fishing and boating. Many of

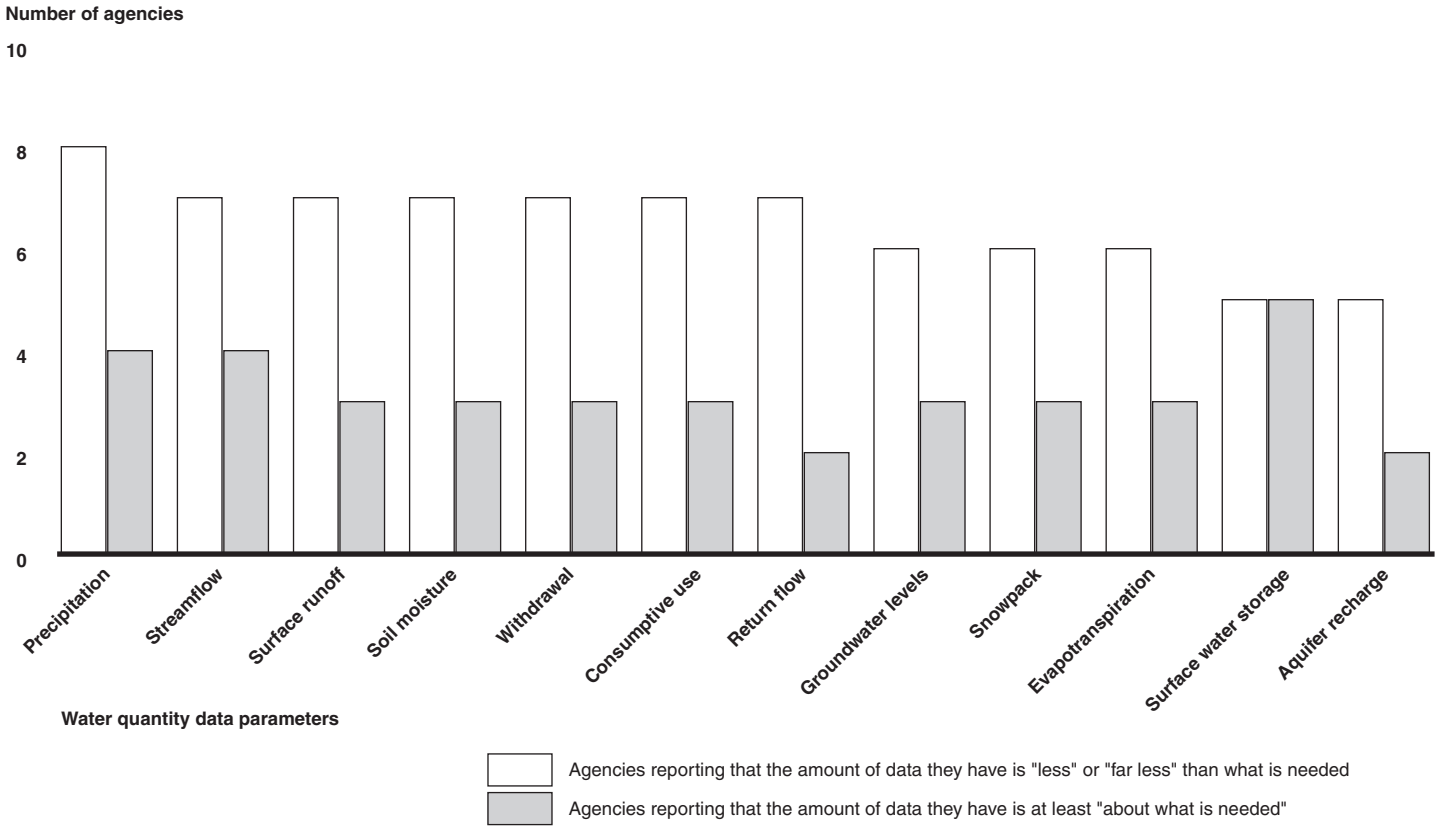
these activities require decisions to be made on a daily basis, which means timely, yet reliable, data are necessary.

Overall Lack of Water Quantity Data Is a Key Concern

Among federal and state officials we interviewed, the most frequently cited concern about water quantity data was the general lack of data available to aid decision making. As shown in figure 9, the majority of federal agencies using water quantity data for watershed management reported having "less" or "far less" than the amount of data that they need to make well-supported decisions, for almost all the listed water quantity parameters, according to our survey of 15 federal agencies. Additionally, in a 2003 GAO survey of state water quantity managers, managers in 39 states ranked expanding the number of federal data collection points, such as streamgage sites, as the most useful federal action to help their state meet its water quantity information needs.[1] In particular, several officials at the federal and state level reported that the decline in U.S. Geological Survey streamgaging stations is a concern, and respondents from the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service and the Agricultural Research Service reported that there are gaps in precipitation monitoring stations.

[1]GAO-03-514.

Figure 9: Federal Agencies Reporting on the Amount of Data That They Have to Make Well-Supported Watershed Management Decisions



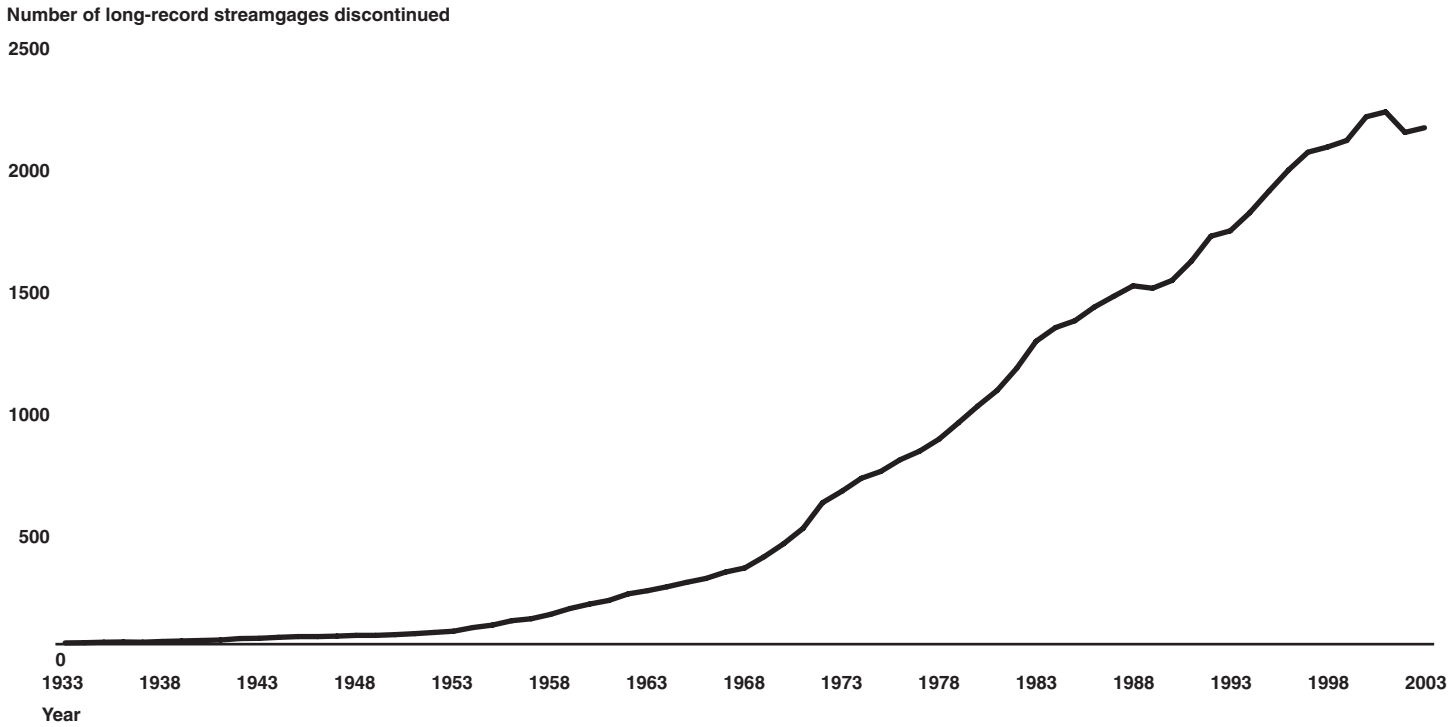
Source: GAO.

According to several federal and state agencies, they are particularly concerned about the continuing decline in U.S. Geological Survey streamgaging stations, which provide many entities with water quantity information needed for key watershed management decisions. Officials at the Colorado Department of Natural Resources explained that in their state, the U.S. Geological Survey has cut streamgage stations that collect data that the state needs. Where possible, the Colorado Department of Natural Resources has taken on the abandoned sites, but it has had to leave some abandoned because of resource constraints. U.S. Geological Survey officials in Mississippi reported that the state Department of Environmental Quality decided to drop Cooperative Program funding to support 19 streamgages, which accounted for half the state's streamflow

monitoring. According to officials at Mississippi's Department of Environmental Quality, some of these gages collected data the state needs to enforce diversion permits, and others have 50 to 60 years of continuous data collection on record, which they do not want to discontinue. However, the state does not have the funds to support expensive U.S. Geological Survey gages, according to the state officials. Similarly, an Environmental Protection Agency (EPA) regional official reported that one state within its region—Wyoming—recently applied for EPA funding to reactivate needed U.S. Geological Survey streamgage stations.

As figure 10 shows, a large number of U.S. Geological Survey long-record streamgages have been discontinued over the past 70 years. According to a U.S. Geological Survey headquarters official, the loss of long-record streamgages is a serious matter because trend data from these gages are requisites for understanding climate change issues and for designing bridges to withstand floods, among other concerns. While the number of long-record streamgages has declined over the past 70 years, the number of total gages remains largely the same from year to year. In many cases, as long-record gages were eliminated, new shorter-term gages were established through the Cooperative Program. The U.S. Geological Survey expects funding from cooperators to decline this year and the next due to current state fiscal constraints, which will likely cause the overall number of gages to go down in the next couple of years.

Figure 10: Cumulative Number of U.S. Geological Survey Gages with 30 or More Years of Record Discontinued, 1933-2003



Source U.S. Geological Survey.

Officials at two federal agencies also identified NOAA's National Weather Service rain gauge data as an area with information gaps. According to the National Weather Service, while currently its observation systems primarily exist at airports, it is trying to improve coverage, especially in the West where the biggest gaps exist. According to a National Weather Service official, studies conducted by the Agricultural Research Service and the National Weather Service show that improving the coverage of monitoring sites to a 20 mile by 20 mile grid would improve stage forecasting by 50 percent. If this coverage is realized, the federal government could save $700 million annually through more accurate flood forecasts, according to the official. To achieve this better coverage, the National Weather Service is beginning to add 4,000 new sites and to upgrade 4,000 existing sites. As we previously reported, the U.S. Geological Survey and the National

Weather Service stated that a lack of sufficient funding is their primary barrier to expanding or automating data collection.[2]

Efforts to Coordinate Water Quantity Data Collection Have Been Comparatively Successful

While the lack of funds for monitoring water quantity parallels the lack of funds for monitoring water quality, efforts to coordinate water quantity data collection have generally been successful and are comparatively unimpeded by barriers. Federal and state officials cited several key reasons for better coordination of water quantity data as follows:

- Water quantity data collection is more centralized among fewer entities, which allows users and collectors to more easily identify data sources that may be helpful in making watershed management decisions and encourages coordination to meet a common purpose.
- Critical, urgent, and controversial decisions concerning issues such as water rights and flood management require accurate and complete real-time water quantity data and provide an impetus for groups to collaboratively generate such data.
- Advanced technology, such as satellites that relay data monitored in stream to computers and radio technology that reports data from collection sites to the Internet, greatly improve the ability of data collectors to share data.
- The general consistency of water quantity data parameters, a result of the well-developed methods available to measure and report them, allows data users to more easily integrate data from separate collection efforts.

Data Collection Is More Centralized among Fewer Entities

Compared with water quality data, collection of water quantity data is more centralized among a smaller number of primary data collectors, according to several federal and state officials. As discussed in chapter 2, in most states, the U.S. Geological Survey collects the majority of streamgaging data, while other agencies have clearly delineated responsibilities for collecting other water quantity data. While these efforts are cleanly divided, they also share the common purpose of predicting and measuring the

[2]GAO-03-514.

nation's water availability and use, which facilitates better coordination, according to some officials. For example, once NOAA's National Weather Service, the Natural Resources Conservation Service, and the U.S. Geological Survey collect their data, they combine them to forecast water supplies and floods.

Some officials also cited the common purpose of data collection as a reason coordinating data collection efforts on water quantity has been more successful than for water quality. According to the U.S. Geological Survey, all states participate in its Cooperative Program, in which nonfederal entities and the U.S. Geological Survey jointly fund water resources projects that involve water quantity data collection.

Critical and Time-Sensitive Water Quantity Management Decisions Require Accurate and Complete Water Quantity Data

Accurate and complete data are critical in supporting urgent and controversial water quantity management decisions made by state and federal agencies. According to many federal and state officials, there is generally a more critical need for accurate and complete real-time water quantity data than there is for water quality because important decisions must be made daily with regard to water allocation, reservoir projects, flood and drought management, navigation, and evaluation of compliance with water withdrawal permits.

According to water quantity officials in Virginia, the critical need for water quantity data increases as the quantity of available water becomes more equivalent to the amount of water being used, or where floods occur. In some of these instances, water quantity decisions must be made quickly with accurate data. For example, according to an Army Corps of Engineers official, when floods occur, managers must make critical on-the-spot decisions, such as which residents need to be evacuated or how much water should be released from a reservoir to reduce risk and optimize flood reduction. Similarly, according to a U.S. Geological Survey official in Virginia, during the state's drought in 2002, discharge permit holders with limits on how much they could discharge at various streamflows relied on hourly streamflow data to be sure that their discharges were not exceeding permitted levels. Several federal and state officials explained that this critical need for data has prompted water quantity officials to coordinate better.

Numerous officials also noted the need for accurate and complete data for controversial decisions, especially when they may be challenged in court. In particular, states need data to, among other things, administer water

rights to various users, establish and maintain in-stream flow requirements for endangered species and, generally, to comply with interstate compacts. The need for adequate data for these sensitive decisions is especially critical in western states, like Colorado, where rising populations combined with increasing demand for water for recreation, scenic value, and fish and wildlife habitat, have resulted in conflicts and litigation. An official in Colorado explained that in his state, there is great emphasis on keeping track of water because "every drop of water is owned by someone."

When water is improperly allocated, states can face costly consequences, which encourages states to coordinate data collection and share results. For example, according to Colorado water officials, the state may be required to pay almost $30 million to Kansas as a result of litigation Kansas initiated when Colorado allegedly withdrew more than its share of water from the Arkansas River as a result of ground water pumping. The officials acknowledged that at the time, the state did not have adequate ground water use data. The state has since decided to focus its resources to bring high-quality data together to make well-supported decisions instead of paying for litigation and payments resulting from inadequately supported decisions. Toward this end, the state has established the Colorado Decision Support System, a central query-based data system that incorporates data from various entities in the state.

Technology Allows for Immediate Distribution of Some Data

Advanced technology within the water quantity field allows for data to be directly and almost instantaneously delivered to data users, which makes it easier to share data and facilitates coordination of water quantity data collection, according to many federal and state officials. Part of the reason that water quantity data is easier to collect and share is because many of the water quantity parameters for which groups collect data can be measured in situ through electronic equipment. This is not true of most water quality parameters, which require manually intensive sampling and subsequent lab processing and analysis to obtain the final data values.

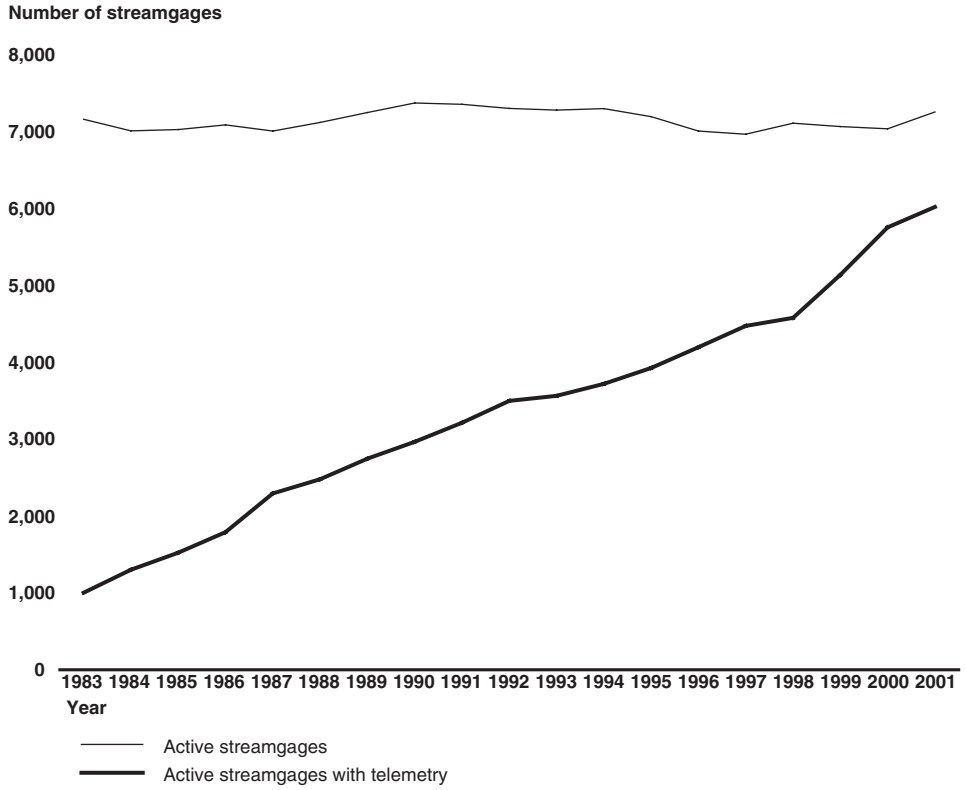
Where data are measured electronically, telemetry systems such as satellite technology—depicted in figure 11—can relay data from the instrument to data users almost immediately. For example, much of the U.S. Geological Survey's streamflow data, which are collected continuously by electronic in-stream equipment, are available within 4 hours of collection through use of satellite systems or other telemetry systems such as phones and radios.

Figure 11: Satellite Used to Relay Collected Water Quantity Data to Data Users (Lawson, Colorado)

Source: GAO.

Since the mid-1980s, the proportion of the U.S. Geological Survey's streamgages with telemetry has increased dramatically, as shown in figure 12. The U.S. Geological Survey's computers also have built-in checking routines, which provide some quality assurance, according to a Colorado U.S. Geological Survey official. Satellites, in particular, transmit much of the hydrologic data collected by the U.S. Geological Survey to data users. Once data are picked up by satellite, they can be transmitted to users in a couple of ways. For example, some data collected by the Bureau of Reclamation can be captured directly by users with their own domestic satellite receivers, or can be accessed on the Web through NOAA's National Geophysical Data Center, a repository for satellite data within the National Environmental Satellite, Data, and Information Service.

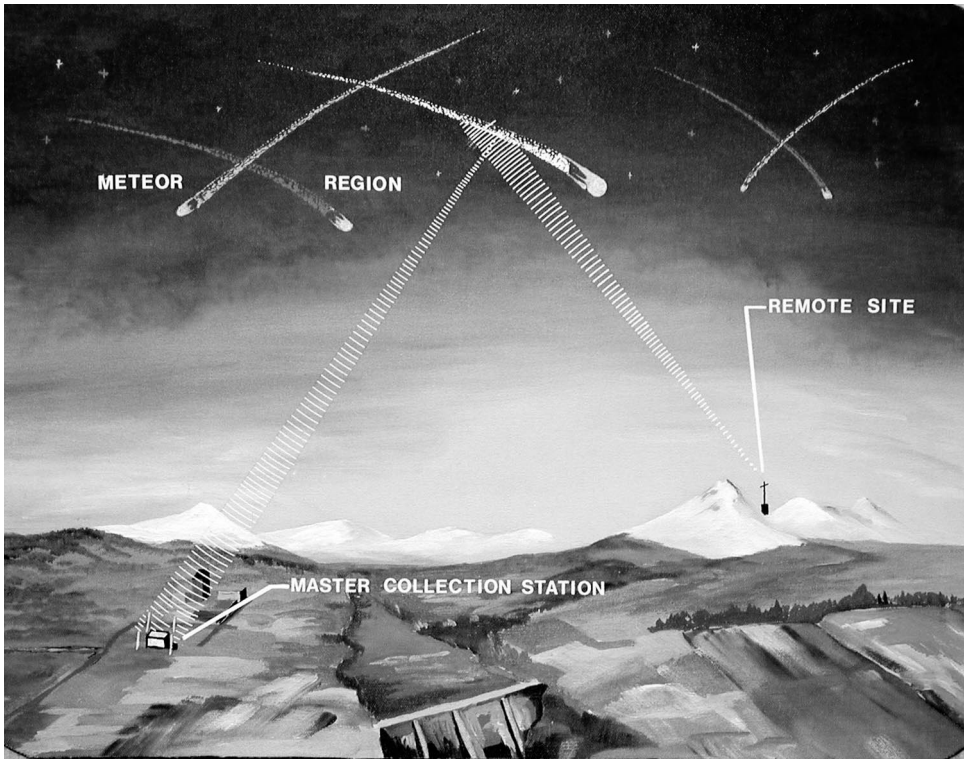
Figure 12: Increase in the Use of Telemetry Systems at U.S. Geological Survey Streamgage Stations



Source: U.S. Geological Survey.

Another telemetry system—“meteor burst” communication technology—used by the Natural Resources Conservation Service also facilitates timely sharing of water quantity data. Meteor burst technology (see figure 13) is the ability to reflect radio signals, sent from remote locations, off of ionized meteorite trails 50 to 75 miles above the earth's surface. With this technology, collection sites as far apart as 1,200 miles can communicate with one another for short time intervals, which are sufficient to "burst" relatively short data messages between sending and receiving stations. This method of communications is preferable for transmitting snowpack data because, among other reasons, interference that mountains often cause in conventional communications is not a problem for a meteor burst system, long-term costs are lower than they are for satellite technology, and data transfer reliability is higher for meteor burst. The Natural Resources Conservation Service operates over 700 automated, high-elevation snow and climate measurement sites in 12 western states and Alaska; these sites use advanced radio technology to report data on the Internet about once each day.

Figure 13: Meteor Burst Communication Technology Used to Relay Radio Signals from Remote Collection Locations to a Master Station



Source: Natural Resources Conservation Service.

Water Quantity Data Parameters Are Generally More Consistent Nationwide

Water quantity parameters, such as streamflow and precipitation, are generally more uniform nationwide than water quality parameters, according to several federal and state officials, making it easier for groups to integrate data from separate collection efforts. For example, water withdrawal is measured as a volume of water in gallons, and stage is measured as the height of water in feet, which can be easily compared. Water quality parameters, on the other hand, are less uniform. Sediment concentration in water is one example of a measure that may be described by multiple parameters—total suspended solids, turbidity, and transparency—that are not easily integrated.

According to several federal and state officials, water quantity parameters are more uniform partly because traditional parameters and the same

methods of measurements have been around for decades. For example, the U.S. Geological Survey has operated its streamgaging network to measure streamflow since 1889, and the Army Corps of Engineers has collected stage data as far back as 1785 on the Mississippi River with more regular measurements beginning about 1838. Their monitoring methods and standardized techniques for converting stage data to flow data are established and relatively uniform among entities, according to an Army Corps of Engineers official. Many water quality parameters and assessment methods, on the other hand, are relatively new. For example, an EPA bioassessment guidance document noted that many natural resource agencies throughout the country have begun the process of developing and implementing biological assessment and criteria programs. In part because these processes are relatively new, sampling methods differ across agencies, impeding data sharing.

In addition to water quantity parameters being more uniform, there are also fewer than for water quality, which lessens the burden of coordination according to some of the federal and state officials we spoke with. While water quantity can be characterized by a relatively small number of parameters (in magnitude of tens) concerning the volume of water available and the volume that is used, a much larger number of chemical, physical, and biological parameters (in magnitude of thousands) are required to provide an accurate picture of water quality. Chemical measures alone account for a large number of parameters because there are so many agricultural, industrial, pharmaceutical, and household chemicals in use today that are found in surface waters. According to a U.S. Geological Survey official, the agency's water quantity monitoring largely concentrates on discharge and water height (stage) measurements. In contrast, the U.S. Geological Survey alone collects water quality data on about 500 different chemicals and identifies thousands of biological species in streams, lakes, and reservoirs.

Conclusions

We found a broad consensus that, for a variety of reasons, water quantity data collection efforts have relatively been well coordinated. At the same time, we found that more water quantity data are needed to make well-supported watershed management decisions. The efficient collection and use of water quantity data will only grow in importance, as the nation's population grows and water supplies continue to face increasing demands among competing uses. And given the inherent interrelationship between water quality and water quantity, it will also be increasingly important for

data collectors to extend their collaborative efforts to include organizations that collect both water quantity and water quality data.

Agency Comments and Our Evaluation

The U.S. Army Corps of Engineers and the Department of the Interior offered comments on a draft of this report that were particularly germane to the material in this chapter. The Corps commented that the lead agency concept described in the previous chapter applies here as well, stating its belief that "designation of a lead federal agency by Congress to operate as a clearinghouse for water quantity data is an important step to improving data collection and management." The Corps noted that setting up a clearinghouse of water quantity data could result in significant savings for the federal government, while also assisting state and local governments with their land use decisions. As noted in the conclusions to this chapter, there is an inherent interrelationship between water quality and water quantity. We recognize that it is increasingly important for data collectors to extend their collaborative efforts to include both water quantity and water quality data collection.

The Department of the Interior expressed agreement with our concern that while water quantity data collection is comparatively well coordinated and consistent, the data currently being collected is not adequate to address the needs of decision makers trying to address water quantity-related questions. Interior explained that it is particularly troubled by the loss of many of the long-term data collection stations, which are needed for trend analysis to answer many important questions about flood and drought conditions and their recurrence.

Water Data Collection Activities by Federal Agency

We identified 16 key federal agencies that collect water data. The following descriptions provided by each agency detail their data collection activities, including general information about the purpose for which their agency collects data, the specific data parameters for which they collect data, the geographic scope and frequency of collection, how their data are stored, and how their data can be accessed.

Department of Agriculture's Agricultural Research Service

Agency Mission

The Agricultural Research Service conducts research to develop and transfer solutions to agricultural problems of high national priority. It disseminates information related to this research to

- ensure high-quality, safe food and other agricultural products;
- assess the nutritional needs of Americans;
- sustain a competitive agricultural economy;
- enhance the natural resource base and the environment; and
- provide economic opportunities for rural citizens, communities, and society as a whole.

Water Quality Data

As shown in table 1, the Agricultural Research Service collects data on a variety of water quality parameters. The primary purpose for which the Agricultural Research Service collects water quality data is research and technology transfer. Most of the research is conducted on farms or ranches, with varying types of data collected. The second purpose for which the Agricultural Research Service collects water quality data is to provide research information to other federal agencies, as well as public and private agricultural customers and organizations. In terms of water quality data and research, the Agricultural Research Service's primary customer is

the Natural Resources Conservation Service, which helps owners of private land conserve their soil, water, and other resources. The Agricultural Research Service also cooperates with the Environmental Protection Agency (EPA) and the U.S. Geological Survey in the collection and dissemination of water quality data.

Table 1: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Agricultural Research Service

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides	X								X[b]	
Organics	X								X[b]	
Metals			X						X[b]	
Nutrients	X								X[b]	
Dissolved oxygen			X						X[b]	
Physical										
pH			X						X[b]	
Temperature			X						X[b]	
Conductivity			X						X[b]	
Transparency										X
Turbidity			X						X[b]	
Total suspended solids			X						X[b]	
Biological										
Structure/ function of aquatic communities			X						X[b]	
Fish tissue										X
Habitat			X						X[c]	
Health/ abundance of aquatic species or fish populations										X
Indicator bacteria			X						X[c]	

Source: Agricultural Research Service.

[a]The Agricultural Research Service also collects project-specific pathogen data. The frequency of collection varies depending on the objectives of site-specific research studies.

[b]The frequency of data collection varies depending on the objectives of site-specific research studies.

[c]The Agricultural Research Service collects very little habitat and indicator bacteria data.

Water Quantity Data

As shown in table 2, the Agricultural Research Service collects data on a variety of water quantity parameters. The Agricultural Research Service primarily collects water quantity data in conjunction with water quality data to provide research information to other federal agencies, as well as public and private agricultural customers and organizations. In addition, the Agricultural Research Service collects some water quantity data in cooperation with other agencies, such as the Natural Resources Conservation Service, the National Weather Service, and the U.S. Geological Survey, to forecast water supplies and drought.

Table 2: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Agricultural Research Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff	X								X[a]	
Streamflow	X								X[a]	
Surface water storage			X						X[a]	
Aquifer recharge										X
Groundwater levels			X						X[a]	
Snowpack			X						X[a]	
Precipitation			X						X[a]	
Evapotranspiration			X						X[a]	
Soil moisture			X						X[a]	
Water withdrawal										
Withdrawal			X						X[a]	
Consumptive use			X						X[a]	
Return flow			X						X[a]	

Source: Agricultural Research Service.

[a]The frequency of data collection varies depending on the objectives of site-specific research studies.

Storage Method and Accessibility

According to the Agricultural Research Service, its water data are stored in numerous databases, largely on a project-specific basis. These data are publicly accessible via the Internet, by specific request, and through publications.

Department of Agriculture's Cooperative State Research, Education, and Extension Service

Agency Mission

The mission of the Cooperative State Research, Education, and Extension Service (CSREES) is to advance knowledge for agriculture, the environment, human health and well being, and communities. The primary functions, as follows, of CSREES are to provide:

- program leadership to identify, develop, and manage programs to support university-based and other institutional research, education, and extension; and
- fair, effective, and efficient administration of federal assistance implementing research, education, and extension awards and agreements.

Water Quality Data

CSREES does not collect water quality data directly but funds a lot of data collection on a wide variety of parameters (as shown in table 3) through research projects at universities, government laboratories, and nonprofit organizations. All data collected through CSREES-funded projects are used for educational or research purposes. Water quality data collection is funded under the following programs:

- $15-20 million is provided to states through the Hatch Act for agricultural research. Individual research projects collect water quality data as needed.
- $12 million is provided through the National Integrated Water Quality Program, which emphasizes integration of research, education, and extension. Approximately $6 million is used to support a network of regional coordination projects for state water quality coordinators.

- $4.5 million is provided through the National Research Institute for research projects focused on watershed management and hydrologic processes.

- $2-3 million is provided through congressionally directed projects to states. Projects supported through this funding mechanism include the National Drought Mitigation Center at Lincoln, Nebraska, which studies drought preparedness.

Table 3: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by CSREES

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other[b]	Not collected
Chemical										
Pesticides			X						X	
Organics			X						X	
Metals			X						X	
Nutrients			X						X	
Dissolved oxygen			X						X	
Physical										
pH			X						X	
Temperature			X						X	
Conductivity			X						X	
Transparency			X						X	
Turbidity			X						X	
Total suspended solids			X						X	
Biological										
Structure/ function of aquatic communities			X						X	
Fish tissue			X						X	
Habitat			X						X	
Health/ abundance of aquatic species or fish populations			X						X	
Indicator bacteria			X						X	

Source: CSREES.

[a]CSREES sponsors research and education projects that collect water quality data in support of investigator-defined project objectives.

[b]The frequency of data collection varies for each parameter based on project needs.

Water Quantity Data

Although CSREES programs tend to focus on water quality, researchers need flow data to interpret and support their findings. Therefore, CSREES encourages researchers to collect water quantity data in conjunction with water quality data. As shown in table 4, CSREES researchers collect data on a variety of water quantity parameters.

Table 4: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by CSREES

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other[b]	Not collected
Water availability										
Surface runoff			X						X	
Streamflow			X						X	
Surface water storage			X						X	
Aquifer recharge			X						X	
Groundwater levels			X						X	
Snowpack			X						X	
Precipitation			X						X	
Evapotranspiration			X						X	
Soil moisture			X						X	
Water withdrawal										
Withdrawal			X						X	
Consumptive use			X						X	
Return flow			X						X	

Source: CSREES.

[a]CSREES researchers collect a lot of streamflow data; a fair amount of soil moisture data; some surface water storage data, a little surface runoff, aquifer recharge, snowpack, and precipitation data; and occasional water withdrawal parameters.

[b]The frequency of data collection varies for each parameter based on project needs.

Storage Method and Accessibility

According to CSREES, it does not have a central database for water data collected with CSREES funding. Individual researchers store the data they collect, and the data can be accessed by request.

Department of Agriculture's Forest Service

Agency Mission

The mission of the Forest Service is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. The Forest Service manages public lands in national forests and grasslands through activities such as the following:

- Protection and management of the natural resources of the national forests and grasslands through the national forest system.
- Research on all aspects of forestry, rangeland management, and forest resource utilization through the research branch.
- Management of nonfederal forest and rangelands to improve conditions in rural areas through state and private forestry programs.
- Formulating policy and coordinating United States support for the protection and sound management of the world's forest resources through the International Assistance Program.

Water Quality Data

As shown in table 5, the Forest Service collects data on a wide variety of water quality parameters. The Forest Service generally collects water quality data for two purposes: research studies (done through the research branch) and forest administrative studies (usually implemented through the national forest system). Research studies are often long-term studies that require the collection of various parameters at frequencies that are specific to each individual research project. For example, there are at least a dozen projects throughout the Forest Service that currently involve the collection of long-term data. However, no two share identical objectives and, as a result, data collection methods vary based on individual project needs. Research grade projects tend to be executed with a high level of concern for technical rigor and statistical validity.

Forest administrative studies are shorter-term studies intended to evaluate the environmental impact of forest management practices. For example, the agency performs best management practice evaluations to determine

the implementation rates and effectiveness of water protection measures. Administrative studies are normally more qualitative in nature than research projects. Administrative studies may also involve more focused evaluations of individual projects or seek to answer more site-specific questions that relate to local management concerns. Forest scientists or researchers may collect data for 10 or more years, but typically, an administrative project implemented at the forest level takes 1 to 3 years to complete. Like research studies, forest administrative studies may also implement technically rigorous projects, but statistical rigor is usually not required to answer the more locally relevant questions these studies generally pose.

Table 5: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Forest Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other[a]	Not collected
Chemical										
Pesticides			X						X	
Organics			X						X	
Metals			X						X	
Nutrients			X						X	
Dissolved oxygen			X						X	
Physical										
pH			X						X	
Temperature			X						X	
Conductivity			X						X	
Transparency			X						X	
Turbidity			X						X	
Total suspended solids			X						X	
Biological										
Structure/ function of aquatic communities			X						X	
Fish tissue			X						X	
Habitat			X						X	
Health/ abundance of aquatic species or fish populations			X						X	
Indicator bacteria			X				X[b]		X	

Source: Forest Service.

[a]The Forest Service conducts no routine monitoring for water quality parameters except in the case of individual research projects. Most data are collected for specific research or administrative studies.

[b]Water systems are sampled monthly for indicator bacteria.

Water Quantity Data

Although the Forest Service generally relies on data collected by the U.S. Geological Survey in order to estimate the amount of water available to manage the national forests, the agency collects a limited amount of its own water quantity data. Data collection is usually limited to projects where more site-specific information is needed. The data are used, for example, along with U.S. Geological Survey data, to estimate the total flows

yielded from national forests and determine how that water may be allocated to other uses. Table 6 shows the water quantity parameters collected by the Forest Service and the scope and frequency of collection.

Table 6: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Forest Service

	Geographic scope			Frequency of collection[a]						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff			X	X						
Streamflow			X	X						
Surface water storage			X						X	
Aquifer recharge										X
Groundwater levels			X				X			
Snowpack		X					X			
Precipitation	X	X	X	X	X	X	X			
Evapotranspiration										X
Soil moisture			X			X	X			
Water withdrawal										
Withdrawal										X
Consumptive use										X
Return flow										X

Source: Forest Service.

[a]Data are collected as needed for specific projects. In addition, the Forest Service relies on data from other federal agencies, such as the U.S. Geological Survey.

Storage Method and Accessibility

According to the Forest Service, its water quality data are currently stored in scattered internal databases, and a limited amount of data are stored in EPA's Storage and Retrieval (STORET) System. Recently, the agency has established a centralized data storage system that is now being implemented. Access to data varies, with some data available through the Internet and other data available by request in electronic or paper formats. Water quantity data are stored in published reports and are available by request through the U.S. Geological Survey.

Department of Agriculture's Natural Resources Conservation Service

Agency Mission

The mission of the Natural Resources Conservation Service is to provide leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment. The Service also helps owners of America's private land to conserve their soil, water, and other natural resources. The Service works with local partners and serves almost every county in the nation, and in the Caribbean and Pacific Basin.

Water Quality Data

As shown in table 7, the Natural Resources Conservation Service collects water quality data on a watershed or site-specific scale, such as an agricultural location, for project-specific purposes. For example, the Service collects data in watersheds to determine effects of animal feeding practices on water quality and to identify potential mismanagement of manure.

Table 7: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Natural Resources Conservation Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides			X					X		
Organics			X					X		
Metals			X					X		
Nutrients			X					X		
Dissolved oxygen			X					X		
Physical										
pH			X					X		
Temperature			X					X		
Conductivity			X					X		
Transparency			X					X		
Turbidity			X					X		
Total suspended solids			X					X		
Biological										
Structure/ function of aquatic communities			X					X		
Fish tissue			X					X		
Habitat			X					X		
Health/ abundance of aquatic species or fish populations			X					X		
Indicator bacteria			X					X		

Source: Natural Resources Conservation Service.

Water Quantity Data

The Natural Resources Conservation Service collects water quantity data (as shown in table 8) primarily to derive forecasts of water supply in western states. The Service produces reservoir storage reports and a water supply outlook report, posted on its Web site daily from January through spring, to identify snowpack and runoff amounts. The data are used by states to predict water surpluses and shortages.

The Service collects snowpack and precipitation data in association with the National Weather Service and the U.S. Geological Survey. In addition,

the Soil Climate Analysis Network measures soil temperature and moisture content, which aids in determining the severity of drought.

Table 8: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Natural Resources Conservation Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff										X
Streamflow										X
Surface water storage		X[a]					X			
Aquifer recharge										X
Groundwater levels										X
Snowpack		X[b]			X					
Precipitation		X[b]			X					
Evapotranspiration										X
Soil moisture			X[c]	X						
Water withdrawal										
Withdrawal										X
Consumptive use										X
Return flow										X

Source: Natural Resources Conservation Service.

[a]The Natural Resources Conservation Service collects surface water storage data in Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[b]The Natural Resources Conservation Service collects snowpack and precipitation data in the western states.

[c]The Natural Resources Conservation Service collects soil moisture data at over 80 real-time sites in 39 states and territories.

Storage Method and Accessibility

According to the Natural Resources Conservation Service, water quality data are stored primarily with the partners who collect the data. The data are most likely stored in paper-based project files and are available by request. Snowpack and precipitation data are stored in Internet-accessible databases and in published reports.

Department of Commerce's National Oceanic and Atmospheric Administration, National Marine Fisheries Service

Agency Mission

The mission of the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service is the stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems. NOAA's National Marine Fisheries Service is responsible for the management, conservation, and protection of living marine resources within the United States Exclusive Economic Zone. It also plays a supportive and advisory role in the management of living marine resources in coastal areas under state jurisdiction, provides scientific and policy leadership in the international arena, and implements international conservation and management measures as appropriate.

Water Quality Data

The Service collects project-specific water quality data (as shown in table 9) for a variety of uses. For example, data are used to substantiate whether a species should be covered under the Endangered Species Act, to designate a critical habitat, to establish a recovery plan and/or substantiate the rate of recovery, to conduct a consultation and work with federal and other entities to determine effects, to determine effects of different programs on the environment, or for enforcement. The Service collects water quality data at varying, project-specific frequencies, durations, and locations through its Science Centers, Office of Protected Resources, and Office of Habitat Conservation.

Table 9: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by NOAA's National Marine Fisheries Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other[a]	Not collected
Chemical										
Pesticides			X						X	
Organics			X						X	
Metals			X						X	
Nutrients			X						X	
Dissolved oxygen			X						X	
Physical										
pH			X						X	
Temperature			X						X	
Conductivity			X						X	
Transparency			X						X	
Turbidity			X						X	
Total suspended solids			X						X	
Biological										
Structure/ function of aquatic communities			X						X	
Fish tissue			X						X	
Habitat			X						X	
Health/ abundance of aquatic species or fish populations			X						X	
Indicator bacteria			X						X	

Source: NOAA's National Marine Fisheries Service.

[a]These parameters are not routinely collected. The frequency of collection depends on project-specific needs.

Water Quantity Data

As shown in table 10, the National Marine Fisheries Service collects water quantity data on a project-specific basis. The Service collects some water quantity data such as those needed to understand the effects of freshwater flowing into coastal habitats. The Army Corps of Engineers provides some funds to NOAA to collect streamgage data, and NOAA's National Marine Fisheries Service provides funding to federal, state, and local groups to

collect water quantity data through the Pacific Coastal Salmon Recovery Fund.

Table 10: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by NOAA's National Marine Fisheries Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other[a]	Not collected
Water availability										
Surface runoff			X						X	
Streamflow			X						X	
Surface water storage			X						X	
Aquifer recharge			X						X	
Groundwater levels			X						X	
Snowpack			X						X	
Precipitation			X						X	
Evapotranspiration			X						X	
Soil moisture			X						X	
Water withdrawal										
Withdrawal			X						X	
Consumptive use			X						X	
Return flow			X						X	

Source: NOAA's National Marine Fisheries Service.

[a]These parameters are not routinely collected. The frequency of collection depends on project-specific needs.

Storage Method and Accessibility

According to the National Marine Fisheries Service, it does not maintain a centralized, internal water database. Some water data are stored in the National Oceanographic Data Center and some data are stored in paper or electronic files, which are dispersed throughout the agency. Data stored in the National Oceanographic Data Center are available via the Internet, while other data are available upon request.

Department of Commerce's National Oceanic and Atmospheric Administration, National Ocean Service

Agency Mission

The mission of NOAA's National Ocean Service is to preserve and enhance the nation's coastal resources and ecosystems along 95,000 miles of shoreline and 3.5 million square miles of coastal ocean. At the same time, it works to support economic growth for the long-term benefit of the nation.

Water Quality Data

As shown in table 11, the National Ocean Service collects data on a project-specific basis. These projects primarily seek to assess the health of coasts and establish trends in the health of coastal systems through activities such as monitoring the health of coral reefs and mapping sea grass beds. According to the Service, it collects water quality under a number of programs, such as the following:

- National Status and Trends Program.
- National Estuarine Research Reserves System Program.
- National Marine Sanctuary System Program.
- Benthic Habitat Assessment Mapping Program.
- Coral Reef Monitoring Program.
- Harmful Algal Bloom Monitoring Program.

Table 11: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by NOAA's National Ocean Service

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides	X		X					X[b]		
Organics	X		X					X[b]		
Metals	X		X					X[b]		
Nutrients	X		X	X						
Dissolved oxygen	X		X	X						
Physical										
pH	X		X	X						
Temperature	X		X	X						
Conductivity	X		X	X						
Transparency			X						X[c]	
Turbidity	X			X						
Total suspended solids										X
Biological										
Structure/ function of aquatic communities										X
Fish tissue[d]	X							X	X[c]	
Habitat			X						X[c]	
Health/ abundance of aquatic species or fish populations			X						X[c]	
Indicator bacteria			X						X[c]	

Source: NOAA's National Ocean Service.

[a]NOAA's National Ocean Service also collects harmful algal bloom data on a project specific basis.

[b]Pesticides, other organic contaminants, and metals data are collected every year under the National Status and Trends Program; however, only half the stations are occupied per year.

[c]The frequency of collection varies depending on project needs.

[d]Data is collected on both fish and shellfish tissue. In general, shellfish tissue data are collected yearly, and fish tissue data are collected on a varying frequency depending on project needs.

Water Quantity Data

The National Ocean Service collects precipitation data (as shown in table 12) at some data collection locations through its National Estuarine Research Reserve System Program, which seeks to track short-term

variability and long-term changes in coastal ecosystems represented in the reserve system. In addition, through the National Water Level Program and its National Current Observation Program, the agency measures tide levels and water levels in the Great Lakes, tidal currents for navigation purposes, and storm surges associated with tropical storms and hurricanes. Water level data and tidal current data are collected on a continuous long-term basis.

Table 12: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by NOAA's National Ocean Service

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff										X
Streamflow										X
Surface water storage										X
Aquifer recharge										X
Groundwater levels										X
Snowpack										X
Precipitation	X			X						
Evapotranspiration										X
Soil moisture										X
Water withdrawal										
Withdrawal										X
Consumptive use										X
Return flow										X

Source: NOAA's National Ocean Service.

[a]NOAA's National Ocean Service also collects tidal current and tide and water level data on a continuous, nationwide basis.

Storage Method and Accessibility

According to the National Ocean Service, it stores its water quality data in internal program databases, with each National Ocean Service program having its own database. Some of these data are available online through NOAA data centers, and some are archived in project files that are accessible by request. Its water quantity data are stored in a NOAA national water level database and are available through the Internet.

Department of Commerce's National Oceanic and Atmospheric Administration, National Weather Service

Agency Mission

The mission of NOAA's National Weather Service is to provide weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. National Weather Service data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector, the public, and the global community.

Water Quality Data

The National Weather Service does not collect water quality data.

Water Quantity Data

NOAA's National Weather Service collects water quantity data (as shown in table 13) to support weather forecast activities and aviation operations, as well as the needs of the meteorological, hydrological, and climatological research communities. Two of its programs, the Automated Surface Observing Systems Program and the Cooperative Observer Program, serve as the nation's primary weather and climate observation networks. Through these programs, data are gathered on a long-term, daily basis and are used to define the climate of the United States and to support forecast, warning, and other public service programs of NOAA's National Weather Service.

Table 13: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by NOAA's National Weather Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff	X				X					
Streamflow	X				X					
Surface water storage										X
Aquifer recharge										X
Groundwater levels										X
Snowpack	X				X					
Precipitation	X				X					
Evapotranspiration	X				X					
Soil moisture										X
Water withdrawal										
Withdrawal										X
Consumptive use										X
Return flow										X

Source: National Weather Service.

Storage Method and Accessibility

According to the National Weather Service, its data are stored in the National Climatic Data Center of NOAA's National Environmental Satellite, Data, and Information Service and are available to the public via the Internet.

Department of Defense's Army Corps of Engineers

Agency Mission

The Army Corps of Engineers' mission is to provide quality, responsive engineering services to the nation, including

- planning, designing, implementing and, in some cases, operating water resources and other civil works projects (navigation, flood and storm damage reduction, environmental protection and restoration, hydropower, water supply, disaster response, etc.);
- designing and managing the construction of military facilities for the Army and Air Force (military construction); and
- providing design and construction management support for other Defense and federal agencies (interagency and international services).

Water Quality Data

The Army Corps of Engineers collects water quality data (as shown in table 14) on a broad geographic scale at many of its approximately 700 water projects. These projects primarily are operated to facilitate navigation, reduce flood or storm damages, provide water supply storage, or generate hydropower. It also collects some data for other projects, such as the Florida Everglades. In that particular case, the Army Corps of Engineers collects data on pesticides, nutrients, and dissolved oxygen in order to maintain the health of the Everglades.

Table 14: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Army Corps of Engineers

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides		X				X				
Organics		X								
Metals		X				X				
Nutrients		X	X						X[b]	
Dissolved oxygen		X	X		X				X[b]	
Physical										
pH		X			X					
Temperature	X			X						
Conductivity			X						X[b]	
Transparency		X			X					
Turbidity		X	X		X					
Total suspended solids		X	X		X					
Biological										
Structure/ function of aquatic communities			X						X[b]	
Fish tissue			X				X			
Habitat			X						X[b]	
Health/ abundance of aquatic species or fish populations		X							X[b]	
Indicator bacteria										X

Source: Army Corps of Engineers.

Note: The Army Corps of Engineers noted that it collects additional data for purposes such as planning and design. These additional data are collected by staff in district offices for specific needs and the data are stored in project-specific files at the district offices.

[a]In addition to its in-house data collection, the Army Corps of Engineers partners with multiple agencies and often contracts out data collection activities to others (e.g., the U.S. Geological Survey, NOAA's National Weather Service, universities, and private contractors).

[b]The frequency of collection varies depending on project needs.

Water Quantity Data

The Army Corps of Engineers collects water quantity data (as shown in table 15) largely in association with its water management projects. For example, it keeps track of rainfall amounts, reservoir storage, and inflow

and outflow as part of operating specific projects. It also collects stage data to monitor flood control efforts. In addition to their data collection activities, the Army Corps of Engineers funds approximately 25 percent of the U.S. Geological Survey's National Streamflow Information Program. Moreover, according to the Army Corps of Engineers, it contributes to the analysis of water data by developing water resources software models that are used worldwide.

Table 15: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Army Corps of Engineers

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff	X			X						
Streamflow	X			X						
Surface water storage	X			X						
Aquifer recharge										X
Groundwater levels										X
Snowpack		X			X					
Precipitation	X			X						
Evapotranspiration		X		X						
Soil moisture		X		X						
Water withdrawal										
Withdrawal	X			X						
Consumptive use	X			X						
Return flow										X

Source: Army Corps of Engineers.

[a]In addition to its in-house data collection activities, the Army Corps of Engineers partners with multiple agencies and often contracts out data collection activities to others (e.g., the U.S. Geological Survey, NOAA's National Weather Service, universities, and private contractors).

Storage Method and Accessibility

According to the Army Corps of Engineers, it stores its data in a number of databases, including internal databases as well as EPA's STORET and the U.S. Geological Survey's National Water Information System (NWIS). Many of these data are available through their district or division Web pages. In addition, some water quality data are stored in district offices in individual project files for which the data were collected. Many of these data are

accessible upon request. Some Corps water data are not publicly available for security reasons.

Department of Energy's Bonneville Power Administration

Agency Mission

The Bonneville Power Administration (BPA) markets wholesale electrical power and operates and markets transmission services in the Pacific Northwest. The power comes from 31 federal hydroelectric projects, one nonfederal nuclear plant, and several other nonfederal power plants. The hydroelectric projects and the electrical system are known as the Federal Columbia River Power System. About 45 percent of the electric power used in the Northwest comes from BPA. BPA's transmission system accounts for about three-quarters of the region's high-voltage grid and includes major transmission links with other regions.

Water Quality Data

BPA collects water quality data in conjunction with some of the hundreds of fish and wildlife projects it funds each year throughout the U.S. portion of the Columbia-Snake River Basin. As shown in table 16, BPA collects a variety of water quality data on a project-specific scale. The purpose for data collection is usually to obtain baseline water quality data in a specific area and then compare it with water quality after a project is complete. BPA collects data in both small watersheds as well as big watersheds, such as the Columbia River Basin.

BPA provides funds to a variety of agencies to collect water quality data, including state departments of fish and wildlife, NOAA's National Marine Fisheries Service, the U.S. Fish and Wildlife Service, local soil and water conservation districts, and tribes in the Columbia River Basin. BPA's fish and wildlife program has an approximately $140 million annual budget and operates hundreds of projects, of which as many as 50 to 75 percent collect a small amount of water quality data.

Table 16: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by BPA

	Geographic scope			Frequency of collection[b]						
Data type[a]	National	Regional	Project-specific[c]	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides			X							
Organics			X							
Metals			X							
Nutrients			X							
Dissolved oxygen			X							
Physical										
pH			X							
Temperature			X							
Conductivity			X							
Transparency										X
Turbidity			X							
Total suspended solids			X							
Biological										
Structure/ function of aquatic communities			X							
Fish tissue			X							
Habitat			X							
Health/ abundance of aquatic species or fish populations			X							
Indicator bacteria										X

Source: BPA.

[a]BPA also collects total dissolved gas data on a project-specific basis.

[b]Because BPA lacks a database that could provide information on the specific type and frequency of data collection, they were not able provide more detailed information for frequency of collection. Project-specific data is collected on anywhere from a daily to yearly basis.

[c]Projects last one to several years, and data is collected and analyzed for one or more watersheds or subbasins.

Water Quantity Data

As shown in table 17, BPA collects a wide variety of water quantity data on a project-specific scale. Generally, water quantity data are used for complying with the Endangered Species Act and dam operations. BPA water quantity data are also used by others such as state fish and wildlife

agencies and the Northwest Power and Conservation Council and Columbia River Basin navigation programs. BPA also uses data collected by the U.S. Geological Survey, Army Corps of Engineers, Bureau of Reclamation, and Natural Resources Conservation Service, which are readily available via the Internet. In addition, BPA sometimes funds data collection by others, such as the U.S. Geological Survey, tribes, and states.

Table 17: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by BPA

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other[a]	Not collected
Water availability										
Surface runoff			X						X	
Streamflow			X						X	
Surface water storage			X						X	
Aquifer recharge			X						X	
Groundwater levels			X						X	
Snowpack			X						X	
Precipitation			X						X	
Evapotranspiration			X						X	
Soil moisture			X						X	
Water withdrawal										
Withdrawal			X						X	
Consumptive use			X						X	
Return flow			X						X	

Source: BPA.

[a]The frequency of data collection varies depending on project-specific needs.

Storage Method and Accessibility

According to BPA, the water quality data collected with BPA funding are stored in external, project-specific databases that are maintained by the data collectors. Most of the data are available by request, although small amounts of data are available via the Internet. Water quantity data are stored in internal, project-specific databases. Data are available through publications and via the Internet.

Environmental Protection Agency

Agency Mission

The Environmental Protection Agency's (EPA) mission is to protect human health and to safeguard the natural environment and to ensure the following:

- All Americans are protected from significant risks to human health and the environment where they live, learn, and work.
- National efforts to reduce environmental risk are based on the best available scientific information.
- Federal laws protecting human health and the environment are enforced fairly and effectively.
- Environmental protection is an integral consideration in U.S. policies concerning natural resources, human health, economic growth, energy, transportation, agriculture, industry, and international trade, and these factors are similarly considered in establishing environmental policy.
- All parts of society—communities, individuals, business, state and local governments, tribal governments—have access to accurate information sufficient to effectively participate in managing human health and environmental risks.
- Environmental protection contributes to making our communities and ecosystems diverse, sustainable, and economically productive.
- The United States plays a leadership role in working with other nations to protect the global environment.

Water Quality Data

EPA supports states' monitoring programs to assess the quality of their waters and to identify waters that do not meet water quality standards. While EPA obtains most of the water quality data it uses from states, tribes, grantees, contractors, and regulated entities, EPA's laboratories collect some data for independent studies to determine the environmental impacts of special concerns, such as mining operations and underground storage

tanks. In addition, EPA also collects or funds the collection of some water quality data (as shown in table 18) under the following monitoring programs:

- Water Quality Protection Program for the Florida Keys National Marine Sanctuary;
- Monitoring and Reporting on the State of the Chesapeake Bay Program;
- Monitoring and Reporting on the State of the Great Lakes Ecosystem;
- Gulf of Mexico Monitoring;
- Office of Research and Development Environmental Monitoring and Assessment Program;
- National Estuary Program: National Coastal Assessment Intensive Sampling;
- Regulation of Ocean Dumping;
- National Marine Debris Monitoring Program and the International Coastal Cleanup;
- Pesticides in Selected Water-Supply Reservoirs and Finished Drinking Water, 1999-2000;
- National Study of Chemical Residues in Lake Fish Tissue;
- Beach Program; and
- Atmospheric Deposition.

Table 18: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by EPA

	Geographic scope[a]			Frequency of collection[b]						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides	X		X							
Organics	X		X							
Metals	X		X							
Nutrients		X	X					X		
Dissolved oxygen		X	X					X		
Physical										
pH		X	X					X		
Temperature		X	X					X		
Conductivity		X	X							
Transparency			X							
Turbidity			X					X		
Total suspended solids			X							
Biological										
Structure/ function of aquatic communities		X	X							
Fish tissue	X	X	X							
Habitat			X							
Health/ abundance of aquatic species or fish populations			X							
Indicator bacteria		X	X							

Source: EPA.

Note: The information provided in this table is primarily based on the following six programs: the Beach Program, Chesapeake Bay Program, Great Lakes Program, National Estuary Program, Water Quality Protection Program for the Florida Keys National Marine Sanctuary, and National Study of Chemical Residues in Lake Fish Tissue.

[a]According to EPA, data is collected on varying geographic scales, depending on the project.

[b]EPA noted that the frequency of collection varies depending on program needs. EPA only provided frequency information for data collected under the Florida Keys National Marine Sanctuary Program, which collects data on nutrients, dissolved oxygen, pH, temperature, and turbidity on a quarterly basis.

Water Quantity Data

EPA does not collect water quantity data, except in rare circumstances.

Storage Method and Accessibility

According to EPA, most of its water quality data are stored in STORET, which is Internet accessible. Data collected under some programs, such as the Water Quality Protection Program for the Florida Keys National Marine Sanctuary and the Chesapeake Bay Program, are stored in external databases that are managed by others. Project-specific data are added to contractor databases, some of which are available through STORET. In addition, some water quality data collected under Superfund has recently been loaded into STORET.

Department of the Interior's Bureau of Land Management

Agency Mission

The mission of the Bureau of Land Management is to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. The Bureau manages 262 million acres of land—about one-eighth of the land in the United States—and about 300 million additional acres of subsurface mineral resources. It is also responsible for wildfire management and suppression on 388 million acres.

Most of the lands the agency manages are located in the western United States, including Alaska, and are dominated by extensive grasslands, forests, high mountains, arctic tundra, and deserts. The Bureau oversees a wide variety of resources and uses, including energy and minerals; timber; forage; wild horse and burro populations; fish and wildlife habitat; wilderness areas; archaeological, paleontological, and historical sites; and other natural heritage values.

Water Quality Data

The Bureau uses water quality data in its management of public lands and to fulfill its obligations under the Clean Water Act. In most cases, its data are collected at the agency's 157 field offices for specific projects. It uses project-specific water quality data to understand the conditions of the lakes, rivers, streams, and ponds on agency-managed lands. As shown in table 19, the Bureau collects data on a variety of water quality parameters.

Table 19: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Bureau of Land Management

	Geographic scope[b]			Frequency of collection[c]						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides			X							
Organics										X
Metals			X							
Nutrients			X							
Dissolved oxygen			X							
Physical										
pH			X							
Temperature			X							
Conductivity			X							
Transparency			X							
Turbidity			X							
Total suspended solids			X							
Biological										
Structure/ function of aquatic communities			X							
Fish tissue			X							
Habitat			X							
Health/ abundance of aquatic species or fish populations			X							
Indicator bacteria			X							

Source: BLM.

[a]This information is based on 22 of BLM's 157 field offices. Water quality data collection varies among field offices, and BLM data are not aggregated at the national level.

[b]BLM's 22 field offices indicated that they collect data on both regional and project-specific geographic scopes. However, a BLM official noted that field offices vary in their interpretation of "regional."

[c]While BLM did not provide specific information for the frequency of data collection, it reported that data collection at 22 of its 157 field offices was typically conducted annually and rarely on a monthly or continuous frequency.

Water Quantity Data

BLM collects and analyzes water quantity data for a variety of needs, such as

- designing a variety of fish and wildlife habitat and stream channel stabilization projects,
- in-stream flow analysis for habitat and recreation needs,
- floodplain management,
- fire management,
- fuel treatment planning,
- analyzing water quality data, and
- habitat assessments for fisheries.

Examples of types of water quantity data collected by the Bureau of Land Management are as follows:

- streamflow and stream discharge data, in conjunction with water quality data on a project-specific basis;
- snowpack data, in conjunction with the Department of Agriculture's Natural Resources Conservation Service;
- surface water storage and groundwater data, perhaps once or twice a year (at the beginning or end of a growing season) to monitor agricultural areas;
- precipitation and evapotranspiration data during the growing season; and
- data from rain storage gages.

As shown in table 20, the Bureau collects data on a variety of water quantity parameters.

Table 20: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Bureau of Land Management

	Geographic scope[b]			Frequency of collection[c]						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff										X
Streamflow			X							
Surface water storage			X							
Aquifer recharge										X
Groundwater levels			X							
Snowpack			X							
Precipitation			X							
Evapotranspiration			X							
Soil moisture			X							
Water withdrawal										
Withdrawal			X							
Consumptive use										X
Return flow										X

Source: BLM.

[a]This information is based on 22 of BLM's 157 field offices. Water quantity data collection varies among field offices, and BLM data are not aggregated at the national level.

[b]More than half of the 22 BLM field offices indicated that they collect data on a project-specific basis. Three responses indicated that data are collected on a regional scale. However, a BLM official noted that field offices vary in their interpretation of "regional."

[c]Data collection at BLM's field offices varies depending on specific project needs. Staff may collect data at any of the above listed frequencies.

Storage Method and Accessibility

According to the Bureau of Land Management, its data are stored primarily at the local level, such as in field office databases. In addition, a small amount of Bureau data are stored in EPA's STORET database and the U.S. Geological Survey's NWIS. While the data stored in STORET and NWIS are publicly available via the Internet, most of the Bureau's water data are available by request.

Department of the Interior's Bureau of Reclamation

Agency Mission

The mission of the Bureau of Reclamation (Reclamation) is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Reclamation

- manages, develops, and protects water and related resources in an environmentally and economically sound manner in the interest of the American public;
- serves as the fifth largest electric utility in the 17 western states and the nation's largest wholesale water supplier, administering 348 reservoirs with a total storage capacity of 245 million acre-feet (an acre-foot, 325,851 gallons of water, supplies enough water for a family of four for one year);
- provides one out of five western farmers (140,000) with irrigation water for 10 million farmland acres that produce 60% of the nation's vegetables and 25% of its fruits and nuts;
- operates 58 hydroelectric power plants averaging 42 billion kilowatt-hours annually;
- delivers 10 trillion gallons of water to more than 31 million people each year for municipal, rural, and industrial use; and
- manages in partnership over 300 recreation sites visited by 90 million people a year.

Water Quality Data

As shown in table 21, Reclamation collects a wide variety of water quality data to meet project needs. Reclamation works together with the Natural Resources Conservation Service to collect water quality data under the Colorado River Basin Salinity Control program. In addition, Reclamation

collects water quality data in compliance with its responsibilities under the Clean Water Act.

Table 21: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Bureau of Reclamation

	Geographic scope			Frequency of collection[b]						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides		X	X				X	X		
Organics		X	X				X	X		
Metals		X	X		X	X	X	X		
Nutrients		X	X				X	X		
Dissolved oxygen		X	X	X	X	X	X	X		
Physical										
pH		X	X		X	X	X	X		
Temperature		X	X	X	X	X	X	X		
Conductivity		X	X	X	X	X	X	X		
Transparency		X	X				X	X		
Turbidity		X	X	X	X	X		X		
Total suspended solids		X	X			X	X	X		
Biological										
Structure/ function of aquatic communities			X			X	X	X		
Fish tissue			X				X	X		
Habitat			X				X	X		
Health/ abundance of aquatic species or fish populations			X		X	X	X	X		
Indicator bacteria		X	X			X	X	X		

Source: Bureau of Reclamation.

[a]In addition, a Reclamation official indicated that some projects collect data on the following parameters: phytoplankton, cyanotoxins, total dissolved gas, and pharmaceuticals.

[b]The frequency of data collection varies for each parameter based on project needs (i.e., the Bureau may not collect a particular parameter for some projects but may collect the parameter on a regular basis for other projects).

Water Quantity Data

As shown in table 22, Reclamation collects water quantity data on a project-specific basis. For example, Reclamation measures inflow, outflow, and reservoir surface elevation at reservoirs.

Table 22: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Bureau of Reclamation

	Geographic scope			Frequency of collection[a]						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff		X	X	X						
Streamflow		X	X	X	X	X	X	X		
Surface water storage		X	X	X	X	X	X	X		
Aquifer recharge			X				X	X		
Groundwater levels			X				X	X		
Snowpack		X	X		X			X		
Precipitation		X	X	X	X	X		X		
Evapotranspiration		X	X		X		X	X		
Soil moisture			X		X		X			
Water withdrawal										
Withdrawal		X	X	X	X	X	X	X		
Consumptive use		X	X		X	X		X		
Return flow		X	X	X	X	X	X	X		

Source: Bureau of Reclamation.

[a]The frequency of data collection varies for each parameter depending on project needs (i.e., the Bureau may not collect a particular parameter for some projects but may collect the parameter on a regular basis for other projects).

Storage Method and Accessibility

According to Reclamation, it often stores project-specific water quality data in internal databases. These data are generally available in hard copy or in publications. In addition, a small amount of Bureau data are stored in EPA's STORET and the U.S. Geological Survey's NWIS. These data are available via the Internet.

Water quantity data are stored in project-specific, internal databases or in Reclamation's Hydromet and Agrimet databases. Hydromet and Agrimet

are available via the Internet. All water quantity data are generally available by request, though some data may be restricted due to security concerns.

Department of the Interior's Fish and Wildlife Service

Agency Mission

The mission of the Fish and Wildlife Service is, working with others, to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service manages the 95 million-acre National Wildlife Refuge System of 543 National Wildlife Refuges and thousands of small wetlands and other special management areas. Under its Fisheries and Habitat Conservation Program, the Fish and Wildlife Service also operates 66 National Fish Hatcheries, 64 fishery resource offices, and 78 ecological services field stations.

Among its key functions, the Fish and Wildlife Service enforces federal wildlife laws, protects endangered species, manages and conserves migratory birds, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, manages the world's largest system of lands devoted to the conservation of fish, wildlife, and plants, and helps foreign governments with their international conservation efforts. It also oversees the federal aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies for fish, wildlife, and habitat conservation.

Water Quality Data

As shown in table 23, the Service typically collects water quality data on a project-specific basis. For example, the agency collects data in order to assist in restoration of Superfund sites, where a suspected contaminant may affect lands within the National Wildlife Refuge System, or may collect data in specific watersheds where threatened or endangered species are present. The agency also collects data for the National Irrigation Water Quality Program—a cooperative effort with the Bureau of Reclamation, Bureau of Indian Affairs, and U.S. Geological Survey that operates mostly in the West to study endangered species on trustee land. In general, the Fish and Wildlife Service does not conduct long-term monitoring.

Table 23: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Fish and Wildlife Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides			X				X	X		
Organics			X				X	X		
Metals			X				X	X		
Nutrients			X				X	X		
Dissolved oxygen			X				X	X		
Physical										
pH			X				X	X		
Temperature			X				X	X		
Conductivity			X				X	X		
Transparency			X				X	X		
Turbidity			X				X	X		
Total suspended solids			X				X	X		
Biological										
Structure/ function of aquatic communities			X				X	X		
Fish tissue			X				X	X		
Habitat			X				X	X		
Health/ abundance of aquatic species or fish populations			X				X	X		
Indicator bacteria			X				X	X		

Source: Fish and Wildlife Service.

Water Quantity Data

The Fish and Wildlife Service collects a modest amount of water quantity data and often relies on data from other agencies, such as the U.S. Geological Survey. The Service collects water quantity data on a project-specific basis (as shown in table 24), to protect water rights and assure proper management of lands within the National Wildlife Refuge System, such as during drought conditions in order to protect endangered species.

Table 24: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the Fish and Wildlife Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other[a]	Not collected
Water availability										
Surface runoff			X				X	X		
Streamflow			X						X	
Surface water storage			X						X	
Aquifer recharge										X
Groundwater levels			X				X	X		
Snowpack										X
Precipitation			X					X		
Evapotranspiration										X
Soil moisture			X					X		
Water withdrawal										
Withdrawal			X					X		
Consumptive use			X					X		
Return flow			X					X		

Source: Fish and Wildlife Service.

[a]The frequency of data collection varies depending on project needs.

Storage Method and Accessibility

According to the Fish and Wildlife Service, its water data are stored in project-specific databases at agency field offices. In addition, it has historically stored some data in a database operated by Maryland's Department of Environmental Quality. While some of its water quality information may not be publicly available for legal reasons, other water quality and water quantity data are available by request.

Department of the Interior's U.S. Geological Survey

Agency Mission

The U.S. Geological Survey is a nonregulatory agency that serves the nation by providing reliable scientific information to describe and understand the earth; minimize the loss of life and property from natural disasters; and manage water, biological, energy, and mineral resources. The U.S. Geological Survey provides comprehensive, high-quality, and timely scientific data and information to decision makers and the public faced with complex natural resources issues.

Water Quality Data

The U.S. Geological Survey collects water quality data on a wide variety of parameters, as shown in table 25. The U.S. Geological Survey operates several large national water quality programs, including the National Water Quality Assessment Program and the National Stream Quality Accounting Network. The programs describe and provide an understanding of water quality in major river basins and aquifer systems, as well as in small watersheds, and cover about two-thirds of the land area of the conterminous United States.

Water quality data are also collected through the Cooperative Water Program, which is an ongoing partnership between the Geological Survey and nonfederal agencies in every state (as well as Puerto Rico and several U.S. trust territories). Through this program, about half of the $64 million of appropriated funds and $90 million of local matching funds are used for water-quality programs. Data collected for this program, along with a scientific understanding of these data the U.S. Geological Survey provides, are often used to address local management needs. The U.S. Geological Survey Cooperative Water Program funds approximately 750 projects targeted at specific water-resource issues, such as the effects of urbanization, agricultural practices, and energy development on water quality.

Table 25: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the U.S. Geological Survey

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides	X	X	X		X	X	X	X		
Organics	X	X	X			X	X	X		
Metals	X	X	X		X	X	X	X		
Nutrients	X	X	X	X	X	X	X	X		
Dissolved oxygen	X	X	X	X	X	X	X	X		
Physical										
pH	X	X	X	X	X	X	X	X		
Temperature	X	X	X	X	X	X	X	X		
Conductivity	X	X	X	X	X	X	X	X		
Transparency	X	X	X	X	X	X	X	X		
Turbidity	X	X	X	X	X	X	X	X		
Total suspended solids	X	X	X		X	X	X	X		
Biological										
Structure/ function of aquatic communities	X	X	X				X	X		
Fish tissue	X	X	X					X		
Habitat	X	X	X					X		
Health/ abundance of aquatic species or fish populations	X	X	X				X	X		
Indicator bacteria	X	X	X		X	X	X	X		

Source: U.S. Geological Survey.

[a]In addition, a U.S. Geological Survey official indicated that the agency collects data for the following parameters: radio chemistry, stable isotopes, major ions, solid phase chemistry, alkalinity, plant tissue, and bed sediments.

Water Quantity Data

The U.S. Geological Survey collects water quantity data on a variety of parameters, as shown in table 26. The U.S. Geological Survey is the main collector of streamflow data (the volume of water moving down a stream) under the National Streamflow Information Program, the Cooperative Water Program, and federal reimbursement agreements. The Geological

Survey continuously collects streamflow data from rivers and streams at about 7000 gaging stations nationwide.

The Geological Survey is also a major collector of water use data under its National Water Use Information Program. It works in cooperation with local, state, and federal environmental agencies to collect water-use information at a site-specific level, such as the amount of water used to produce power at a fossil-fuel power-generation plant in Georgia. It also compiles the data from hundreds of thousands of these sites to produce water-use information aggregated up to the county, state, and national levels. Every 5 years, data at the state and hydrologic region level are compiled into a national water-use data system and are published in a national circular.

Table 26: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the U.S. Geological Survey

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff										X
Streamflow	X	X	X	X	X			X		
Surface water storage			X				X			
Aquifer recharge										X
Groundwater levels		X	X	X	X	X	X	X		
Snowpack										X
Precipitation	X	X	X	X	X	X				
Evapotranspiration			X	X	X		X			
Soil moisture			X	X	X	X				
Water withdrawal										
Withdrawal			X	X	X	X	X	X		
Consumptive use										X
Return flow			X	X	X	X	X			

Source: U.S. Geological Survey.

Storage Method and Accessibility

According to the U.S. Geological Survey, it stores water quality data primarily in NWIS and the National Water Quality Assessment Program data warehouse. Data from both databases are available via the Internet. Water quantity data are also available through NWIS.

Department of the Interior's National Park Service

Agency Mission

The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. It cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world. Among its primary responsibilities is the preservation of natural resources. In order to make sound management decisions, National Park Service managers need accurate information about the condition of park natural systems, how they change over time, and what amount of change is within natural variability. Therefore, the Service has begun long-term natural resource monitoring throughout the national parks.

Water Quality Data

In the area of water quality, the National Park Service has three main data collection programs:

- The Natural Resource Challenge-Vital Signs Monitoring Program is a Service-wide program that involves long-term water quality monitoring in parks for key indicators of change that could impair the long-term health of natural systems. The National Park Service, contractors, or cooperators, such as the U.S. Geological Survey, may collect data for the Vital Signs Monitoring Program.

- The National Park Service-U.S. Geological Survey Water Quality Assessment and Monitoring Partnership Program was initiated in 1998. Under this program, the U.S. Geological Survey funds and conducts water quality projects that address high priority National Park Service

water quality issues identified by parks. The data collected are shared between the agencies and made available for public use.

- The National Park Service funds the collection of water quality data in parks to address specific problems. The agency calls for single- or multiyear projects in an annual call for park project proposals and may also conduct some discretionary projects that have high national priority. These projects may be conducted directly by the Service or by contractors or cooperators.

As shown in table 27, the National Park Service collects a wide variety of water quality data.

Table 27: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the National Park Service

	Geographic scope[a]			Frequency of collection[b]						
Data type	National[c]	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides	X	X	X				X	X		
Organics	X	X	X				X	X		
Metals	X	X	X			X	X	X		
Nutrients	X	X	X			X	X	X		
Dissolved oxygen	X	X	X	X	X	X	X	X		
Physical										
pH	X	X	X	X	X	X	X	X		
Temperature	X	X	X	X	X	X	X	X		
Conductivity	X	X	X	X	X	X	X	X		
Transparency	X	X	X			X	X	X		
Turbidity	X	X	X	X	X	X	X	X		
Total suspended solids	X	X	X			X	X	X		
Biological										
Structure/ function of aquatic communities			X					X		
Fish tissue			X					X		
Habitat			X					X		
Health/ abundance of aquatic species or fish populations			X					X		
Indicator bacteria	X	X	X			X	X	X		

Source: National Park Service.

[a]Most water quality data collected by National Park Service staff, contractors, and cooperators are project-specific.

[b]Frequency of collection for all data types is prescribed in individual Project Implementation Plans, Vital Signs Monitoring Plans, or applicable program plans. Frequency of collection varies based on those plans.

[c]Planning is under way for Service-wide water quality monitoring as part of the Park Vital Signs Monitoring Program. On-the-ground monitoring will begin in fiscal year 2005.

Water Quantity Data

The Service's Water Resources Division assists parks in identifying water quantity needs and in pursuing appropriate means to secure and protect water supplies for resource protection and administrative purposes. In

addition, some water quantity data are collected in conjunction with water quality data. As shown in table 28, the type, frequency, and geographic scope of water quantity data collected in and around parks depend on project needs and can vary substantially from one project to another.

Table 28: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by the National Park Service

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability[a]										
Surface runoff			X					X		
Streamflow		X	X		X	X	X	X		
Surface water storage		X	X		X	X	X	X		
Aquifer recharge			X					X		
Groundwater levels		X	X		X	X	X	X		
Snowpack			X					X		
Precipitation			X		X	X	X	X		
Evapotranspiration										X
Soil moisture										X
Water withdrawal										
Withdrawal			X					X		
Consumptive use			X					X		
Return flow			X					X		

Source: National Park Service.

[a]Most of the National Park Service's water availability data is collected by contractors (especially the U.S. Geological Survey), and the type, location, and frequency are determined on a site-specific basis by project needs.

Storage Method and Accessibility

According to the National Park Service, its water quality data are stored in an in-house version of EPA's STORET, and all data are available via the Internet through EPA's national STORET database. The agency's water quantity data are stored separately within the agency, though the Service's water quantity data that are collected by the U.S. Geological Survey are available through NWIS.

Tennessee Valley Authority

Agency Mission

The Tennessee Valley Authority (TVA) is a federal corporation and the nation's largest public power company. As a regional development agency, TVA supplies affordable, reliable power, supports a thriving river system, and stimulates sustainable economic development in the public interest. It operates fossil, nuclear, and hydropower plants, and has also begun producing energy from renewable sources. It manages the nation's fifth-largest river system to minimize flooding, maintain navigation, provide recreational opportunities, provide water supply, and protect water quality in the 41,000-square-mile watershed. The river system covers about half of Tennessee and parts of Mississippi, Kentucky, Alabama, Georgia, North Carolina, and Virginia.

Water Quality Data

TVA collects water quality data to evaluate ecological health in reservoirs throughout the Tennessee Valley. TVA conducts Reservoir Ecological Health Assessments, using a scoring process based on five ecological indicators (dissolved oxygen, chlorophyll, fish, bottom life, and sediment contaminants). Chemical analysis (pesticides, organics, and metals) is conducted for fish tissue and sediment contaminant monitoring. As shown in table 29, TVA collects a wide variety of water quality data on a regional scale and at varying frequencies. TVA provides its data to states to use at their discretion for determining whether their waters meet water quality standards. Others, such as industry and environmental groups, also use TVA data to perform environmental assessments.

Table 29: Water Quality Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by TVA

	Geographic scope			Frequency of collection						
Data type[a]	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Chemical										
Pesticides		X							X[b]	
Organics		X							X[b]	
Metals		X							X[b]	
Nutrients		X					X[c]			
Dissolved oxygen		X					X[c]			
Physical										
pH		X					X[c]			
Temperature		X					X[c]			
Conductivity		X					X[c]			
Transparency		X					X[c]			
Turbidity		X					X[c]			
Total suspended solids		X					X[c]			
Biological										
Structure/ function of aquatic communities		X						X[d]		
Fish tissue		X						X[e]		
Habitat		X						X[f]		
Health/ abundance of aquatic species or fish populations		X						X[g]		
Indicator bacteria		X						X[h]		

Source: TVA.

[a]TVA also collects yearly data on sport fish populations (primarily focused on largemouth bass) and weekly data on zebra mussel and corbicula populations. These data are collected at 60 sites on 25 reservoirs from spring to fall.

[b]TVA analyzes fish tissue and sediment samples for pesticides, organics, and metals contamination. Sediment contaminants monitoring is conducted at 59 sites on 32 reservoirs.

[c]These data parameters are collected under TVA's core monitoring program, which has 59 sites on 32 reservoirs and 18 major tributary inflows. Reservoirs are monitored annually with data collections monthly from April through October. Tributary inflows are monitored on a 2-year rotation with quarterly data collections.

[d]Data on the structure/function of aquatic communities is collected on a 2-year rotation at 69 sites on 31 reservoirs and a 5-year rotation on 650 streams.

[e]Fish tissue data is collected on a 4-year rotation at 69 sites on 31 reservoirs and a 2-year rotation on 18 major tributaries.

[f]Habitat data is collected on a 5-year rotation on 650 streams.

[g]Data on the health/abundance of aquatic species or fish populations is collected on a 2-year rotation at 69 sites on 31 reservoirs and a 5-year rotation on 650 streams.

[h]Indicator bacteria data is collected at 300 formal and informal swimming areas.

Water Quantity Data

TVA collects water quantity data to help decide how much water should be released from its 49 dams, for purposes such as protecting aquatic habitat, assimilating waste, and cooling power plants. To make these decisions, TVA needs to know how much and where water is entering the system, how much water is stored within the system, and rainfall amounts. As shown in table 30, TVA collects data on several water quantity parameters on a regional scale, and the data are collected on either a continuous basis or periodically.

Table 30: Water Quantity Parameters for Which Data Are Collected and the Frequency and Geographic Scope of Collection, as Reported by TVA

	Geographic scope			Frequency of collection						
Data type	National	Regional	Project-specific	Continuously	Daily	Weekly	Monthly	Yearly	Other	Not collected
Water availability										
Surface runoff		X		X[a]						
Streamflow		X		X						
Surface water storage		X		X						
Aquifer recharge										X
Groundwater levels										X
Snowpack										X
Precipitation		X		X[b]						
Evapotranspiration										X
Soil moisture										X
Water withdrawal										
Withdrawal		X							X[c]	
Consumptive use		X							X[c]	
Return flow		X							X[c]	

Source: TVA.

[a]Surface runoff data and streamflow data are collected through a network of streamgages. Data on water levels at dams are also collected through this network.

[b]Precipitation data are collected through the rain gauge network.

[c]Withdrawal, consumptive use, and return flow data are collected for a periodic 5-year survey.

Storage Method and Accessibility

According to TVA, its data are stored in internal databases and generally available by request. Some data are classified and not available to the public.

Comments from the Army Corps of Engineers

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

MAR 10 2004

Mr. John B. Stephenson
Director, Natural Resources and Environment
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548.

Dear Mr. Stephenson:

This is the Department of Defense response to the GAO draft report, 'WATERSHED MANAGEMENT: Better Coordination of Water Data Collection Efforts Can Increase Data Available to Support Key Decisions,' dated February 10, 2004, (GAO Code 360320/GAO-04-382).

The U.S. Army Corps of Engineers has reviewed the draft report and agrees with the majority of the findings. Most importantly, we agree with the conclusion that better coordination of data collection and analytical tools would lead to significantly improved decision-making capability with the Tribal, State and local governments, as well as provide important information to the general public. The Corps believes that designation of a lead Federal agency by Congress to operate as a clearinghouse for water quantity data is an important step to improving data collection and management.

Data acquisition through the many and varied Civil Works projects along with permit evaluation, is one of the most significant capabilities of the Corps. During development of this report, we provided to the study team a paper that summarized and exemplified these activities and their relationship to watershed principles. Most Corps projects collect large quantities of data on water quality and quantity, in addition to other factors important to a watershed assessment. The report does not clearly and accurately reflect the enormous amount of water quantity and quality data that is collected and maintained by the Corps. For example, projects like the Upper Mississippi River, the Everglades, and Coastal Louisiana Restoration efforts generate tremendous datasets containing both water quantity and quality information. However, due to the absence of statutory authority and funding, most data do not reach Tribal, State and local government or the public. Another category of water quantity and quality data in the custody of the Corps comes from the more than 80,000 Clean Water Act permits issued each year. These permits incorporate data from various Tribal, State, and local agencies, as well as data developed by applicants, for project-specific analysis of impacts. Finally, the Corps has served as an agent for a number of large projects carried out by other agencies and maintains large quantities of water quality and water quantity data from these efforts. A notable example of this type of effort is the Department of Energy (DOE) Pantex Facility near Amarillo, Texas. State and local governments have told us that all these data are of a great value but not conveniently accessible to them or the public. The Corps, along with other Federal agencies, is evaluating opportunities to organize and provide these data to State and local governments through initiatives that organize water data along watershed boundaries.

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The Corps is moving forward with a new vision for a *comprehensive integrated* watershed management approach to take advantage of the interdisciplinary team approach and integrate all of its programs, projects, and data collection responsibilities within a holistic watershed framework. This comprehensive management approach envisions that all water resources management activities and decisions, whether they be for planning, operations, regulatory, engineering, or military construction, will be made with full consideration of the effects on the particular watershed(s) in which the action would occur. Data generated through these programs would be made available to everyone through web-based applications based on these watershed boundaries. A preliminary draft mission statement has been developed:

> "The Corps will use a comprehensive, integrated watershed management approach in all activities, projects, and permits, using data and analytical procedures for evaluating the physical, environmental, economic, social and political elements characterizing that watershed."

This watershed approach will include a unified framework of analytic tools and watershed data that will be used to support the Corps and stakeholders' decision to be shared among the community of water interests outside the Corps. An integrated system of analyses, applicable to any watershed, will be used to evaluate the environmental, economic, and social equity aspects of all decisions. Furthermore, these data will be used with various environmental models that predict the impact of decisions on the values and functions of the watershed.

Because watershed data have an inherent spatial context, Enterprise Geographic Information Systems (EGIS) technology will be employed to collect and organize these data. The transparency associated with sharing data and analytical tools empowers collaboration and consensus building and thereby produces sustainable decisions with wide acceptance by all affected parties and stakeholders. These data, analytical tools, and procedures permit the evaluation of alternatives and clarify the trade-offs and balance required among value and function, the environment, economy, and social equity values. For example, from the outset of project development within this framework, planners and project managers will share the data and analyses with stakeholders to formulate holistic solutions having broad based support. Designers and engineers will define solutions within the same collaborative framework, ensuring that shared stakeholder concepts are incorporated into implementation. Existing projects will be operated with an awareness of integrating and balancing the impacts and benefits of management decisions on the watersheds where projects are located. The public will have the advantages of a transparent set of data, decision tools, and timely access to key Corps managers to facilitate their participation in the process. Wetland permit decisions will also be watershed based and the full community of stakeholders will be able to participate in an open process empowered by direct access to the shared framework.

The Corps is taking the next steps to develop and utilize its watershed-based approach through the effective management of all programs within the agency. We are acquiring significant amounts of data through our internal efforts as well as importing externally generated

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data from other sources for use by our programs. In many places where State, regional or local agencies have led or are leading the way, the Corps can work with those agencies cooperatively to integrate those data for use in this approach. These data are being systematically compiled and most are being made available to other agencies and the general public for broader use. As we compile these data, we are incorporating the EGIS into all core business processes. The Corps is moving to leverage our existing investments in data acquisition by integrating mapping and EGIS technology across all districts and divisions. EGIS will provide the information foundation for the Corps, support the district offices in their conduct of multi-level analysis and associated decision making, and provide an over-arching national view of water resources initiatives and their associated practitioners. Implementation of the Enterprise GIS will facilitate the identification of data gaps, identify potential sources of external data and underscore the need for refinements in analytic tools.

Integrating comprehensive watershed management on a regional basis depends on the formation of partnerships between governments and the public, across disciplines and borders, and among water users, planners, engineers, and regulators with different interests and missions. Achieving and maintaining close, functional linkages with our Tribal, State and local partners, are the keys to effective execution of the watershed management concept. The Corps, with its on-going efforts, is strategically placed to play a vital role in this effort in the future. The Corps appreciates the opportunities that would be afforded to State and local managers and the public by making these large data sets available in EGIS format. Unfortunately the Corps lacks statutory authority to seek funds to compile and make this data accessible to the public. Studies and projects are cost shared by project sponsors making undesirable and inequitable the use of project overheads to centrally fund the management of these data. The Corps would be willing to participate in any discussions associated with establishing a clearinghouse for water quantity data. Setting up a clearinghouse of water quantity data could result in significant savings for the Federal government as well as assisting State and local governments with their land use decisions.

We thank you for the ability to provide these comments on an important subject that will have great benefits to our country in the future.

Sincerely,

Carl A. Strock
Major General, U.S. Army
Director of Civil Works

Comments from the Department of the Interior

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

Mr. John B. Stephenson
Director, Natural Resources
and the Environment
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

MAR 12 2004

Dear Mr. Stephenson:

Thank you for providing the Department of the Interior (DOI) the opportunity to review and comment on the draft U.S. General Accounting Office (GAO) report entitled, "Watershed Management: Better Coordination of Water Data Collection Efforts Can Increase Data Available to Support Key Decisions," (GAO-04-382). The GAO has done an excellent job of gathering information from many sources and assembling the perspectives into a well-organized document. Considering all the organizations and issues around water resource information, management, and remediation at the national and local level, and the various competing mission responsibilities, the GAO has brought many of the most important perspectives of successes and challenges to light. The GAO is commended on their comprehensive job in assembling information on a large complex subject in a short time frame.

Several issues are worth comment from the DOI perspective: a) The suggestion that Congress consider designating a lead organization or agency for coordinating water data collection nationwide; b) identification of deficiencies in the coordination and collaboration of water-quality data collection that such a designee might address, and what deficiencies would remain; c) determination of data sharing and database issues that need to be addressed, and those that should remain even after collaboration is maximized; and d) examination of what is still missing for the more highly coordinated water quantity data collection issue that needs support.

The Office of Management and Budget's (OMB) Memorandum 92-01 designates the U.S. Geological Survey (USGS) as the lead agency for coordinating water information. As a result of implementing OMB M-92-01, the USGS has worked with other agencies to establish and operate the Water Information Coordination Program. As GAO mentioned (pages 52-56), though advancements have been made through the Advisory Committee on Water Information (ACWI) and the National Water-Quality Monitoring Council (NWQMC), the USGS lacks financial resources to facilitate further coordination and collaboration. Many agencies at the Federal and local level participate in ACWI and NWQMC on a voluntary basis, with staff time only marginally available.

The issue is not the absence of an established process or lead agency, but rather the level of funding and personnel resources dedicated to these efforts across all of the participating agencies.

Mr. John B. Stephenson 2

Even if the suggestion of designating a lead agency were implemented, some issues would remain, including: 1) Differing purposes for data collection; 2) variation in data collection protocols; 3) lack of awareness regarding who is collecting water data; and 4) low priority and insufficient funding for collaboration of water data collection and data sharing. Of these four key barriers to coordination and collaboration, the suggestion for a lead organization with resources would address #3 and #4, but the first two barriers would remain.

The first barrier results primarily from differing mission responsibilities, and from implementing legislation or regulations. That barrier can be lowered to some extent by coordination and collaboration; however, bureaus will continue to have distinct responsibilities and missions, which require that they ask different questions about water resources. These different questions lead to differences in geographic scale and timing of data to provide the answers. For example, in managing water delivery for a large watershed area, the Department needs information over a large area covering seasonal to annual variations. In contrast, in managing habitat for a protected species, the Department needs water resource data for a small stream reach over shorter time scales. These responsibilities require different data collection efforts. The data collection protocols also may vary across organizations for two reasons: 1) Different questions often lead to separate approaches or protocols; and 2) as long as protocol selection is voluntary (as it is among the States), differences will remain as each authority selects its preferred approach.

The GAO accurately described many of the database issues in the draft report. We want to further highlight a few points. First, databases are used for other purposes beyond that of a data repository. Within the Department, the USGS National Water Information System (NWIS) is not only an archive containing data of known quality and origin, but also a data processing system that automatically and continuously applies quality control tests as new data enter NWIS. This is a crucial distinction between NWIS and other databases mentioned in the GAO report such as the new Environmental Protection Agency (EPA) Storage and Retrieval System. The processing capability within NWIS allows the USGS to provide continuous streamflow and water-quality data from monitoring locations within a few hours of data generation. Although those data are subject to further review and quality assurance, they are quickly provided to the public over the Internet after an automatic first level of quality control review. This crucial distinction between NWIS and the other databases mentioned in the GAO report illustrates why the Department needs NWIS to meet mission responsibilities to protect life and property.

In addition, as we have observed the evolution of data systems, we have become convinced that establishing one huge Federal database is neither feasible nor desirable. Current database and Internet technology is best suited to multiple databases that conform to data standards, creating the ability to identify and share data among systems. When data systems are too large and remote from the data generation responsibility, maintaining data integrity becomes difficult and inefficient. Thus, data sharing can be achieved through developing a data portal. Development of such a portal should also create organizational interest in identifying other data that could be made available for sharing through the portal. Such an approach is the one currently pursued by the USGS and EPA. The major constraint for both organizations right now is working within the limit of resources available; however, progress is being made and the first phases of this effort will be made public soon.

Mr. John B. Stephenson 3

The GAO has accurately identified water quantity data collection as being more highly coordinated and consistent because fewer agencies and organizations are involved in the majority of data collection activities. In addition, the science of water quantity data collection is more mature than the science supporting water quality data collection. What is primarily missing in water quantity data collection, as appropriately identified by the GAO, is adequate data. More data production at this point will not result from efficiencies of coordination and collaboration; what is lacking at all levels of government are the financial resources to support more data collection. Especially troubling is the loss of long-term data collection stations (Figure 10), as many important questions around flood and drought conditions and their recurrence require long-term data sets to answer. The USGS is striving to work with many Federal, State, and local partners to continue long-term data collection within existing resources.

Finally, coordination and collaboration is a huge challenge because of the multitude of agencies and organizations involved. The Department and its bureaus are committed to making water data collection and coordination activities as effective as possible at all levels of government. While designating a lead organization or agency has value, without resources we will not see fast results. All organizations are working within a complex environment including changing water quality perspectives and needs and differing mission responsibilities, which result in legitimately different approaches. Thus, one cannot expect that coordinated approaches will answer all questions or meet all water resource needs.

The enclosure provides specific comments from the U.S. Geological Survey, U.S. Fish and Wildlife Service, the National Park Service, and the Bureau of Reclamation. We hope our comments will assist you in preparing the final report.

Sincerely,

P. Lynn Scarlett
Assistant Secretary - Policy,
Management and Budget

Enclosure

Comments from the Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 2 2004

OFFICE OF WATER

John B. Stephenson, Director
Natural Resources and Environment
U.S. General Accounting Office
441 G. Street, N.W.
Washington D.C. 20548

Dear Mr. Stephenson:

Thank you for the opportunity to review the draft March 2004 report "Watershed Management: Better Coordination of Water Data Collection Efforts Can Increase Data Available to Support Key Decisions."

As the draft report notes, the Environmental Protection Agency (EPA) has long believed that the watershed approach is the best way to manage the nation's water resources. We agree with GAO that effective implementation of the watershed approach depends upon reliable, comprehensive, and accessible data on water quality. These data are also necessary in order to characterize the state of the nation's waters.

EPA believes that it is important for the report to reflect the critical leadership role that States have in implementing programs under the Clean Water Act. We also believe that the report could be strengthened by noting: (1) the high cost of monitoring, (2) recent significant improvements to the STORET system, and (3) the emphasis placed on coordination and data sharing in EPA's "Elements of a State Monitoring and Assessment Program" guidance.

Regarding the high cost of monitoring, states report that they currently have an annual shortfall of $100-150 million for their water quality monitoring programs. The magnitude of this shortfall underscores the importance of collaboration and coordination on data collection efforts.

Regarding STORET, the report recognizes that data should be stored in accessible databases, and identifies STORET as the only database available to most users. STORET is evolving quickly. Last year, EPA completed a new STORET data warehouse that has increased data retrieval speed from STORET by 200-fold. With the completion of the data warehouse, EPA has now significantly increased customer outreach and support to better meet States' needs for the STORET system. We believe that the report should note new developments to the STORET system in conjunction with comments on past performance of the database.

EPA's "Elements of a State Monitoring and Assessment Program" guidance specifically addresses the issues of better coordination and data sharing. The first page of the guidance states:

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"EPA recommends that State monitoring program managers work with other State environmental managers and interested stakeholders (including EPA Regions, other Federal water quality and land management agencies, volunteer monitoring organizations, and academic institutions) as they develop their strategy. This collaboration provides the State water quality program an opportunity to maximize its use of other parties' data and effectively expand its monitoring resources. Many States have formed monitoring councils that help facilitate coordination of monitoring activities among various organizations."

The guidance also states on page 10:

G. Data Analysis/Assessment

The State has a methodology for assessing attainment of water quality standards based on analysis of various types of data (chemical, physical, biological, land use) from various sources, for all waterbody types and all State waters*...The methodology describes how the state integrates its primary data – collected specifically for making attainment decisions according to a State QAPP – with data from secondary sources, collected for a variety of purposes under a variety of quality control practices. (Secondary data could include, for example, volunteer monitoring data or discharge monitoring reports.) The methodology should:*

- *Identify the required or likely sources of existing and available data and information and procedures for collecting or assembling it; . . .*

Please see our additional specific technical comments, enclosed. EPA appreciates this opportunity to comment on the draft report. The Agency agrees with GAO on the critical importance of coordination and collaboration on data sharing. We appreciate your undertaking this investigation and look forward to working with you in the future. If you have any questions, please contact Peter Grevatt, Chief of the Monitoring Branch, at 202-566-1925.

Sincerely yours,

Benjamin H. Grumbles
Acting Assistant Administrator

Enclosure

Comments from the Department of Commerce's National Oceanic and Atmospheric Administration

UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary of Commerce
for Oceans and Atmosphere
Washington, D.C. 20230

MAR 4 2004

Mr. John B. Stephenson
Director, Natural Resources
and Environment
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Stephenson:

Thank you for the opportunity to review and comment on the General Accounting Office's draft report entitled, "Watershed Management: Better Coordination of Water Data Collection Efforts Can Increase Data Available to Support Key Decisions." GAO-04-382. Enclosed are the National Oceanic and Atmospheric Administration's comments on the draft report.

These comments were prepared in accordance with the Office of Management and Budget Circular A-50.

Sincerely,

Conrad C. Lautenbacher, Jr.
Vice Admiral, U.S. Navy (Ret.)
Under Secretary of Commerce for
Oceans and Atmosphere

Enclosure

THE ADMINISTRATOR

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NOAA Comments on the GAO Draft Audit Report Entitled: "Better Coordination of Water Data Collection Efforts Can Increase Data Available to Support Key Decisions" (GAO-04-382)

General Comments

All occurrences of "Fisheries" or "NOAA's Fisheries" should be replaced with "NOAA's National Marine Fisheries Service" throughout the draft report.

The Executive Summary and Introduction section of the draft report should clarify the information contained in the report relates to "freshwater," not "saltwater."

We recommend eliminating, in general, references to "watersheds" for two major reasons: (1) The draft does not include many references to "watersheds," and (2) the remainder of the draft report would not be affected, if revised. All of it supports the second part of the present title, "Better Coordination of Water Data Collection Efforts Can Increase Data Available to Support Key Decisions."

Specific Comments

Now on p. 3.

Page 1, paragraph 1: Delete "both" before the phrase, "significant environmental and financial implications."

Now on p. 3.

Page 1, paragraph 2, second sentence: Insert the article, "the" before "states' standards."

Now on p. 3.

Page 1, paragraph 2, third sentence: Insert the article, "the" before the noun, "states."

Now on p. 5.

Page 3, footnote 3: Add the acronym "(NOAA)" after the "National Oceanic and Atmospheric Administration," under footnote 3, page 3.

Now on p. 5.

Page 4, first sentence: Revise top of page 4 by deleting the article, "the" before "National Weather Service" and substitute "NOAA's" in lieu thereof.

Now on p. 8.

Page 6, seventh sentence: Delete in its entirety and replace with the following: "It stores these data in the National Climatic Data Center of NOAA's National Environmental Satellite, Data, and Information Service and makes them available to the public via the Internet."

Now on p. 27.

Page 25, use of the term "STORET": Beginning on page 25, STORET is introduced and perhaps the distinction between the old STORET and the modernized STORET should be introduced at this point to make it clear the current system goes a long way to correct the apples and oranges approach to the original system and the current emphasis on metadata.

Now on p. 29.

Page 27, subheading: Revise the subheading, *Federal Water Quality Data Storage*, page 27, by deleting the last line of the first paragraph in its entirety and replacing it with the following: "... used to assess the health of marine and coastal ecosystems in internal program-specific databases."

1

Now on p. 42.

Page 39, subheading: Revise the subheading, *Storage and Accessibility of Federal Water Quantity Data* by deleting "Commerce's" before "National Environmental Satellite, Data, and Information Service" and replace it with "NOAA's."

Now on p. 54.

Page 50, in the section entitled, "Different Metadata Standards: To clarify the meaning of the term "metadata" we suggest providing a characteristic such as mode of sample collection or periodicity of sampling. "Quality of the data" is determined by a user who assesses the metadata to better understand the standard used to collect, analyze, and assess the data set.

Now on p. 56.

Page 52, in the section entitled "Data Coordination is Often Assigned a Low Priority:" The authors discuss the reasons for limited coordination even where efforts have been made to coordinate and consolidate the data collection, such as the National Council effort, the participation is only as useful as the breadth of knowledge that the agency representative has of the Agency's water quality collection efforts. Too often, individuals represent their individual office activities but make limited effort to reflect the other activities in other offices of the Agency. In many cases, there is little interaction or awareness of other programs so any error in presentation is one of omission and not volition.

Now on pp. 80-81.

Page 77, first paragraph: The thought suggests the water quantity data will become more important as populations grow and, by the way, we should collect water quality data too. Water quantity data are critical to protect human and natural populations at times of extreme events, i.e., floods and droughts, and must be monitored to avoid errors in water distribution. With increases in population density, water quality data will become increasingly important to everyday needs of protecting humans and wildlife exposure to increased concentrations of biological and chemical products of human activities thrust upon an environment that has exceeded its capacity to store or neutralize the daily assaults. One set of data collections is more important to protect and improve management responses to extreme events while the other set of data collections are of increasing importance on a daily and long term scale.

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GAO Contacts and Staff Acknowledgments

GAO Contacts

John B. Stephenson, (202) 512-3841
Steve Elstein, (202) 512-6515

Staff Acknowledgments

In addition to the individuals named above, Leah DeWolf, Laura Gatz, Barbara Patterson, and Emmy Rhine made key contributions to this report. Also contributing to this report were Robert Crystal, Lynn Musser, and Carol Shulman.

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