Chapter 6
Federal Efforts To Detect Groundwater Contamination

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CHAPTER OVERVIEW

This chapter describes the investigatory activities of the Federal Government related to groundwater contamination. Some of these activities are explicitly mandated by Federal legislation. Others have been undertaken by Federal agencies either to support regulatory programs or as special studies. The *techniques* used for detection activities are discussed in chapter 5.

Four major types of Federal investigatory programs are discussed:

1. conducting hydrogeologic investigations of aquifer systems, including ambient groundwater quality;
2. monitoring drinking water supply systems;
3. conducting inventories of potential sources of contamination; and
4. monitoring groundwater in the vicinity of specific sources of contamination (includes: monitoring conducted by Federal agencies with respect to federally financed remedial action programs, hydrogeologic investigations, special studies, and monitoring required under regulatory programs that apply to facility owners or operators).

These programs are providing significant information on the Nation's groundwater problems. However, their coverage is generally limited relative to the sources of contamination and substances discussed in chapter 2. For example, only recently are hydrogeologic investigations starting to look for organic chemicals; monitoring provisions for drinking water supplies address only selected substances found in public systems; inventories are conducted for only particular sources; and monitoring requirements are specified for only particular sources and their coverage is inconsistent.

The chapter begins with an overview of U.S. Geological Survey (USGS) activities. Although USGS does not have regulatory authority with respect to groundwater contamination, hydrogeologic information developed by its Water Resources Division supports the programs of other Federal agencies as well as State and local governments.

GROUNDWATER ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY

Principal responsibility in the Federal Government for-providing hydrogeologic information and appraising the Nation's water resources lies within the Water Resources Division of the USGS. [1] The division conducts three types of programs: 1) Federal programs, 2) the Federal-State Cooperative Program, and 3) activities for other Federal agencies.

Federal Programs

Congressional appropriations for USGS support activities on research, data collection, high-priority special topics, and coordination of Federal use and acquisition of water data.

[1] USGS was established by legislation passed in 1879 (see 43 U.S. C. 31 et seq). Subsequent legislation specifically authorized USGS to gaug-c streams and dcterm ine the Nation water supply. For an overview of all L'SGS activit ics sec Chase, ct al., 1983.

Examples of programs related to groundwater quality include the Regional Aquifer-System Analysis Program, the Toxic Wastes-Groundwater Contamination Program, the Radioactive Waste Program, and the Coal Hydrology and Oil Shale Hydrology Programs. In addition, USGS maintains the National Water-Data Exchange (NAWDEX) and is involved in research efforts related to groundwater contamination (see ch. 3).

Federal-State Cooperative Program

The Federal-State (Inoperative Program encompasses hydrologic data collection and water resources investigations relevant to State and local needs and issues. Congressional appropriations support the program, and the States are required to match Federal funds on a ***50-50*** basis. USGS considers this program "the foundation of much of the water-resources management and planning activity in the Nation and it serves as an early warning system for the detection of emerging water problems' (USGS, 1982). The program is active in all ***50*** States, Puerto Rico, Virgin Islands, Guam, and the Trust Territories; and during 1982, USGS had agreements with more than 800 State and local agencies (at a total funding of more than $80 million). Of these projects, 414 were at least partly related to either groundwater quality or quantity. The total budget for the groundwater portions of the investigations was $25 million (USGS, 1982; Chase, et al., 1983).

Activities for Other Federal Agencies

USGS also provides hydrologic expertise and related information to other Federal agencies upon request. The agencies are generally required to reimburse USGS. Programs established through Interagency Agreements and Memoranda of Understanding are included in this category (see ch. 3). In 1982, USGS undertook 115 projects at least partly related to groundwater for other Federal agencies. The total budget for the groundwater portion of these projects was $5,5 million (USGS, 1982).

INVESTIGATIONS OF AQUIFER SYSTEMS AND AMBIENT GROUNDWATER QUALITY

Section 104(a)(5) of the Clean Water Act specifies that EPA shall,

> . . . in cooperation with the States, and their political subdivisions, and other Federal agencies establish, equip, and maintain a water quality surveillance system for the purpose of monitoring the quality of the navigable waters and *groundwaters* . . . [emphasis added].

As noted above, USGS is responsible for collecting most of the Nation's water quality data. It operates two nationwide *surface water* monitoring programs: the National Stream Quality Accounting Network (NASQAN) and the National Hydrologic Benchmark Network.[2] Fundamental differences between surface water and groundwater have precluded the establishment of a similar nationwide program for the collection of groundwater data. For example, there is no single point in an aquifer from which ' 'upstream' water quality can be deduced, as in river basins.

Although there is no nationwide groundwater data collection program, groundwater studies have been conducted by numerous Federal, State, and local agencies.[3] The data collected relate to site-specific conditions and the characterization of certain aquifers. Historically, the studies have focused on certain inorganic compounds; only recently have hydrogeologic investigations of specific instances of

[2] z'I'h, NASQAN pr~rarn is cornpr]sed of 504 operating stations designed to monitor the quantity and quality of water in major U.S. rivers. The National Hydrologic Benchmark Network monitors hydrologic characteristics of 52 small drainage basins that are relati~"ely unaffected by human activities. Data collected from these programs are stored in computer systerls maintained by USGS and EPA.

[3] Therc were 28,964 active obser~'ations by Federal agencies at groundwater stations in 1968 (see Langford, 1977). In 1982, groundwater quality data were collected at more than 7,000 stations through the Federal-State Cooperative Program and other L'SGS activities (see Chase, et al,, 1983, p. 34).

contamination started to provide some information on organic chemicals in groundwater. In recognition of these data gaps, USGS is currently involved in a program to characterize the Nations major aquifer systems and will begin to monitor ambient groundwater in selected areas of the United States in 1984.

Regional Aquifer-System Analysis Program

In 1978, USGS began a series of studies to provide basic information about certain regional groundwater systems that comprise a significant portion of the Nation's water supply. The Regional Aquifer-System Analysis (RASA) Program has identified 28 systems for possible study. Types of information being developed include: characteristics of the flow system; general water quality; regional utilization patterns; and response of aquifer systems to stress. Computer simulation models are being developed for each system to assist in understanding the natural flow regime and changes resulting from human activities and in predicting the effects of future stresses (e. g., waste disposal, artificial recharge, and pumping). The status of RASA studies as of September 1984 is shown in figure 3.

The RASA studies are conducted on a very large scale and contribute only indirectly to site investigations of groundwater contamination by providing a framework for model selection and analysis. Studies conducted as part of the Federal-State Cooperative program provide more detailed information about local areas within the regional systems.

Ambient Groundwater Quality Appraisal

USGS is initiating an ambient groundwater quality study that will emphasize detection of organic chemicals and trace metals. Representative areas of the United States will be selected on the basis of climate, hydrogeology, land use, and other factors. A sampling network will be designed for each area, both with samples taken first at a reconnaissance level and then at a more detailed level (Cohen, 1983).

MONITORING DRINKING WATER SUPPLIES

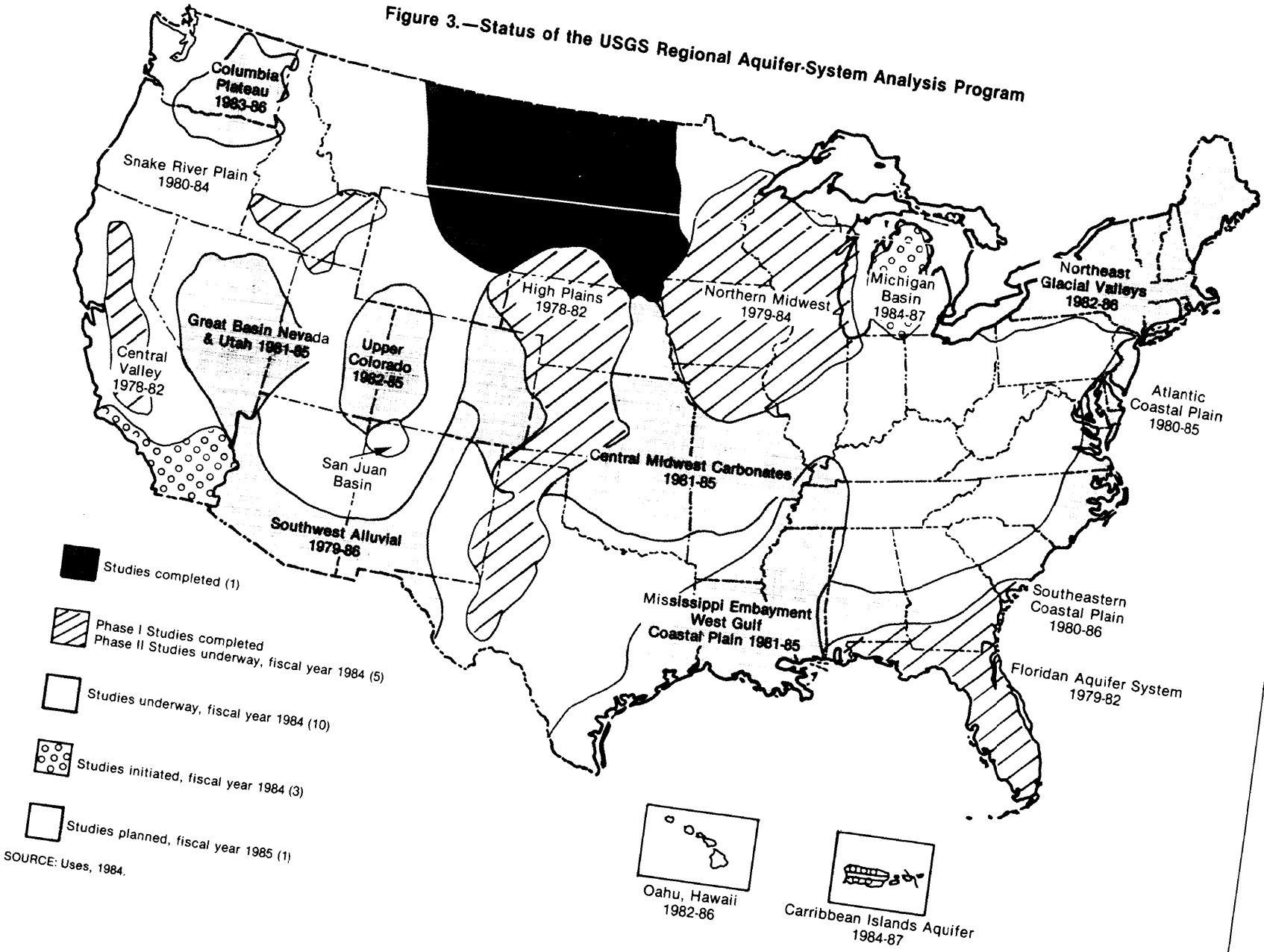
Public Water Systems

Part B of the Safe Drinking Water Act (SDWA) establishes a program to ensure that public drinking water supply systems comply with minimum national standards for substances that may adversely affect human health. The requirements apply to both surface water and groundwater. Section 141 requires the Environmental Protection Agency (EPA) to promulgate National Drinking Water Regulations that specify either Maximum Contaminant Levels (MCLs) or treatment techniques for such substances. (See app. C. 3 for a listing of standards for specific substances and other quality indicators.)

The act also provides for the establishment of an enforcement program for public water systems. Under Section 1413, a State may assume primary enforcement responsibility if it:

1. adopts drinking water regulations at least as stringent as the Federal regulations;
2. adopts and implements adequate enforcement procedures;
3. complies with EPA record-keeping and reporting requirements;
4. permits variances or exemptions based on conditions at least as stringent as the Federal requirements (Sections 1415 and 1416 of SDWA allow for variances and exemptions, respectively, from the drinking water regulations if such action would not pose an unreasonable risk to health); and
5. adopts and implements an adequate plan for provision of safe drinking water under emergency circumstances.

Figure 3.—Status of the USGS Regional Aquifer-System Analysis Program



SOURCE: Uses, 1984.

As of September 1984, 52 out of the 57 States and Territories covered by the program had accepted primacy for public water supply systems (Baltay, 1984).[4] EPA is responsible for enforcing the regulations when a State does not assume primacy.

The Safe Drinking Water Act defines a public water system as "a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves at least 25 individuals. The Safe Drinking Water Act does not address individual drinking water supplies (e.g., private domestic wells). EPA estimates that there are approximately 12-14 million individual private wells in the United States supplied by groundwater (EPA, 1983a).

Public water systems are further divided into "community' and ' 'non-community' systems by EPA regulations.[6] 'Community' systems serve at least 15 connections year-round or regularly serve at least 25 people. " Non-community' systems serve transient users, such as at highway rest stops or campgrounds, and are not required to comply with the standards for organic chemicals.[7] The States may also decide that non-community systems not be required to meet the nitrate standard; nonetheless, concentrations may not exceed a specified level.[8] A recent EPA inventory indicates that there are 59,660 community systems and approximately 160,000 non-community water supplies (Kimm, 1983).

EPA Drinking Water Surveys

EPA's Office of Drinking Water and Office of Research and Development have conducted a num-

[4] l)ri m.ic y has not ken a(ccpted b} the Ilist ri(t of (;olurnbia, I nd i-,ina, P(, nnsyl\an ia, Orcgmn, or W'yorning (Pcnns~l\ania is expcctcd [() [I(I s() in 1 98.5) (13altay, 1984) '1'erri[orie\ under EPA jurisdiction arc Ameri(arl Samoa, (;uam, ?J(Jrt hem hlarianas, Puerto Rico, Trust '1'crrit[)rics, ,int] L'. S. \'ir~in Jslar](l\.

'Section 1 401(4), $2 U .S C; 300(f)(4).

[6] 40 CFR 141 .2(c).

[7] 40 CFR 141.12.

[8] 40 CFR 141.1 1(d). The water supplier must demonstrate that the water will not be a~'ailable to children under the age of 6; that use of the water will not ~'suit in adl'crse health effects; that there will be public notification of the levels; and that the local and State officials will be notifrcd of levels exceeding the national standard.

Photo credit: State *of Florida Department of Environmental t3egu/atiorr*

There are 12-14 million individual private wells in the United States used for drinking water; these wells are not covered by SDWA. Shown here are the pump and storage tank for a private well.

ber of surveys of *drinking water* supplies to provide data to support regulatory actions under SDWA (e. g., development of MCLs). These surveys include: the National Organic Reconnaissance Survey (1975, focused primarily on surface water); the National Organics Monitoring Survey (conducted 1976-77); the Rural Water Survey (conducted 1978-79); the Community Water Supply Survey (1978); and the Groundwater Supply Survey (conducted 1980-81) (see ch. 2 for additional information), EPA initiated a survey in July 1984 to collect necessary information about the nationwide occurrence of selected inorganic contaminants and radionuclides in community drinking water supplies (EPA, 1983b); results are not expected to be available before 1986 (Westrick, 1984).

SOURCE INVENTORIES

The Federal Government is also involved in investigatory efforts concerning specific sources of known or potential groundwater contamination. Activities related to the compilation of information on locations and characteristics of actual or potential sources are generally referred to as inventories. Inventories provide one indication of the extent to which particular sources are or may be contributors to contamination problems.

Federal inventory activities are of three types:

1. Federal statutes authorize the use of funds to support formal studies or projects involving the collection of information from, for example, Federal, State, and local government files and records, field investigations, and aerial photography;
2. Federal statutes or regulatory programs establish requirements for the submission of information on spills, accidents, or other releases of contaminants that have the potential to enter groundwater; and
3. Federal regulations require responsible parties to submit information about particular sources.

These inventories focus on selected sources in OTA Categories I, II, and 111 (namely, sources designed to discharge substances; sources designed to store, treat, and/or dispose of substances; and sources that transport or transmit substances; see ch. 2, table 5). There are no explicit inventory provisions for sources in OTA Categories IV, V, and VI (namely, sources discharging substances as a consequence of other planned activities; sources that provide conduits for or induce discharges of substances; and naturally occurring sources).

Formal Studies

The Resource Conservation and Recovery Act (RCRA) and the Safe Drinking Water Act (SDWA) contain provisions authorizing the use of Federal funds to conduct formal studies that involve the collection of information about particular sources—open dumps, hazardous waste sites, and surface impoundments.

Open Dumps

Section 4005(b) of RCRA requires EPA to publish an inventory of all open dumps in the United States. The States were to conduct the inventory on the basis of specific criteria developed by EPA for classifying solid waste facilities as sanitary landfills or open dumps, and the inventory was to be completed no later than 1 year after promulgation of the criteria. The criteria were published in 1979 (with subsequent amendments in 1981), almost 2 years later than the date specified by the statute. [g] EPA first published its inventory in 1981. It listed 1,209 open dumps; 80 of them were cited as having violated the groundwater requirements specified in the criteria. However, a General Accounting Office (GAO) study indicated that the 1981 inventory was based on incomplete reports from the States (GAO, 1981).

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[g] 'RCRA specifies that a facility may be classified as a sanitary landfill ' 'only if there is no reasonable probability of adverse effects on health or the environment from disposal of solid waste at such facility' [42 ~'. S.C. 6944(a)]. Criteria established by EPA specify eight conditions that must be met by a facility in order to be classified as a sanitary landfill; onc of the criteria requires that a facility not contaminate an underground drinking water source beyond the facility boundary or an alternatiic boundary (set on a case-b)'-case basis). See 40 CFR 257.3,

Photo credit: u.S. Environmental Protection Agency

Open dumps and their potential for groundwater contamination have been partially inventoried by the States but inventories have not been completed due to inadequate funding from EPA.

The inventory was published a second time in 1982, to reflect State efforts during 1981. The third edition of the inventory, published in 1983, incorporated both additions and deletions submitted by 18 States during 1982 (EPA, 1983c). The third edition contains 2,081 facilities; 130 violations of EPA's groundwater criteria were reported. EPA estimates that these figures are based on evaluation of only 3 percent of the more than 300,000 solid waste facilities in the United States (Absher, 1983).

A major problem encountered by the States with respect to completion of the inventory has been the lack of financial assistance from EPA. No Federal funds for Subtitle D programs were made available during 1982 and 1983, although funding was originally planned to extend through 1984 (EPA, 1983c).

Hazardous Waste Sites

The 1980 amendments to RCRA added Section 3012, which requires each State to, "as expeditiously as practicable, undertake a continuing program to compile, publish, and submit . . . an inventory describing the location of each site within such State at which hazardous waste has at any time been stored or disposed of."[10] Although Section 3012 also provides for Federal financial assistance to the States, funds were not appropriated until September 1982, when $10 million was appropriated from the Hazardous Substance Response Trust Fund under the Comprehensive Environmental Resource, Compensation, and Liability Act (CERCLA).[11]

[10] 42 U S.C 69:12,
L 1 &,, public 1,al$. 97.272, Appmprl~t ionj .Act for the Eni'ironmc'ntd Protection Agency, Sept. 30, 1982

Funds were allocated to the States in proportion to the number of sites listed in EPA’s hazardous waste site inventory as of January 17, 1983.

In addition to State inventories, some Federal agencies have undertaken or have proposed inventories on Federal lands. For example, the Department of Defense conducted record searches of its installations to identify hazardous waste sites. As of August 10, 1983, 781 (out of911) searches were completed (Daley, 1983). The Fish and Wildlife Service recently requested all field stations to inventory all lands and facilities (Hester, 1983); and the Bureau of Land Management is developing a strategy to conduct hazardous waste site inventories (Lawton, 1983).

Surface Impoundments

Section 1442(b)(3)(C) of the Safe Drinking Water Act allows EPA to award grants and enter into contracts with any public agency, educational institution, or other organization to develop and expand the capability of States and municipalities to carry out the purposes of the statute. In 1978, EPA made $5 million available to the States to conduct studies to assess the magnitude and potential effects of surface impoundments on groundwater quality. Although a draft report was issued in 1982 on the results of the assessment, a final report has not yet been issued by 13 PA. Subsequent drafts have been issued; the most recent is dated July 1983.

The objectives of the studies were: to locate and count the number of surface impoundments in the United States and its Territories; to provide a first approximation of the groundwater pollution potential of the impoundments; to assist the States and EPA in developing a better understanding of the problems caused by surface impoundments; and to provide a data base upon which Federal (e.g., EPA) and State authorities could develop a strategy to control or regulate pollution from these sources, including to recommend legislative programs, if necessary (EPA, 1983d).

The States located 180,973 surface impoundments used for industrial, municipal, agricultural, mining, and oil and gas extraction purposes. [13] EPA concluded from the studies that fewer than 10 percent of all sites are located in a manner that poses little threat of groundwater contamination, and approximately 85 percent of all sites are located within 1 mile of a potential surface or groundwater source (EPA, 1983d). (See ch. 2 and app. A.5 for further information on surface impoundments.)

“48 FR 5686.
i +S(lnlc. S(att.s ~ls() ~epor t(.d (In other types of impoundments such as septic systetns, farm ponds used for stock watering, and safety impoundments around bulk sto~ ge tanks.

Reporting Requirements

Four Federal statutes and their associated regulatory programs require notification of EPA or the Department of Transportation (DOT) in the event of a spill, accident, or other release of specified contaminants. The relevant statutes are the Clean Water Act and CERCLA for EPA; and the Hazardous Liquid Pipeline Safety Act (HLPSA) and the Hazardous Materials Transportation Act (HMTA) for DOT. Although reporting activities are not inventories in the strict sense, they do provide documentation on releases of substances from various sources. But, with the exception of CERCLA, the emphasis of reporting requirements is on surface water discharges, not groundwater. In addition, the programs address different substances; although there is some overlap, each agency has developed its own list of contaminants that it considers hazardous.

EPA Regulations: CWA and CERCLA

Section 311 of the Clean Water Act (CWA) requires individuals in charge of facilities or vessels to notify the National Response Center in the event of any discharge of oil or a hazardous substance into navigable waters, along adjoining shorelines, or into waters of the contiguous zone. The National Response Center is operated by the U.S. Coast Guard in Washington, DC. Its function is to convey information about releases of oil and hazardous substances to the appropriate government agencies so that they, in turn, can determine whether and how response action should be taken.[15] Although Section 311 relates to surface water dis-

14Section 3 I l@)(2)(A) requires EPA to promulgate regulations listing the hazardous substances that are subject to this section. These substances are listed in 40 CFR 116. Section 31 l(b)(4) requires the determination of quantities of oil and hazardous substances, discharge of which may be harmful to public health or welfare. 40 CFR 117 specifies the quantities.

[15]40 CFR 300.36.

charges, it is significant here to the extent that there may be a connection between surface water and groundwater.

CERCLA contains a provision that is similar to Section 311 of CWA, but it is explicitly applicable to groundwater as well as surface water. Section 103(a) requires individuals in charge of facilities or vessels to notify the National Response Center in the event of *any* release of any hazardous substances in quantities equal to or greater than specified amounts.[16] The definition of the term "release' encompasses: spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment.[17] In addition, Section 103(c) of CERCLA required individuals to notify EPA of the existence of any unauthorized hazardous waste facilities by June 1981. The sites identified are part of EPA's inventory of hazardous waste sites.

DOT Regulations: HLPSA and HMTA

Under regulations promulgated by DOT for pipelines and transportation-related sources, all carriers are required to submit written reports to DOT describing any accidents within 15 days of their discovery. DOT prepares annual reports which summarize the information reported under these regulations. (See app. A.5 for data on numbers of accidents from these reports.)

DOT regulations under HLPSA specify that any failure in a pipeline system must be reported if the release of a hazardous liquid (defined as petroleum, petroleum products, or anhydrous ammonia) results in: 1) an explosion or fire not intentionally set by the operator; 2) loss of 50 or more barrels of liquid; 3) escape to the atmosphere of more than 5 barrels a day of highly volatile liquids; 4) the death of anyone; 5) bodily harm to anyone; or 6) estimated damage to the property of the operator or others, or both, exceeding $5,000.18 In cases of significant damage, DOT must be notified immediately by telephone. Criteria for such instances include, but are not limited to, accidents resulting either in damage exceeding $5,000 (as above) or in the "pollution of any stream, river, lake, reservoir, or other similar body of water that violated applicable water quality standards, caused discoloration of the surface of the water or adjoining shoreline, or deposited a sludge or emulsion beneath the surface of the water or on adjoining shorelines. "[19] Similar conditions for groundwater are not specified,

DOT regulations for HMTA contain similar provisions. The hazardous materials coverage is extensive.[20] DOT must be notified by telephone at the earliest practicable moment after any incident in which: 1) a person is killed; 2) a person receives injuries requiring hospitalization; 3) estimated damage to the carrier or other property exceeds $50,000; 4) fire, breakage, spillage, or suspected radioactive contamination involving shipment of radioactive material occurs; 5) fire, breakage, spillage, or suspected contamination involving shipment of etiologic agents occurs; or 6) in the judgment of the carrier, the situation should be reported .21 In the event of a discharge of a reportable quantity of a hazardous substance into navigable waters or along adjacent shorelines, the National Response Center must be notified (see the discussion under CWA above). As is true for the pipeline requirements, no reporting requirements are tied to groundwater contamination other than the property damage provisions.

Regulatory Requirements Related to Inventories

Part C of SDWA requires EPA to establish regulations specifying minimum requirements for State Underground Injection Control (UIC) Programs.

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l'L'nder CERCI,A, the term "hazmfous substances' includes those substances ct]~cred h} Se(tions 311 (b)(2)(A) and 307(a) of CWA, Section 102 of CER[; I.A, Section 3001 of RCRA, Section 112 of the Clean Alr Act, and Sm-tion 7 of '1'SCA. Se(tion 102(a) of CIERC IA reyu i res F-PA to designate hazardous substances (in add it ion to those spcclfied abo~x-) and to establish reportable quant it ics for them, S«- tion 102(b) specifics that a reportable quantity of 1 pound shall apply to all the haza~iou$ substances includccl in the statutes 1 isted abm'c (ex(ept for differ-ent quantltie~ established under Section 31 l(b)(4) of CWA) unless and until F,P.A estahlishcs reportahlc quantitt regulations pursuant to %ction 1 02(a).

[i]SC(t ion 101 (22)

18,9 c FR 195,50. A sp«i«l accident reporting form has been d(.- ~clop~d b~ DOT (110'1' Form 7000-1).

1949 c FR 19.5. 52(a).

"See 49 C FR 172

z 14q c FR 171 15, 1)0"1' F{)rnl F 5800, 1 must also be submit te(l within 15 days of disco~ery of the accident (see 4° (~ FR 171. 16).

Final Federal regulations were published on February 3, 1982, and the States are now in the process of developing UIC programs based on these requirements. The States are required to establish a permitting program for injection wells. Most existing wells are authorized by rule until a State program is in place and site-specific permits are issued. One section of the Federal regulations requires owners and operators of injection wells authorized by rule to submit inventory information to the States or EPA about their operations within one year after they are authorized. The inventory form requires information on the facility name and location, a legal contact, ownership, the nature and type of wells, and the operating status of the wells .22

'Z40 CFR 144.26.

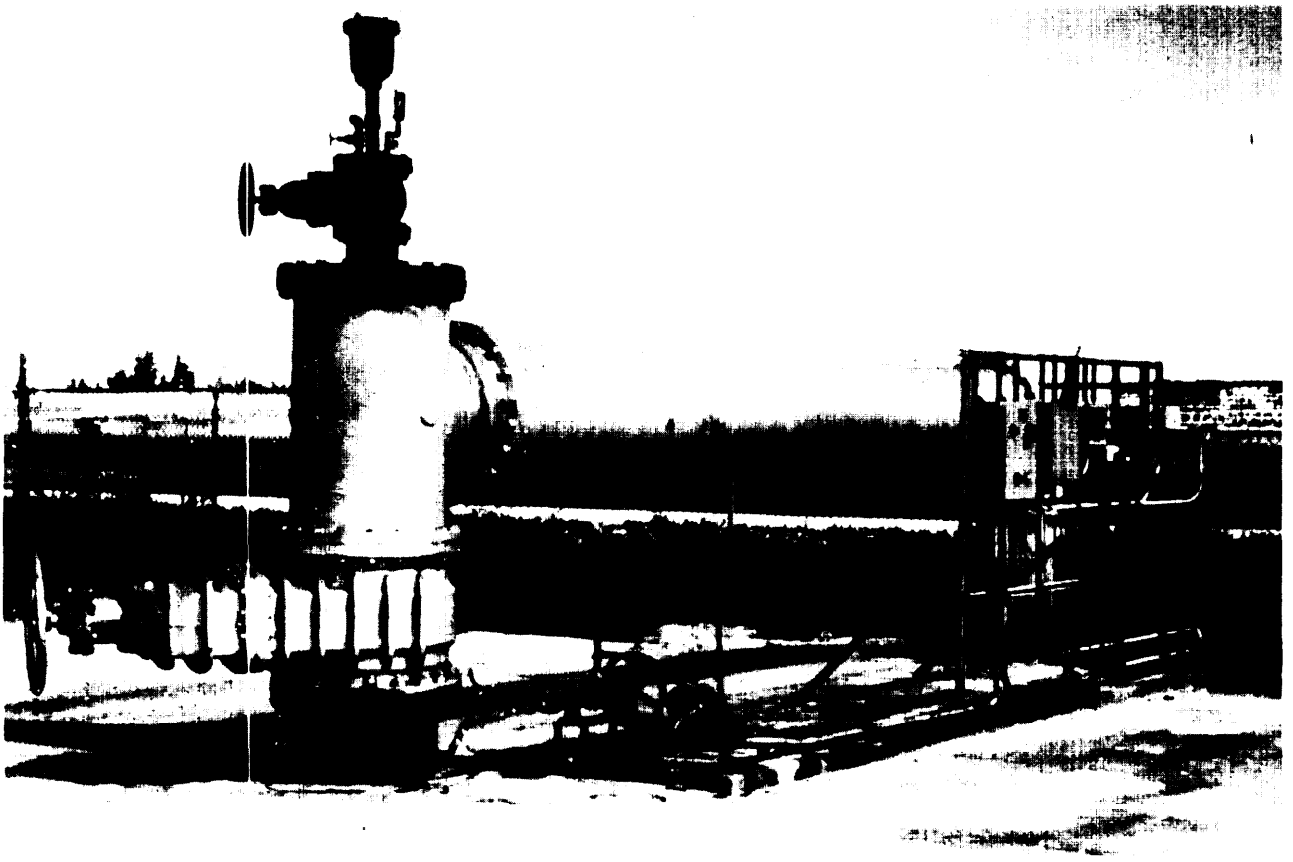

Photo credit: State of Florida Depatiment of Environmental Regulation

Permitting rules developed under State Underground Injection Control Programs typically address the construction and monitoring of injection wells.

GROUNDWATER MONITORING AND SOURCES

This section summarizes Federal efforts related to monitoring specific sources of groundwater contamination. Three types of monitoring activities are discussed:

1. monitoring requirements specified by Federal regulations that apply to facility owners and operators;
2. monitoring conducted by Federal agencies relative to federally funded remedial programs; and
3. monitoring conducted by Federal agencies as part of hydrogeologic investigations related to certain sources.

Table 30 summarizes these groundwater monitoring activities as they relate to Federal statutes and indicates the objectives of each program. Appendix E contains more detailed information about these activities for each source. In addition to the statutory provisions shown in table 30, other Federal groundwater monitoring activities are also described below.

In summary, Federal monitoring requirements are specified for certain sources in OTA Categories 1, II, IV, and V (see ch. 2, table 5). But there are inconsistencies in the coverage of the monitoring provisions for similar sources under different programs. Detailed guidance on the design of site-specific monitoring systems is not provided in the regulations. Although guidance manuals have been developed by some agencies, the individuals who draft and review permits (including exemptions) are responsible for ensuring the adequacy of site-specific systems; adequately trained personnel are in short supply. A detailed discussion of these conclusions follows.

Monitoring Provisions of Federal Programs

There are 10 regulatory programs authorized by Federal statutes that establish groundwater monitoring provisions for sources of contamination. However, these programs address only certain sources in OTA Categories I, 11, IV, and V, and monitoring is not ***required*** for many of them. For example, there are no requirements for non-point sources in Category IV such as irrigation practices and fertilizer applications. Groundwater monitoring requirements are not established for any sources in Categories III and VI.

In addition, monitoring requirements for sources within the same category are not uniform. Under the Toxic Substances Control Act (TSCA), for example, required groundwater monitoring for PCB disposal sites is limited to an initial collection of background data. In contrast, the regulations promulgated for radioactive disposal sites under the Atomic Energy Act (AEA) and for hazardous waste sites under the Resource Conservation and Recovery Act (RCRA) require monitoring during operation and after closure.

For the most part, final Federal regulations do not contain explicit monitoring requirements (e. g., numbers and locations of wells) in recognition of the site-specific nature of groundwater contamination problems and the technical uncertainties associated with hydrogeologic investigations (see ch. 5). Because of the variety and complexity of factors that must be considered in designing a program to monitor (e. g., sample and analyze) groundwater quality, Federal regulations establish monitoring objectives and general guidelines rather than detailed requirements. 23

In the absence of detailed monitoring requirements, several Federal agencies have developed manuals to assist both permit (or license) writers and the regulated community. 24 The manuals provide guidance on determining background levels, selecting parameters, designing a monitoring network (e. g., number and location of wells), selecting appropriate sampling frequencies, and other topics. Because monitoring programs do not specify detailed requirements, the burden of ensuring that

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Z~s$_{cC}$. ~, ~,, Fi~ N~ R$_{cw}$l[ions ~Or 1.o\\I Lrvcl Radioact i~'e \$'astt' Disposal Facilities, 47 FR 57452, Dec. 27, 1982; Final OShl Rc'~ulationj for Surface Coal hlining and Rcrlamat ion Opm-ations, 48 FR 43974, Scpt. 26, 1983; and Final EPA Rc~ulations for Hazardous J\$'astc I,and Disposal Facilities, 47 FR 32274, July 26, 1982,

24 ~'~~r ~.~amp]~., s{>c FY,4, 1983c,, 1983f; and NRC, 1983a, 1983t~.

Table W.—Federal Groundwater Monitoring Provisions and Objectives

Statutory authority	Monitoring provisions[a]	Monitoring objectives
Atomic Energy Act	Groundwater monitoring is specified in Federal regulations for low-level radioactive waste disposal sites. The facility license must specify the monitoring requirements for the source. The monitoring program must include: —Pre-operational monitoring program conducted over a 12-month period. Parameters not specified. —Monitoring during construction and operation to provide early warning of releases of radionuclides from the site Parameter and sampling frequencies not specified. —Post-operational monitoring program to provide early warning of releases of radionuclides from the site. Parameters and sampling frequencies not specified. System design is based on operating history, closure and stabilization of the site.	to obtain background water quality data and to evaluate whether groundwater is being contaminated.
	Groundwater monitoring related to the development of geologic repositories will be conducted. Measurements will include the rate and location of water inflow into subsurface areas and changes in groundwater conditions.	To confirm geotechnical and design parameters and to ensure that the design of the geologic repository accommodates actual field conditions.
	Groundwater monitoring may be conducted by DOE, as necessary, part of remedial action programs at storage and disposal facilities for radioactive substances.	To characterize a contamination problem and to select and evaluate the effectiveness of corrective measures.
Clean Water Act		
—Sections 201 and 405	Groundwater monitoring requirements are established on a case-by-case basis for the land application of wastewater and sludge from sewage treatment plants.	To evaluate whether groundwater is being contaminated.
—Section 208	No explicit requirements are established; however, groundwater monitoring studies are being conducted by SCS under the Rural Clean Water Program to evaluate the impacts of agricultural practices and to design and determine the effectiveness of Best Management Practices.	To characterize a contamination problem and to select and evaluate the effectiveness of corrective measures.
Coastal Zone Management Act	The statute does not authorize development of regulations for sources. Thus, any groundwater monitoring conducted would be the result of requirements established by a State plan (e.g., monitoring with respect to salt-water intrusion) authorized and funded by CZMA.	
Comprehensive Environmental Response, Compensation, and Liability Act	Groundwater monitoring may be conducted by EPA (or a State) as necessary to respond to releases of any hazardous substance+ contaminant, or pollutant (as defined by CERCLA).	To characterize a contamination problem (e.g., to assess the impacts of the situation, to identify or verify the source(s), and to select and evaluate the effectiveness of corrective measures).
Federal Insecticide, Fungicide, and Rodenticide Act—Section 3	No monitoring requirements established for pesticide users. However, monitoring may be conducted by EPA in instances where certain pesticides are contaminating groundwater.[b]	To characterize a contamination problem.
Federal Land Policy and Management Act (and Associated Mining Laws)	Groundwater monitoring is specified in Federal regulations for geothermal recovery operations on Federal lands for a period of at least one year prior to production. Parameters and monitoring frequency are not specified.	To obtain background water quality data.
	Explicit groundwater monitoring requirements for mineral operations on Federal lands are not established in Federal regulations. Monitoring may be required (as a permit condition) by BLM.	
Hazardous Liquid Pipeline Safety Act	Although the statute authorizes development of regulations for certain pipelines for public safety purposes, the regulatory requirements focus on design and operation and do not provide for groundwater monitoring.	
Hazardous Materials Transportation Act	Although the statute authorizes development of regulations for transportation for public safety purposes, the regulatory requirements focus on design and operation and do not provide for groundwater monitoring.	
National Environmental Policy Act	The statute does not authorize development of regulations for sources.	
Reclamation Act	No explicit requirements established; however, monitoring may be conducted, as necessary, as part of water supply development projects.	
Resource Conservation and Recovery Act	Groundwater monitoring is specified in Federal regulations for all hazardous waste land disposal facilities (e.g., landfills, surface impoundments, waste piles, and land treatment units).	

Table 30.—Federal Groundwater Monitoring Provisions and Objectives—continued

Statutory authority	Monitoring provisions	Monitoring objectives
Resource Conservation and Recovery Act (cent'd) –Subtitle C	These requirements specify the installation of at least one upgradient well and three downgradient wells. Samples must be taken quarterly during the first year and analyzed for the National Interim Drinking Water Regulations, water quality indicator parameters (chloride, iron, manganese, phenols, sodium, and sulfate), and indicator parameters (pH, specific conductance, TOG and TOX). In subsequent years, each well is sampled and analyzed quarterly for the six background water quality indicator parameters and semiannually for the four indicator parameters. *Groundwater monitoring requirements can be waived* by an owner/operator if a written determination indicating that there is low potential for waste migration via the upper-most aquifer to water supply wells or surface water is made and certified by a qualified geologist or engineer. The determination is not submitted to EPA for verification or approval.	To obtain background water quality data and evaluate whether groundwater is being contaminated.
	The monitoring requirements for a *fully permitted* facility are comprised of a three-part program: —*Detection Monitoring* — Implemented when a permit is issued and there is no indication of leakage from a facility. Parameters are specified in the permit. Samples must be taken and analyzed at least semiannually. *Exemptions* from detection monitoring program may be granted by the regulatory authority for landfills, surface impoundments, and waste piles with double liners and leak detection systems. —Compliance *Monitoring* — Implemented when groundwater contamination is detected. Monitoring is conducted to determine whether specified concentration levels for certain parameters are being exceeded (levels are based on background concentrations, maximum contaminant levels specified by the National Drinking Water Regulations [if higher than background], or an alternative concentration limit [established on a site-specific basis]). Samples must be taken and analyzed at least quarterly for parameters specified in the permit. Samples must also be analyzed for a specific list of 375 hazardous constituents (Appendix Vlll, 40 CFR 261) at least annually. —*Corrective Action Monitoring* – Implemented if compliance monitoring indicates that specified concentration levels for specified parameters are being exceeded (and corrective measures are required). Monitoring must continue until specified concentration levels are met. Parameters and monitoring frequency not specified. —Exemption from groundwater monitoring requirements may be granted by the regulatory authority if there is no potential for migration of liquid to the uppermost aquifer during the active life and closure and post-closure periods.	To obtain background water quality data or evaluate whether groundwater is being contaminated (detection monitoring), to determine whether groundwater quality standards are being met (compliance monitoring), and to evaluate the effectiveness of corrective action measures.
—Subtitle D	Groundwater monitoring may be required by State solid waste programs. Federal requirements for State programs *recommend* the establishment of monitoring requirements.	
Safe Drinking Water Act —Part C—Underground Injection Control Program	Groundwater monitoring requirements may be specified in a facility permit for injection wells used for in-situ or solution mining of minerals (Class Ill wells) where injection is into a formation containing less than 10,000 mg/l TDS. Parameters and monitoring frequency not specified except in areas subject to subsidence or collapse where monitoring is required on a quarterly basis. Groundwater monitoring may also be specified in a permit for wells which inject beneath the deepest underground source of drinking water (Class I wells). Parameters and monitoring frequency not specified in Federal regulations.	To evaluate whether groundwater is being contaminated.

Table 30.— Federal Groundwater Monitoring provisions and Objectives—continued

Statutory authority	Montoring provisions	Monitoring objectives
Surface Mining Control and Reclamation Act	Groundwater monitoring is specified in Federal regulations for surface and underground coal mining operations to determine the impacts on the hydrologic balance of the mining and adjacent areas. A groundwater monitoring plan must be developed for each mining operation (including reclamation). At a minimum, parameters must include total dissolved solids or specific conductance, pH, total iron, and total manganese. Samples must be taken and analyzed on a quarterly basis.	To obtain background water quality data and evaluate whether groundwater is being contaminated.
	Monitoring of a particular water-bearing stratum may be waived by the regulatory authority if it can be demonstrated that it is not a stratum which serves as an aquifer that significantly ensures the hydrologic balance of the cumulative impact area.	
Toxic Substance Control Act —Section 6	Groundwater monitoring specified in Federal regulations requires monitoring prior to commencement of disposal operations for PCBs. Only three wells are required if underlying earth materials are homogeneous, impermeable and uniformly sloping in one direction. Parameters include (at a minimum) PCBs, pH, specific conductance, and chlorinated organics. Monitoring frequency not specified.	To obtain background water quality data
	No requirements are established for active life or after closure.	
Uranium Mill Tailings Radiation Control Act	Federal regulatory requirements for active mill tailings sites are, for the most part, the same as those established under Subtitle C of RCRA.[c]	To obtain background water quality data, evaluate whether groundwater is being contaminated, determine whether groundwater quality standards are being met, and evaluate the effectiveness of corrective action measures.
	Groundwater monitoring for inactive sites may be conducted if necessary to determine the nature of the problem and for the selection of an appropriate remedial action.	To obtain background water quality data and to characterize a contamination problem.
Water Research and Development Act	The statute does not authorize the development of regulations for sources. Groundwater monitoring may be conducted as part of projects funded by the act.	

a The ~ Provisions presented in this table are either those specified by regulatmns for exlstlng and new sources; or for groundwater monitoring that may be conducted as Part of an lnvesti9atoW study or remedial

b~~~~~i$~o~~n~jacturers may be required b, EpA t. subm{t **g~oundwater monitoring data as** pafi of the registration requirements for a pestlclde product to evaluate the potentlat for a pesticide tO COntaf_llinate groundwater. cs, ap,. E.2 for a surnma~ of the differences between UMTRCA and RCFtA rnOnitOrh9 rfWJirernents.

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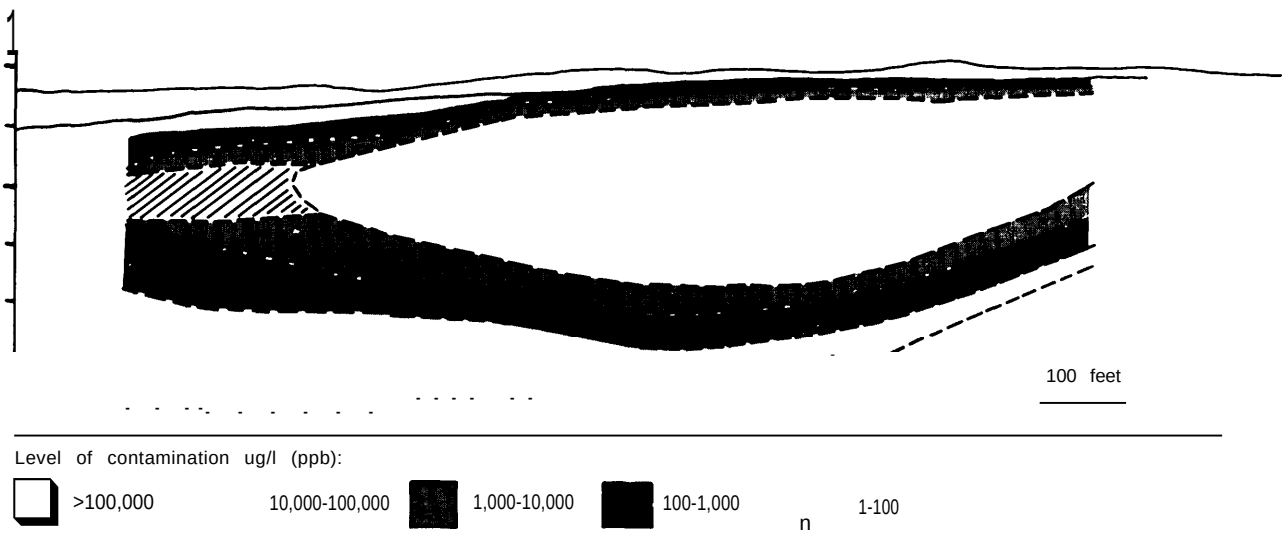

Cred/t Tewhey, et al, 7982

The site-specific nature of groundwater contamination problems requires that hydrogeologic investigations be tailored to site conditions. At this site, the design of the monitoring system provided data that were used for determining the vertical distribution of volatile organic chemicals.

site-specific monitoring satisfies program objectives lies with the individuals responsible for drafting and approving facility permits and licenses.

Although monitoring requirements generally lack specificity, some Federal regulations contain more detailed requirements than others. For example, the regulations developed under the Surface Mining Control and Reclamation Act (SMCRA) and TSCA specify the minimum parameters that must be measured; and RCRA (Subtitle C), the Safe Drinking Water Act, SMCRA, and the Uranium Mill Tailings Radiation Control Act (UMTRCA) specify monitoring frequencies. In addition, the number of monitoring wells is specified in both the requirements for PCB disposal sites under TSCA and the interim *status* requirements under Subtitle C of RCRA.

OTA's study did not focus on the implementation of Federal regulations (see OTA, forthcoming). A recent General Accounting Office (GAO) stud y of the RCRA *interim status* program in four States indicates a substantial amount of non-compliance with the groundwater monitoring requirements (GAO, 1983). For example, in two of the four States, 78 percent of the facilities required to conduct groundwater monitoring were not in compliance with the regulations (e. g., monitoring wells were lacking and wells were not sited correctly). Some of the non-compliance was related to the technical complexities of locating and constructing wells and the costs of well installation, sampling, and analysis. The States also cited a number of problems regarding enforcement of the RCRA regulations: lack of resources (e. g., staff); lack of technical expertise and guidance; and confusion among State agencies about jurisdiction over facility inspections.

As indicated in table 30, the interim status requirements (which specify the number of monitoring wells) must be met by hazardous waste land disposal facilities until a final permit is approved either by the Environmental Protection Agency (EPA) or a State with an EPA-approved RCRA program, EPA estimates that it will take approximately 10 years to review and approve permits for an estimated 1,350 land disposal facilities nationwide (GAO, 1983).

Certain facilities are exempted from groundwater monitoring requirements. The exemption or waiver provisions noted below provide varying degrees of guidance for making exceptions on a site-by-site basis:

- Under the SMCRA regulations for coal mining, monitoring of a water-bearing stratum may be waived by the regulatory authority if

it is determined that the stratum is not an aquifer that significantly ensures the hydrologic balance of the ' 'cumulative impact area."[25] The waiver determination is based on information developed as part of an assessment (referred to as a ' 'probable hydrologic consequences determination") regarding whether the mining operation will adversely affect the hydrologic balance; cause surface or groundwater contamination; and affect groundwater availability, water quality, or a variety of other factors.[26]

- Under the RCRA Subtitle C *interim status* program, owners and operators of land disposal facilities can waive groundwater monitoring requirements if they obtain a written determination, certified by a qualified geologist or geotechnical engineer, that there is low potential for water migration from the facility via the uppermost aquifer to water supply wells or surface water. The waiver document is retained at the facility; it is not submitted to EPA for review until the facility is called in for final permit review, which may be as long as 10 years. The evaluation of the potential for migration must be based on an assessment of the water balance, unsaturated and saturated zone characteristics, and proximity of the facility to water supply wells or surface water. 27
- RCRA Subtitle C regulations for *fully permitted* land disposal facilities also contain exemption provisions. Groundwater monitoring may be waived by the regulatory authority for facilities if it is determined that there is no potential for migration of liquids to the uppermost aquifer during active, closure, and postclosure periods, Any predictions made about migration potential must be based on assumptions that maximize the rate of liquid migration.[28] In addition, at landfills, surface impoundments, and waste piles where double liners and leak detection systems are installed, exemptions from the detection monitoring program may be granted. A previous OTA study of the hazardous waste land disposal technologies specified in the RCRA regulations concluded that the lack of groundwater monitoring at double-lined facilities does not protect groundwater because such systems are not failsafe (OTA, 1983).

Monitoring and Remedial Action Programs

In addition to the monitoring requirements described in the previous section, groundwater monitoring may also be conducted as part of a federally funded remedial action effort-e. g., to characterize a contamination problem and to evaluate and select among alternative corrective measures.

Table 30 indicates that monitoring is addressed by programs authorized by AEA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and UMTRCA. Like the requirements discussed above for permitted or licensed facilities, explicit groundwater monitoring requirements are not specified under these programs. Such an approach is consistent with the site-specific nature of groundwater contamination problems.

Other Monitoring Activities

A number of Federal agencies are undertaking additional groundwater monitoring programs with

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Hydrogeologic investigations, including soil testing as shown, provide important input to the evaluation and selection of corrective actions.

ZSTh, cumulative impact ~rea is the area within which the proposed mining operation may interact with all other anticipated mining. (30 CFR 701.5, 48 FR 43985, Sept. 26, 1983).

ZGS,, 30 CFR 780,21, 48 FR 43985, Sept. 26, 1983. The regulations specify the types of information that must be submitted to support this,

2740 CFR 265.90(c),

ZS40 CFR 264.90(b)(4).

respect to specific sources of contamination. Some of this work focuses on some of the sources in Categories IV and VI for which no monitoring requirements are established (e.g., fertilizer applications, animal feeding operations, and natural leaching).

Additional monitoring has been undertaken by the following Federal agencies:

- The Soil Conservation Service (SCS), in conjunction with the States, private institutions, and other Federal agencies such as the Agricultural Stabilization and Conservation Service, is involved with several contamination investigations under the Rural Clean Water Program authorized by Section 208(j) of the Clean Water Act relating to agricultural operations (table 30). The groundwater data being collected will be used to support the development of Best Management Practices. 29
- EPAs Office of Pesticide Programs has been involved with several groundwater monitoring studies. For example, the office conducted monitoring studies where contamination from pesticide applications was detected. The studies focused on aldicarb and DBCP. In addition, EPA has been evaluating groundwater quality and the fate and transport of pesticides in several States (e. g., Wisconsin, Georgia, and California) in conjunction with the States, local governments, universities, and other Federal agencies (e. g., USGS). The studies focus on those pesticides used in each State that, based on their chemical properties, have the greatest potential to leach into groundwater (Severn, et al., 1983). EPA and other Federal agencies have been working together on monitoring related to the formulation and implementation of the National Pesticide Monitoring Plan (NPMP) under the Federal Insecticide, Fungicide, and Rodenticide Act.[30] A program directed exclusively at groundwater, however, has not been implemented .31
- The Bureau of Reclamation, in conjunction with SCS and USGS, is participating in monitoring efforts as part of the Colorado River Basin Salinity Control Program.[32] The sources of contamination are underlying geologic formations containing salts, which are being leached due to infiltration of excessive amounts of irrigation water. The groundwater data collected will be used in the development of irrigation water management strategies.
- USGS has programs devoted to three specific sources of groundwater contamination: 1) coal and oil shale development, 2) radioactive waste disposal, and 3) toxic waste disposal (see preceding section on *Federal Programs)* Each involves groundwater monitoring. For example, as part of the coal and oil shale programs, USGS is collecting data at thousands of mining areas. Under the Toxic Wastes-Groundwater Contamination Program, field investigations are being conducted on the mobility and fate of organic substances in groundwater.[33]

~q cjne s ~u ~|, ~ I J~ ~Ca S tcr count),, PA, is concerned with contamina - t ion result Ins from w]ur(es such as animal wastes and fertilizer and pcsticidc applic-ations. Groundwater is being monitored to cstahlish bac kgrounc] lmels and to aswss the impacts of the Best !tIanagcment Practices (USDA, 1982) A similar -xuct>' is being undertaken in eastern South Dakota (South I]akota State' Coordinating Committm. 1982).

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+ZTh<, c:olo r~o R i~,er Basin Sal lnlt f, Con[ml Act Of 1 !] ~ 4 (l'Ub] i(I.aw 93-320) authorizes construction, operation, and maintenan~ t, of certain works to cent rol water salinit}, in the (3010rado Ri\er Basin The program is extensive, cm"cnng se~'en States (California, Arizon,l. -New \fexico, Colorado, Nc\'ada, Utah, and \$'yoming) di~ided int[) numerous units. Othcr Federal agencies such as the ASricultur.d Stabilization and Conscr\ation Ser\ice, EPA, the Bureau of Land Managcrncnt, and the Fish and Wildlife Service are involted in varloui aspects of the projcrt, As an example, see DOI, 1983,

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