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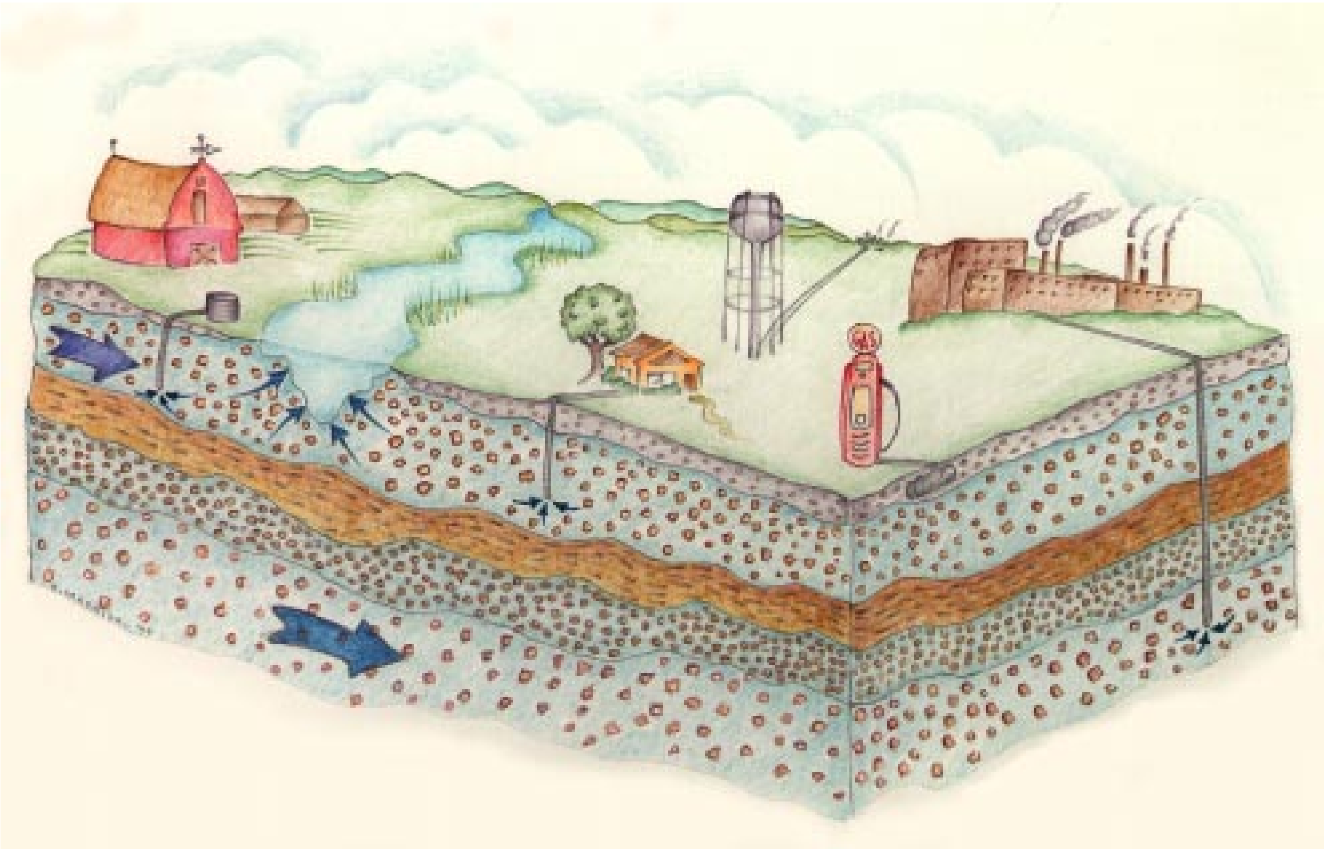
Safe Drinking Water Act, Section 1429 Ground Water Report to Congress



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Safe Drinking Water Act, Section 1429
Ground Water Report to Congress

Acknowledgments

The Ground Water Report to Congress was developed with the help of many people from the U.S. Environmental Protection Agency (EPA), the U.S. Geological Survey (USGS), state governments and state water associations. The project manager and chief editor of this document was Denise Coutlakis of the Office of Ground Water and Drinking Water (OGWDW) within the Office of Water (OW). Many EPA staff within OW and other EPA program offices assisted with and contributed to the document along the way. EPA would especially like to thank the federal/state workgroup that was critical in the development of this report. The workgroup consisted of representatives from the Ground Water Protection Council (GWPC), the Association of State Drinking Water Administrators (ASDWA), the Association of State and Interstate Pollution Control Administrators (ASIWPCA), and other state governments, EPA, and the USGS, as follows:

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Special thanks goes out to Mike Paque and the staff at GWPC for their work with ASDWA, ASIWPCA and their state members in developing the Summaries of State Ground Water Conditions that are included as an addendum to this document. EPA thanks each of the state ground water managers and authors for their time and diligence in preparing the fact sheets that further elucidate the progress of each state in the protection of their ground water resources.

Contractor support was provided under Contract No. 68-C7-0056 with Tetra Tech Inc. (TT), a subcontractor of Research Triangle Institute (RTI). Bill Ward of TT gave critical support in developing this document, as did many others who lent support at Tetra Tech and RTI. Roger Anzzolin managed the work assignment under this contract for EPA. His help was greatly appreciated.

Executive Summary

Section 1429 of the Safe Drinking Water Act (SDWA) authorizes the U.S. Environmental Protection Agency (EPA) Administrator to make grants to the states for the development and implementation of programs to ensure the coordinated and comprehensive protection of ground water resources. Under this authority, EPA is also required every three years to evaluate funded state programs and report to Congress on the status of ground water quality in the United States and the effectiveness of state programs for ground water protection.

> **SDWA Section 1429(e) *Evaluations and Reports***
>
> "Not later than 3 years after the date of enactment of the Safe Drinking Water Act Amendments of 1996, and every 3 years thereafter, the Administrator shall evaluate the State ground water protection programs that are the subject of grants awarded pursuant to this section and report to the Congress on the status of ground water quality in the United States and the effectiveness of State programs for ground water protection."

Under the 1996 Amendments to SDWA, Congress authorized up to $15 million for each of fiscal years 1997 through 2003 to support these state programs, although these funds have not been appropriated for fiscal years 1997 through 1999. This report reviews the status and effectiveness of state ground water programs and examines our nation's approach to protecting ground water.

Over the past fifteen years, numerous reports have documented the need for more effective coordination of ground water protection programs at the federal, state, and local levels. Similar efforts in surface water programs have led many states to adopt watershed-based management approaches that coordinate the activities of agencies and programs that play a role in water quality protection. At the federal level, the 1998 Clean Water Action Plan is designed to promote similar coordination among federal agencies. While the Clean Water Action Plan and some state watershed protection approaches address ground water, true coordination of ground water management efforts has not been achieved in most states.

Nevertheless, progress has been made in the protection of the nation's ground water resources. For example, 47 states have approved wellhead protection programs. These programs are now being expanded under the Source Water Assessment and Protection provisions of the 1996 SDWA amendments. Although wellhead and source water protection focus solely on drinking water sources, more comprehensive protection programs that address the entire ground water resource are also being developed by the states. Virtually every state has indicated that they are undertaking some component of a comprehensive ground water protection program, including enacting protection legislation and regulations, coordinating activities of various agencies responsible for ground water management, performing ground water mapping and classification, monitoring ambient ground water quality, developing data management systems, and implementing remediation and prevention programs. However, more comprehensive planning needs to be done to make the best decisions regarding remediation and the efficient use of ground water efforts.

Federal support is available for comprehensive ground water protection planning, primarily through the Clean Water Act (CWA) and SDWA. However, the vast majority of federal resources allocated for ground water have been devoted to ground water remediation. Millions, and in some cases hundred of millions, of dollars from public and private funds have been spent in each state on clean-up activities, or government oversight of clean-up performed by private parties. The need for such spending will continue. In 1994, the National Academy of Sciences estimated that over a trillion dollars, or approximately $4,000 per person in the U.S., will be spent in the next thirty years on clean-up of contaminated soil and ground water. However comparatively few of those clean-up resources will be used to manage future threats to the resource in a comprehensive way that may prevent the need for future, costly clean-up efforts. A comprehensive protection program would help determine the most significant threats to the resource, help establish the local priorities and direct funds to those programs that would deal with the most significant threats first.

Although there is no targeted source of funding for state ground water protection programs, EPA guidance encourages states to use 15 percent of their grant funds appropriated under Section 106 of the CWA for ground water protection. Also, states may set aside funds from the Drinking Water State Revolving Fund (DWSRF) to finance source water assessment and protection activities. This includes three possible set-asides: (1) up to 10% of a state's allotment for the DWSRF to administer or provide technical assistance for Source Water Protection programs within the state; (2) up to 15% of the state's capitalization grant for more than one of several Source Water Protection activities (i.e., land acquisition/ easements, voluntary protection and petition activities, source water assessments [available for FY 1997 grants only], and Wellhead Protection); and (3) up to 2 percent of the state's allotment for additional technical assistance to small Public Water Systems (PWS).

Funds may also be allocated through Public Water Supply Supervision (PWSS) grants for assisting with compliance of federal and state drinking water regulations. Although these grants are targeted to assist in implementation of drinking water regulations, including several new federal regulations, states could potentially use these funds for comprehensive ground water protection if they can make a direct correlation to PWS compliance with drinking water regulations.

This report presents the findings that EPA has developed in consultation with a work group of state ground water managers, the Ground Water Protection Council, the Association of State and Interstate Water Pollution Control Administrators, and the Association of State Drinking Water Administrators regarding how our federal and state ground water protection programs can more effectively prevent ground water contamination problems in the future. In this initial report prepared under Section 1429, EPA programs are the focus of the discussion of federal ground water management activities. The next report to be prepared in three years will include a broader discussion with more information about other federal programs. U.S. EPA is grateful to our partners, the states, for their help in developing this report.

Ground Water and the Health of the Nation

Maintaining access to clean, plentiful ground water sources is critical to protect the health and welfare of all parts of the country. Today, we rely on ground water more than ever:

- ground water supplies drinking water to half of the nation and virtually all people living in rural areas,
- ground water supports many billions of dollars worth of food production and industrial activity, and
- ground water supplies the majority of streamflow in large areas of the country and provides much of the water in lakes and wetlands.

Ground water is used in every state and accounts for about one-quarter of all freshwater used in the United States today.

Ground Water Quality

Information about the extent and condition of ground water quality is limited at the national and state level, especially when compared to our understanding of surface water quality. In contrast to surface water quality monitoring, ground water monitoring is more expensive and time consuming, and ground water quality and vulnerability are more difficult to characterize beyond the local level. Furthermore, monitoring data to characterize the overall quality of the resource have not been collected in a consistent way. Without consistent, long-term monitoring data, our ability to characterize ground water quality and how land use affects ground water is limited, particularly on a national scale.

However, based on the data that have been collected to date, ground water quality appears to be generally good nationwide (that is, ground water contaminant levels are usually below applicable drinking water standards). Locally, however, ground water quality is being threatened by a variety of land uses. Although ground water appears to be of higher quality than surface water throughout the United States, contamination incidents and over-pumping remain a problem for numerous localities.

A variety of agricultural, industrial, commercial, and waste disposal practices are known to contaminate ground water. The occurrence of nitrates, pesticides, organic chemicals, and other contaminants reveal the impact of certain land uses on ground water quality. Over-pumping can limit water availability to nearby wells; reduce ground water flow to streams, lakes, and wetlands; permanently damage aquifer storage capacity; and induce salt water intrusion to freshwater aquifers. Because no one federal, state, or local authority can manage all of these threats, a coordinated approach for ground water management is needed.

Ground Water Management

Many states are working toward aspects of a more comprehensive resource-based approach to ground water protection, but much remains to be done. In order to better manage the resource, increased efforts towards such activities as data gathering, coordination and integration of programs, and comprehensive priority-setting must be achieved. These planning activities, however, are often lacking due to budget constraints and institutional barriers that prohibit effective communication between agencies and groups that have control over activities that impact ground water.

Federal, state, and local governments need to reexamine the current approach to ground water management to assess the future direction of federal and state programs. The critical question for many states is how to increase efforts to prevent new ground water contamination while managing the clean-up of resources that were contaminated in the past. While the liability for clean-up may act as a deterrent to polluting ground water and programs like the Toxics Release Inventory create public relations incentives for reducing pollution, these types of programs alone do not fully address our need to manage ground water resources in a sustainable manner. Supporting the comprehensive management efforts that are emerging in the states will best serve the nation's need for maintaining sustainable ground water resources into the future.

Findings

- Ground water is a critical resource to maintain public health, the economy, and the environment.

- From what we know at most locations around the country, ground water is generally of good quality but continues to be threatened by point and non-point sources, as well as over-pumping.

- States have made considerable progress in implementing federal and state programs aimed at specific contamination concerns.

- Most states agree that a more comprehensive, resource-based approach holds greater potential for accomplishing effective ground water protection and many states are pursuing key aspects of such an approach.

- Much still remains to be done to achieve a more comprehensive approach.

  - About a dozen states have developed an EPA-approved Comprehensive State Ground Water Protection Program (CSGWPP) that promotes a more strategic, resource-based approach to ground water protection, and more than half the States are undertaking efforts that are essential to a comprehensive approach to ground water protection.

  - However, only a few states have been able to complete, or have begun to develop, a comprehensive list of ground water protection priorities. Even fewer states have indicated that they have identified available program funding sources to address their comprehensive ground water protection priorities in a systematic, consistent way.

- States have identified three primary barriers to achieving a more comprehensive approach:

  1) Fragmentation of ground water programs impedes effective management. Most state and federal ground water protection programs are fragmented among and within agencies. At the state level, authorities to manage the resource are often held among different state agencies with conflicting priorities and goals. Communicating and coordinating among departments with ground water responsibilities can be difficult. In turn, these barriers can create an impediment to accessing funds for comprehensive planning efforts.

  2) There is a lack of understanding of ground water resources locally and regionally (e.g., the extent and condition of the resource, the physical nature of the aquifer, the behavior of contaminants within and their movement through aquifers, the influence of surface water to ground water and vice versa).

     Better information to assess the effectiveness of ground water protection efforts and to determine the impact of certain land uses on ground water is needed to set priorities for ground water protection efforts. The states need to support the development of coordinated, comprehensive approaches for ground water monitoring that includes priority setting.

3) Lack of funding targeted directly to ground water is the reason most often cited by states for limited efforts at undertaking a more comprehensive resource-based approach. Ground water protection is often not a high priority for funding; mandated programs usually prevail for funding. Most states indicate that the mandates under other federal programs often preclude the state from exercising flexibility to use funds for non-mandated ground water protection priorities. This is particularly the case under the Clean Water Act (CWA), where states have the opportunity to pursue ground water activities, including more comprehensive resource assessment and planning, utilizing State Water Quality Program Grants, Non-point Source Grants or the non-point source projects supported by the CWA State Revolving Fund loans.

- While the funds are relatively limited, most states believe that funding of SDWA Section 1429 grants would support more coordinated state planning and priority setting for ground water protection as a first step toward solving some of these problems. States believe that by providing a source of targeted funding, states will be able to better address the issues of program fragmentation within the state and basic program needs, such as monitoring, resource characterization, and the development and implementation of protection programs.

List of Abbreviations, Acronyms, and Symbols

AFO	Animal feeding operations
AST	Above ground storage tank
AU	Animal unit
BMP	Best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CSGWPP	Comprehensive State Ground Water Protection Program
CWA	Clean Water Act
EDMS	Environmental Data Management System (Idaho)
EPA	U.S. Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GIS	Geographic information system
GWFG	Ground Water Focus Group
IGPA	Illinois Groundwater Protection Act
ITFM	Intergovernmental Task Force on Monitoring Water Quality
MCL	Maximum contaminant level
MTBE	Methyl *tert*-butyl ether
mg/L	Milligram per liter
NAWQA	National Water Quality Assessment
NWQMC	National Water Quality Monitoring Council
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
UIC	Underground injection control
USDA	U.S. Department of Agriculture
UST	Underground storage tank
VOC	Volatile organic compounds
USGS	U.S. Geological Survey
ug/L	Microgram per liter

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LIST OF EXHIBITS

1.0. INTRODUCTION

1.1 Purpose of this Report

Section 1429 of the Safe Drinking Water Act (SDWA) authorizes the U.S. Environmental Protection Agency (EPA) Administrator to make grants to the states for the development and implementation of programs that ensure the coordinated and comprehensive protection of ground water resources. Under this authority, EPA is also required every three years to evaluate funded state ground water protection programs and report to Congress on the status of ground water quality in the United States and the effectiveness of state programs for protecting ground water.

> Section 1429 of the Safe Drinking Water Act requires EPA to prepare a *Report to Congress* on ground water protection programs.

Congress enacted SDWA to protect the quality of drinking water in the United States. The Act has become one of the principal authorities for managing and protecting ground water resources by controlling the underground injection of waste, providing authority and support for wellhead and drinking water source protection, and recommending the development of comprehensive state programs for ground water management.

Section 1429 of the Safe Drinking Water Act requires EPA to prepare a *Report to Congress* on ground water protection programs.

Under the 1996 amendments to SDWA, Congress added Section 1429 to the Act, which authorized up to $15 million for each of fiscal years 1997 through 2003 to support state programs for comprehensive ground water protection. Funds under this authority have not been appropriated for fiscal years 1997 through 1999. This report addresses the current status and effectiveness of state ground water programs and examines our nation's approach to protecting ground water.

1.2 Report Development Process and Content

EPA convened a work group of state and federal ground water experts to develop the findings presented in this report regarding approaches to protect and sustain the nation's ground water.

To support this effort, EPA and the work group used the following two principal sources of information:

- ❑ Existing literature and research reports developed by federal agencies, the states, universities, and private research organizations; and
- ❑ A report of state ground water management agencies completed in April 1999 (GWPC 1999a)[1].

Information sources, which support EPA and work group findings, are cited throughout this report.

This report is organized in the following five sections:

- ❑ Section 1, Introduction, which discusses the purpose of this report and its organization
- ❑ Section 2, Ground Water's Importance to the Health of the Nation, which summarizes ground water characteristics and uses
- ❑ Section 3, Ground Water Quality, which discusses threats to the nation's ground water
- ❑ Section 4, Ground Water Management, which discusses federal, state, and local government approaches and programs for protecting ground water
- ❑ Section 5, Findings, which discusses ground water and management approaches to protect and sustain the nation's ground water

In addition, this report contains two appendices: Appendix A cites references used to prepare this report and Appendix B presents a glossary of terms used in this report. A summary of state ground water management programs is included as an addendum to this report.

[1] The report of state ground water management agencies was completed under the sponsorship of the Ground Water Protection Council (GWPC), the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), and the Association of State Drinking Water Administrators (ASDWA). GWPC, ASIWPCA, and ASDWA compiled information from 26 states for this report.

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2.0 THE IMPORTANCE OF GROUND WATER TO THE HEALTH OF THE NATION

Beneath the surface of the earth, a huge supply of fresh water is available to support the health and economic well-being of the nation. This ground water is generally of good quality[2] and, unlike surface water, it can in many cases be used safely without treatment. Although ground water is largely a hidden resource, it is critical to our public health and economic welfare as a source of drinking water; a key agricultural, industrial, and ecological resource; and a large source of recharge water for our lakes, streams, and wetlands.

> Ground water is the source of drinking water supply for half of the nation; is a key component of the economy; and maintains our streams, lakes, and wetlands.

Maintaining access to clean and plentiful ground water is therefore critical. Today, we rely on ground water more than ever, as illustrated by the following:

- Ground water supplies drinking water to half of the nation and virtually all people living in rural areas.
- Ground water supports many billions of dollars worth of food production and industrial activity.
- Ground water supplies the majority of streamflow in large areas of the country and provides much of the water in lakes and wetlands.

Ground water uses and characteristics are discussed below.

2.1 Ground Water Uses

In the United States, ground water is used for agricultural, domestic, industrial, and commercial purposes. The primary uses of ground water are for drinking and bathing, irrigation of croplands, livestock watering, mining, industrial and commercial uses, and thermoelectric cooling applications. Exhibit 2-1 illustrates ground water use among these categories (USGS 1998a). As shown, irrigation and public water supply are the largest ground water uses, accounting for 64 and 20 percent of all fresh ground water withdrawals.

About 77.5 billion gallons of ground water are withdrawn daily for use in this country. In 1995, USGS reported that ground water supplied 50 percent of the nation with drinking water either through a public or private water supply[3]. USGS also estimates that 42 million Americans living in rural areas, or 16 percent of the U.S. population, drink ground water daily (USGS 1998a) (see Exhibit 2-2.).

Ground water supports public health, economic, and ecological needs, as discussed below.

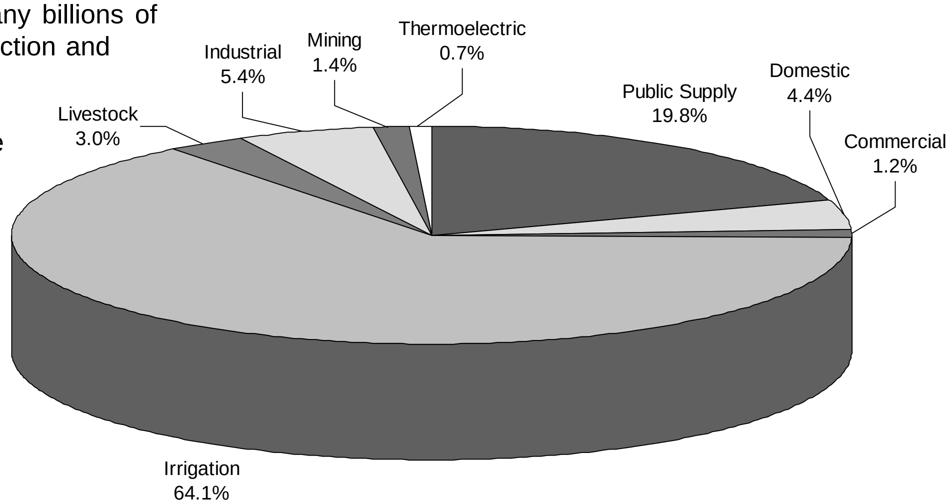


Exhibit 2-1: Categories of Ground Water Use Source: USGS (1998a)

[2] When contaminants for which there are drinking water standards are found in ground water, they are usually at levels that are below the drinking water standard.

[3] In this report, private water supplies refer to wells operated by individuals for domestic use.

Exhibit 2-2: Percentage of Population Relying on Ground Water as a Drinking Source by State Source: USGS (1998a)

Public Health

The average person does not often think about ground water because it is hidden beneath the land surface, has historically been plentiful, and is generally of good quality. In fact, we have come to expect that clean, abundant ground water will always be available. Ground water is used in every state and accounts for close to one-quarter of all fresh water used in the United States today. Over half of the people in this country use ground water for all or part of their drinking water supply. In rural areas, virtually all water used in homes is ground water from private wells.

Economic Needs

Plentiful, clean ground water is also critical to our economy. Nationally, over 40 percent of all water used for crop irrigation or livestock watering and over 20 percent of water used by industries is ground water (USGS 1998a). Every state uses some amount of ground water to fulfill its water resource needs. Seventeen states obtain greater than 25 percent of their overall water supply from ground water, and seven states obtain greater than 50 percent of their total water supply from ground water (USGS 1998a). As a portion of total freshwater use, ground water withdrawals during 1995 were highest in the western United States, where the water was used primarily to supply increasing population and to sustain important agricultural activities. Exhibit 2-3 shows the volume of ground water withdrawn by states for all uses.

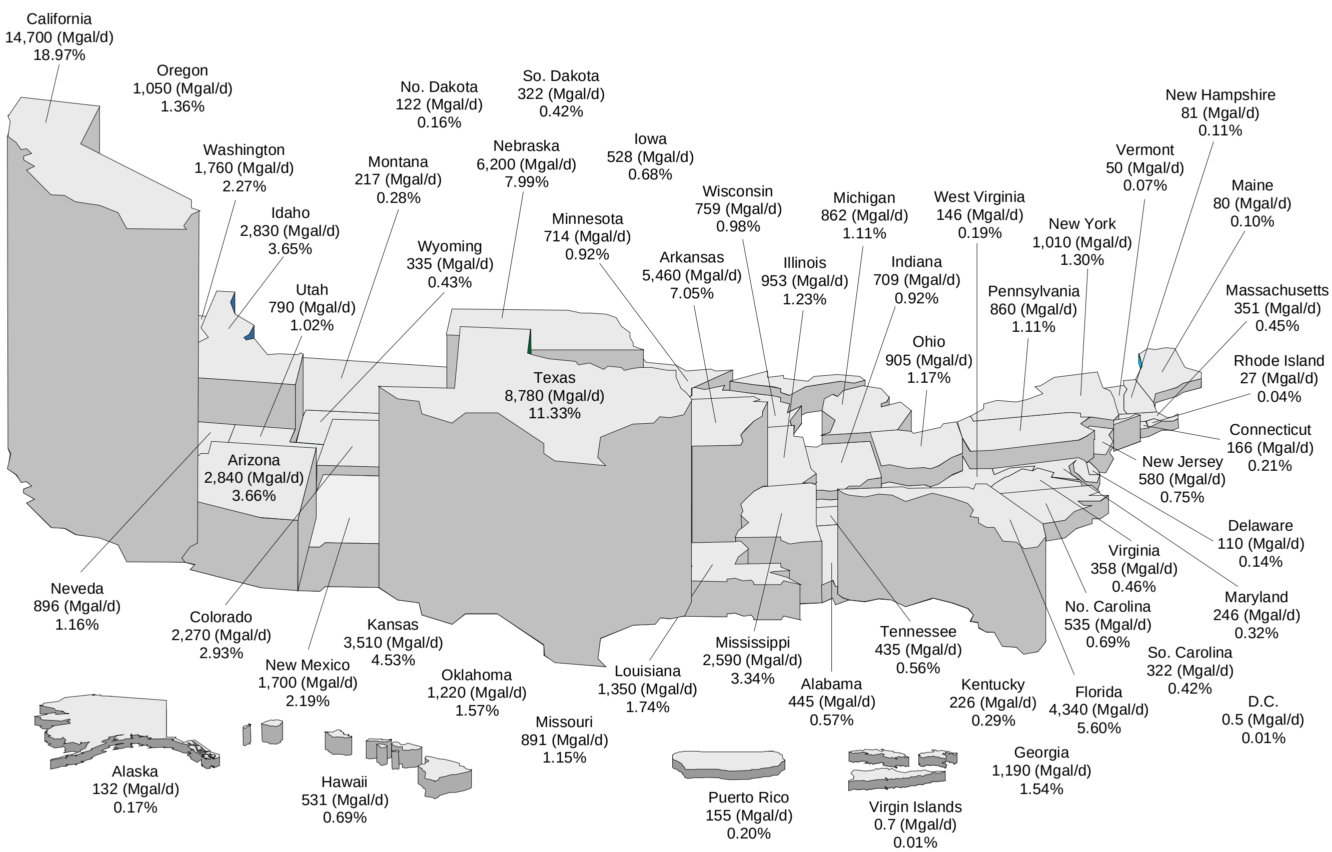


Exhibit 2-3: Volume of Ground Water Used by the States (Mgal/d) and Percentage of Total Ground Water Withdrawals Occurring In Each State
Source: USGS (1998a)

Ecological Needs

The abundance and quality of surface water is directly linked to ground water quality and quantity. Ground water entering rivers and lakes helps maintain surface water levels during dry periods.

As a result, ground water plays a critical role in maintaining fish habitat and other critical ecological resources, such as wetlands, estuaries, and coastal marshlands (USGS 1998b).

Ground Water and Surface Water: One Resource

Ground water does not remain underground forever. Not only do we pump it to the surface through wells, ground water also comes to the land surface through springs and seeps into rivers, lakes, and other water bodies. In some portions of the country, especially arid regions, aquifers contribute a large portion of the water found in streams. Overall, up to half of the water flow in our streams comes from ground water. This source of surface water recharge (see Exhibit 2-5) is especially important in sustaining stream flow during dry periods. Reductions in surface water flow can have adverse impacts on the ecology of a watershed, recreational potential, the use of surface waterways for transportation, and the availability of drinking water and water for other uses. Ground water depletion has eliminated surface water flows altogether in some areas. Ground water also supports plants and animals that live in certain wetlands or along certain streambanks.

Because baseflow in the nation's streams is derived from ground water, ground water is increasingly becoming recognized as a conduit for nonpoint source contamination to surface water. Under Section 303(d) of the Clean Water Act (CWA), the states have identified over 20,000 lakes and stream segments whose contaminant levels exceed one or more water quality standards.

2.2 Ground Water Characteristics

Ground water does not rest; it moves continuously but often very slowly to areas of natural discharge. Except for water removed by wells, ground water travels until it reappears naturally as springs or empties into rivers, lakes, wetlands, or oceans.

Ground water constitutes an enormous quantity of the fresh water found on Earth. Ninety-six percent of all fresh water on earth is ground water (EPA 1998a). As illustrated in Exhibit 2-4, major ground water aquifers are located all over the country. Besides these major aquifers, smaller aquifers exist at the regional level either above or below these major or principal aquifers. A well can be drilled just about anywhere in the country at some depth to supply enough water to support a household.

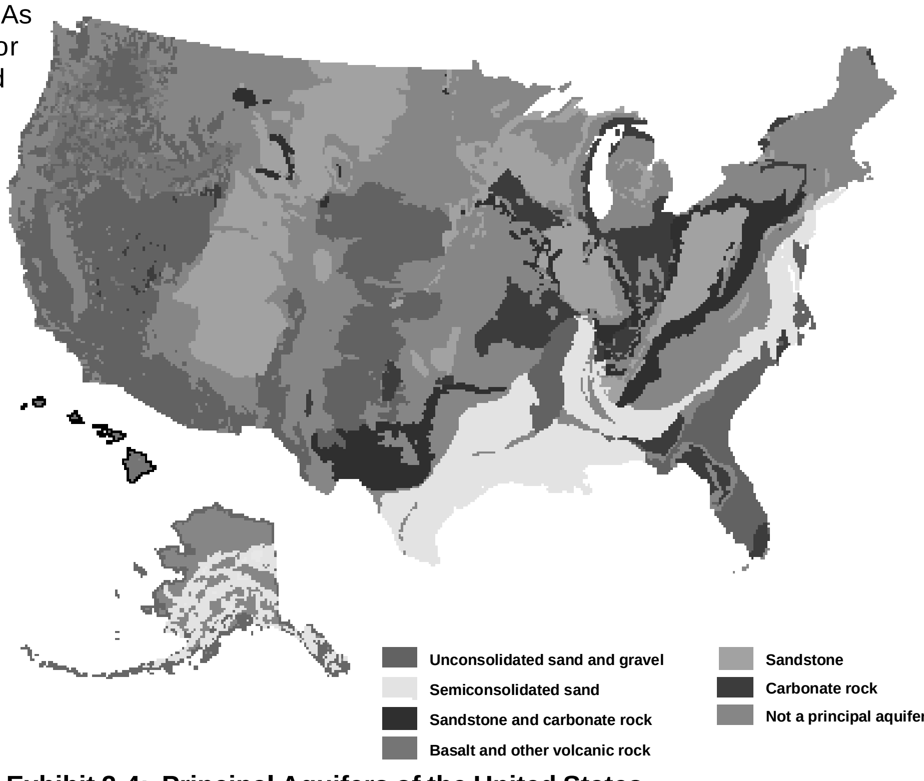
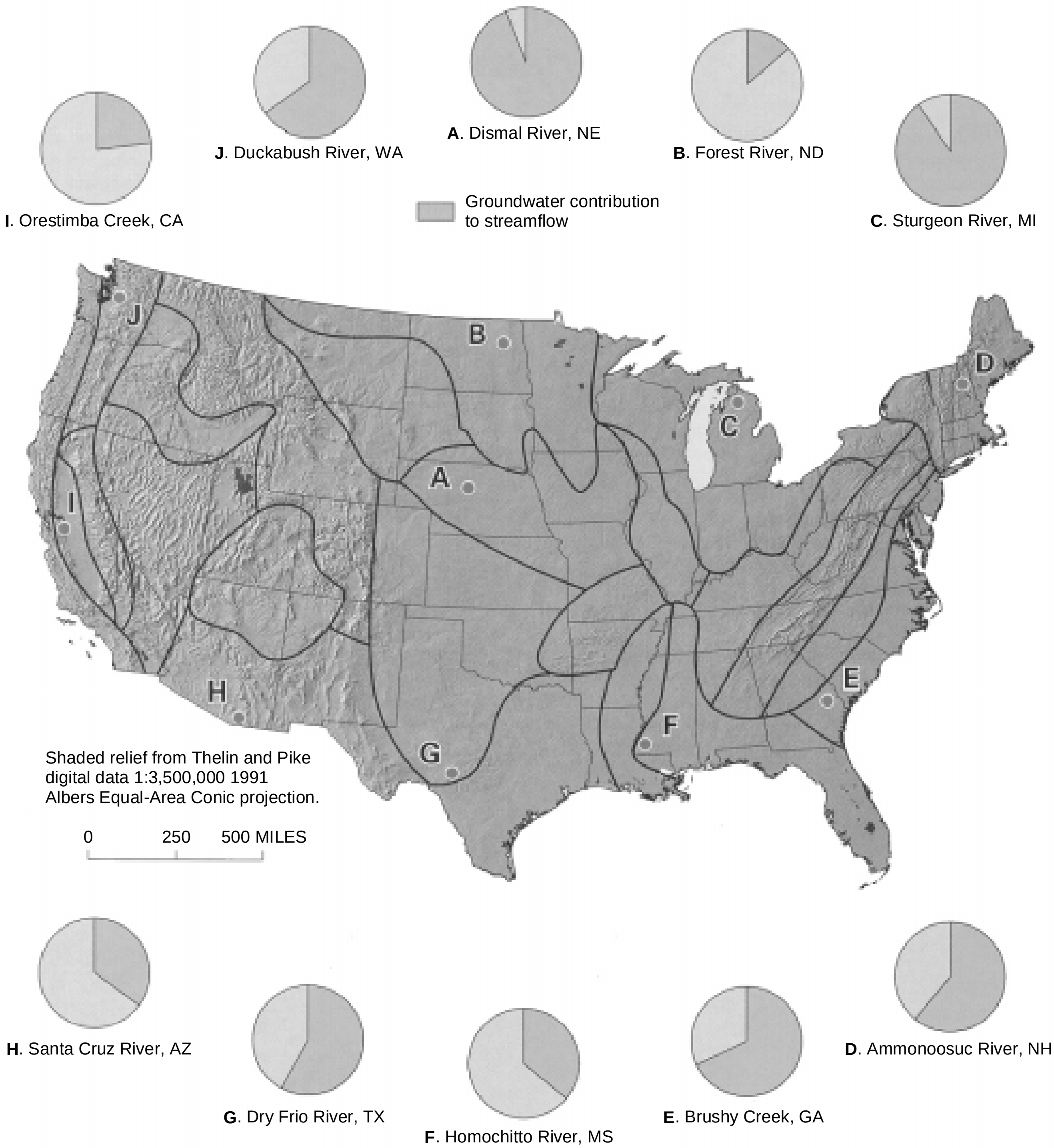


Exhibit 2-4: Principal Aquifers of the United States
Source: U.S. Geological Survey (1998b)



In the conterminous United States, 24 regions were delineated where the interactions of groundwater and surface water are considered to have similar characteristics (i.e., ground water accounts for a similar proportion of surface water discharge within each region). The estimated groundwater contribution to stream flow is shown for specific streams in 10 of the regions.

Exhibit 2-5: Ground Water Contributions to Surface Water in 10 Hydrologic Regions Around the County
Source: USGS (1998g)

Although the ground water resource is extensive, it is also vulnerable to contamination and locally vulnerable to over-pumping and loss of aquifer capacity. Recognition of these threats to our ground water resources has prompted the U.S. Geological Survey (USGS) to refocus its strategic direction to support assessments of ground water vulnerability. Ground water vulnerability is governed by a variety of factors, including the amount of soil or other geologic materials overlaying ground water, the depth and geologic characteristics of the aquifer, and the time it takes to replenish the aquifer. On average, every gallon of water withdrawn from the ground takes 280 years to replace (Heath 1983). By comparison, surface water is replaced shortly after withdrawal from a lake or stream. Agricultural activities account for the majority of ground water use in this country. Irrigation is important for maintaining yields from cropland throughout the nation, with the greatest volume of irrigation water use occurring in the western and southeastern United States (Exhibit 2-6). Approximately 75 percent or more of harvested cropland in many of the western United States is irrigated.

Exhibit 2-6: Agricultural Irrigation
Source: Marty Link, Nebraska Department of Environmental Conservation

Watering of livestock also accounts for significant withdrawals of fresh ground water. Of all the states, California uses the greatest volume of ground water supplies to support agriculture — 80 percent of all fresh ground water withdrawn in the state is used for agriculture.

Ground water use between 1950 and 1995 has followed national trends in total water use. From 1950 through 1980, ground water withdrawals increased, which coincided with a steady increase in total water withdrawals. Although recent USGS studies indicate a possible decrease in the amount of ground water used in the United States due to water conservation, over-pumping continues to threaten many ground water supplies at the local and state level, leading to problems such as salt water intrusion, loss of discharge to surface water, and loss of aquifer capacity (USGS 1998b).

Factors Making Ground Water Vulnerable to Contamination - The Puget Sound Basin, Washington

Ground water vulnerability is a relative measure of the risk that ground water will be contaminated by a particular chemical, such as nitrate. Nitrate contamination of ground water primarily results from fertilizers, septic systems, and urban runoff. In the Puget Sound Basin of Washington State, shallow wells screened in aquifers that have coarse-grained glacial deposits at the surface and a high percentage of urban (residential, commercial, and industrial) or agricultural land use are most vulnerable to nitrate contamination. For example, shallow wells in agricultural areas overlying coarse-grained glacial deposits, such as much of the Lower Nooksack Valley, and urban areas overlying such deposits, like parts of Tacoma and Olympia, have a greater than 50 percent probability of nitrate concentrations at or above 3 mg/L. Nitrate concentrations at these levels are well above naturally occurring levels in the Puget Sound Basin and indicate that a man-made source of nitrate is contaminating ground water. Areas containing wells with elevated levels of nitrate should be closely monitored to ensure that the nitrate drinking water standard of 10 mg/L is not exceeded.

Source: Erwin, M.L. and Tesoriero, A.J., 1998 (USGS Fact Sheet 061-97).

The Movement of Water on the Earth

When precipitation falls on the surface of the earth, the water may either (1) run off the land surface to the nearest stream, (2) be taken up by plants, (3) be lost to evaporation, or (4) soak into the soil (see Exhibit 2-7). Water that soaks into the soil may continue to percolate through open spaces to deeper subsurface geologic formations. The water that enters these subsurface areas is considered ***ground water***. Certain types of geologic formations can store and hold large quantities of ground water because of their physical characteristics. These formations are called ***aquifers***. However, even the water that does percolate into the soil will eventually flow into lakes, streams, or oceans.

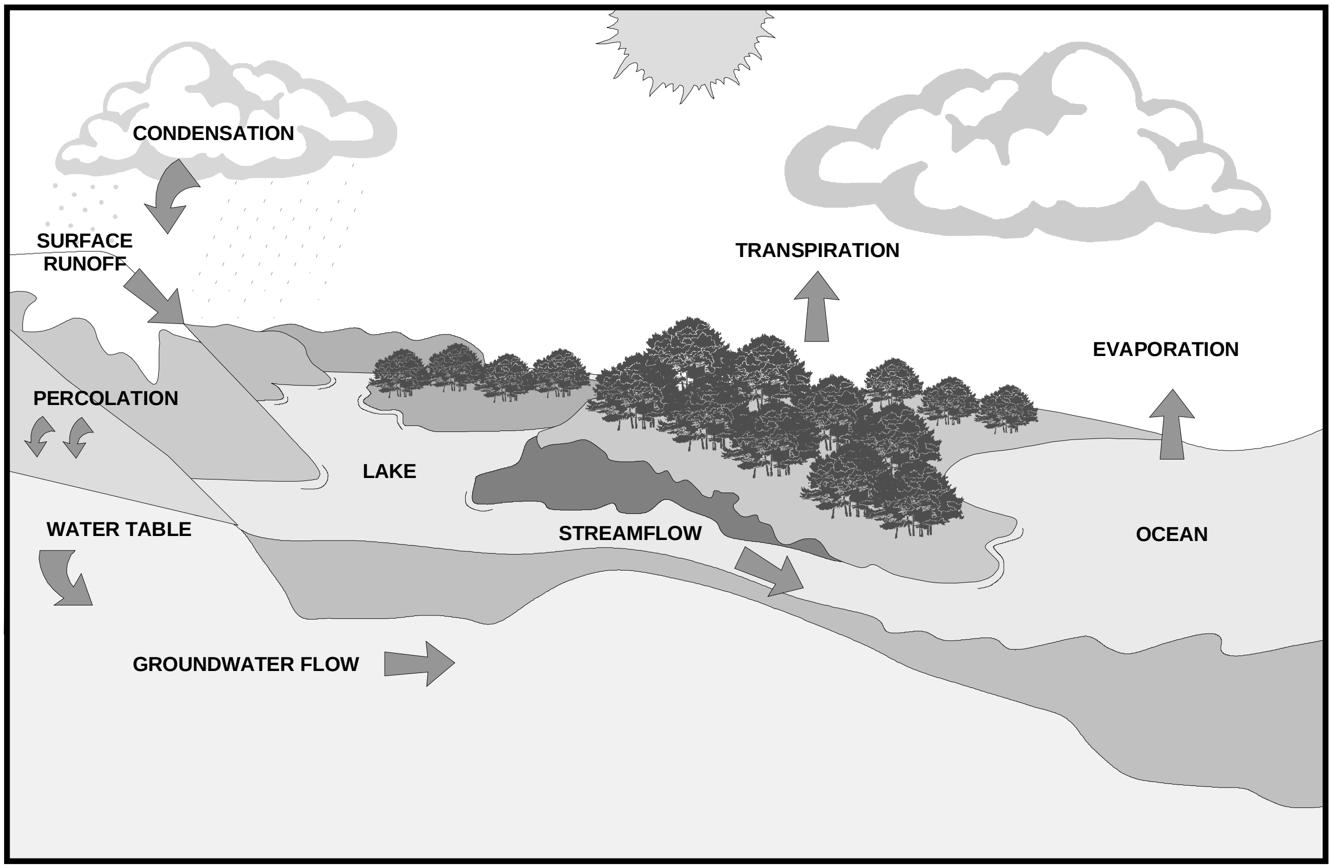


Exhibit 2-7: The Hydrologic Cycle

3.0 GROUND WATER QUALITY: A RESOURCE AT RISK

This section discusses the key threats to ground water quality that occur nationwide and the available data to characterize those threats.

3.1 The Quality of the Nation's Ground Water

Ground water is a valuable natural resources. Because of filtration through vegetation, soil, and geologic materials, ground water is generally considered to be a more naturally protected resource than surface water. In addition, unlike surface water bodies (such as streams, rivers, and lakes) that are only found in discrete areas, ground water is present across the nation at various depths below the ground surface. Because of these characteristics, the public has come to expect ground water to be generally available and of high quality. Although the nation has come to rely strongly on this resource, the threats discussed in this section pose significant management challenges for state and federal ground water management programs.

> Ground water quality in this country is generally good, but many local activities threaten the resource.

National and local studies increasingly indicate that many activities adversely impact ground water quality. Contamination incidents and impairment from over-pumping, such as permanent loss of aquifer storage capacity and land subsidence, remain a local problem because of the relatively slow rate at which ground water travels. A variety of agricultural, industrial/commercial, and waste disposal practices are known to contaminate ground water. The occurrence of nitrate, pesticides, volatile organic chemicals (VOCs), and other contaminants in ground water all reveal the impact of land use on ground water quality. Over-pumping can impair nearby wells; reduce ground water flow to streams, lakes, and wetlands; permanently damage aquifer storage capacity; and induce salt water intrusion to freshwater aquifers. Because no one federal, state, or local authority can manage all of these threats, a coordinated approach for ground water management is needed.

This section includes an overview of many of these threats and provides general findings regarding the quality of ground water in the nation today. Although the nation is just beginning to gather national-scale data on the occurrence of a limited number of chemicals in ground water, our knowledge of ground water quality and the threats to the resource is growing[1]. As discussed below, information about trends in ground water quality is preliminary because the nation has not assessed ground water quality nationwide on a consistent basis. However, we do know that certain land use changes result in more widespread occurrences of contamination in the nation's ground water.

3.2 Threats to Ground Water

Over the past twenty years, thousands of local ground water contamination incidents have been identified and the nation has devoted many billions of public and private dollars to clean-up these problems. Although these efforts have protected many people from exposure to ground water contaminants released from sources such as hazardous waste sites and leaking underground storage tanks, some incidences of ground water contamination have not yet been fully cleaned up. In some instances, ground water remediation can take a decade or more to be completed. Furthermore, in many parts of the country, we are using ground water at a faster rate than it can be replenished through natural recharge, and, in some cases, we are permanently losing future storage capacity. As a result, while we are not yet facing a ground water crisis, current trends in ground water quality and ground water use point to the need for a more coordinated ground water protection effort in this country.

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[1] The USGS National Water Quality Assessment (NAWQA) Program, discussed below, is designed to assess changing ground water quality conditions as they relate to land use. While sufficient data sets are not yet available to monitor for ground water quality trends in a consistent, systematic manner, NAWQA will serve to identify changing ground water quality conditions in important agricultural and urban settings overlying aquifers used for public and domestic supply. This information may allow for the development of trend models that states and others can use to improve the design of future sampling efforts.

Various federal, state, and academic information relates agricultural, industrial, waste disposal, and other land uses with ground water degradation. Certain land uses are known to impair ground water quality, but the ability to predict the level of impairment from specific activities is difficult, especially over long periods of time.

The U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program is the principal source of information on ground water quality available in the United States today and provides the basis for the findings presented in this section.

Under the NAWQA program, USGS collects new water quality data in 60 special study regions of the country, conducts retrospective analyses of existing data (such as state data), and prepares national-scale syntheses of the results. U.S. EPA relied on the most recent NAWQA reports in preparing this discussion.

In addition, U.S. EPA prepares summary reports on ground water quality. In the Biennial Water Quality Inventory Report to Congress (also known as the "305(b) Report"), EPA synthesizes a national picture of ground water quality and protection programs by consolidating state-level water quality assessments. The 1998 report represents only the second cycle of data synthesis, and is a compilation of individual state reports. As state reporting matures, improvements in data comparability, coverage, and better representation of actual conditions are expected.

EPA is also developing a National Contaminant Occurrence Database (NCOD) to track contaminants in ground water and surface water sources of drinking water supply. The NCOD will aid in the identification and selection of contaminants for future drinking water regulations, support regulation development or other appropriate actions, and assist in the review of existing regulations for possible modification. The NCOD will also inform the public about contaminants in drinking water. The NCOD will incorporate data of documented quality from existing federal databases on regulated and unregulated physical, chemical, microbial, and radiological contaminants, and other contaminants that are known or are likely to occur in the source and finished waters of public water systems of the United States and its territories.

These studies and reports are important for national policy decision-making. Some study results are highlighted below, as well as information on contaminant sources known to significantly impact ground water quality.

Preliminary findings from NAWQA studies regarding the impact of certain land uses and contaminants on ground water are presented in this section. The greatest volume of national data is available to characterize nitrate occurrence in ground water. Because nitrate is often found in conjunction with other nutrients and pesticides, nitrate is often used as an indicator of the impact of agricultural and residential land use on ground water quality. In addition, the characteristics of the major contaminant sources are described. This section does not present a comprehensive list of land uses or contaminants that affect ground water, but it does provide an illustration of common threats and their impacts.

Major Sources of Ground Water Contamination (from the 1996 305(b) Report)

In the 1996 305(b) Report, 37 states reported on potential sources of ground water contamination. Those sources most frequently cited as being of greatest concern include underground storage tanks, landfills, septic systems, hazardous waste sites, surface impoundments, aboveground storage tanks, industrial facilities, spills, fertilizer and pesticide applications, pipelines and sewer lines, agricultural chemical facilities, shallow injection wells, salt water intrusion, animal feedlots, land application, mining, urban runoff, salt storage and road salting, and hazardous waste generators.

Source: EPA (1998a)

Agricultural Practices

Food production in this country has become highly dependent on the use of agricultural chemicals, including fertilizers and pesticides. When these chemicals are applied to the land, they may be transported through the soil and into ground water. The impact of agricultural chemical use on ground water may be especially severe in areas with the following characteristics:

(1) high rainfall, snowmelt, or excessive irrigation, especially following recent agricultural chemical application;

(2) well drained and permeable soils that are underlain by sand and gravel or fractured bedrock, which enable rapid downward movement of water;

(3) crop-management practices that slow runoff and allow more time for water to infiltrate into the ground; and

(4) soils low in organic matter and high levels of dissolved solids

Ground Water Quality

On the basis of preliminary findings, the NAWQA program has found that the highest concentrations of pesticides, primarily herbicides, and nitrate detected in ground water are in areas overlain by agricultural activities (USGS 1996, 1998d, 1998e, 1998f, 1999b, and 1999c). Specific findings from the NAWQA studies with regard to pesticides and nitrate are discussed on the following pages:

Pesticides

Concentrations of individual pesticides in ground water generally are low and rarely exceed most EPA drinking water standards and guidelines. In less than 1 percent of wells sampled in the NAWQA program, pesticide concentrations exceeded standards or guidelines (USGS 1999c). Concentrations of some herbicides (a type of pesticide), including herbicides used to control weeds and vegetation on lawns, golf courses, and along roads and rights-of-way, were elevated in samples collected from streams and shallow ground water in urban areas, although these concentrations were found to be slightly higher overall in agricultural areas. (USGS 1999c).

NAWQA study results also show that although pesticide concentrations do not exceed drinking water standards frequently, this assessment may be incomplete with regard to the overall health and environmental risks associated with the presence of pesticides in shallow ground water (USGS 1998d, 1998e, 1999c). Drinking water standards for the protection of human health have only been established for 25 of the 46 pesticide compounds examined. These drinking water standards only consider the effects of individual compounds and do not account for the presence of more than one pesticide compound; some studies indicate that combinations of pesticide compounds may exhibit additive or even synergistic toxic effects. Seventy-three percent of the sampling sites where pesticides were detected had two or more compounds present, 25 percent had four or more, and 6 percent had six or more compounds present.

Other pesticide compounds for which drinking water standards or surface water quality criteria have not been developed, particularly pesticide degradates, have been detected in ground water. It has not yet been determined whether these compounds may have adverse health effects.

Nitrate

Nitrate concentrations in ground water are highest in samples collected from wells in agricultural areas. Contamination from nitrate occurs most frequently in shallow ground water (less than 100 feet below the land surface) and in aquifers located in geologic settings that allow the rapid movement of water. Furthermore, high levels of nitrate may serve as an early warning of possible future degradation of older, underlying ground water, commonly a primary source for public-water supply.

Nitrate in Ground Water in Oklahoma

In the mid-1990's, 5,677 water samples from privately-owned wells were analyzed by the State of Oklahoma. These water samples were collected from homeowners with private wells. Of the 5,677 samples, nitrate concentrations of at least 3 mg/L were detected in 3,687 samples (i.e., 65 percent). In general, a nitrate concentration at or above 3 mg/L is indicative of human impacts on ground water quality. In addition, 1,462 of the collected samples (i.e., 27 percent) contained nitrate above the drinking water standard of 10 mg/L. In the extremes, 36 samples contained nitrate in excess of 100 mg/L, with one sample at 625 mg/L.

Source: Ground Water Protection Council (1999)

Concentrations in about 12 percent of domestic-supply wells in agricultural areas exceeded the drinking water standard of 10 mg/L. Regional differences are related to soil-drainage properties and other geologic characteristics, and agricultural practices. Nitrate in ground water is highest in areas of well-drained soils and intensive cultivation of row crops, such as corn, cotton, or vegetables. Low concentrations of nitrate are found in areas of poorly drained soil and where pasture or woodland is intermixed with cropland.

Contaminant Sources

As mentioned above, a variety of fertilizers and pesticides are used in agricultural operations. In addition, the high volume of wastes associated with animal feeding operations are also being recognized as a potential threat to ground water.

Animal Feeding Operations (AFOs)

AFOs are agricultural operations where animals are kept and raised in concentrated areas. AFOs congregate animals, feed, manure and urine, dead animals, and production operations in a small land area. Because of the high concentration of animals and the large amount of animal manure and wastewater generated, it is widely recognized that AFOs can pose a number of risks to water quality and public health. Approximately 450,000 agricultural operations nationwide confine animals.

Exhibit 3-1: Animal Feeding Operation (AFO)

Manure and wastewater from AFOs have the potential to contribute pollutants such as nutrients (for example, nitrogen and phosphorus), pathogens, hormones, and antibiotics to ground water. Nitrogen in the form of nitrate can contaminate ground water drinking water supplies. In areas where nutrient-rich ground water discharges to surface water, excess nutrients in surface water can also result in or contribute to eutrophication, anoxia, and hypoxia (low levels of dissolved oxygen), toxic algal blooms that may be harmful to human health, and outbreaks of microorganisms such as *Pfiesteria piscicida*.

The U.S. Department of Agriculture (USDA) and EPA jointly published a Unified National Strategy for Animal Feeding Operations. The Unified Strategy discusses the relationship between AFOs and environmental and public health and establishes a national performance expectation for all AFO owners and operators. The Strategy presents a series of actions to minimize public health impacts and improve water quality while complementing the long-term sustainability of livestock production. In particular, the Strategy states the expectation that all AFO owners and operators will develop and implement technically sound and economically feasible site-specific Comprehensive Nutrient Management Plans.

Industrial and Commercial Practices

Raw material extraction, primary and secondary product fabrication, and certain retailing and service industries manage a wide range of potential ground water contaminants. Heavy industrial practices, such as large-volume petroleum and chemical production and storage facilities, are well documented potential sources of contamination and are subject to extensive regulatory and management controls. Other light industrial and commercial practices, such as electroplaters, auto repair shops, and dry cleaners, may also manage products or waste materials that can contaminate ground water (EPA 1990).

There are three common types of chemical contaminants that may be associated with industrial and commercial activities, volatile organic compounds (VOCs), other organic compounds, and inorganic compounds. Although the most commonly found contaminants in ground water are VOCs, inorganic contaminants are commonly found in contaminated ground water at Superfund National Priority List sites. Inorganic contaminants, however, are rarely found above drinking water standards away from these sites.

Ground Water Quality

Ground water in areas with industrial and commercial activities can become contaminated by releases of chemicals. Based on preliminary NAWQA findings (USGS, 1998c, 1999a), 46 (out of 60 selected for analysis) different VOCs have been detected in ground water nationwide, however, these detections are generally below the applicable drinking water standards. VOCs are most frequently detected in shallow ground water in urban areas. Approximately 54 percent of samples taken in shallow ground water in urban areas contained one or more VOCs.

Chemical solvents (such as trichloroethylene, perchloroethylene, and carbon tetrachloride) are a type of VOC that is used in a wide variety of industrial and commercial facilities for cleaning or degreasing purposes. Some of these chemicals are very mobile in the subsurface environment. As a result, solvents are common sources of ground water contamination. Some municipal and private wells have had to shut down as the result of solvent contamination.

Methyl *tert*-butyl ether (MTBE)

MTBE is a VOC that is added to gasoline to increase octane levels and to reduce carbon monoxide and ozone levels in the air. MTBE is identified as a potential human carcinogen by EPA. Under the NAWQA program, MTBE was detected in 21 percent of 480 wells located in areas that use MTBE in gasoline to abate air pollution. In the rest of the nation, MTBE was detected in 2 percent of ground water samples (2,263 wells sampled) . Most of the MTBE detections have been at levels below the EPA drinking-water advisory of 20 to 40 micrograms per liter (ug/L). Sources of MTBE in ground water include gasoline released from accidental spills, leaking underground storage tanks, pipelines, and watercraft emissions.

Source: USGS (1999a)

Contaminant Sources

Underground Storage Tanks

Leaking underground storage tanks (UST) are of special concern at commercial and industrial facilities. As of February 28, 1999, about 386,000 releases from regulated UST systems have been reported. These releases have contaminated soil and potentially ground water. Gasoline leaking from UST systems at service stations is one of the most common sources of ground water contamination. Because the released petroleum products contain many potential hazardous and toxic chemicals (e.g., benzene), many of these releases have posed serious threats to human health and the environment. Some municipal and private wells have had to shut down as the result of gasoline contamination.

As of December 1998, regulated USTs were required to be upgraded to prevent leaks to ground water or be closed (40 CFR Part 280).

Waste Disposal

According to 1997 EPA Toxic Release Inventory data, U.S. industries reported that over 840 million pounds of toxic materials were disposed on the land or in underground injection wells. In addition, large volumes of waste materials are also disposed by households and other small commercial and industrial facilities in septic systems and underground injection wells. The likelihood of contaminants from these sources reaching ground water is highly site-specific, and state and federal waste disposal regulations are intended to prevent such problems.

Ground Water Quality

The inappropriate disposal of wastes from various land use activities, including residential, industrial, and commercial activities, may pose serious contamination threats to ground water. Improperly sited or maintained septic systems, improper waste disposal into the ground through shallow wells,

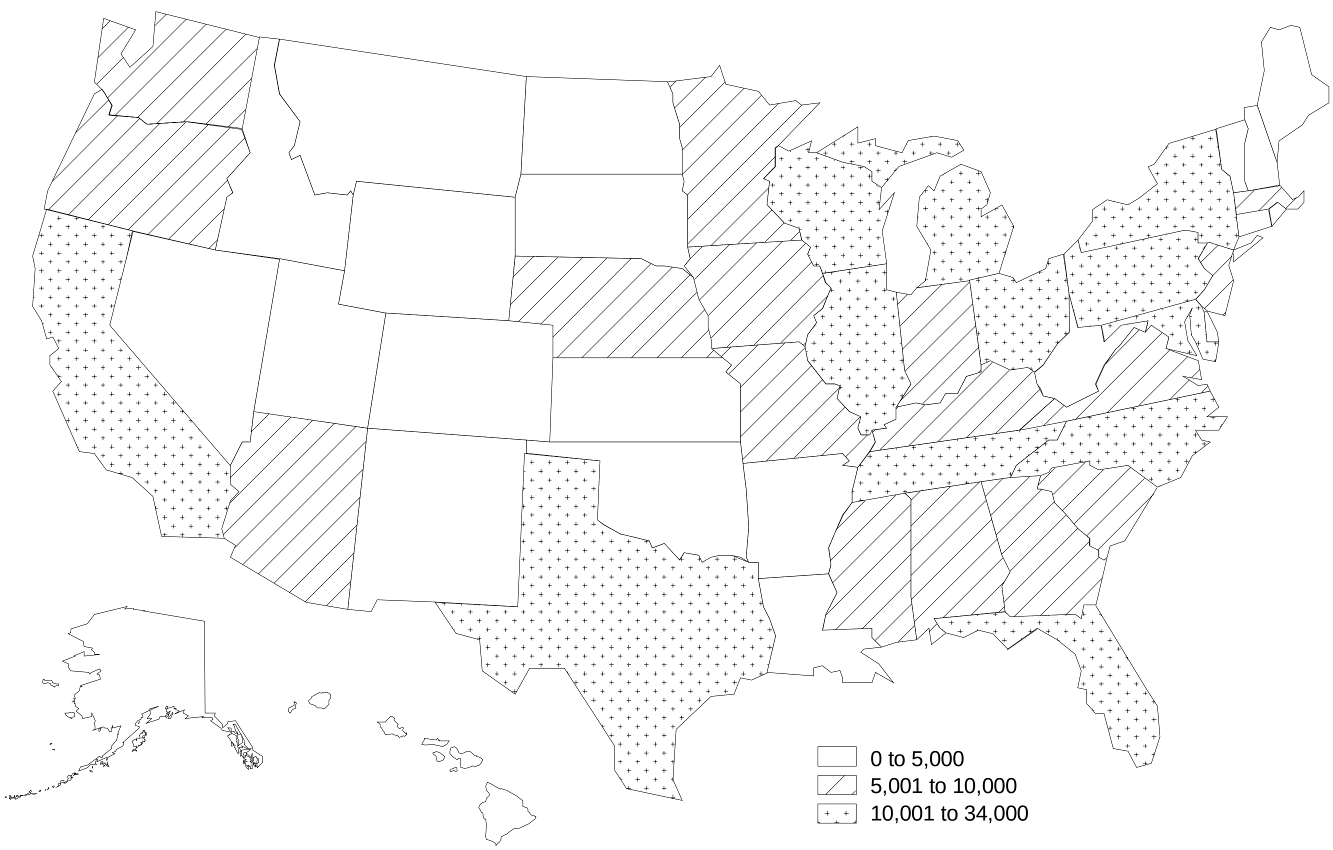

Exhibit 3-2: Confirmed Underground Storage Tank Releases to Soil and Potentially Ground Water as of February 28, 1999
Source: EPA (1999)

mismanagement of wastes from AFOs, and waste disposal at landfills and open dumps have contaminated ground water. In addition to chemical contaminants, some disposal activities introduce microorganisms such as bacteria and disease-causing viruses into ground water.

Contaminant Sources

Septic systems and Class V underground injection wells are discussed below as sources of ground water contaminants. In addition, the impact of over-pumping on ground water quality and availability is discussed.

Septic Systems

According to data from the U.S. Bureau of Census (1997) and information collected by the National Small Flows Clearinghouse (1999a), over 23 million U.S. households rely on septic systems for their domestic wastewater disposal (National Small Flows Clearinghouse 1999a). In addition, millions of commercial and industrial facilities use septic systems for wastewater disposal. Septic system effluent represents a significant source of ground water contamination and has resulted in waterborne disease outbreaks in the United States. In 1993 and 1994, 17 states and one territory reported 30 disease outbreaks associated with drinking water, affecting an estimated 405,000 people. Twenty of the outbreaks were caused by septic contamination of well water (Kramer et al., 1996). Bacteria and viruses in household wastewater are principal causes of acute gastrointestinal illness and Hepatitis A, and thus pose a significant threat to drinking water supplies. In addition, recent studies suggest that up to 10 percent of septic systems in the U.S. have major failures annually, releasing as much as 4 million gallons of untreated septage.

Septic systems are usually regulated locally through health ordinances that require a separation distance or setback between the septic system and a private well. EPA has data that suggest there is a significant risk of illness from drinking fecally contaminated ground water. Fecal contamination of ground water is associated with human waste or animal waste which enters the ground water from sources such as leaking sewer lines, septic systems, improperly treated sewage treatment plant discharge, or leakage from AFOs. Fecal contamination contains viruses and bacteria that cause illnesses, such as diarrhea, and have been associated with even more severe diseases, such as congential heart disease. EPA believes there is the potential for significant risk from drinking untreated and partially treated ground water due to the large number of ground water systems in the nation (over 156,000). EPA expects to issue a new regulation in the year 2000 called the “Ground Water Rule” (GWR). EPA plans to propose the GWR in order to reduce the risk of illness from viruses and bacteria for people drinking ground water from public water systems.

Class V Injection Wells

Class V injection wells are typically shallow disposal systems used to place a variety of nonhazardous fluids underground. These fluids can contaminate ground water and threaten public health if they are present in high levels. These injection wells, along with other classes of injection wells, are regulated by EPA and the states through the Underground Injection Control (UIC) program to protect underground sources of drinking water from contamination.

EPA estimates that from 700,000 to one million Class V injection wells are currently used in the United States. Class V injection wells are located in every state, especially in unsewered areas where the population is likely to depend on ground water for its drinking water source. Fluids released by certain types of Class V wells have a high potential to contain elevated concentrations of contaminants that may endanger drinking water. These high-risk wells are commonly used, for example, by motor vehicle repair shops, commercial printers, and a wide range of light industries (EPA 1998c).

Under existing federal regulations (40 CFR 144), Class V injection wells are “authorized by rule”, which means that they do not require a permit if they do not endanger underground sources of drinking water and comply with UIC program requirements. Because EPA believes that certain high-risk Class V injection wells are posing a threat to underground sources of drinking water, it is formulating strategies to ensure the protection of drinking water. In 1998, EPA proposed new regulations to address high-risk Class V injection wells (i.e., motor vehicle waste disposal wells and large-capacity cesspools). A final Class V rule regulating these wells is expected in late 1999. Also, a study is underway to examine other high-risk wells to determine those additional categories of wells that need to be regulated.

Ground Water Over-Pumping

Ground water is pumped for municipal (drinking water and other household uses), agricultural (irrigation and livestock), industrial (manufacturing), mining, and other uses. If these withdrawals exceed the rate at which ground water is recharged, they result in the lowering of ground water to levels that may impair the use of the resource. In some cases, ground water levels have dropped by hundreds of feet. Impacts from over-pumping may include the following:

- ❑ Neighboring wells may dry up requiring construction of new, deeper wells, or significant changes to existing wells.
- ❑ Compaction of aquifer materials causing land subsidence that may damage buildings and infrastructure (such as, pipelines, roads, and canals).
- ❑ Compaction of aquifer materials can also cause permanent loss of aquifer capacity. This can result in higher pumping cost and a decrease in well yields.
- ❑ Changes in the volumes and direction of ground water flow can induce flow of salty water and undesirable water (water of lower quality) into a well.
- ❑ Lower stream baseflows can dry up wetlands and cause adverse impacts on ecological systems that are dependent on ground water discharge.

3.3 What These Ground Water Threats Mean to the Nation

Ground water contamination or depletion have many impacts on our society and may result in the public health, economic, and ecological impacts discussed below.

Public Health Impacts

Both short-term illness and chronic health impacts are associated with the consumption of contaminated drinking water. For example, the presence of pathogenic microorganisms can cause acute gastrointestinal illness, Hepatitis A, and other diseases. Carcinogenic chemicals can increase the incidence of cancer. Other chemicals can adversely impact the growth and development of children. For instance, high levels of nitrate in drinking water consumed by newborns can lead to a fatal condition known as "blue baby syndrome." Once ground water is contaminated with certain compounds, certain treatment processes such as disinfection with chlorination used by public water systems, can transform these compounds into chemicals that may also pose concern (such as trihalomethanes, a group of carcinogenic disinfection-byproducts), thereby exposing the population to other health risks. Also, some contaminants, such as nitrates, are expensive to treat and may be very costly to remove through home treatment.

Ground water contamination in rural areas is a particular public health concern. Rural homes often take their drinking water from shallow ground water

Salt Water Intrusion - Salinas Valley, California

Located 100 miles south of San Francisco, the Salinas Valley supports a major portion of California's and the nation's vegetable production. Virtually all of the water used for municipal, industrial, and agricultural purposes is ground water. Throughout the years, saltwater has intruded into valley aquifers because of excessive pumping and dewatering of the aquifers. In and around Castroville, a highly productive agricultural area about two miles from the Monterey Bay Sanctuary, the saltwater intrusion has made ground water too salty for agricultural and drinking water use. The salt water layer has actually moved 6 miles inland at a depth of 180 feet. If left unchecked, salt water intrusion will continue to move up the Salinas Valley toward the City of Salinas, thereby rendering all ground water in the area unusable.

One solution is a 30,000 acre-foot per year water recycling plant to recycle wastewater and a 45-mile long pipeline and well project to use recycled water on crops and thereby reduce ground water pumping. Congress has appropriated $15.7 million for these two projects from 1995 to 1999.

Source: Monterey County Resource Agency and Monterey Regional Water Pollution Control Agency (1999).

systems, which are vulnerable to contamination by agricultural chemicals. As a result, rural families may be unknowingly exposed to a variety of hazardous substances in their drinking water.

EPA has promulgated drinking water maximum contaminant levels (MCL) for 90 substances to set safe limits for public water supplies. However, many contaminants in drinking water have no MCLs. Furthermore, combinations of chemicals in drinking water can have health impacts that are not well understood. As a result, preventing ground water contamination used as the source of drinking water supply is a critical concern.

Economic Impacts

Ground water contamination can also impair the economic well-being of the nation through the following:

- ❑ Removal of contaminants from drinking water sources through remediation or at the point of supply through treatment can be very costly.
- ❑ Relocating wells and finding new ground water supplies is expensive and may not be technically feasible.
- ❑ The presence of contaminants in ground water adds liability to the land owners of the property that is the source of the contamination.
- ❑ Loss of ground water due to over-pumping and contamination can lead to loss of drinking water, agricultural and industrial supplies, and recreational uses.

In 1995, EPA examined costs associated with six communities that had experienced actual or imminent contamination of the ground water supplying their public water systems (EPA 1995b).

Ground Water Treatment and Well Replacement Costs - Massachusetts

The State of Massachusetts has spent millions of dollars in state funds to clean-up and treat contaminated public water supply wells. For example, the Town of Easthampton, MA, in conjunction with the state, has spent $1.7 million for treating a 5 million gallon per day wellfield. The Town of Millis, MA has spent $750,000 treating a 1.5 million gallon per day wellfield.

Source: New England Interstate Water Pollution Control Commission (1996)

The costs associated with alternative water supplies, water treatment, and contaminant source removal or remediation ranged from over $0.5 million to about $2.4 million. A 1992 analysis by EPA indicated that for 51 selected communities with contaminated or threatened drinking water systems, the cost of remediation averaged $5.9 million per community water system, with most costing between $1 million and $10 million (EPA 1992a).

According to the National Research Council (1994), as much as $1 trillion in public and private funds may be needed to clean-up soil and ground water in this country over a period of 30 years. The Ground Water Protection Council estimated $14 billion is needed annually to remediate ground water and soil at Superfund sites, hazardous waste sites with corrective actions, leaking UST sites, Department of Defense and Department of Energy waste sites, and other contaminated sites (Ground Water Protection Council 1996). Furthermore, the potential liability associated with contamination, including ground water contamination, at former industrial or commercial sites with known or suspected contamination is often one of the greatest deterrents to site redevelopment. EPA and state Brownfield initiatives are designed to address concerns over site redevelopment of contaminated sites by, in part, promoting innovative approaches to address contamination.

Ecological Impacts

Ground water is also critical to the ecological health of the country. Loss of ground water can lead to reduction of stream flows (especially during low flow conditions), which in turn negatively affects surface water ecosystems. Contaminated ground water discharging into surface water can degrade surface water quality and affect surface water ecosystems.

Ground water provides many ecological benefits through its linkage with surface water. The interrelationships of ground water with wetlands, lakes, ponds, and streams are complex. In areas where ground water has been contaminated (by domestic wastewater or industrial discharges), ecological impacts can be detected in the form of eutrophication and loss of native fish and plants.

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4.0 GROUND WATER MANAGEMENT

> Responsibility for ground water management is shared by a large number of federal, state, and local programs.

Ground water management in this country is highly fragmented, with responsibilities distributed among a large number of federal, state, and local programs. At each level of government, unique legal authorities allow for the control of one or more of the ground water threats described in Section 3.0. These authorities need to complement one another and allow for comprehensive management of the ground water resource. If these authorities are to be used effectively, the implementing agencies must coordinate and share information on the following topics:

- ❑ Ground water characteristics and quality.
- ❑ The locations of ground water threats.
- ❑ Resources and regulatory authorities to control threats and remediate existing problems.
- ❑ Means for establishing common management priorities.

This section describes approaches that have been taken at the federal and state levels to promote coordination as a means of improving the effectiveness of ground water management programs.

4.1 Federal Ground Water Management Programs

Over the past 25 years, federal laws, regulations, and programs have come to reflect the growing importance that the nation places on using ground water wisely and protecting the resource. Federal legislation and programs to manage ground water are discussed below.

Beginning with the 1972 amendments to the federal Water Pollution Control Act, and followed by the Safe Drinking Water Act in 1974, the federal government's role in ground water protection has increased. With the passage of the Resource Conservation and Recovery Act (RCRA) in 1976 and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980, the federal government's current focus on ground water remediation was established. These federal remediation programs require parties responsible for contamination to pay for clean-up activities. Since the passage of those Acts, the federal government has directed billions of dollars in public and private resources toward clean-up of contaminated ground water at Superfund sites, RCRA corrective action facilities, and leaking underground storage tanks.

To date, federal, and related state, ground water programs have focused primarily on clean-up of existing contamination, rather than on pollution prevention. These programs have been very costly. As such, remediation programs have provided considerable incentives for pollution prevention efforts by responsible parties.

Furthermore, where ground water has already been contaminated, clean-up can help protect other ground water resources from further degradation by containing the migration of contaminants within an aquifer and to lower aquifers.

Certain federal and state programs are intended to prevent ground water contamination; however, those programs tend to focus on a narrow set of contaminants or contaminant sources. For example, under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the federal government establishes regulations to prevent ground water contamination resulting from pesticide use. Under RCRA, the federal government also has promulgated standards for the "cradle to grave" management of hazardous and solid wastes and the management of waste site operations and underground storage tanks that will reduce the likelihood of ground water contamination.

Under the SDWA, EPA is developing a regulation that will require public water supplies to increase monitoring and/or treat their source waters derived from ground water sources that could be contaminated by microbial pathogens (see discussion of "The Ground Water Rule" in Section 3.0). The Source Water Assessment and Protection Program, authorized under Section 1453 of the SDWA, should lead to better management of potential drinking water contaminant sources within drinking water source protection areas, such as potential pathogenic sources like sewer lines, septic systems or animal feeding operations.

Federal Laws Administered by EPA Affecting Ground Water

Clean Water Act (CWA)
Ground water protection is addressed in Section 102 of the CWA, providing for the development of federal, state, and local comprehensive programs for reducing, eliminating, and preventing ground water contamination.

Safe Drinking Water Act (SDWA)
Under the SDWA, EPA is authorized to ensure that water is safe for human consumption. To support this effort, SDWA gives EPA the authority to promulgate Maximum Contaminant Levels (MCLs) that define safe levels for some contaminants in public drinking water supplies. One of the most fundamental ways to ensure consistently safe drinking water is to protect the source of that water (i.e., ground water). Source water protection is achieved through four programs: the Wellhead Protection Program (WHP), the Sole Source Aquifer Program, the Underground Injection Control (UIC) Program, and, under the 1996 Amendments, the Source Water Assessment Program.

Resource Conservation and Recovery Act (RCRA)
The intent of RCRA is to protect human health and the environment by establishing a comprehensive regulatory framework for investigating and addressing past, present, and future environmental contamination or ground water and other environmental media. In addition, management of underground storage tanks is also addressed under RCRA.

Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA)
CERCLA provides a federal "Superfund" to clean-up soil and ground water contaminated by uncontrolled or abandoned hazardous waste sites as well as accidents, spill, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the clean-up. The program is designed to recover costs, when possible, from financially viable individuals and companies when the clean-up is complete.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
FIFRA protects human health and the environment from the risks of pesticide use by requiring the testing and registration of all chemicals used as active ingredients of pesticides and pesticide products. Under the Pesticide Management Program, States and Tribes wishing to continue use of chemicals of concern are required to prepare a prevention plan that targets specific areas vulnerable to ground water contamination.

This approach to ground water protection at the federal level has left the management of many contaminant threats to state and local government authorities. Examples of these threats include hazardous material or product use by light industry, such as dry cleaners, printers, or auto maintenance facilities; above-ground tanks; and certain types of waste disposal or drainage wells. Also, other ground water threats, such as over-pumping, are not generally addressed under federal law and are left to be managed by states and local governments.

In the absence of a federal regulatory framework, the degree to which states and local governments address ground water concerns varies considerably. Some states have well-coordinated, effective ground water protection programs. However, in many states, gaps exist in state management of some contaminant sources (e.g., above ground storage tanks of product rather than waste). This often occurs because there is no federal program with which states can align their programs. In other words, state efforts may be hampered by the absence of a federal program targeted to fill in the gaps among federal programs beyond those that address specific sources of ground water contamination, such as, RCRA, LUST, and Superfund. State and local governments may also need to give priority to mandates prescribed by existing federal programs even though, from a comprehensive resource protection viewpoint, these

Chronology of EPA Ground Water Protection Activities

1972	Federal Water Pollution Control Act Amendments
1972	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
1974	Safe Drinking Water Act (SDWA)
1976	Resource Conservation and Recovery Act (RCRA)
1980	Underground Injection Control Program established
1980	Comprehensive Environmental Response and Compensation and Liability Act (Superfund)
1984	Hazardous and Solid Waste Amendments to RCRA
1984	U.S.EPA Ground Water Strategy and Office of Ground Water Protection established
1986	Superfund Amendments and Reauthorization Act: Underground Storage Tank Program
1986	SDWA Amendments: Wellhead Protection and Sole Source Aquifer Programs
1987	Clean Water Act
1991	EPA Ground Water Strategy Revised
1992	Comprehensive State Ground Water Protection Program Guidance
1992	Interagency Task Force on Monitoring Water Quality (through 1996)
1993	Pesticide State Management Plans under FIFRA
1996	SDWA Amendments: Source Water Assessment and Protection Program
1996	FIFRA Amendments under the Food Quality Control Act of 1996
1997	National Water Quality Monitoring Council formed
1998	Clean Water Action Plan
1998	Underground Storage Tank Closure/Upgrade Requirements
1999	(planned) Class V Underground Injection Control Final Rule
2000	(planned) Ground Water Final Rule

mandates may not address the most pressing ground water protection concerns of a particular community or area.

In 1984, EPA established the Office of Ground Water Protection to serve as a focus for a more comprehensive ground water resource protection approach with the responsibility for developing Agency-wide, comprehensive ground water strategies and to lead programs aimed at protection of ground water as a resource. Such programs include the Wellhead Protection and Sole Source Aquifer Programs, which were established by Amendments to the Safe Drinking Water Act in 1986. The Wellhead Protection Program (WHPP) encourages communities to protect their ground water resources used for drinking water. The Sole Source Aquifer Program limits federal activities that could contaminate important sources of ground water. However, in spite of these and other programs, the need for a more comprehensive approach to ground water protection was documented through a series of private studies in the late 1980s, such as the Conservation Foundation's (1987) "Groundwater: Saving the Unseen Resource" Report and the Urban Institute's review of state ground water management programs (Liner et al. 1989).

In response to the need for stronger ground water management programs, EPA established a Ground Water Strategy in 1991 to place greater emphasis on comprehensive state management of ground water as a resource. EPA supported these state efforts through the promotion of Comprehensive State Ground Water Protection Programs (CSGWPPs) and better alignment of federal programs with state ground water resource protection priorities -- EPA's encouragement of state Pesticide Management Plans being the prime example of this new approach. In participation with other state and federal agencies, EPA also promoted the need for improved and more comprehensive ground water resource data collection and management practices through the Interagency Task Force on Monitoring Water Quality (see below). The 1996 amendments to SDWA also provided new resources to implement Source Water Assessment and Protection Programs, which supports the Wellhead Protection Program and a comprehensive approach to assess threats and protect ground water used as a source of drinking water supply. Finally, recent Agency efforts to support watershed protection activities under the Clean Water Action Plan call for comprehensive ground water protection, as a vital component of watershed protection.

Because of the growing awareness that a wide range of land use practices can impair ground water quality, the need for coordinated, state-led management programs is growing in importance. The federal government's emphasis on contaminant or contaminant source-specific approaches, with a focus on remediation, has led to considerable achievement in correcting past contamination and preventing further misuse of the resource. However, comprehensive state ground water management programs are critical to truly achieve more comprehensive, effective and efficient protection to ensure sustainable, long-term use of this valuable national resource.

> Prevention of ground water contamination is largely the responsibility of state and local governments.

4.2 State Ground Water Management Programs: Building on federal Authorities

Each state is implementing one or more components of a comprehensive ground water protection program. However, because ground water characteristics and ground water program priorities vary from state to state, the structure and focus of state programs also vary. Overall, the GWPC/ASDWA/ASIWPCA state report found that states are committed to some type of comprehensive planning process that addresses existing ground water contamination problems and works to prevent future resource impacts. Most states, however, have not been able to fully implement these plans.

This section (1) summarizes what is known about the current status of state ground water programs, (2) provides examples of comprehensive management approaches that have been used in some states and among federal agencies, including coordination examples, and (3) outlines the common elements from comprehensive programs that can serve as a model for other state ground water protection efforts. Fact sheets from each state describing specific state ground water management activities were completed by the states and compiled by GWPC/ASDWA/ASIWPCA. This compilation is included as an Appendix to this report.

Existing State Ground Water Protection Programs

Based on data reported by the states in 1996 and 1998 in their 305(b) Reports, Exhibit 4-1 shows the percentage of states that have begun implementing key ground water management program components (each component is discussed below). Although most states have begun implementing components of a comprehensive program, many states report that much work remains to be completed (GWPC 1999). Funding, lack of agency coordination, and an absence of priority-setting mechanisms are obstacles most frequently identified by the states to explain the lack of comprehensive planning and coordination.

The GWPC/ASDWA/ASIWPCA report examined the state's level of achievement in implementing the components of a comprehensive ground water protection program. With regard to the states' ability to analyze ground water, in terms of the extent of the resource, its quality, and vulnerability to contamination, approximately half of the states that responded indicated that comprehensive assessment programs are in place, but only just over half of each state's aquifers have been mapped. Furthermore, the states also report that the ambient water quality in less than 40 percent of their ground water is monitored.

In the state survey, the states were asked whether they have sufficient information to identify priority ground water management issues with regard to preventing degradation of or restoring ground water quality, preventing over-pumping, or restoring aquifer capacity. Less than half of the states indicated that all of the programs involved with managing these threats use ground water resource assessment information to set priorities for ground water management. Furthermore, virtually all of the states reported that they have no process in place to set priorities for ground water management involving other state, federal, or local government organizations.

The states were also asked to identify their needs for better assessing their ground water resources, setting priorities for management, and coordinating management activities with other organizations. Every state reported a need for additional funding to better implement these program activities. Most states surveyed also identified the need for mechanisms to better coordinate inter-agency activities.

Examples of Comprehensive Water Resource Management Approaches

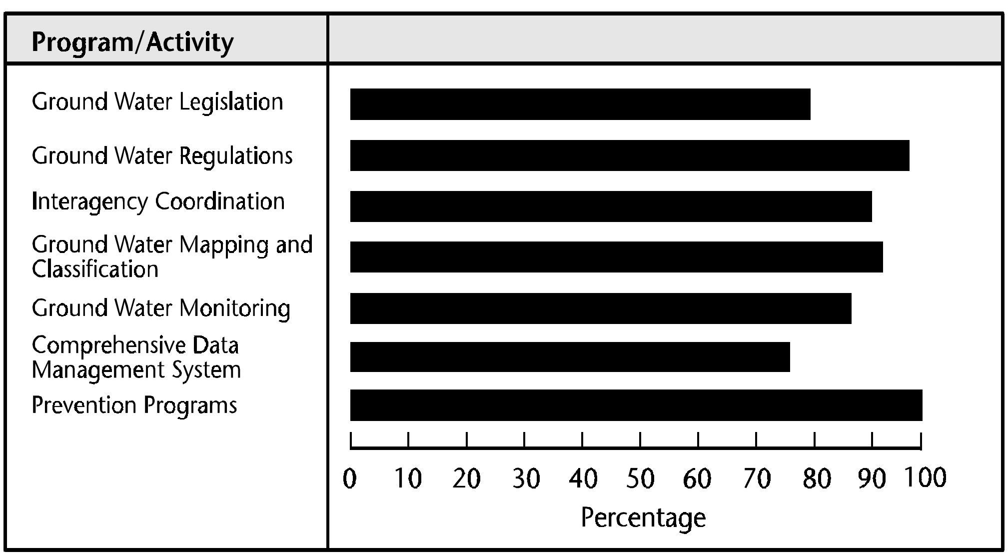
While the states are making progress in developing their ground water programs, lessons can still be drawn from other comprehensive water resource management efforts.

Over the past several years, it has become apparent that water quality and quantity protection problems cannot be managed by one agency or level of government. As a result, both state and federal government are developing and implementing coordinated approaches for water resource protection. Although many of these programs emphasize surface waters and need to integrate ground water management for a truly comprehensive approach to water resource management, they provide models for better coordination and integration.

At the federal level, the **Clean Water Action Plan** (CWAP) emphasizes the importance of a comprehensive approach to restoring and protecting waters among nine federal agencies (EPA, Department of Interior, Department of Defense, Department of Energy, Department of Agriculture, Department of Transportation, Department of Commerce, Department of Justice, and Tennessee Valley Authority). The nine agencies signed a Memorandum of Understanding to support and assist states, Tribes, and local communities to protect and restore the nation's drinking source waters on November 13, 1998.

The Clean Water Action Plan is both a vision statement and a blueprint for the future. The Clean Water Action Plan focuses on (1) promoting water quality protection and restoration on a watershed basis and (2) strengthening core clean water programs to protect human health, increase natural resources stewardship, reduce polluted runoff, and provide citizens and officials with crucial information. Through CWAP, an agreement was signed with the participating agencies to encourage federal partnerships with state and local efforts to protect their sources of drinking water, particularly within existing federal water quality initiatives.

Federal agencies are also working to better coordinate water quality monitoring and data sharing activities. The **Intergovernmental Task Force on Monitoring Water Quality** (ITFM) was established



* Based on 30 states

Exhibit 4-1: Percentage of States that Have Begun Implementing Components of a Comprehensive Ground Water Protection Program as Reported by the States in the 305(b) report

in 1992 and given the charge of reviewing water quality monitoring nationwide and developing an integrated national monitoring strategy. In 1995, ITFM produced *The Strategy to Improve Water-Quality Monitoring in the United States.* In 1997, the **National Water Quality Monitoring Council** (NWQMC) was formed as a successor to ITFM. During overall strategy development, a Ground Water Focus Group (GWFG) concentrated on issues related to ground water and aquifer systems. The GWFG recommended that water quality monitoring must consider differences in spatial, temporal, and other characteristics between ground and surface water resources. The GWFG recognized that many agencies do not have the capability or sufficient resources to undertake complete ground water quality monitoring efforts. Therefore, it was recommended that the agencies work together by combining resources and talents to begin a systematic process of sampling highest priority aquifers for the full set of indicators identified for each aquifer.

Many states are also moving to a more coordinated, comprehensive approach for surface water resource protection at the watershed level. **State Watershed Protection Frameworks** are designed to coordinate existing resource management programs and build new partnerships that result in more effective and efficient management of land and water resources. These frameworks provide a mechanism for coordinating not only the point and nonpoint source management activities that have been the historic focus of state water quality programs, but also can provide a forum for meeting the objectives of ground water, wellhead, and drinking source water protection programs. Many state Watershed Protection Frameworks incorporate a priority-setting and targeting mechanism to focus resources on watersheds requiring the highest degree of management to remediate existing problems or address emerging threats.

To date, approximately one-half of the states are moving toward the development and implementation of statewide watershed frameworks. Unfortunately, few of these states are using the Frameworks to coordinate the management of both surface water and ground water. As a result, coordinated ground water management is still a critical need in those states.

Finally, the state **Source Water Assessment Programs** established under the 1996 Amendments to the Safe Drinking Water Act provide an additional coordination mechanism for state programs. The states are required in their Source Water Assessment Programs to assess the degree to which all public water systems (PWS) in the state are susceptible to contamination. These assessments will be accomplished by (1) delineating the sources of water supply to the PWS, (2) inventorying the contaminants and contaminant sources within that delineated area, and (3) assessing how susceptible the PWS is to those sources of contamination. In many states, these assessments will be accomplished through cooperative efforts, involving several state agencies, local governments, and private water suppliers.

Key Elements of Comprehensive Ground Water Protection Programs

One of the key lessons learned by agencies and organizations implementing these comprehensive water resource protection approaches is the need for coordination with other federal, state, and local authorities.

As described in Section 4.1, existing federal programs provide guidelines for various prevention and remediation activities authorized under federal law. However, states that are beginning to implement comprehensive ground water programs must work with a broad range of other federal, state and local agencies to characterize the resource and manage ground water threats. This problem is complicated by the fragmentation of authorities for managing ground water that is found in many states. Often, authority for implementing the federal and state mandated ground water protection programs that address the threats outlined in Chapter 3 is spread across more than one state agency. A formal coordination mechanism is essential to ensure that these programs are working towards common goals, hold similar priorities, and use federal and state funds with maximum efficiency. Some states are implementing coordination mechanisms on an informal basis. Other states, like Illinois, have passed specific legislation and have adopted formal approaches to better coordinate their ground water management activities (see next page).

In general, comprehensive planning and assessment of ground water is a critical step to effectively protect this resource. Although only 11 states have EPA-endorsed Comprehensive State

Illinois Ground Water Protection Act

The Illinois Ground Water Protection Act (IGPA), adopted in 1987, responds to the need to manage ground water quality by a prevention oriented process, and is a comprehensive law relying on a state and local partnership. The IGPA responds to the need to protect ground water quality and establishes a unified groundwater protection program using the following elements:

- Sets a ground water protection policy
- Enhances cooperation
- Establishes water well protection zones
- Provides for surveys, mapping and assessments
- Establishes a groundwater education program
- Establishes a priority regional ground water planning process
- Establishes authority for recharge area protection
- Requires new ground water quality standards
- Requires new technology control regulations

The groundwater policy sets the framework for management of this vital resource. The law focuses upon uses of the resource and establishes statewide protection measures directed toward potable water wells. In addition, local governments and citizens are provided an opportunity to perform an important role for groundwater protection in Illinois.

This comprehensive ground water protection approach is also supported by a state Natural Resources Coordinating Committee, which serves as a planning committee for the six, major natural resource management agencies in Illinois. The Coordinating Committee has standing committees to address not only ground water issues, but other surface water, land use, and natural resource management issues.

Ground Water Protection Programs in place, with another 11 working towards endorsement, many other states have developed programs that utilize this concept of comprehensive planning across to align their priorities across state and federal programs.

The key benefit derived from comprehensive ground water management approaches is the ability to establish coordinated priorities among the many groups involved in ground water management. To support this need, the following key components are common to successful state programs:

- ❑ enacting legislation,
- ❑ promulgating protection regulations,
- ❑ establishing interagency coordination with surface water and other programs,
- ❑ performing ground water mapping and classification,
- ❑ monitoring ambient ground water quality,
- ❑ developing comprehensive data management systems, and
- ❑ adopting and implementing prevention and remediation programs.

Each component is discussed below. These findings are largely based upon information reported by the states in their 1998 305(b) reports. Successful examples of each component are also provided in text boxes.

Ground Water Legislation

State legislation may be developed in response to federal mandates and state and local concerns, but in most cases, states enact legislation to establish policy and associated protection programs with the purpose of restoring and maintaining ground water quality. In general, State ground water legislation focuses on the need for program development, increased data collection to support decision making, and public education activities.

Ground Water Regulations in Georgia

Georgia's ground water regulatory programs follow an anti-degradation policy under which regulated activities will not develop into significant threats to the state's ground water resources. This anti-degradation policy is implemented through three principal elements:

- Pollution prevention.
- Management of ground water quantity.
- Monitoring of ground water quality and quantity.

Prevention of pollution includes (1) the proper siting, construction, and operation of environmental facilities and activities through a permitting system; (2) implementation of environmental planning criteria by incorporation of land-use planning by local government; (3) implementation of a Wellhead Protection Program for municipal drinking water wells; (4) detection and mitigation of existing ground water problems; (5) development of other protective standards, as appropriate, where permits are not required; and (6) education of the public to the consequences of ground water contamination and the need for ground water protection. Management of ground water quantity involves allocating the state's ground water, through a permitting system, so that the resource will be available for present and future generations. Monitoring of ground water quality and quantity involves continually assessing the resource so that changes, either good or bad, can be identified and corrective action implemented when and where needed.

Ground Water Protection Regulations

State governments protect ground water quality by instituting regulations to control business, agricultural, and community activities that could adversely impact ground water. Regulations frequently stipulate controls for the management of specific sources of contamination. Controls include Best Management Practices (BMPs), nonpoint source controls, and discharge permits.

Regulations may also specify standards for chemical constituents in ground water as applicable to its appropriate use (for example, drinking water standards, surface water standards, and irrigation water standards). Standards may be used to apply limits on allowable discharges from contaminant sources or to set contaminant concentration targets or threshold levels for ground water clean-up. Although federal MCLs are often used as ground water protection standards, states may independently develop and use more restrictive standards.

Interagency Coordination

Ground water protection programs have historically been overseen by many different agencies within the states, Territories, and Tribes, making coordination difficult. As discussed above, coordinating the activities of these agencies to ensure efficient ground water protection program has become a top priority in many jurisdictions. Implementing a CSGWPP or similar program is an example of establishing interagency coordination.

Interagency Coordination in Alabama

The State of Alabama recognized the need to coordinate the management of ground water programs. As a result, The state set up the Ground Water Programs Advisory Committee (GWPAC) in 1994. The committee includes representatives of state and federal agencies, consultants, water system representatives, and others who work in ground water related fields. The committee members meet to dispense ground water program information, receive feedback, and coordinate ground water projects.

Ground Water Mapping and Classification

A ground water mapping and classification program systematically sets priorities for ground water management. States are developing ground water mapping and classification systems to aid in the protection and management of aquifers by better

> ***Ground Water Mapping and Classification in Hawaii***
>
> The Hawaii Department of Health and Water Resources Research Center (WRRC) identified and classified aquifers in the state. The WRRC identified general aquifer sectors and smaller aquifer systems for the islands of Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. Each aquifer system was divided into aquifer types that were characterized in accordance with (1) hydrologic factors such as basal, high level, unconfined, confined, and confined/unconfined conditions; and (2) geologic factors such as flank, dike, perched, sedimentary, or combination aquifer types. They also identified the status of the aquifer types through identification of their development stages, potability/salinity, utility, uniqueness, and vulnerability to contamination. The vulnerability determination was based on geographical limits of the resource, interconnection among ground water sources, time of travel, and familiarity with environmental conditions. Vulnerability was ranked high, moderate, or low.
>
> Source: Mink and Lau 1990a, 1990b, 1992a, 1992b, 1993a, and 1993b

understanding the inherent quality of different aquifers, their vulnerability, and the uses of the water taken from the aquifer.

Mapping and classification systems can be used as a basis for the maintenance and restoration of ground water quality, the development of ground water quality standards, and land use and pollution source management and regulation. The systems are designed to redirect human activities that have the potential to degrade ground water to areas overlying lower quality aquifers, thereby protecting the most vulnerable and ecologically important ground water systems. Most states that have mapping and classification systems apply them to the permitting of discharges or potential discharges to ground water, the remediation of contaminated ground water, the development of new supplies, or to site certain types of industries.

Ground Water Monitoring

Various ground water monitoring programs are used by states to collect data on ground water quality. Ambient monitoring programs measure background or existing water quality and can be used to track long-term trends in contaminant concentrations. Compliance monitoring programs are required by federal or state regulations generally at or near facilities where ground water contamination has occurred or where there is a potential for release. Compliance monitoring activities measure for specific constituents to ensure that their concentrations in ground water are below regulated levels. States may also rely on monitoring data collected by federal agencies to assess ground water quality.

Comprehensive Data Management Systems

Traditionally, data from monitoring programs is managed by, and is only available to, the specific state agency responsible for its collection, which is not necessarily the same agency with responsibility for ground water protection. Data management has been a limiting factor in monitoring the condition of the state's principal aquifers and the general quality of the Nation's ground water resources. States are now making progress in developing comprehensive data management systems. These systems will encourage interagency sharing of data and cooperation in planning and implementation of monitoring programs. The interactive database systems that are an integral part of the data network also allow for the use of state-of-the-art technologies such as geographic information systems (GIS) to display and evaluate data spatially.

Prevention and Remediation Programs

Under several statutory provisions, states have developed programs to prevent and reduce contamination of ground water. They serve to:

- analyze existing and potential threats to the quality of public drinking water,
- focus resources and programs on drinking water source protection,
- prevent pollution at the source whenever feasible,
- manage potential sources of contamination, and
- tailor preventive measures to local ground water vulnerability.

Prevention programs may provide local communities with technical assistance, educational programs, or economic incentives. Examples of programs that fully or in part address pollution prevention include: Source Water Assessment Program (SWAP), Wellhead Protection Program (WHPP), Underground Injection Control (UIC) Program, aquifer vulnerability assessments and vulnerability assessments of drinking water/wellhead protection under SDWA; Pesticide State Management Plan under FIFRA; and Superfund Amendments and Reauthorization Act (SARA) Title III Program. Prevention programs are critical to the effective long-term management of ground water resources.

In addition to prevention, states also take a lead role in implementing ground water remediation activities, either under federal or state authorities. For example, states may have primary responsibility for implementing RCRA corrective action and underground storage tank remediation and closure programs. Furthermore, while CERCLA remedial actions are a federal responsibility, many states, such as New Jersey, have established their own programs to remediate abandoned waste sites. Other states, such as Illinois, are also aggressively promoting voluntary site clean-ups and the return of brownfield sites to beneficial public uses.

State Ambient Ground Water Monitoring Programs

A 1997 study (EPA 1997a) described the nine key components of a state ambient water quality monitoring program and the associated costs:

- **Monitoring program design** addresses the geographic area covered by the program, the number of wells needed to characterize ambient conditions, the number and frequency of wells sampled, and the water-quality constituents to be analyzed.

- **Monitoring network installation** includes well procurement, installation, or refitting.

- **Monitoring network maintenance** consists of well integrity inspections and repairs to correct well anomalies.

- **Ground water sampling** incorporates labor, materials, and expenses for collecting monitoring samples and transporting them to a laboratory for analysis.

- **Ground water sample analysis** entails laboratory analysis of ground water samples for a set of constituent elements.

- **Ground water analyte data management** includes collecting ground water analysis results, compiling data into a database, and formatting data for analysis and interpretation.

- **Ground water analyte data interpretation** involves examining data to assess the general ground water quality throughout the study area.

- **Communication of ground water monitoring results** informs the public about the status of the ground water quality and the effects of contamination.

- **Program evaluation and redesign** assesses effectiveness and deficiencies after comparison of program results and program goals.

Monitoring Programs in Kansas

The Kansas ground water quality monitoring network was established in 1976 as a cooperative program between the USGS and the Kansas Department of Health and Environment (KDHE). The KDHE assumed sole responsibility for this program in 1990. Since that time, the program has gathered data suitable to identify changes in ground water quality associated with alterations in land use, the implementation of nonpoint source best management practices, changes in ground water withdrawal rates, and shifts in climatological conditions.

Currently, the Kansas monitoring network is comprised of 242 wells used for public or private (domestic) water supply, irrigation, livestock watering, and/or industrial purposes. During the period 1996-1997, 267 well samples were analyzed for common inorganic chemicals, heavy metals, and pesticides; 43 for volatile organic compounds; and 38 for radionuclides.

The study presented the costs associated with each of the nine components of ambient ground water quality monitoring programs for the States of Arizona, Arkansas, Florida, Idaho, Kansas, Maryland, Minnesota, and North Dakota. The total costs ranged from $18,585 per year in Arkansas to $474,666 per year in Florida.

Prevention Programs: Wellhead Protection and Source Water Assessment and Protection

The 1986 Amendments to SDWA established the Wellhead Protection (WHP) Program. It is essentially designed to provide a pollution prevention program for underground sources of drinking water. Under Section 1428 of the SDWA, each state must develop a WHP Program to protect wellhead areas from contaminants that may have an adverse effect on human health. Protection measures include (1) the identification of areas around public water supply wells that contribute ground water to the well, and (2) the management of potential sources of contamination in these areas to reduce threats to the resource. As of April 1, 1999, 47 of the states and two territories have developed and implemented EPA-approved WHP Programs and 3 states are continuing their efforts to develop their approved WHP Program. See Exhibit 4-2 for a summary of the number of community-based WHP programs that are being implemented.

The 1996 Amendments to the SDWA initiated source water protection through the creation of state Source Water Assessment and Protection Programs. Under Section 1453, states have developed programs for delineating source water areas for public water supply systems and assessing the susceptibility of the source water to contamination. The WHP Program has become the cornerstone in development of state Source Water Assessment and Protection Programs because the design of these programs builds on components of existing state WHP Programs, including source water area delineation, contaminant source inventories, management measures, and contingency planning. States with EPA-approved WHP Programs in place have met the ground water-based requirements for the Source Water Assessment Program (SWAP). States have started to develop and implement their SWAPs. Assessments must be completed for all public water supply systems within 3.5 years of EPA approval of the state's programs.

Comprehensive Data Management in Idaho

Idaho's Ground Water Quality Plan recognizes an Environmental Data Management System (EDMS) as the State's comprehensive data management system to include data from past, present, and future ground water quality monitoring. Although the EDMS is currently in use, not all relevant ground water quality data is routinely submitted to and entered into the system and there is a backlog of past data that could be incorporated into the system. Recent efforts to help increase the amount of data routinely submitted to EDMS include development of a compatible Access database structure that can be placed on individual computers and utilized for project or program specific data. Once the data is entered into the Access database, it can be transferred into EDMS.

4.3 Comprehensive Ground Water Management and Sustainable Ground Water Quality

To make better decisions about ground water management, the activities of many federal, state, and local programs must be coordinated. Better prevention now could reduce the high costs of ground water remediation in the future. Because resources available for ground water management are limited, (no program has unlimited funds,) upfront planning and prioritizing are critical activities to ensure the best, most efficient use of the resources available. These planning activities, however, are sometimes lacking due to budget constraints and institutional barriers that prohibit effective communication between agencies and groups with control over activities that impact ground water.

States have made considerable progress and need to continue to work to fully implement and integrate comprehensive planning processes.

- ❑ State ground water managers have reported (GWPC/ASDWA/ASIWPCA report) that state programs would be more effective if comprehensive ground water management programs were supported by consistent laws, planning, and funding.

State and local governments need to work together to protect ground water.

Although remediation programs are often critical, they do not fully address our need to manage ground water resources in a sustainable manner. Supporting the comprehensive management efforts that are emerging in the states will best serve the nation's need for maintaining sustainable ground water resources into the future.

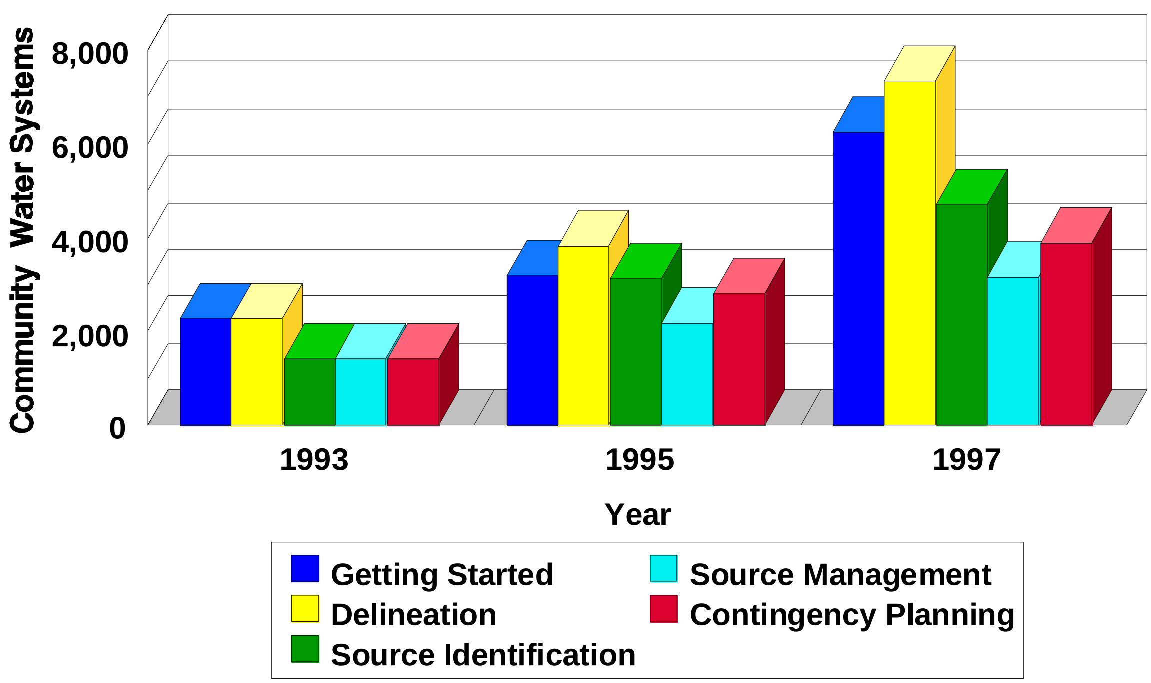


Exhibit 4-2: State Wellhead Protection Programs

Comprehensive Ground Water Management in Massachusetts

The Canoe River Aquifer Advisory Committee is a regional group comprised of fifteen locally-appointed members, three each from the towns of Easton, Mansfield, Norton, Foxborough, and Sharon, Massachusetts. Their goal is to protect the shared Canoe River aquifer which supplies drinking water to the towns.

The Committee includes local Water Suppliers; Board of Health, Board of Selectmen, Conservation Commission, and Planning Board members and staff; and members of land trusts and other local groups. The Committee has no annual budget but has successfully established a reputation as a credible, productive group by conducting extensive public outreach and by effectively involving residents, local citizen groups, and state and Federal agencies in local ground water protection.

The group started meeting in 1987 due to concerns about the vulnerability of the public wells within the Canoe River aquifer and shortly after pursued and achieved adoption of state legislation to establish a charter and formal recognition of the Committee. Coordinated efforts with state and federal agencies have included:

- State designation of the aquifer as an Area of Critical Environmental Concern (ACEC);
- co-sponsoring of land use management workshops and other public education events, including a popular annual Canie River Awareness Day;
- arranging guest speakers for the Committee's monthly meetings;
- formation of volunteer Shoreline Stream Team to monitor and report on river conditions;
- receipt of grants, including fund to identify and map land parcels abutting the river with the goal of creating a protective riparian buffer; and
- Federal EPA designation as a Sole Source Aquifer.

Additional information about the Canoe River Aquifer Advisory Committee can be obtained by contacting Chairman Wayne Southworth at (508) 238-3641.

Comprehensive Ground Water Management in South Dakota

South Dakota has had a comprehensive ground water protection program in place since 1989, although the state has not formally submitted a document to EPA for approval. South Dakota law states that ground water related programs, activities and funds are components of the state ground water protection strategy and that departments, agencies, and programs responsible for ground water protection activities shall coordinate their efforts to ensure that comprehensive ground water protection and management is performed efficiently.

Most major ground water protection and clean-up activities are located in the South Dakota Department of Environment and Natural Resources (DENR). Within DENR, most ground water protection and clean-up activities are centered in the Ground Water Quality Program, which consists of the following programs: Wellhead Protection, Source Water Protection, Underground Injection Control, Superfund, Underground Storage Tanks, Leaking Underground Storage Tank Trust Fund, and Community-Right-to-Know. The Ground Water Quality Program tracks all spills and discharges from sources that pollute or have the potential to pollute the waters of the state and ensures that proper assessments, remediation, and monitoring are performed until case closure. The state has classified and prioritized ground water bodies. The Ground Water Quality Program reviews plans and specifications for new facilities to help ensure ground water protection and enforces state ground water quality standards, state ground water discharge permits, and state above ground storage tank regulations. Those few programs that are not DENR's responsibility are coordinated through memoranda of understanding. For example, the South Dakota Department of Agriculture and DENR coordinate their activities to regulate all aspects of fertilizer and pesticide use and disposal.

This approach has provided a framework for coordinating state ground water protection and clean-up activities. It also provides a one-stop-shopping approach for industry, business, and the public. For further information on South Dakota's approach to ground water protection and clean-up, visit their website at http://www.state.sd.us/state/executive/denr/DES/Ground/groundprg.htm.

5.0 FINDINGS

Based upon the literature synthesis, GWPC/ASIWPCA/ASDWA report, and contributions from the state workgroup, the following findings are made with regard to ground water and management approaches to protect and sustain its use for the nation:

The State of the Resource

- ❑ Ground water is a critical resource to maintain public health, the economy, and the environment.

  Ground water is an important freshwater resource that is critical for drinking, irrigation, industry, and maintaining lakes, streams, and wetlands. Approximately 133 million people rely upon ground water for drinking, and agriculture uses over 51 billion gallons of water daily to irrigate cropland and water livestock. Ground water feeds streams and wetlands especially during dry periods to sustain surface water flows.

- ❑ From what we know, in most locations around the country, ground water is generally of good quality but continues to be threatened by point and nonpoint pollution sources, as well as over-pumping.

  Ground water quality is generally good (i.e., when contaminants are found, they are usually at concentrations below drinking water standards at most locations). Certain land use activities, however, including agriculture, industrial, commercial, and waste disposal, all have the potential to contribute contaminants to ground water that range from pesticides and nutrients to organic chemicals and waterborne pathogens. In some locations, these contaminants have and may continue to threaten public health. Ground water is also over-pumped in parts of the country, resulting in depletion of the resource, loss of aquifer storage capacity, and reduced recharge to surface water. Overall, ground water management may not be occurring in a way that will ensure its sustainable use well into the future.

The Status of Ground Water Management Efforts

- ❑ States have made considerable progress in implementing federal and state programs aimed at specific contamination concerns.

  Most states have made progress in carrying-out the requirements of several federal laws aimed at remediating or preventing specific types of ground water contamination problems. Evidence of this progress can be found by examining the federal and state programs addressing various ground water concerns, such as wellhead protection, underground storage tanks, pesticides, and hazardous waste management and remediation.

- ❑ Most states agree that a more comprehensive, resource-based approach holds greater potential for accomplishing effective ground water protection and many states are pursuing key aspects of such an approach.

  Most states believe that greater flexibility to address the highest priority ground water concerns from a more comprehensive, resource-based approach would be effective and efficient. Such an approach requires: a good technical understanding of the resource; determinations of its relative use, value and vulnerability in different locations; identification of potential threats, agreement on priorities for addressing these threats, and coordination of resources and efforts to effectively and efficiently address those priorities across the various federal, state and local agencies and programs with relevant responsibilities.

- ❑ Efforts to achieve a more comprehensive approach are underway in many states, but more work needs to be done.

  Today, only about a dozen states have developed an EPA-approved Comprehensive State Ground Water Protection Programs (CSGWPP) that promotes the above aspects of a more strategic, resource-based approach to ground water protection. However, a recent report compiled from a survey of 26 states by the Ground Water Protection Council, the Association of State Drinking Water Administrators, and the Association of State and Interstate Pollution Control Administrators, indicates that more than half the states surveyed are undertaking efforts that are essential to a comprehensive approach to ground water protection; these states are working to differentiate their ground water resources based on use/value and vulnerability and, most of the surveyed states are identifying their ground water problems or concerns on a geographic basis. These states also reported that they are keeping the various federal and state agencies with ground water responsibilities aware of their comprehensive analysis and findings.

Some states have completed, or have begun to develop, a comprehensive list of ground water protection priorities.

- ❑ States have identified three primary barriers to achieving a more comprehensive approach:

Fragmentation of ground water programs impedes effective management.

Most state and federal ground water protection programs are fragmented among and within agencies. At the state level, authorities to manage the resource are often held among different state agencies with conflicting priorities and goals. Communicating and coordinating between departments with ground water responsibilities can be difficult and ineffective. Additionally, because of this fragmentation, there is not a unified effort in most states to acquire available state and federal funds for comprehensive ground water protection activities.

Overall, authorities to manage the resource are not comprehensive, and the programs that have developed are structured under specific legislative authorities that, for the most part, have a narrow focus regarding ground water management.

The lack of understanding of ground water resources (e.g., the extent and condition of the resource, the physical nature of the aquifer, the behavior of contaminants within and their movement through the aquifer, the influence of surface water to ground water and vice versa)

Better information to assess the effectiveness of ground water protection efforts and to determine the impact of certain land uses on ground water is needed to set priorities for ground water protection efforts. The states need federal support to develop coordinated, comprehensive approaches for ground water monitoring that includes priority setting.

Lack of funding targeted directly to ground water is the reason most often cited by states for limited efforts at undertaking a more comprehensive resource-based approach. Ground water protection is often not a high priority for funding; mandated programs usually prevail for funding.

In the state Survey, the lack of a targeted source of funding was cited by nearly all states as a reason why various aspects of a more comprehensive, resource-based approach to ground water protection was not underway or was limited in scope. While States have the flexibility to use funds under several federal programs to pursue ground water protection efforts, they often choose not to or to do so in only a limited way. Additionally, because of this fragmentation, there is not a unified effort in most states to take advantage of existing available state and federal funds for comprehensive ground water protection activities.

Most states indicate that the mandates under other federal programs often preclude the state from exercising flexibility to use funds for non-mandated ground water protection priorities. This is particularly the case under the Clean Water Act, where states have the opportunity to pursue ground water activities, including more comprehensive resource assessment and planning, and to utilize state Water Quality Program Grants and Non-point Source Grants.

Funds are available for ground water activities in drinking water source areas as defined by a state in their Source Water Assessment and Protection Plans, if the states chooses to set-aside funds received from their DWSRF capitalization grant. Most states set-aside funds to delineate and assess these areas (which include ground water and surface water sources) in FY 1997 and 1998, the only years that funds could be set-aside for these purposes. Fewer states have chosen to set-aside funds from the DWSRF for other ground water activities, although it is unclear at this time, exactly how those funds were used.

Over the last 25 years, federal, state and local governments, and private parties have spent billions of dollars to clean-up contaminated ground water. According to the National Research Council, as much as $1 trillion may be needed to clean-up soil and ground water contamination over the next 30 years. As a result, the resources devoted to remediation vastly exceed the resources devoted to protection.

The ability of states to use funds from remediation programs for more comprehensive ground water assessment and planning is very limited. Greater emphasis on prevention is needed to sustain ground water into the future.

❑ While the funds are relatively small, most states believe that funding of SDWA Section 1429 grants would support more coordinated state planning and priority setting for ground water protection as a first step toward solving some of these problems.

Furthermore, the states believe that by providing a source of targeted funding, states will be able to better address the issues of program fragmentation within the state and basic program needs, such as monitoring, resource characterization, and the development and implementation of protection programs.

New federal funds have been available to the states to address some of the key components of comprehensive ground water protection that have been missing. The Drinking Water State Revolving Fund has made money available for some ground water activities in high priority drinking water source areas through the Source Water Protection and Wellhead Protection set-asides. Also, funds are available for states to work on critical comprehensive ground water activities through the Clean Water Act Section 319 and the Section 106 grants. (EPA recommends that states use 15% of their Clean Water Act Section 106 grant for ground water activities.) Funds may also be available to the states through Public Water Supply Supervision grants for assisting with compliance of federal and state drinking water regulations. Although these grants are targeted to assist in implementation of drinking water regulations, including several new federal regulations, states could potentially use these funds for comprehensive ground water protection if they can make a direct correlation to PWS compliance with drinking water regulations. It is too early to know how or if the states are using and will continue to use these funds for ground water activities.

In these early years of the Drinking Water State Revolving Funds, states are making important decisions on competing priorities; the states must decide how to best use these funds to protect public health and the environment. As required by the 1996 SDWA amendments, EPA will be conducting an evaluation of the DWSRF over the next few years.

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GLOSSARY OF TERMS

Ambient Ground Water Monitoring - Ambient ground water monitoring programs measure background or existing water quality and are used to track long-term trends in contaminant concentrations.

Anoxia - A condition or environment without oxygen.

Aquifer - An underground geologic unit that stores ground water.

Best Management Practices (BMPs) - Structural and management practices used in agriculture, forestry, urban land development, and industry to reduce the potential for damage to natural resources from human activities.

Brownfields - Abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination.

Carcinogen - An agent capable of inducing a cancer response.

Class V Injection Wells - Shallow disposal systems that are used to place a variety of fluids below the land surface, into or above underground sources of drinking water.

Clean Water Act - Enacted in 1972, the Clean Water Act is the primary federal law that protects our nation's waters, including lakes, river, aquifers, and coastal areas. Its primary objective is to restore and maintain the integrity of the nation's waters.

Clean Water Action Plan - An initiative, released in February, 1998 that aims to achieve clean water and aquatic habitat by strengthening public health protections, targeting community-based watershed protection efforts at high priority areas, providing communities with new resources to control polluted runoff, enhancing wetlands and natural resource stewardship, and improving public access to environmental information.

Compliance Ground Water Monitoring - Compliance monitoring programs are required by federal or state regulations generally near facilities where ground water contamination has occurred or where there is a potential for release. These activities measure for specific constituents to ensure that their concentrations in ground water are below regulated levels.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - A law that established a national program to respond to past releases of hazardous substances in to the environment. CERCLA created the Superfund for financing remedial work not undertaken by responsible parties.

Concentrated Animal Feeding Operations (CAFOs) - Agricultural operations where animals are kept and raised in confined areas. CAFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area.

Contamination (Water) - Water that contains disease-causing or toxic substances.

Discharge - The volume of water that passes a given location within a given period of time.

Ecosystem - A community of interdependent organisms together with the environment they inhabit and with which they interact.

Eutrophication - An increase in the concentration of nutrients in an aquatic ecosystem, causing: an increased productivity of green plant, leading to the blocking out of sunlight; elevated temperatures within the water body; depletion of the water's oxygen resources; increased algal growth; and reduction in the level of and variety of fish and animal life.

Evaporation - The changing of liquid water from rivers, lakes, bare soil and vegetative surfaces into water vapor.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - A consumer protection statute passed in 1947 to regulate the manufacture, sale, distribution, and use of pesticides. FIFRA protects human health and the environment from the risks of pesticide use.

Freshwater - Water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids;

generally, more than 500 mg/L of dissolved solids is undesirable for drinking and many industrial uses.

Ground Water - The subsurface water beneath the water table in soils and geologic formations that are fully saturated.

Hydrologic Cycle - The constant process of water movement from the Earth to the atmosphere by evaporation and transpiration, and from the atmosphere to the Earth in various forms of precipitation. This term includes movement of water on and beneath the Earth's surface.

Hypoxia - A condition or environment with very low oxygen concentrations.

Industrial Wastes - Any waste that results from manufacturing or other industrial processes. These wastes often contain hazardous chemicals which require special treatment processes.

Irrigation - The controlled application of water for agricultural purposes through manmade systems to supply water requirements not satisfied by rainfall.

Land Subsidence - The loss of surface elevation due to removal of subsurface support. One cause of subsidence is over-pumping ground water.

Maximum Contaminant Levels (MCLs) - The maximum amount of a compound allowed in drinking water under the Safe Drinking Water Act. MCLs are set by considering both health effects of the compound and technical feasibility of removing the compound from the water supply.

Monitoring Well - Wells used to collect ground water samples for the purpose of physical, chemical, or biological analysis. They are generally installed where ground water contamination exists or has a potential to exist.

Nitrate - The most oxidized form of inorganic nitrogen and a contaminant commonly associated with septic systems and agriculture activities. High concentrations of nitrate and nitrite in drinking water are know to cause methemoglobinemia in infants.

Nonpoint Source Pollution - Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land-use activities, which are carried to lakes and streams by surface runoff. Non-point source pollution is contamination that occurs when rainwater, snowmelt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants, such as nutrients and pesticides.

Over-pumping - The reduction of ground water storage that occurs when withdrawals from an aquifer exceed recharge.

Pathogens - Microorganisms potentially harmful to humans or animals, including parasites, bacteria, and viruses.

Percolation - The downward movement of water through layers of soil or rock.

Precipitation - The process by which water vapor condenses in the atmosphere or onto a land surface in the form of rain, hail, sleet, or snow.

Recharge - The replenishment of ground water by seepage (deep percolation) of precipitation and runoff. Also stated as the process of addition of water to the saturated zone.

Resource Conservation and Recovery Act (RCRA) - A law that regulates monitoring, investigation, and corrective action at operating hazardous treatment, storage, and disposal facilities.

Runoff - The portion of precipitation or irrigation water that moves across land as surface flow and enters streams or other surface receiving waters. Runoff occurs when the precipitation rate exceeds the infiltration rate.

Safe Drinking Water Act - The law passed in 1974 that required the setting of standards to protect the public from exposure to contaminants in drinking water.

Salt Water Intrusion - The migration of salt water into freshwater aquifers under the influence of ground water development.

Section 1429 - Section 1429 of the Safe Drinking Water Act (SDWA) authorizes the U.S. Environmental Protection Agency (EPA) Administrator to make grants to the States for the development and implementation of programs to ensure the coordinated and comprehensive protection of ground water resources.

Septic System - An on-site waste disposal system. Septic systems are constructed using conventional, alternative, or experimental system designs. Septic tanks are used to detain domestic wastes to allow the settling of solids prior to distribution to a leach field for soil absorption. Septic tanks are used when a sewer line is not available to carry them to a treatment plant.

Sinkhole - The cavities in bedrock that are open to the atmosphere. These usually result from the collapse of overlying soil or geologic material.

Sole Source Aquifer - A ground water aquifer which is the sole or principal drinking water source for an area and which, if contaminated, would create a significant hazard to public health.

Stormwater - Rain water and snow melt that runs off the land and enters streams, rivers, and lakes.

Surface water - The water from all sources that occurs on the Earth's surface either as diffused water or as water in natural channels, artificial channels, or other surface water bodies.

Treatment - Remedial techniques or actions used to restore contaminated ground water.

Underground Injection Well - A well through which fluids are injected into the subsurface.

Underground Storage Tanks (USTs) - Any system having 10 percent of the total tank volume below ground.

Volatile Organic Compound (VOC) - An organic chemical that volatilizes (evaporates) relatively easily when exposed to air.

Water Quality - The chemical, physical, biological, and radiological condition of a surface or ground water body.

Watershed - The land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds, like the Mississippi River basin contain thousands of smaller watersheds.

Water Table - The top of the subsurface zone that is saturated with ground water.

Well (water) - An artificial excavation put down by any method for the purposes of withdrawing water from the underground aquifers. A bored, drilled, or driven shaft, or a dug hole whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies or oil, or to store or bury fluids below ground.

Wellhead Protection Area - A designated surface and subsurface area surrounding a well or well field that supplies a public water supply and through which contaminants or pollutants are likely to pass and eventually reach the aquifer that supplies the well or well field. The purpose of designating the area is to provide protection from the potential of contamination of the water supply. These areas are designated in accordance with laws, regulations, and plans that protect public drinking water supplies.

Wetlands - A land area that is inundated or saturated by surface and/or ground water with a frequency and duration sufficient to support an abundance of water-loving plants or other aquatic life that require permanently saturated or seasonally saturated soil conditions for growth and reproduction. Examples include swamps, marshes, bogs, sloughs, potholes, wet meadows, river overflow areas, mud flats, and natural ponds.