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Waste Disposal Practices: A Threat to Health and the Nation's Water Supply. CED-78-120: B-166506. June 16, 1978. 31 pp. + 2 appendices (3 pp.).

Report to the Congress; by Robert F. Keller, Acting Comptroller General.

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Budget Function: Natural Resources, Environment, and Energy: Pollution Control and Abatement (304).
Organization Concerned: Environmental Protection Agency.
Congressional Relevance: House Committee on Public Works and Transportation; Senate Committee on Environment and Public Works; Congress.
Authority: Resource Conservation and Recovery Act of 1976 (P.L. 94-580). Safe Drinking Water Act (42 U.S.C. 300(f)). Clean Water Act of 1977 (P.L. 95-217). Toxic Substances Control Act.

Millions of tons of waste are generated annually and disposed of on land because this is usually the cheapest method of waste disposal. Land disposal sites are often located in areas considered to have little value for other uses. Findings/Conclusions: There has not been enough concern for soil or proximity to water resources in selecting land disposal sites. Leachate, a polluted liquid resulting when water comes in contact with waste, contaminates groundwater and creates a potential public health threat. Federal and State agencies have not assessed the extent of damage to groundwater supplies or determined the number of sites which may be leaching. Studies have been made only after wells have been contaminated. The Environmental Protection Agency (EPA) estimated that about 14,000 of the nearly 20,000 municipal wasteland disposal sites do not comply with State standards, and almost nothing is known of the over 100,000 industrial sites. State programs have been ineffective because of lack of staff and funds and because of the unavailability of alternative sites. Federal legislation aimed at improving waste disposal practices has not been effective enough because time frames for improvements have not been met, problems of existing groundwater contamination have not been addressed, and monitoring of drinking water systems does not include all contaminants. Recommendations: The Administrator, EPA, should: determine when the legislative mandate for completing the open dump inventory can reasonably be achieved and present this information and estimates of needed Federal funding to congressional committees, include in criteria for sanitary landfills monitoring at sites located in areas

where conditions enable the development of leachate contamination unless States specify that groundwater will not be used as drinking supply, and amend implementing regulations to the Safe Drinking Water Act applicable to State programs to include minimum standards for performing the sanitary survey of public water systems. These standards should include an analysis of sources of pollution and effects on water quality and provide for public notification of survey results. (HTW)

6750

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Waste Disposal Practices — A Threat To Health And The Nation's Water Supply

Past practices for disposing of waste on the land have contaminated groundwater resources (water below the surface of the earth) in some heavily populated areas of the Nation to the point of threatening public health. The extent of the damage done to this important resource has not been determined and the total number of sites which may be contaminating groundwater has not been established by the responsible Federal or State agencies.

State control programs have been ineffective and the improvements mandated by the Resource Conservation and Recovery Act of 1976 will not be accomplished within the time frames specified by the Congress.

CED-78-120
JUNE 16, 1978

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-166506

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses (1) the effects that unsound waste disposal practices may be having on the Nation's health and water supply and (2) Federal and State efforts to control waste disposal practices.

The review was made to determine what the Environmental Protection Agency was doing to alleviate the danger to public health and the environment from municipal waste disposal and to encourage environmentally sound waste disposal practices.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of the report to the Director, Office of Management and Budget, and to the Administrator, Environmental Protection Agency.

ACTING Comptroller General
of the United States

D I G E S T

Land disposal sites are often located in areas considered to have little or no value for other uses and without sufficient concern for the type of soil on which they are situated or their proximity to water resources, particularly groundwater. Such improper siting, coupled with limited State enforcement of other standards and requirements, has resulted in groundwater contamination in some heavily populated areas throughout the country.

Millions of tons of waste are generated annually and this volume will continue to increase. Over the years this waste has been disposed on land because this method is usually the cheapest alternative.

Leachate, a highly polluted liquid resulting from water coming in contact with waste, contaminates the groundwater and poses a potential threat to public health where the water may be used as a public drinking water supply.

For example, in 1972 the primary drinking water source for thousands of people in New Castle County, Delaware, was found to be contaminated. Engineers estimated that daily about 170,000 gallons of leachate were entering the groundwater from a landfill. (See p. 9.)

Although leachate can be a potent contaminant, the relationship between waste disposal practices and groundwater has generally been ignored by those responsible for waste disposal.

So far, Federal and State agencies have not assessed the extent of damage to groundwater supplies or determined the number of disposal sites which may be leaching. The limited information that is available is a result of studies made only after specific water wells have been contaminated. In this regard, the Environmental Protection Agency estimates that

about 14,000 of the nearly 20,000 municipal waste land disposal sites do not comply with State standards. In addition, virtually nothing is known about the over 100,000 industrial waste land disposal sites. (See pp. 10 and 11.)

State programs to control waste disposal activities have been ineffective because, even though most States have enacted legislation governing waste disposal activities, they lack the staff and funds to adequately manage the programs. Acceptable alternative disposal sites are not always available to assure compliance with legislative requirements. Federal financial assistance to the States was also limited. (See pp. 7 and 14.)

To improve waste disposal practices, the Congress has enacted the Resource Conservation and Recovery Act of 1976. Although the act specifies a series of actions which would culminate in the closing or upgrading of all open dumps by October 1983, key activities will not be completed within the legislative time frames. These activities include (1) developing criteria for sanitary landfills and (2) publishing within 1 year an inventory of all disposal sites not in compliance. (See pp. 15 to 17.)

WATER SUPPLY EVALUATIONS ARE NEEDED TO PROTECT THE PUBLIC

Effectively carrying out the Resource Conservation and Recovery Act of 1976 will significantly eliminate or minimize groundwater contamination from new or upgraded existing sites. However, the act does not address the potential threat to public health that exists because of groundwater that is already contaminated or that may become contaminated as a result of older, closed disposal sites. Once groundwater is contaminated by leachate, little can be done to clean the aquifer (an underground water-bearing geologic formation). Any corrective measures that can be taken are expensive and technically difficult. (See p. 23.)

Under the regulations implementing the Safe Drinking Water Act, the monitoring performed by public water systems is directed to those contaminants most often found in drinking water. However, there are hundreds of other chemical contaminants in water. Since it would be impractical to monitor for the presence of all such contaminants, it is important to evaluate drinking water sources to determine whether past or present disposal practices may be affecting the quality of the water. (See pp. 25 to 29.)

RECOMMENDATIONS

The Administrator, Environmental Protection Agency, should:

--Determine when the legislative mandate for completing the open dump inventory can reasonably be achieved and present this information, along with an estimate of the total Federal funding that will be needed, to the appropriate congressional committees. (See p. 21.)

--Include in the criteria for sanitary landfills, monitoring at all such sites located in areas of the country where the hydrology and geological conditions enable the development of leachate contamination. This would be required unless the States specifically designated, through the procedures specified in the proposed criteria, that the groundwater will not be used as a drinking water supply. (See p. 21.)

--Amend the regulations implementing the Safe Drinking Water Act applicable to State programs to include minimum standards for performing the sanitary survey of public water systems. Such standards should

  --include an analysis of all sources of pollution and their effect on the water quality (the extent of the analysis performed should depend on such factors as climate, geology, hydrology, and disposal practices used) and

  --provide for public notification of the survey results. (See p. 29.)

AGENCY COMMENTS

Although written comments were not obtained, GAO discussed the report with Agency officials and where appropriate their comments were included. The Agency generally agreed with the conclusions and recommendations.

Agency officials said, however, that they could not easily make a precise estimate of the time and cost to complete the open dump inventory and that the requirements for the sanitary survey need not be specified in regulations; but a separate guidance would be sufficient. GAO believes that the cost and time needed for the open dump inventory is basic information necessary for the Congress in its oversight role on the implementation of the act; the Agency should provide the best estimates it can on these matters. GAO also believes that regulations requiring the sanitary survey should specify minimum standards for the completion of the survey regardless of any additional guidances to be provided by the Agency. (See pp. 22 and 30.)

Contents

ABBREVIATIONS

EPA	Environmental Protection Agency
GAO	General Accounting Office
RCRA	Resource Conservation and Recovery Act of 1976

CHAPTER 1

INTRODUCTION

This report discusses Federal and State efforts to control the disposal of solid waste. It also discusses the relationship between land disposal activities and the quality of our drinking water. Our previous reports focused on solid waste management on Federal lands, limitations of the solid waste demonstration grant program, and the use of wastes to conserve resources and to create energy. 1/

SOLID WASTE AND ITS DISPOSAL

The most recent (1975) EPA estimate is that 136 million tons of municipal solid waste is being generated annually --about 3.4 pounds per person daily- and that this volume will increase by another 89 million tons by the year 1990. This estimate does not include the millions of tons of industrial wastes, sewage sludges, junk automobiles, and construction and demolition wastes. If all wastes were considered, the total volume would be about 3 to 4 billion tons annually.

EPA estimates that there are nearly 20,000 municipal waste land disposal sites. In addition to receiving the usual household wastes, they may receive medical wastes, paints, pesticides, dead animals, metals, plastics, and liquid chemical wastes. (See photograph on the following page.) Many sites are located on land that is considered to have little or no value for other uses, such as marshes, and sand and gravel pits, and it is such siting which poses the greatest potential for environmental damage.

About 6,000 of the municipal waste land disposal sites are "sanitary landfills", usually operated under permits issued by the States. Sanitary landfilling as traditionally defined is a method of disposing of solid waste with only

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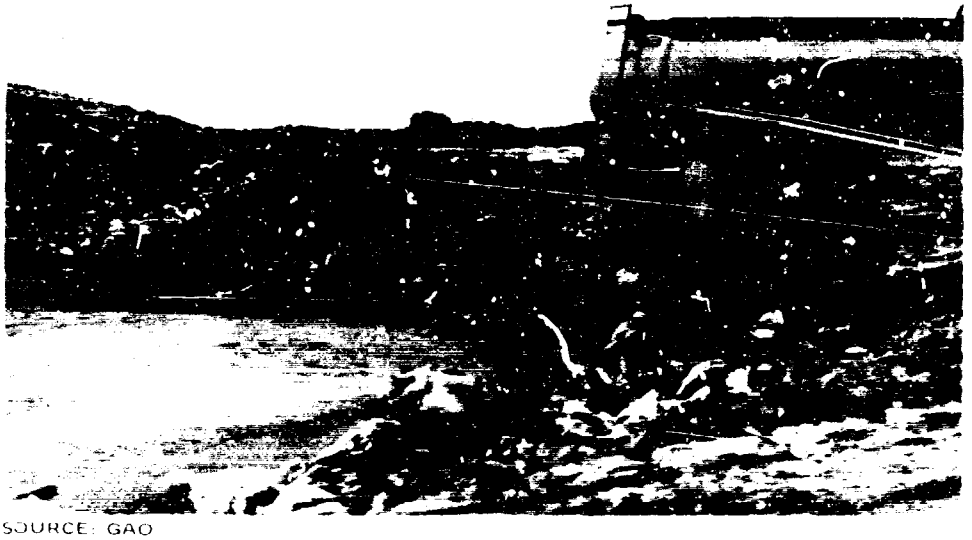
1/ "Demonstration Grant Program Has Limited Impact on National Solid Waste Disposal Problem," B-166506, February 4, 1972.
"Need for Federal Agencies to Improve Solid Waste Management Practices," B-166506, October 26, 1972.
"Using Solid Waste to Conserve Resources and to Create Energy," RED-75-326, February 27, 1975.
"Improving Military Solid Waste Management: Economic and Environmental Benefits," LCD-76-345, June 2, 1977.

SOURCE: GERAGHTY AND MILLER, INC.

ABANDONED INDUSTRIAL LIQUID WASTE LAGOON IN NEW JERSEY



SOURCE: GAO

CHEMICAL WASTE BEING DUMPED INTO A LANDFILL

minimal damage to the environment and poses no hazard to public health or safety.

Solid waste is also disposed on land through

--surface impoundments (lagoons, pits, and ponds) for liquid wastes (see photograph on previous page) and

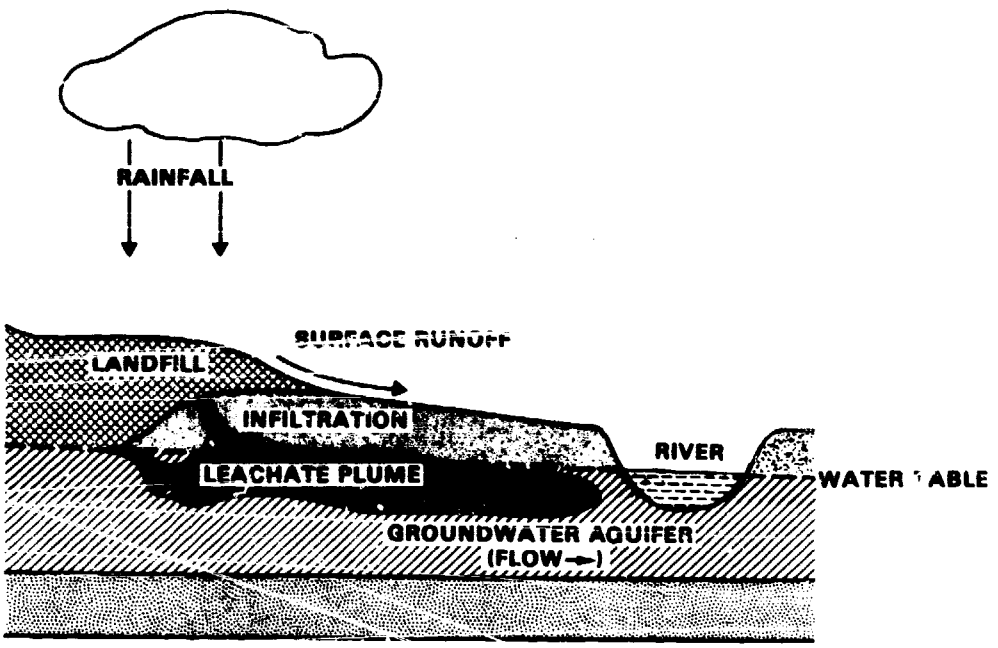
--landspreading of sewage, industrial, and other sludges.

Incineration and, to a lesser extent, various resource recovery techniques have been used to process waste; however, each of these processes results in a residue which must still be disposed of on the land.

LEACHATE FORMATION AND MOVEMENT

When water comes in contact with waste, it removes the soluble components producing a grossly polluted liquid called leachate. Depending on the wastes received at a land disposal site, leachate may contain various decaying organics, bacteria, viruses, and toxic chemicals including heavy metals and known and suspected carcinogens. When saturated, a land disposal site produces an amount of leachate equal to the amount of water entering it. Liquid wastes add to the leachate quantity and often increase its strength and complexity. The leachate process, which can continue for as long as 50 to 100 years, is illustrated in figure 1 below.

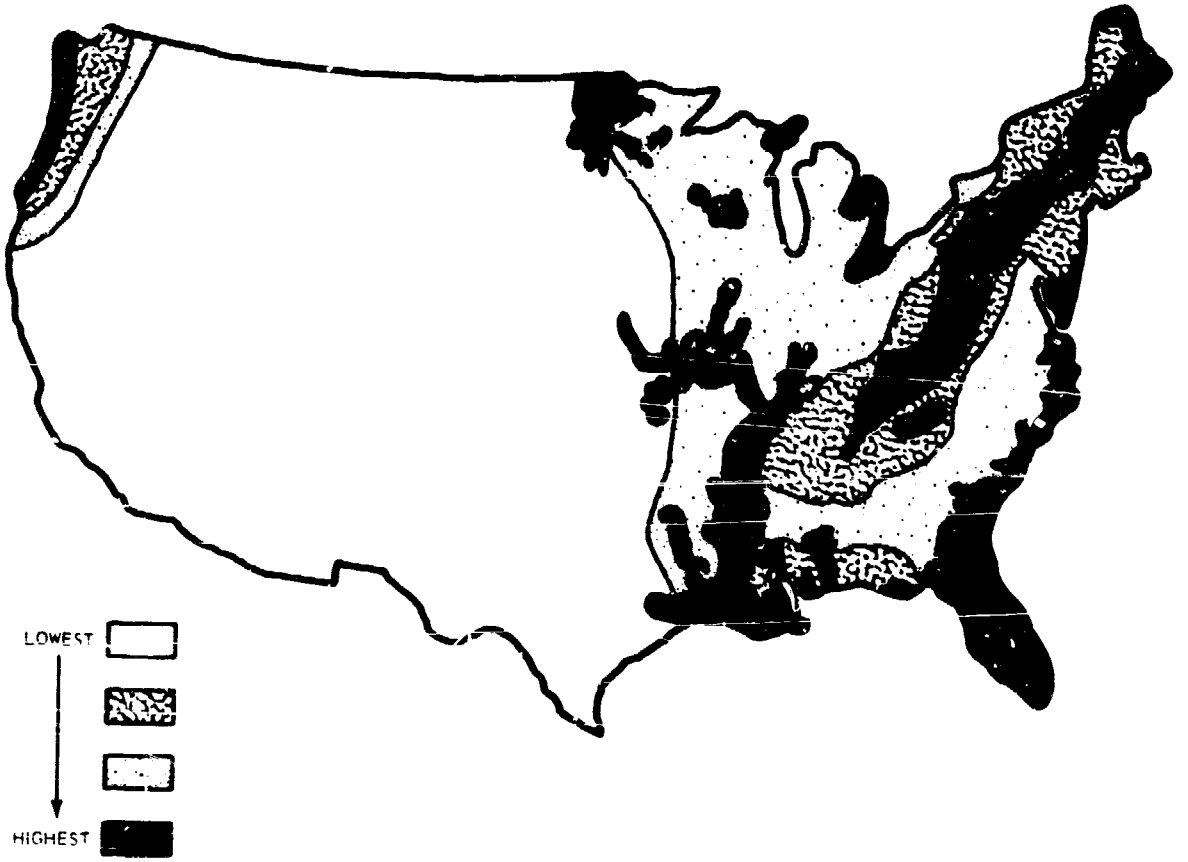
FIGURE 1. LEACHATE FORMATION AND MOVEMENT



The potential for leachate formation is greater in humid areas where the amount of rainfall exceeds the amount of moisture returned to the atmosphere. As shown in figure 2 below, those areas of the country with the highest potential for leachate contamination are also those with the largest concentrations of people, industry, and volumes of waste. These areas are also heavily dependent on land disposal and have millions of people obtaining water from public and private wells. EPA officials believe that land disposal sites pose a threat to public health through the water supplies.

Upon entering groundwater, leachate can move vertically and horizontally, usually in the form of a plume or slug. The rate of flow (typically less than 2 feet a day) depends primarily on the characteristics of the aquifer, but it can be accelerated, or even reversed, by the pull exerted by pumping wells. Since most groundwater systems must eventually discharge to the surface, leachate could eventually degrade surface water supplies.

FIGURE 2. POTENTIAL FOR LEACHATE CONTAMINATION



Surface water can also be contaminated by leachate seeping from the sides of a land disposal site or by water run off from an uncovered site. (See photograph on the next page.) Unlike groundwater which, if contaminated, may be lost to human use for centuries, surface water quality would soon return to normal if the sources of contamination were controlled.

EPA's Office of Solid Waste has estimated that an average land disposal site--17 acres--with an annual average infiltration of 10 inches of water could produce 4.6 million gallons of leachate per year. Such a site, even if not currently used, could continue to leach for an indefinite number of years. The effect of this leachate on groundwater, however, depends on such factors as the type and amount of soil under the site and the size of the aquifer.

GROUNDWATER: AN IMPORTANT RESOURCE

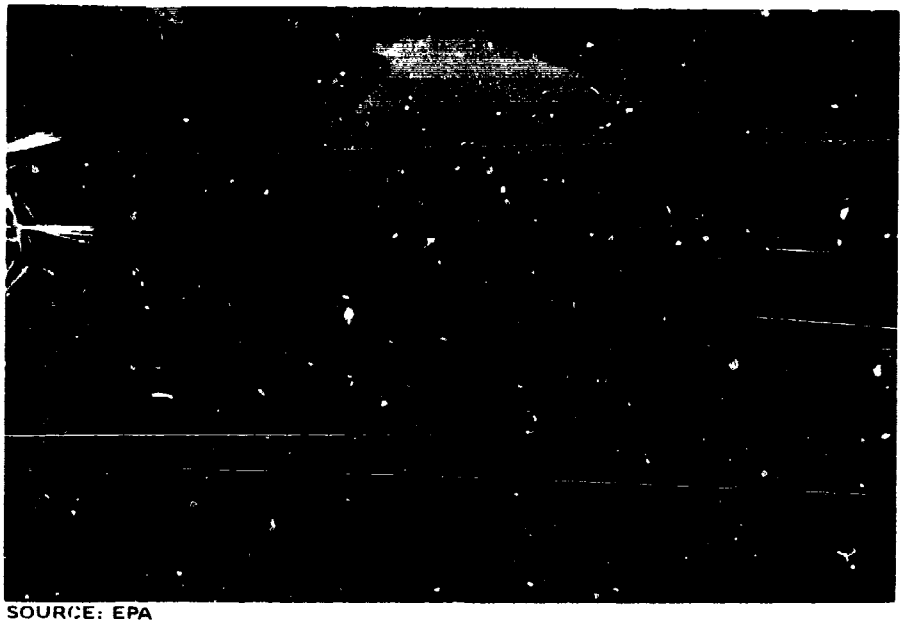
Although the Nation's usable supply of groundwater is estimated at 150 times the amount of water now used, it is not equally distributed and only a quarter of it can be extracted using existing technology. Groundwater is chiefly used for irrigation; but it is also an important drinking water source because of its generally good quality. National fresh groundwater withdrawals are projected to rise from about 82 billion gallons a day in 1980 to 127 billion gallons a day in 2010.

Groundwater is the major drinking water source for 32 States and is the only source for extensive parts of several States. For example, 91 percent of Florida's population and 53 percent of New Jersey's population use groundwater. Overall, about 61 million people supplied by municipal water systems and some 10 million families with individual well systems are dependent on groundwater.

FEDERAL, STATE, AND LOCAL ROLES

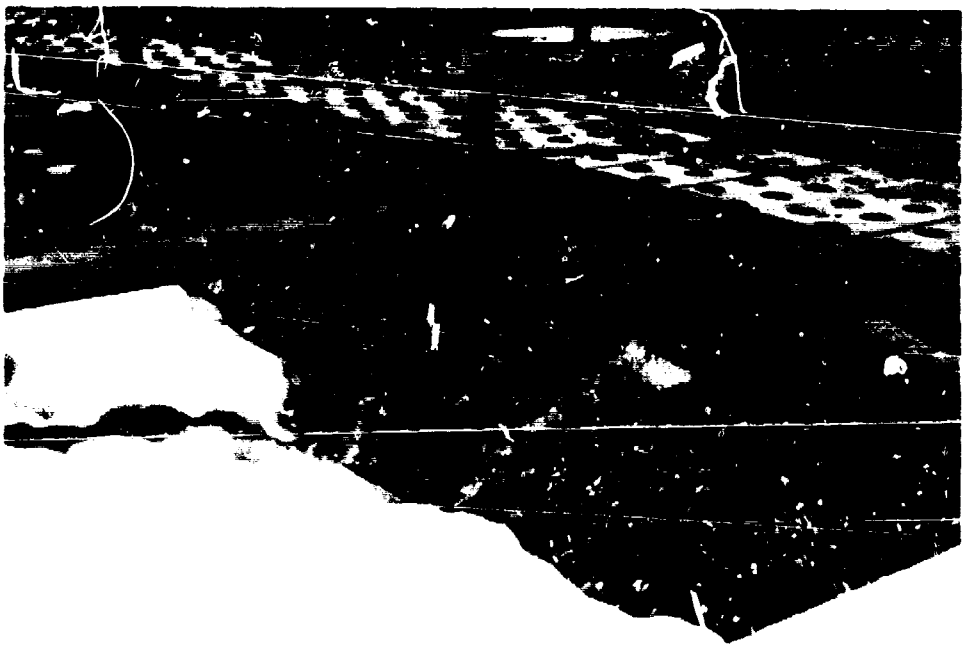
Several Federal laws have been enacted in recent years concerning the disposal of waste and the protection of water resources. Although the Environmental Protection Agency (EPA) has primary responsibility for implementation, generally each act provides for a Federal-State partnership in achieving its objectives. These acts are: the Resource Conservation and Recovery Act of 1976 (Public Law 94-580), the Safe Drinking Water Act (42 U.S.C. 300(f), Supp. V, 1976), and the Clean Water Act of 1977 (Public Law 95-217).

The Resource Conservation and Recovery Act of 1976 (RCRA) directs EPA to issue, within 1 year of enactment, criteria



SOURCE: EPA

LEACHATE FLOWING TO A CREEK AT A NEW JERSEY LANDFILL



SOURCE: GAO

LEACHATE UNDERGOING TREATMENT AT A PENNSYLVANIA LANDFILL

for the classification of all land disposal sites as either environmentally acceptable or unacceptable. Within 1 year year after issuing the criteria, an inventory is to be published of all unacceptable sites "open dumps" identified according to the criteria. Open dumping is prohibited except as covered by an acceptable schedule for compliance under a State plan. Such a schedule must include an enforceable sequence of actions leading to full compliance within 5 years from the date of publication of the inventory. The State plans provide the framework for the regulatory elements to become functional and effective.

Subtitle C of RCRA mandates establishment of a regulatory control program, which will prevent serious threat to human health and the environment from current practices in managing hazardous wastes. Key provisions provide for development of criteria for determining which wastes are hazardous; institution of a manifest system to track wastes from the point of generation to point of disposal; and organization of a permit system, based on standards, for hazardous waste treatment, storage, and disposal facilities. The standards and regulations lay the framework for a Federal system to control hazardous wastes. EPA must grant authorization to interested States to implement this system, unless it finds that the proposed State program is not equivalent to, consistent with the Federal or State programs, or does not provide adequate enforcement. In any State that decides not to establish a hazardous waste program meeting Federal standards, EPA must administer regulatory control.

Generally, States have regulated waste disposal by issuing permits for the siting and operation of land disposal sites and setting operating standards. They also have overseen the development of waste disposal plans by county governments, usually with Federal financial assistance. Although most States have similar requirements, the enforcement authorities vary from State to State. Collecting and disposing of waste is usually the responsibility of local governments.

Federal financial assistance to the States for solid waste programs totaled about $3 million in each of fiscal years 1975 through 1977. About $14.3 million was made available in fiscal year 1978 for grants to assist State solid waste programs under the Resource Conservation and Recovery Act of 1976. For fiscal year 1979, the budget request for EPA's solid waste program includes funds of about $26.2 million for State grants ($11.2 million for solid waste planning and $15 million for hazardous waste management).

CHAPTER 2

WASTE DISPOSAL PRACTICES HAVE CONTAMINATED GROUNDWATER SUPPLIES

Past practices for the disposal of waste on the land have contaminated groundwater resources in certain heavily populated areas of the Nation. Leachate containing many harmful chemical compounds is contaminating groundwater, posing a potential threat to public health where the water may be used as a public drinking water supply. To date, Federal and State agencies have not assessed the extent of damage to groundwater supplies or determined the number of disposal sites which may be leaching. The limited information that is available generally resulted from studies made after specific water wells were contaminated.

State programs to control waste disposal activities have been ineffective because even though most States have enacted legislation governing waste disposal activities, they lack the resources to adequately manage the programs and acceptable disposal alternatives are not always available to assure compliance with the legislative requirements. In enacting the Resource Conservation and Recovery Act of 1976, the Congress recognized the need to improve waste disposal practices and specified a series of actions, which would culminate in the closing or upgrading of all open dumps by October 1983. Key activities, however, will not be completed by the legislative deadlines, including (1) developing criteria for sanitary landfills and (2) publishing within 1 year of publication of the criteria an inventory of all disposal sites not in compliance.

LEACHATE FROM DISPOSAL SITES-- A THREAT TO GROUNDWATER

In a January 1977 report to the Congress, EPA stated that solid waste disposal sites and industrial wastewater impoundments were among the principal sources of groundwater contamination. Although the overall usefulness of groundwater as a national resource had not yet been impaired, the report stated that waste disposal practices had contaminated groundwater on a local basis throughout the country and on a regional basis in certain heavily industrialized and populated areas.

The following cases illustrate the groundwater damage and the economic and social costs which can result from land disposal activities.

Extensive damage to a major aquifer in New Castle County, Delaware

In 1972 a private domestic well near a closed 56-acre landfill became grossly polluted. After extensive investigation, the landfill was identified as the pollution source. Engineers hired by the county estimated that about 170,000 gallons of leachate a day were entering an aquifer used by thousands of people.

The county concluded that it had no choice but to try to control the spread of contamination because of the aquifer's importance as a drinking water source. In addition to reducing the withdrawal rate of water supply wells by 2 million gallons a day, 11 counterpumping wells were installed. The construction, operation, and maintenance cost for the counter pumping wells was estimated at $710,000 through March 1976. Annual costs of the counterpumping operations are about $200,000.

County officials estimated the cost of studies and leachate containment efforts from 1972 to 1976 amounted to over $1.4 million. This cost, however, is minor compared to what may be required to overcome the problem. The alternatives suggested included developing an alternative water supply and removing the waste and incinerating it. Removal and incineration costs have been estimated at $38.3 million in capital costs and about $1.9 million in annual operation and maintenance costs.

Contamination of seven domestic wells in Aurora, Illinois

Four years after a 22-acre site was opened, seven domestic wells became polluted beyond use by leachate. The contaminated water substantially exceeded drinking water standards and was particularly high in chlorides, organic acids, sulfate, sodium, and biological constituents.

Families with contaminated wells were without household water for 16 months. Their homes were finally tied into a public water supply system after legal action was initiated against the city and the disposal company. Although the State water agency proved that leachate from the landfill was the source of the problem, the site remained in operation another 6 years because no other site was available.

An incomplete tabulation of the damage costs directly attributable to the well contamination amounted to $115,000 but this did not include all costs incurred by the well owners. Damages of $54,000 were awarded to seven plaintiffs.

One mile leachate plume found in Islip, Long Island, New York

The U.S. Geological Survey investigated a leachate problem at a 39-year-old, 17-acre landfill (originally an open dump) at Islip, New York. After 3 years of testing and based on data from 30 monitoring wells, it was found that the leachate plume extended about a mile from the site and was 170 feet in depth and up to 1,300 feet in width. This plume contained about 1 billion gallons of groundwater.

Four years after the contamination was found, the affected homes were connected to a public water supply. During this period, the affected homeowners received no assistance. As of April 6, 1978, no action had been taken to prevent further groundwater contamination or to reduce the continued spread of the leachate.

THE NATURE AND EXTENT OF THE DANGER IS UNKNOWN

The relationship between waste disposal practices and groundwater has generally been ignored by those responsible for disposing of waste. The extent of the damage done to this important water resource has not been determined and the total number of sites which may be contaminating groundwater has not been established by the responsible Federal or State agencies.

The States we reviewed had only limited programs for monitoring disposal sites for evidence of contamination. To the extent that it was being done, it was generally restricted to publicly used sites. In fact, not all sites, such as those located on private property, had been identified or investigated to determine the extent they may be contaminating groundwater. In most cases, monitoring was a recent requirement. At new sites it was a condition for obtaining an operating permit, but at existing sites it was usually required only after evidence of contamination was found.

The extent of monitoring being performed at publicly used disposal sites in the eight States we visited is shown in the following table.

Monitoring at Publicly Used Disposal Sites

States visited	Number of sites	Sites monitored	Percent
California	505	39	8
Delaware	10	1	10
Florida	378	101	27
Maryland	74	54	73
New Jersey	349	64	18
Oregon	278	17	6
Pennsylvania	391	206	53
Washington	435	5	1

State officials said that monitoring was limited because of inadequate State funds for staffing and investigation and the complexity and cost of dealing with leachate problems once they are found. Officials of several States told us that they barely had enough resources to cope with known problems without looking for new ones.

In January 1977 EPA reported to the Congress that effective monitoring of potential sources of groundwater contamination was almost nonexistent and that leachate's elusive nature and long duration were major perils inherent in such contamination. EPA has also found that no action was taken to determine the quality of the water near disposal sites until an official complaint was received by the cognizant agencies. Generally what is known about leachate contamination is a result of investigations made after wells have been found to be contaminated.

EPA estimates that nationally 70 percent of the nearly 20,000 municipal waste land disposal sites are not in compliance with current State standards. In addition, State officials told us that imposing more stringent Federal standards would cause some of the sites currently classified as sanitary landfills to be reclassified as open dumps. Officials in the States we visited provided the following estimates of the number of open dumps receiving municipal solid wastes, excluding private industrial waste disposal sites.

California	250	Oregon	49
Delaware	10	Pennsylvania	205
Florida	229	Washington	374
New Jersey	116		

We compared sample results of both untreated and treated leachate from a landfill near Philadelphia, Pennsylvania, with untreated sewage received at one of the city's sewage treatment plants. The landfill accepted both municipal and industrial wastes and the following comparison shows that even after the leachate had been treated the concentration of four of the six constituents measured exceeded the values observed for untreated sewage.

Comparison of Leachate to Untreated Sewage

Constituent	Relative strength of constituents		
	Sewage	Leachate	
	Untreated	Untreated	Treated
Biochemical oxygen demand	2.1	82.5	1.0
Chemical oxygen demand	1.0	39.1	2.3
Cadmium	1.0	4.9	1.4
Lead	3.5	4.5	1.0
Mercury	1.0	37.5	10.0
Nickel	1.0	2.5	1.3

Heavy metal concentrations in undiluted surface leachate have also been found. Samples taken by EPA over a 1-year period at five municipal land disposal sites showed that the average levels of lead, mercury, and selenium in the leachate were 3, 13, and 8 times greater than the respective maximum levels specified in EPA's Interim Primary Drinking Water Standards.

In an EPA-funded study of organic compounds entering groundwater from a landfill near Norman, Oklahoma, researchers found over 40 chemicals in the groundwater of test wells. The compounds able to be identified comprised only a small portion--less than 10 percent--of the total organic matter in the sample. Some of the more harmful compounds noted are as follows. (See app. I for a complete list.)

COMPOUND FOUND	REMARKS
Ethyl Carbamate	Animal carcinogen as determined by the International Agency for Research on Cancer.
p-Cresol	Cresols--Testing recommended for carcinogenicity, mutagenicity, teratogenicity, other chronic effects, and environmental effects. (note a)
o-Xylene p-Xylene	Xylenes--Testing recommended for mutagenicity, teratogenicity, and epidemiological study. (note a)
Diethyl Phthalate Diisobutyl Phthalate Di-n-Butyl Phthalate Butylcarbobutoxymethyl Phthalate Dicyclohexyl Phthalate Dioctyl Phthalate	Alkyl Phthalates--Testing recommended for environmental effects. (note a)

a/One of 10 substances or categories selected by the Interagency Testing Committee established by the Toxic Substances Control Act. The substances and categories were recommended for priority testing to determine their hazard to human health or the environment because of unresolved questions associated with their potential hazards.

The researchers concluded that

"Because of the low levels of pollutants likely to be involved, physical properties of the polluted ground water would probably not be altered sufficiently to indicate the presence of the offending compounds. This presence could be a matter of considerable concern, however, since the health effects of chronic ingestion through water of even very low levels of compounds such as those identified in this study are largely unknown."

IMPROVEMENTS NEEDED IN CONTROLLING AND IDENTIFYING WASTE DISPOSAL SITES

Most States have laws or regulations to control waste disposal and to protect water resources but their enforcement authority varies. According to EPA, 44 States have statutes requiring waste disposal sites to obtain a permit. Requirements for obtaining a permit ranged from a simple notification that a site existed to a detailed description of the site, including the results of soil borings and analyses of baseline groundwater quality.

The eight States we reviewed all required new sites to be located and designed to prevent or mitigate leachate problems. At existing sites, however, the requirements were not fully carried out because of the financial and technical constraints associated with leachate control. Moreover, there was a reluctance to close a site if an alternative was not readily available. As a result, many sites not meeting State permit requirements remained in operation.

We also found that even though all but two of the eight States reviewed had regulations governing private use sites, none had identified all of the private sites or routinely determined their compliance with the regulations. This is significant in that EPA estimates that nationally there are over 100,000 industrial waste land disposal sites compared to nearly 20,000 municipal waste land disposal sites. Pennsylvania, for example, has identified over 600 public use sites but State officials estimate that between 2,000 and 4,000 private sites are not under State control. Although these sites are generally smaller than public sites, they receive the bulk of industrial waste, much of which is hazardous.

The following examples illustrate some of the enforcement problems experienced by the States in attempting to implement improved solid waste management practices

Delaware

State solid waste disposal regulations, issued in August 1974, prohibited open dumping and required all landfills to provide leachate collection, treatment, and disposal systems. Noncomplying sites were given 6 months to submit a plan for upgrading their operation and be in compliance by August 1976. As of April 14, 1978, 18 of the 42 original sites have been closed and 12 were found to be used for disposal of inert wastes. The remaining 12 disposal sites (9 public sanitary landfills and 3 private sites) have

been issued permits. Two of these sites are in full compliance, whereas 10 are operating under compliance schedules. Reasons given for the delay in meeting the requirements of the regulations were that the State lacked the necessary resources and that adequate alternative disposal sites were not available.

Pennsylvania

The State has comprehensive laws designed to protect the State's waters, including groundwater, from pollution. Solid waste regulations issued in August 1971 required all disposal sites to have an operating permit and to be located and operated in such a manner as to preclude ground and surface water contamination. Sites not meeting the geological requirements would be granted a permit only if leachate collection and treatment systems were installed at the disposal facility. An operating permit is not issued until a site meets these State requirements. Almost 6 years after the regulations were adopted, only 186 of the 391 municipal land disposal sites in the State had received operating permits. An Enforcement Division official said that these sites were not permitted because (1) compliance schedules had not yet been met, (2) some sites were being phased out, and (3) the courts had allowed sites to remain open when an acceptable alternative site was not available.

Improvements will be slow under the Resource Conservation and Recovery Act of 1976

The Congress, in passing the Resource Conservation and Recovery Act of 1976, recognized that while the collection and disposal of solid wastes should continue to be primarily the function of State, regional, and local agencies, the problems of waste disposal are national in scope requiring a broader Federal role. The act required EPA to develop national standards (criteria) for the protection of health and the environment from solid waste disposal facilities. An inventory is also to be made and a list published of all sites not in compliance with the minimum standards--open dumps--by October 1978. Within 5 years of the publication--October 1983--all open dumps are to be either closed or upgraded according to a State-established compliance schedule.

EPA's proposed criteria for classifying solid waste disposal facilities required by new sections 1008(a)(3) and 4004(a) added by the act were published in the Federal Register on

February 6, 1978. EPA officials estimate that final criteria will be issued in October 1978--about 1 year after the October 1977 statutory deadline.

In addition, EPA has acknowledged that the inventory deadline also will not be met. EPA's guidance to its regional offices for the development of State work programs for fiscal year 1978 states:

> "It is recognized that all States do not currently possess the same level of information on the disposal sites within their jurisdictions, and that they may desire or need to conduct the inventory at different rates. A phasing of the inventory over several years is acceptable and we recommend that priorities for sites to be inventoried be set by type of wastes handled * * *."

EPA recommended that the first priority be given to inventorying sites used for the disposal of residential, commercial, and institutional wastes and of municipal wastewater treatment sludge. The largest category--sites used for industrial wastes and pollution abatement sludges and residues--would be inventoried after the States completed the first phase of the inventory. According to EPA officials, this category was placed last because some of this waste may be defined as hazardous and, therefore, would not be included in the inventory. In addition, this phasing allows States to initiate action immediately in those areas where current authority exists, while developing the authority to pursue other waste disposal practices.

In conjunction with the phased inventory program, EPA's strategy allows for compliance with the upgrading and closing requirements within 5 years after a site is listed on the inventory. Under this strategy all sites will not be inventoried and listed by October 1978 nor will the 1983 deadline be met by which <u>all</u> open dumps must be upgraded or closed.

EPA, in testimony before the Subcommittee on Transportation and Commerce, House Committee on Interstate and Foreign Commerce, stated that the funds available for fiscal year 1978 are sufficient to implement the agency's strategy for conducting the inventory. Funds made available for fiscal year 1978 under section 4008 of the act will be used to begin the inventory. Of the $14.3 million available under this section, EPA estimates that about $3.9 million will be provided to the States to perform the inventory. In fiscal year 1979, EPA estimates that about $4.4 million of the $11.2 million requested under this section will be spent on the inventory.

EPA officials estimate that the average cost to inventory each municipal waste land disposal site is about $1,000. Since there are nearly 20,000 of these sites, the cost of this portion of the inventory alone could approach $20 million. An EPA official, however, said that the actual cost could be lower because (1) the cost to inventory a site should decrease as experience is gained and (2) the better sites will be inventoried last. The fiscal year 1979 effort will be directed to inventorying those sites considered by EPA to be the worst 10 percent of the municipal waste land disposal sites.

The total cost to complete the inventory of all open dumps, public and private, and the time needed to complete the inventory have not been determined by EPA. Officials of the eight States we visited told us that they could not estimate the total cost until EPA published the new criteria and advised the States what inventory methods would be accepted.

Problems with control technology and waste management practices

According to the proposed criteria, sanitary landfills which could adversely affect groundwater currently used or designated by the State for future use as a drinking water supply for human consumption must be monitored. The supplementary information document pertaining to the proposed criteria states, however, that

> "* * * the State may determine it is not necessary to monitor if the facility is such that no adverse effect is expected * * * because the control technology and practice are considered to be reasonably able to achieve the environmental standards."

The effectiveness of current leachate control technologies and practices, however, has not been demonstrated. Disposal site liners currently used for municipal waste are usually made of the same material as is used in water reservoir liners. However, the base of a land disposal facility can be a very hostile environment because of the contaminants in leachate and the chemical reactions that can occur. Thus, the ability of liners to last over the life of the facility is unproven. In addition, there are other technical problems associated with liners, such as their susceptibility to damage during the operation of the facility and the lack of leak detection systems.

Controlling the migration of leachate using only the site's natural soil conditions, also needs further study before it can be relied on with any degree of certainty.

As leachate passes through the soil and an aquifer, studies show that its potency may decrease. According to a May 1977 Illinois State Geological Survey report, while some chemical constituents are adsorbed and become less potent, others pass through with little or no change. EPA states in the supplement to the criteria that "the mechanisms of soil attenuation (sorption, ion exchange, precipitation, dispersion, or decay) have a limited capacity and are also reversible." Thus, this control mechanism may not assure the permanent prevention of groundwater contamination.

State and local funding problems

Most States do not provide funding to local governments for solid waste control activities. Only three of the eight States we visited, for example, provided loans or grants for facility construction. Under RCRA, some Federal financial assistance is available, such as to certain small rural communities and "special" communities. Special communities are those which (1) have a population less than 25,000, (2) have disposal facilities with previous environmental problems and in which more than 75 percent of the solid waste disposed is from other jurisdictions, and (3) have a serious disposal problem. However, not more than one community and not more than one project in any one State is eligible for a special community grant. Although a total of $27.5 million was authorized for each of fiscal years 1978 and 1979 to assist these communities, funds were not requested or appropriated in fiscal year 1978 and funds have not been requested for fiscal year 1979 because of resource constraints on implementing the act.

Generally, the land disposal site operator is responsible for the costs associated with closing or upgrading sites. State officials told us that strict Federal criteria would force many disposal site operators out of business. This could put a bigger burden on local governments. A few States in our review have made provision for surety or performance bonds but only a few, newly established sites had been required to obtain them.

In a preliminary draft environmental impact statement for EPA's sanitary landfill criteria, the economic impact analysis estimated the annualized costs for all disposal methods at public and private disposal sites--landfills, surface impoundments, and landspreading--at about $1.6 billion, of which $0.6 billion is attributable to the Federal criteria and $1 billion is due to State standards.

The following examples illustrate the costs and problems associated with leachate control and treatment.

Bucks County, Pennsylvania

This site has a patented asphalt liner and a leachate treatment plant with a capacity of 144,000 gallons a day. The cost of the treatment plant was about $600,000. Estimated operation and maintenance costs ranged from $2.80 to $5.12 per 1,000 gallons, depending on the treatment process used. Fixed costs were about $12,000 a year.

Because of its strength even after treatment, the leachate can only be discharged to a nearby river during the 5 high-stream flow months of the year. The rest of the year it must be recirculated back onto the landfill.

The photographs on the next page show the treatment facility and an ammonia stripping lagoon.

Chester County, Pennsylvania

A Pennsylvania firm proposed to develop two sanitary landfills in the county covering a total of 141 acres. The landfills were to have asphalt liners and a shared leachate treatment facility. According to the president of the firm, the total estimated cost was:

	Cost per acre	Total cost
Asphalt liners	$18,000	$2,538,000
Leachate collection systems	2,000	282,000
Land	6,000	846,000
Leachate treatment facility	-	750,000
Total		$4,416,000

In the company's original proposal, the treated leachate--between 100,000 and 200,000 gallons a day--was to be discharged to a nearby creek. However, the people of the community objected to the landfills and the leachate discharge. The proposal was revised to provide for recirculating the collected leachate back to the landfill. This process would continue until such time as the leachate could be taken to a municipal sewage treatment plant.

King County, Washington

A leachate collection system was installed at this operating landfill after a leachate problem was discovered. The estimated cost to install the collection system and provide for future expansion amounted to $2 million. About

SOURCE: GAO

LEACHATE TREATMENT PLANT OUTSIDE PHILADELPHIA, PENNSYLVANIA

SOURCE: GAO

AMMONIA STRIPPING LAGOON (PART OF LEACHATE TREATMENT SYSTEM)

24,000 gallons of leachate is collected daily and trucked to a municipal sewage treatment plant. During our visit to the landfill, we observed leachate seeping from the sides of the landfill at several points about 10 feet below grade. The leachate was observed entering a nearby stream.

CONCLUSIONS

The Resource Conservation and Recovery Act of 1976 was enacted to improve the Nation's solid waste management practices. However, the improvements mandated will not be accomplished within the legislative time frames. According to EPA, it will take several years merely to complete the open dump inventory--a key to improving current practices. We believe the Congress should be fully informed on when the legislative mandate can reasonably be achieved and the full extent of Federal funding that will be needed.

EPA proposed sanitary landfill criteria on February 6, 1978. In order to be considered a sanitary landfill under the criteria, a site which could adversely affect the quality of groundwater used, or designated for future use, as a drinking water supply would have to be monitored. In explaining the criteria, the Agency said that the States may decide that monitoring is not needed if the control technology and practices employed can reasonably assure compliance with the environmental standards. We do not believe this exception is appropriate, considering the state-of-the-art of existing control technologies and practices.

RECOMMENDATIONS

We recommend that the Administrator, Environmental Protection Agency

--determine when the legislative mandate for completing the open dump inventory can reasonably be achieved and present this information, along with an estimate of the total Federal funding that will be needed, to the appropriate congressional committees and

--include in the criteria for sanitary landfills, monitoring at all such sites located in areas of the country where the hydrology and geological conditions enable the development of leachate contamination, unless the States specifically designate, through the procedures specified in the proposed criteria, that the groundwater will not be used as a drinking water supply.

AGENCY COMMENTS AND OUR EVALUATION

In commenting on our report, EPA officials generally agreed with the conclusions and recommendations but stated that they could not easily make a precise estimate of the time and cost to complete the open dump inventory. The cost and time it will take to complete the open dump inventory is basic information needed by the Congress in its oversight role on the implementation of the act. We believe, therefore, that EPA should make the necessary effort to provide the best estimates it can on these matters to satisfy congressional needs.

CHAPTER 3

WATER SUPPLY EVALUATIONS ARE NEEDED TO PROTECT THE PUBLIC

Effectively implementing the Resource Conservation and Recovery Act of 1976 will significantly minimize groundwater contamination from new or upgraded existing sites. However, the act does not adequately address the potential threat to public health that exists as a result of groundwater that is already contaminated or that may become contaminated as a result of older, closed disposal sites.

Under the regulations implementing the Safe Drinking Water Act, the monitoring performed by public water systems is directed to those contaminants which are most often found in drinking water. It would be impractical to monitor for the presence of the hundreds of chemical contaminants which may be in drinking water. We believe, however, it is important that drinking water sources be further evaluated to determine the effect that past or present waste disposal practices may be having on the quality of the water.

CONTAMINATED GROUNDWATER IS DIFFICULT TO CLEAN UP

Although technically, several things can be done to control the spread and continued formation of leachate, the feasibility and costs of various alternative solutions are site specific. For example, a grouting material can be forced into the sides and the base of the site; the groundwater flow can be interrupted and diverted around the site, the leachate contaminated water can be pumped to the surface, or the land disposal site can be excavated. After a site is closed, it can be capped with a soil having low permeability or a manufactured covering and graded so that additional infiltration can be minimized or stopped.

EPA and State officials, as well as consultants, said that there are significant constraints to containing the spread of leachate to an aquifer from a disposal site. Some told us that once a leachate problem is identified, there is little that can be done from a cost-effective standpoint and that prevention of the problem is paramount.

For several years, EPA has been studying the leachate problem and how to correct it. Under the Solid Waste Disposal Act and, more recently, under the Resource Conservation and Recovery Act, 42 research and development projects totaling about $6.8 million have been funded and an additional $0.7 million are pending award.

Research and Development Projects July 1, 1971 to June 24, 1977

	Number	Cost (note a)
Contracts	16	$2,026,144
Grants	20	1,431,674
Interagency agreements	6	3,347,041
Total	42	$6,804,859

a/Awards pending:

Contracts	$131,766
Grants	174,610
Interagency agreements	410,000
Total	$716,376

In addition, three demonstration projects totaling $473,903, have been funded since July 1, 1971.

Research projects included studies of leachate formation, movement, collection, treatment, and testing and evaluations of various disposal site liner materials. An essential part of the research effort involves the use of simulation for characterizing leachate movement in soils adjacent to the disposal site. The results of this work could be used by communities in designing and siting disposal sites to minimize the likelihood of leachate migrating through the soil and contaminating water supplies, particularly groundwater. However, according to EPA officials, the full benefit of the research will not be realized until about 1980.

In addition, RCRA authorized up to $250,000 for a special research program to control leachate from the Army Creek Landfill in New Castle County, Delaware. This program is to develop leachate control methods, which may be applied to other operating or abandoned land disposal sites. An additional $200,000 was authorized for fiscal years 1977 and 1978 to operate the landfill's existing counterpumping program to contain the leachate. However, funds were not specifically appropriated for this program in fiscal year 1977 and EPA said that sufficient funds could not be obtained through reprograming to implement all sections of the act. Moreover, EPA said that a feasibility study rather than a long-term research project was needed at the landfill and that the most EPA was able to set aside for it was $50,000.

The feasibility study would apply available research and technological data to the problem to further investigate corrective actions or alternative solutions.

Groundwater contamination and pollutants in our drinking water are also being studied under other EPA programs. These efforts cover drinking water standards, new or special technologies, groundwater management, and the development of water quality standards for specific pollutants.

IMPROVEMENTS NEEDED IN EVALUATING DRINKING WATER SUPPLIES

Responsible State and local agencies in the States we visited attempted to minimize the probability of exposure to contaminated groundwater by exercising some form of control over the placement of water supply wells. This is a difficult task because the location of all disposal sites and the extent of groundwater contamination is frequently unknown.

The U.S. Water Resources Council expressed concern with this lack of information on the condition of groundwater supplies in its Nationwide Analysis Summary Report, dated September 1977, as follows:

> "In all the regions studied, there is a prime need--to mount a concerned effort toward locating, monitoring, and evaluating other existing cases of ground water contamination, and to determine the effect of this contamination on our health before we reach the point of no return that some other parts of the world now appear to be reaching."

Drinking water monitoring may not detect contaminants

The Safe Drinking Water Act was enacted to assure that water supply systems serving the public meet minimum national standards for protection of public health. In 1976 public water systems--systems with 15 or more connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year--provided water to about 192 million people.

The regulations implementing the act require that (1) public water systems monitor the quality of the water and (2) States assuming primary enforcement authority adopt and implement adequate procedures for the enforcement of a systematic program for conducting sanitary surveys of public water systems in the State.

The National Interim Primary Drinking Water Regulations established maximum contamination levels for 6 organic and 10 inorganic contaminants and specified how often the public water system must test for their presence. The contaminants to be monitored under the interim regulations were limited because of insufficient data on the health effects of the many chemical contaminants which may be found in water and because of the impracticality of monitoring for all such contaminants.

The testing performed is termed compliance monitoring and may not detect or identify the presence of other contaminants found in leachate contaminated water. For example, we reviewed three EPA studies in which inorganic chemicals were found to have leached from dumps and landfills contaminating the groundwater. Inorganic chemicals found which are not monitored under the interim regulations were manganese, ammonia, boron, potassium, and cyanide. These substances are all metabolically active in the human body, and an excess could cause adverse health effects.

Since groundwater is generally assumed to be of good quality and moves slowly, the monitoring frequency specified is also considerably less for groundwater than for surface water. For example, the monitoring frequency for community water systems--systems serving resident populations--is shown in the following table.

Community Water System Monitoring Requirements

	Date of initial analysis		Subsequent intervals	
	Surface	Ground	Surface	Ground
Inorganics	June 1978	June 1979	Annual	3 years
Organics	June 1978	None	Annual	Set by State
Bacteriological	June 1977	June 1977	Monthly	Monthly
Turbidity	June 1977	None	Daily	None
Chlorine residual (Option for substitution for bacterial testing)	June 1977	June 1977	Daily	None

To provide more comprehensive controls for organic chemicals, EPA proposed an amendment to the interim regulations on February 9, 1978. The amendment covers two classes of synthetic organic chemicals in drinking water. One class--trihalomethanes--is generated by chlorinating water containing natural organic constituents. The other class emanates from industrial pollution, agricultural runoff, and leachate from land disposal sites.

Initially, community water systems serving populations greater than 75,000 persons which add chlorine as a disinfectant in the treatment process would be required to meet a maximum contaminant level for trihalomethanes. If the contaminant level exceeds the maximum level, the treatment facility must reduce the contaminant level. One option EPA proposes to reduce the contaminant level is through the use of granular activated carbon. The granular activated carbon treatment technique most likely would remove organic contaminants such as those found in leachate contaminated groundwater.

Systems serving populations between 10,000 and 75,000 persons using chlorine would only be required to monitor for total trihalomethanes. These systems are more heavily dependent on groundwater as their water source. Under the proposed amendment, such systems are only required to monitor total trihalomethanes quarterly for a 1-year period.

Synthetic organic compounds such as those found in the Norman, Oklahoma, study (see p. 12) would not be identified using monitoring procedures for trihalomethanes unless they are specifically looked for. Additional testing would be required to detect their presence. In our opinion, information obtained from a more comprehensive sanitary survey of the public drinking water system could be used to determine whether this additional testing should be performed on the raw water.

Additional evaluations of drinking water sources are needed

The sanitary survey is an important part of an effective drinking water program. One of the requirements which must be met for a State to assume primary enforcement authority under the regulations implementing the Safe Drinking Water Act is that the State have a systematic program for performing sanitary surveys. A sanitary survey means an onsite review of the water source, facilities, equipment, and operation and maintenance of a public water supply system for purposes of evaluating their adequacy for producing and distributing safe drinking water. Other than requiring the enforcement of a sanitary

survey program, the regulations do not specify what the scope of such a survey should include.

We reviewed drinking water programs in six States which are preparing to apply to EPA for primary enforcement responsibility and in two States--Oregon and Pennsylvania--where EPA was expected to assume primacy. Based on the information obtained from State and EPA officials, we found that none of the six States conducted sanitary surveys, which included comprehensive evaluations of groundwater aquifers. In addition, EPA officials said that they did not plan to systematically evaluate water supply sources in Oregon and Pennsylvania. Due to insufficient resources, surveys would only be made in response to systems where the treated water exceeds the maximum contamination levels.

The following summarizes the water supply source evaluations performed by the six States applying for primacy:

--In five of the six States the water source was considered to be untreated water taken at the water supplier's wellhead, reservoir, or treatment facility. The testing performed was usually limited to the contaminants regulated under the Safe Drinking Water Act.

--Only two States physically inspected the area surrounding the supplier's facilities. One of the States, which did not have a formal system for conducting the surveys, depended on the water supply company to protect the source. The source was generally considered to be within a 100-foot radius of the well or wells, although it could be extended based on the geology of the area.

--Five States did not require, as part of the survey, details on the location and identity of potential sources of contamination.

Under the regulations implementing the Safe Drinking Water Act, operators of public water systems are required to notify all users of the system whenever the drinking water fails to meet Federal drinking water standards; however, many people using groundwater do not obtain it from a public water system. If the sanitary survey program included public notification of the survey results, people obtaining water from private wells or systems using the same water source as the public water system would be alerted that their water may be contaminated.

CONCLUSIONS

The testing currently being performed to protect the public from exposure to contaminated drinking water under the implementing regulations of the Safe Drinking Water Act is limited in scope and frequency. As a result, all organic and inorganic chemicals, which could adversely affect human health, may not be identified.

EPA's proposed amendment to the regulations dated February 9, 1978, requires monitoring for synthetic organic chemicals resulting from the chlorinating of drinking water. The tests to be done will not, however, identify other equally harmful synthetic organic chemicals which may be in water as a result of waste disposal activities.

Current State sanitary survey programs are limited in scope in that they do not include (1) evaluations of disposal practices and their possible effects on groundwater quality and (2) public notification of the results. We believe the scope of a sanitary survey should be expanded to include evaluations of the water source. For example, for systems using groundwater, the effects of past and present disposal practices on the quality of the water in the aquifer should be assessed. If contamination is suspected, additional testing should be required at the public water system.

RECOMMENDATION

We recommend that the Administrator, Environmental Protection Agency

--Amend the regulations implementing the Safe Drinking Water Act applicable to State programs to include minimum standards for performing the sanitary survey of public water systems. Such standards should

  --include an analysis of all sources of pollution and their effect on the water quality (the extent of the analysis performed would depend on such factors as climate, geology, hydrology, and disposal practices used) and

  --provide for public notification of the survey results.

AGENCY COMMENTS

Agency officials generally agreed with the need to provide minimum standards for performing the sanitary survey. They did not believe the requirements should be specified in the regulations and that issuing a separate guidance manual would be sufficient.

We believe the regulations requiring the sanitary survey should also specify minimum standards for the survey regardless of whatever additional guidance is issued to the States by EPA.

CHAPTER 4

SCOPE OF REVIEW

We made our review at EPA headquarters in Washington, D.C.; EPA regional offices in Atlanta, Georgia; New York, New York; Philadelphia, Pennsylvania; San Francisco, California; and Seattle, Washington; and State solid waste, water supply and pollution control agencies in California, Delaware, Florida, Maryland, New Jersey, Oregon, Pennsylvania, and Washington. We also obtained information from two regional planning agencies and five county solid waste agencies. We visited several land disposal sites in Delaware, Maryland, Pennsylvania, and Washington.

We examined pertinent legislation, regulations, instructions, reports and other documents. We interviewed persons knowledgeable in the fields of solid waste disposal, groundwater supplies and water pollution, including EPA headquarters and regional officials, U.S. Geological Survey officials, State and county officials, and consulting engineers.

APPENDIX I

ORGANIC CHEMICALS FOUND IN GROUNDWATER NEAR A NORMAN, OKLAHOMA, LANDFILL (See p. 12.)

Compound	Estimated concentration in groundwater (micro-grams/liter)
Fenchone	0.2
Camphor	0.9
2,6-di-Tertiarybutyl Benzoquinone	-
Diethyl Phthalate	4.1
2,6-di-Tertiaryamyl Benzoquinone	-
Diisobutyl Phthalate	0.1
Di-n-Butyl Phthalate	-
Butylcarbobutoxymethyl Phthalate	-
Butylbenzyl Phthalate	-
Dicyclohexyl Phthalate	0.2
Dioctyl Phthalate	2.4
p-Cresol	14.6
o-Xylene	0.6
p-Xylene	0.9
Cyclohexanol	1.0
N-Ethyl-p-Toluenesulfonamide	0.1
N-Ethyl-o-Toluenesulfonamide	-
C_3 Alkylbenzenes (2 compounds)	-
Diacetone Alcohol	10.9
Butoxyethanol	-
Ethyl Carbamate	-
Tri-n-Butyl Phosphate	1.7
p-Toluenesulfonamide	-
Methyl Pyridine	-
N,N-Diethylformamide	-
Triethylphosphate	0.3
Bis-2-Hydroxypropylether	-
3-Methylcyclopentan-1,2-Diol	-
Acetic Acid	-
Isobutyric Acid	48.7
Butyric Acid	1.5
Isovaleric Acid	0.7
Valeric Acid	1.1
2-Ethylhexanoic Acid	4.2
Isomeric C_6 Acid	17.1
Isomeric C_7 Acid	7.5
Isomeric C_8 Acid	-
Cyclohexanecarboxylic Acid	2.8
Caprylic Acid	0.6
Caproic Acid	1.1
Heptanoic Acid	1.0

PRINCIPAL EPA OFFICIALS RESPONSIBLE FOR ADMINISTERING ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
ADMINISTRATOR:		
Douglas M. Costle	Mar. 1977	Present
John R. Quarles, Jr. (acting)	Jan. 1977	Mar. 1977
Russell E. Train	Sept. 1973	Jan. 1977
John R. Quarles, Jr. (acting)	Aug. 1973	Sept. 1973
Robert W. Fri (acting)	Apr. 1973	Aug. 1973
William D. Ruckelshaus	Dec. 1970	Apr. 1973
ASSISTANT ADMINISTRATOR FOR WATER AND HAZARDOUS MATERIALS (note a):		
Thomas C. Jorling	June 1977	Present
ASSISTANT ADMINISTRATOR FOR AIR AND WASTE MANAGEMENT (note a):		
David Hawkins	Sept. 1977	Present
Edward Tuerk (acting)	Jan. 1977	Aug. 1977
Roger Strelow	Apr 1974	Jan. 1977
Charles Elkins (note b)	Oct. 1973	Apr. 1974
David Dominick (note b)	June 1971	Oct. 1973
DEPUTY ASSISTANT ADMINISTRATOR FOR SOLID WASTE MANAGEMENT PROGRAMS (note c):		
Steffen Plehn	Jan. 1978	Present
H. Lanier Hickman, Jr. (acting)	Oct. 1977	Jan. 1978
John Lehman (acting)	Aug. 1977	Sept. 1977
Sheldon Meyers	Oct. 1975	July 1977
H. Lanier Hickman, Jr. (acting)	Aug. 1975	Sept. 1975
Arsen Darnay	Oct. 1973	July 1975
Samuel Hale, Jr.	Oct. 1971	Oct. 1973

APPENDIX II

	Tenure of office	
	From	To
DEPUTY ASSISTANT ADMINISTRATOR FOR WATER SUPPLY:		
Victor J. Kimm	May 1975	Present
Vacant	Feb. 1975	May 1975

a/The Office of Solid Waste was transferred from Air and Waste Management to Water and Hazardous Materials on July 29, 1977.

b/Before January 1974 the title of this position was Assistant Administrator for Categorical Programs.

c/The Office of Solid Waste Management Programs was transferred from the Department of Health, Education, and Welfare on December 2, 1970.

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