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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Sewage Sludge— How Do We Cope With It?

Coping with rapidly increasing volumes of sewage sludge, a potentially toxic substance, is a nationwide problem. Some disposal methods are being phased out, and others are being increasingly restricted by governmental actions.

To compound the problem, the lack of scientific data on environmental and health effects of sludge disposal, unproven technology, and high costs have hampered development and implementation of new techniques which could use sludge beneficially.

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

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

This report addresses problems municipalities face in selecting and implementing sludge management systems that dispose of sludge in a safe, beneficial, and cost-effective manner and actions the Federal Government should take to help them. Sewage sludge disposal is a growing problem because the Nation's sludge volume is increasing dramatically; it is expected to double in size by 1987. At the same time, certain sludge disposal methods are being phased out, and use of others is being restricted. Also, development and implementation of new disposal methods is being hampered for a number of reasons.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), the Accounting and Auditing Act of 1950 (31 U.S.C. 67), and the Legislative Reorganization Act of 1970 (31 U.S.C. 1152).

Copies of this report are being sent to the Director, Office of Management and Budget; the Administrator, Environmental Protection Agency; the Secretaries of Agriculture, Energy, the Interior, and Health, Education, and Welfare; Members of Congress; and interested congressional committees.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

SEWAGE SLUDGE--HOW
DO WE COPE WITH IT?

D I G E S T

The Nation must change its attitude toward sludge use and disposal if it is to cope with rapidly increasing volumes. Solutions to the problem of sludge disposal must be developed and carried out. The Federal Government, particularly the Environmental Protection Agency, must take the lead in this. The best solution is to use sludge as a resource.

In the past, sludge had been treated primarily as a waste to be disposed of as inexpensively as possible. Now, while sludge volumes are increasing (about 5 million tons annually and expected to double by 1987), generally accepted methods for its disposal are being phased out or subjected to more and more regulations and increased restrictions on use. Landfill sites are dwindling, use of incineration is being restricted because of air pollution standards and fuel shortages, and ocean dumping has endangered human and marine life and will be phased out by December 1981. The question is: How will we dispose of sludge in the future as safely, economically, and beneficially as possible? (See pp. 4, 5, 6, 8, and 11.)

Sludge has many beneficial qualities which have been generally disregarded. It contains essential plant nutrients (phosphorus and nitrogen) which make it suitable as a land conditioner or fertilizer, and it can be converted to energy in several ways. However, some pitfalls to this solution exist. Sludge also contains disease-causing bacteria and varying amounts of toxic substances which limit its use on agricultural lands. Further, the technical and economic feasibility of some energy conversion methods have not been conclusively proven. (See pp. 1, 11, 12, 18, and 22.)

Nevertheless, sludge use as a resource appears to be the most viable solution currently available. This use, however, has not been widely accepted because Federal and State authorities cannot agree and guidance was

lacking for some time on the safe uses of sludge as a land conditioner and fertilizer. Compounding the problem are institutional, political, and legal barriers which often discourage and sometimes prohibit sludge use on agricultural and nonagricultural lands. Furthermore, sludge use as an energy source in pyrolysis and copyrolysis (in combination with solid waste) systems has been demonstrated in small-scale pilot projects but not in large-scale operations needed for most communities. Local officials do not believe that energy conversion systems, particularly copyrolysis systems, will be considered locally because the related costs and risks are too great for communities to bear without substantial Federal support. (See pp. 12, 18, and 22.)

In GAO's opinion, the principal reasons sludge has not been used as a resource are (1) such use was not encouraged, (2) guidance was lacking, and (3) a comprehensive national sludge disposal policy does not exist. As a result, full advantage has not been taken of many opportunities to use sludge as a resource. (See p. 27.)

GAO recommends that the Administrator, Environmental Protection Agency, develop a national sludge management policy emphasizing sludge use as a resource. Such a policy should, at a minimum, discuss agricultural and nonagricultural land uses, sales and giveaways of sludge, and the feasibility of thermal combustion systems. Also, the Agency should

--fund full-scale demonstration projects if the engineering consensus within the Agency is that the feasibility of thermal combustion cannot be determined on the basis of current demonstration projects,

--communicate the results of successful demonstrations to interested communities, and

--monitor the growth and development of systems which have been successfully demonstrated to determine the need, if any, for additional Federal support of these systems.
(See p. 28.)

AGENCY COMMENTS

The Environmental Protection Agency fully concurred with GAO's conclusions and recommendations. (See p. 29.)

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ABBREVIATIONS

EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FWPCA	Federal Water Pollution Control Act, as amended
GAO	General Accounting Office
HEW	Health, Education, and Welfare
ISC	Interstate Sanitation Commission
MPRSA	Marine Protection, Research, and Sanctuaries Act
NSF	National Science Foundation
PCBs	Polychlorinated biphenyls
RCRA	Resource Conservation and Recovery Act
USDA	U.S. Department of Agriculture

GLOSSARY

Aquifer	An underground bed or stratum of earth, gravel, or porous stone that contains water.
Conditioning	The treatment of sludge with chemicals or heat so that the water may be readily separated.
Copyrolysis	A method of sludge reduction accomplished by thermal decomposition of solid waste and sludge in an oxygen-free or oxygen-starved environment.
Dewatering	Further separation of water by subjecting the sludge to vacuum pressure or drying processes.
Effluent	The wastewater discharged by an industry or municipality to a receiving water body.
Ground water	The supply of fresh water under the Earth's surface in an aquifer or soil that forms the natural reservoir for public use.
Heavy metals	Metallic elements--such as mercury and cadmium--with high atomic weights, generally toxic in low concentrations to plants and animal life. Such metals are often residual in the environment and exhibit biological accumulation.
Industrial waste	A broad category of wastes from manufacturing operations or processes. These wastes include acids, chemicals, poisons and insecticides, heavy metals, nutrients, and other toxic and nontoxic substances.
Leachate	Liquid that contains extracted, dissolved, or suspended materials from filtering through solid waste or other media.
Oncogen	Causes tumors, both benign and malignant.
Organic	Referring to or derived from living organisms. In chemistry, any compound containing carbon.

Pathogen	Any micro-organism or virus that can cause disease.
Polychlorinated biphenyls	A class of chlorinated hydrocarbon fluids, a toxic substance, used in closed electrical systems, investment casting processes, heat exchange fluids, hydraulic fluids, and ink solvents.
Pyrolysis	A method of sludge reduction accomplished by thermal decomposition of matter in an oxygen-free or oxygen-starved environment.
Secondary waste treatment	Treatment using biological processes to accelerate the decomposition of sewage and thereby reduce oxygen-demanding wastes by 80 to 90 percent and suspended solids by 75 to 90 percent.
Sewage sludge	A nonhomogeneous residue resulting from chemical and physical treatment of wastewater, which consists of both toxic and nontoxic waste materials, with specific concentrations dependent on the various municipal and industrial sources discharging into the sewage treatment plant. Constituents of sludge include (1) nutrients, such as nitrogen, phosphorus, and potassium compounds, (2) heavy metals, such as cadmium, copper, mercury, nickel, lead, and zinc, (3) chlorinated hydrocarbons, including polychlorinated biphenyls and some pesticides, and (4) pathogenic organisms.

CHAPTER 1

PERSPECTIVE

Sewage sludge is the solid matter extracted from municipal wastewater during treatment and is primarily organic, containing varying amounts of nutrients, such as nitrogen, phosphorus, and potassium, all of which may be reused. However, sludge also contains disease-causing organisms and potentially toxic substances, including pesticides; polychlorinated biphenyls (PCBs); and heavy metals, such as cadmium, mercury, zinc, and lead.

Currently, approximately 5 million dry tons of sludge are produced each year and the amount produced is expected to double by 1987 to an estimated 10 million dry tons (about 27,400 dry tons a day). Much of this increase is caused by Federal efforts to clean up the Nation's waterways by upgrading wastewater treatment. The more sophisticated the level of treatment, the greater the volume of sewage sludge produced. For example, use of secondary treatment in addition to primary treatment can increase the amount of sludge produced by over 100 percent. Further, use of advanced waste treatment significantly increases the amounts of sludge produced by adding chemicals and removing almost all remaining nutrients and suspended solids.

While treatment of wastewater returns high quality water to the Nation's waterways and provides clean streams and rivers for boating, swimming, fishing, etc., it also creates a significant problem: How do we dispose of the sludge produced as a result of such treatment as safely, economically, and beneficially as possible?

Disposal would be simple if sewage sludge contained only nutrients. For example, it could be disposed of in the ocean or used as a fertilizer on land without much of a problem since it would be relatively nontoxic. However, industrial waste discharges into municipal sewer systems can add large amounts of heavy metals and other harmful compounds to the wastewater, increasing the toxicity of sewage sludge and thereby restricting sludge use.

Sludge disposal options are limited. Ocean dumping is being phased out, while landfilling, landspreading, and incineration are being increasingly restricted by Federal and State environmental regulations. Some new technologies to use sewage sludge beneficially have not been conclusively demonstrated in the United States, require considerable capital investment, or both. As a result, community development of long-range sludge management programs is severely hampered.

FEDERAL, STATE, AND LOCAL INVOLVEMENT IN SLUDGE MANAGEMENT ACTIVITIES

No one Federal agency or law governs all aspects of sludge management. The Environmental Protection Agency (EPA) is primarily responsible for sludge management activities at the Federal level. EPA; the U.S. Department of Agriculture (USDA); the Food and Drug Administration (FDA); Department of Health, Education, and Welfare (HEW); the Department of the Interior; and the National Science Foundation (NSF) have each performed some research concerning environmental effects of sewage sludge disposal and possible beneficial uses of sewage sludge.

The principal Federal laws that establish requirements and provide guidance for municipal sludge management include

--the Federal Water Pollution Control Act, as amended in 1972 and 1977 (FWPCA),

--the Resource Conservation and Recovery Act of 1976 (RCRA), and

--the Marine Protection, Research, and Sanctuaries Act, as amended in 1977 (MPRSA).

Under the 1972 FWPCA amendments, EPA is authorized to make grants for constructing municipal wastewater treatment plants, including sludge-processing and management facilities. In implementing the construction grants program, the EPA Administrator is required to encourage recycling of potential sewage pollutants. In addition, the 1972 amendments (1) provide for pretreatment of toxic industrial waste before it is discharged into a municipal sewer system and (2) prohibit discharge of sewage sludge into navigable waters without a permit.

The 1977 FWPCA amendments emphasize the intent and direction of the 1972 amendments and provide additional controls over sludge disposal. By December 27, 1978, EPA is required to issue regulations providing guidance for sludge disposal and use. These regulations must (1) identify sludge uses, including disposal, (2) specify factors to be considered when determining the measures and practices applicable to each use or disposal method, and (3) identify the amounts of those pollutants that would hamper each use or disposal method. Further, the 1977 amendments encourage development and implementation of alternative innovative technologies, including sludge management, by allotting funds for this purpose.

RCRA requires that EPA define acceptable and unacceptable solid waste disposal practices. EPA is also required to

define and identify hazardous wastes and establish a permit system for treating, storing, or disposing of hazardous wastes.

MPRSA provides that ocean dumping of harmful sludge will be terminated on or before December 31, 1981.

State and local regulations also affect disposal of municipal sewage sludge. Some States regulate the creation and use of landfills and land application of sludge. State and/or local industrial pretreatment programs, regulating the levels of certain substances which can be discharged into municipal wastewater systems influence sludge toxicity and, therefore, the community's sludge disposal options.

SCOPE OF REVIEW

We reviewed EPA's policies and practices and examined pertinent legislation, documents, reports, and records concerning sludge disposal and use. We interviewed agency officials at EPA, FDA, USDA, and Interior headquarters in Washington, D.C. We also obtained information from agency officials at EPA regional offices in Chicago, New York, and San Francisco and at USDA in Beltsville, Maryland.

To determine how problems with increasing sludge volumes are being solved at the local level, we reviewed sludge disposal practices in the Metropolitan Sanitary District of Greater Chicago (Chicago), the Los Angeles/Orange County metropolitan area (Los Angeles), and the New York/New Jersey metropolitan area (New York) as well as management activities in the States of New York, New Jersey, Illinois, and California. We selected heavily populated areas because they experience the most severe sludge disposal problems. We also studied management activities at selected ongoing sludge research and development projects and at municipalities using sludge as a resource.

It is not possible to address every sludge disposal method in one report; therefore, we have concentrated on those sludge disposal methods that were used or were seriously considered by the metropolitan areas we visited. We also discuss potential alternative sludge disposal methods which are currently being developed, including two technology-intensive thermal combustion systems. A number of other thermal combustion systems exist and are being used at or are planned for several plants in the United States and Europe. These systems will be discussed in another GAO report.

CHAPTER 2

LIMITED DISPOSAL OPTIONS

Disposing of sewage sludge is a growing problem for the Nation. The volume of sludge being produced is rapidly increasing, yet available disposal options are decreasing. In some areas, adverse environmental impacts and health and/or economic factors have virtually eliminated the future acceptability of certain currently used sludge disposal methods.

The Council on Environmental Quality has observed that until better solutions are found, increased amounts of sludge generated by advanced wastewater treatment systems will make the disposal problem progressively worse and more controversial. In chapter 3 we discuss several sludge disposal methods now being developed that use sludge as a resource.

The 1972 FWPCA amendments require that municipalities adopt at least secondary wastewater treatment to improve the water quality of rivers, lakes, and streams. Through fiscal year 1977, the Congress authorized more than $19 billion in grants to help municipalities meet the requirements of the act. In December 1977 the Congress authorized an additional $24.5 billion for fiscal years 1978-82.

The process of upgrading from primary to secondary wastewater treatment will greatly increase sludge volume disposal in the three metropolitan areas we visited--Chicago, Los Angeles, and New York. Together, these three areas currently produce about 1,700 dry tons of sewage sludge daily, or more than 10 percent of the Nation's sludge volume. It is estimated that in less than 10 years this volume will double. To illustrate the magnitude of the sludge volume predicted, the Los Angeles area would require more than 180 trips with 5-ton trucks to carry away its projected 1985 daily sludge volume of more than 900 dry tons.

DWINDLING SLUDGE DISPOSAL OPTIONS

The principal sludge disposal methods currently in use and their estimated costs are as follows:

Disposal method	Percent of total	Estimated cost per dry ton
Ocean disposal	15	$15 to $ 30
Landfilling	25	20 to 90
Land application	25	42 to 116
Incineration	35	80 to 120

Each of these methods may create major health, economic, or environmental problems if not properly managed. In some locations governmental regulations, physical constraints, and increasing costs will reduce future use of the ocean, landfills, and incineration as acceptable sludge disposal methods. Land application probably has the most potential of these four as a disposal option and is discussed in chapter 3.

Ocean disposal to be ended

Boston, Los Angeles, Philadelphia, New York, numerous New Jersey communities, and other coastal communities use the ocean for sewage sludge disposal. Philadelphia and communities in the New York area transport their sludge by barge and dump it at EPA interim-approved sites in the Atlantic Ocean. Boston and Los Angeles discharge their sludge into the ocean through pipes. The Los Angeles outfall extends 7 miles offshore, and the Boston outfall extends into the harbor.

Ocean dumping has two primary advantages: (1) removal of sludge from the treatment plant is complete and (2) the process is relatively inexpensive. However, it can also pose significant risks because dumping wastes in the oceans results in pollution which may seriously damage the environment and endanger human life.

To protect the environment, EPA established interim regulations for terminating municipal dumping of sewage sludge and ordered Los Angeles to stop ocean discharges of sludge by April 1980. This action was consistent with statements of the 1972 International Convention on the Prevention of Marine Pollution by Dumping of Wastes, which was signed by the United States on December 29, 1972, and ratified by the Senate on August 3, 1973. In November 1977 the Congress amended MPRSA and provided that ocean dumping of harmful sludge will be terminated on or before December 31, 1981. Also, EPA will no longer issue interim permits authorizing ocean dumping of nonconforming sewage sludge after December 31, 1981.

The Council on Environmental Quality reported in 1970 that marine pollution, including that caused by ocean dumping, had seriously damaged the environment and endangered human life in some areas. Shellfish had been found to contain hepatitis virus, polio virus, and other pathogens; pollution had closed at least one-fifth of the Nation's commercial shellfish beds; beaches and bays had been closed to swimming and other recreational use; and heavy kills of fish and other organisms had been discovered.

In our January 21, 1977, report "Problems and Progress in Regulating Ocean Dumping of Sewage Sludge and Industrial Wastes" (CED-77-18), we noted similar problems. We said that the United States dumps about 8.5 million wet tons of sewage sludge and industrial wastes into the oceans each year. Sewage sludge and industrial wastes were being dumped at too rapid a rate for ocean waters to assimilate wastes and render them harmless.

In addition, sewage sludge was being dumped even though it contained heavy metals in amounts that exceeded EPA-established safety levels. As a result, ocean dumping caused pollution which may have harmed the environment and endangered public health. EPA has not fully stated what sludge disposal method it prefers in place of ocean dumping.

EPA's actions and MPRSA, in effect, prohibit ocean dumping as a viable sludge disposal method for the future, forcing communities using the ocean to look for and adopt acceptable alternatives.

For a metropolitan area such as New York, where ocean dumping is practically the only disposal method used, an alternative system must be found to handle not only the 500 dry tons of sludge being dumped each day but also the projected 2,000 dry tons which will have to be disposed of daily by the year 2000.

Vanishing landfill sites

Landfilling treats sewage sludge as a waste, and little beneficial use is derived from it. Compared to other disposal methods, landfilling is relatively inexpensive, although it does pose potential problems, including odor, public health dangers, and ground water degradation. The future of landfilling is in question because

--available sites are filling up;

--development of new sites, especially those that are far from the treatment plant, would be expensive because of land acquisition and transportation costs; and

--proper management of a landfill is difficult.

RCRA prohibits open or indiscriminate dumping of sewage sludge, and the number of landfills licensed to accept sludge is decreasing. Experience has shown that improperly managed landfills create adverse environmental conditions. Consequently, strict Federal and State regulations are being imposed on their operations. The Los Angeles Regional Water Quality Control Board allows sludge to be landfilled regularly at only three sites. After 1985 only two sites will have a significant amount of remaining capacity.

An EPA-funded 2-year study of sludge alternatives for the New York area rejected the use of landfilling as a long-term sludge disposal option. This study, which was made for the Interstate Sanitation Commission (ISC) of New York, New Jersey, and Connecticut, indicated that landfilling is not feasible for sludges produced by treatment plants in the highly urbanized segments of the study area because of the volume produced and the limited lifespan (maximum capacity) of available landfills.

Many New Jersey communities landfill their sewage sludge at 11 sites approved by the State and registered with EPA to accept liquid wastes, including sewage sludge. New Jersey has documented the existence of extensive ground water contamination associated with all of these landfills. EPA reported in April 1976 that heavy metals, persistent organics, and other compounds regulated by drinking water standards are of concern in leachates from landfills. According to the report, recent data indicates that ground water contamination due to leachates from landfills receiving sewage sludges may be more widespread than originally envisioned. EPA has also reported that, although ground water contamination levels vary, the concentration of pollutants, such as cadmium and lead, can exceed Federal drinking water regulations.

The concern over ground water is warranted because more than half the Nation's population, according to EPA estimates, relies on ground water. EPA reported to the Congress in January 1977 that once a ground water aquifer is contaminated, its usefulness as a drinking water source may be precluded for decades and possibly centuries.

Future use of incineration is in doubt

Incineration (see fig. 1), a form of combustion, is a volume reduction process which reduces sludge, subject to final disposal, from 10 to 30 percent of the original dry matter volume. The resulting ash is usually landfilled. Because of increased energy costs and environmental factors, primarily potential air pollution, the future of this process is in doubt. Major public resistance to new incinerators has occurred in several areas, due mainly to concerns about meeting air quality standards, operational costs, and potential for odor.

Incineration requires large amounts of energy, both to dewater the sludge and as fuel for the incineration process itself. A recent study of seven U.S. cities using incineration showed that about 50 gallons of number 2 fuel oil are needed to incinerate 1 dry ton of sewage sludge. Another study showed that, if adopted nationwide, incineration would require 900 million gallons of crude oil a year, or about 18 percent of the Nation's total annual oil consumption. Another factor which could influence the future of incineration is that other solid wastes may be adapted and burned as an energy source in the sludge incineration process.

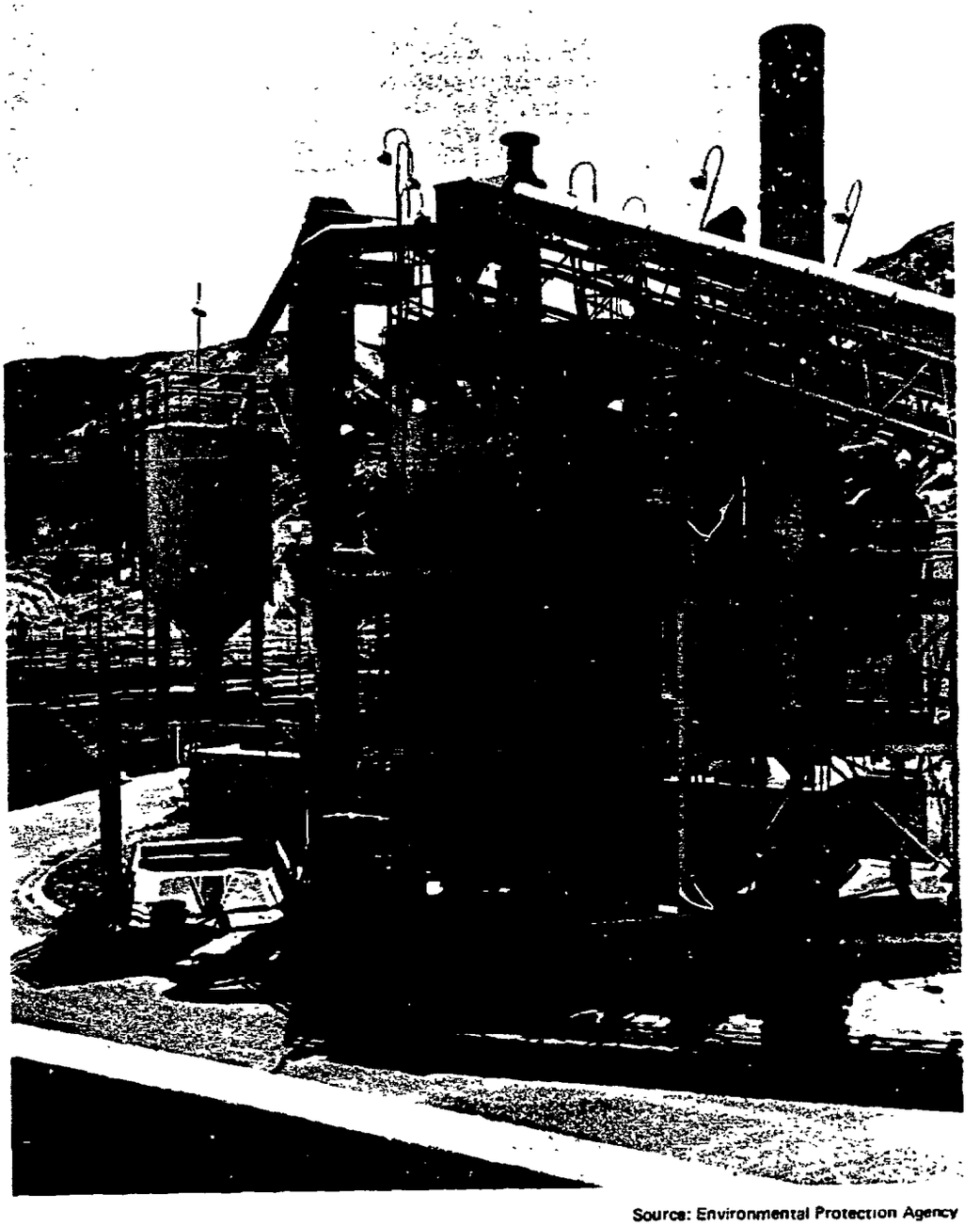
Nonavailability of fuel in some areas has hampered the use of incineration. For example, before completion of two large incinerators, officials of Contra Costa County, California, were notified that an adequate supply of natural gas to fuel the incinerators would not be available and a more expensive energy source (diesel fuel) would have to be used. As a result, operation costs would be higher.

Incineration also poses potential air pollution problems, and construction of new incinerators has been restricted in many locations because of potential air quality degradation. Institutional barriers also tend to discourage incineration as a long-term disposal option. For example, ISC's study to identify sludge disposal alternatives in the New York area stated that:

--Regional incinerators would involve severe site selection problems and could result in extended litigation due to air pollution or other objections by local residents. The legal and institutional problems become even more difficult because of overlapping of jurisdictional lines.

FIGURE 1

MULTIPLE – HEARTH INCINERATOR



Source: Environmental Protection Agency

--The limited number of acceptable incineration sites increases the difficulty and cost of transporting sludge.

CONCLUSIONS

Municipalities are facing a serious sludge dilemma. Upgrading municipal wastewater treatment plants greatly increases the amount of sludge. At the same time, some current sludge disposal methods are being phased out or are being subjected to increased scrutiny because of adverse environmental, economic, and health impacts.

Current ocean disposal practices will be phased out by December 1981. Landfill sites are becoming scarce, particularly in highly populated areas where the sludge problem is most acute. Incineration's dependence on large amounts of energy and its potential for air pollution make it an unattractive long-term sludge disposal system. Clearly, alternative sludge disposal methods must be developed and implemented to cope with rapidly increasing sludge volumes.

CHAPTER 3

SLUDGE AS AN ASSET, NOT A LIABILITY

Heretofore, sewage sludge has been looked upon primarily as a liability that should be disposed of as economically as possible. However, the increase in the volume of sludge combined with a decrease in disposal options necessitates a change in this attitude. The use of sludge as a resource, rather than a waste, needs further development.

Several methods of using sludge as a resource are being developed or are used in varying degrees throughout the country. These methods include (1) use as a land conditioner and fertilizer on agricultural and nonagricultural lands and (2) conversion to energy. But progress has been hampered because Federal and State authorities cannot agree on sludge policy and guidance was lacking for some time on the safe uses of sludge as a land conditioner and fertilizer. In addition, the feasibility of energy conversion methods, especially a process known as pyrolysis (see glossary), has not been demonstrated on a large scale in the United States.

The future of these methods, although quite promising, is uncertain because questions exist concerning the (1) environmental and health effects of sludge used to recondition land and (2) technical and economical feasibility of producing energy from sludge on a large scale. Current data does not conclusively resolve these questions. The Federal Government must encourage development of alternative sludge management systems.

USE OF SLUDGE AS A RESOURCE

Accepting and using sludge as a resource has several advantages. First, treating it as a resource creates new sources of disposal not otherwise available. For example, sludge is valuable as a land conditioner and fertilizer because it contains nutrients such as nitrogen and phosphorus and as an energy source because it can be converted to energy in several ways. Second, its value as a resource partially offsets rising disposal costs. In addition, using it as a substitute for fertilizer and as an energy source also helps to conserve those scarce commodities.

Municipalities are becoming increasingly interested in sludge management systems which derive some benefit from sewage sludge disposal. The three metropolitan areas in our review, for example, are considering or have implemented to some extent disposal methods using sludge as a resource.

Chicago and Los Angeles, which have a total population exceding 13 million, are using some of their sludge as a land conditioner. Half of Los Angeles' daily volume of 325 dry tons of sludge and all of Chicago's 470 dry tons of sludge are applied to agricultural and nonagricultural lands. New York is considering adopting pyrolysis to produce energy from sludge.

SLUDGE USE ON AGRICULTURAL LANDS

Although sewage sludge contains nutrients which make it beneficial as a land conditioner and fertilizer, it also contains heavy metals, including cadmium and other toxic and nontoxic substances. The popularity of using sewage sludge for agricultural purposes is increasing even though most authorities agree that this practice represents a potential health hazard, since those substances in sludge pose a threat to public health, plant growth, and wildlife if the sludge is improperly applied to agricultural lands. However, consensus is lacking on the extent of the hazard and, therefore, the extent of control needed to regulate the use of sludge for agricultrual purposes. Because of this lack of consensus, EPA was hampered for some time in developing an overall sludge management strategy. As discussed later in this chapter, EPA has made progress and recently issued badly needed guidance on sludge management.

Sludge application to agricultural lands--more than 1 million dry tons a year--accounts for about 80 percent of all sludge applied to the surface of land. An April 1976 EPA report entitled "An Overview of the Sludge Management Situation" said that 30 percent of smaller communities had applied their sludge to the land for more than 40 years. Over 400 Illinois towns and 250 Ohio towns apply their sludge to the land, and many other communities simply stockpile dried sludge and allow the public to haul it away for its own use. In addition, several communities, including Los Angeles, Milwaukee, and Chicago, have been drying some of their sludge and selling it for use as a soil conditioner or fertilizer. EPA expects agricultural use of sludge to increase considerably because large communities are becoming more interested in using sludge as a land conditioner or fertilizer and in selling crops grown on such land to offset sludge disposal costs.

Hazardous agricultural uses of sludge have been documented. In April 1977 a Georgia environmental official told FDA that one Georgia municipality had applied sludge containing more than 1,000 parts per million of PCBs on agricultural land. This PCB level is 100 times greater than the maximum level FDA recommended.

In another incident relating to PCBs, milk containing an excessive level of PCBs was traced to a cow which had ingested grass grown on sludge-conditioned land. Fortunately, only one cow had grazed on this land; to avert a health danger, that cow's milk was not used until its PCB count dropped.

Cadmium is a toxic heavy metal that has been classified by the Occupational Safety and Health Administration, Department of Labor, as a suspected carcinogen and by EPA as an oncogen. (See glossary.) In the Chicago area sludge containing cadmium was being given away or sold for possible agricultural use, including home vegetable gardens. The amount of cadmium in the sludge ranged from three to seven times the maximum levels FDA recommends for agricultural use.

The danger of using sludge containing high levels of cadmium to grow food crops is that cadmium accumulates in plant tissues. FDA said cadmium levels in the American diet are close to the tolerable weekly intakes developed by the World Health Organization and the Food and Agricultural Organization of the United Nations. The process of cadmium uptake in plants is not well understood, but the rate of uptake can be reduced through proper land management by controlling soil conditions, the quantity of sludge applied to the land, and the type of crops grown on sludge-treated lands.

However, we found that literature or labeling for sludge products did not caution against use on croplands or explain how to control plant uptake of cadmium. In fact, a brochure for one product indicated that it would be beneficial for vegetable gardens. EPA believes that using contaminated sludges on home vegetable gardens may pose the greatest risk to human health and the environment because presently there is no program to insure proper land management by homeowners.

In a May 23, 1977, letter to the EPA Administrator (see app. II), we expressed our concerns about agricultural land applications of sludge and recommended that EPA (1) promulgate criteria on the use of sludge on agricultural land and (2) warn the public of potential health hazards associated with using sludge to grow food.

In August 1977 the EPA Administrator agreed (see app. III) that a need existed for controlling and issuing timely guidance on heavy metals and organic compounds in sludge. He said that EPA began 4 years ago to develop a policy statement on sludge management but had not succeeded due to widely divergent opinions on acceptable sludge management practices.

Nevertheless, the Administrator said that EPA will develop criteria on acceptable cadmium application rates as well as regulate some highly contaminated sludges and will develop overall guidance on desirable sludge disposal practices. Most of these efforts are being taken to implement RCRA and the 1977 FWPCA amendments.

Federal guidance is needed to prevent a health hazard from developing and contamination of farmland in areas where sludge is used for agricultural purposes. It is important also to preclude local or State regulations from being developed, which in effect would ban land application of sludge for any purpose. The situations in Chicago and California illustrate the effect that the lack of Federal guidance has had on local decisionmaking.

In Illinois sludge from Chicago is applied to agricultural land in Fulton County. Chicago officials believe that sludge distributions to the public and sludge use for growing crops sold on the open market should not be limited because of heavy metal concentrations. In August 1976 Chicago officials used the lack of guidance to respond to a concern that the Fulton County project may pose a health hazard. They said that EPA's June 3, 1976, draft technical bulletin on municipal sludge utilization did not limit land application of sludge based on heavy metal levels. They believed, therefore, that the health hazard concern was inconsistent with the technical bulletin.

Conversely, the California State Health Department at one time considered regulatory controls which would have adversely affected current land application of sludge. If implemented, the regulations would have restricted all sludge fertilizer product sales or giveaway programs if cadmium exceeds specified levels. State Health Department officials delayed issuing land application sludge standards for 3 years in anticipation of Federal standards. In April 1977 these officials said that they could no longer wait for the standards since many sanitation districts in California were considering sludge disposal systems involving land application.

EPA ACTIONS

As mentioned previously, EPA recently issued badly needed guidance on sludge management options, including sludge application to agricultural lands in accord with our May 1977 recommendations.

In the November 2, 1977, Federal Register, EPA published a technical sludge management bulletin addressing those factors important to the environmental acceptability of particular sludge management options. The bulletin specifically

discussed sludge application to agricultural and nonagricultural lands, landfilling, incineration, and ocean dumping. Land application, particularly to agricultural lands, was emphasized because no EPA guidance had ever been published on this subject. Existing EPA guidance on the three other major options--incineration, ocean dumping, and landfill--was included to assure that each community could select the best currently available alternative in terms of environmental acceptability, cost-effectiveness, risk, and benefits. While the technical bulletin is not a regulatory document, it provides criteria and guidelines for selecting sludge management options and detailed information on land application alternatives. Also, specific guidance was provided on those amounts of heavy metals, including cadmium, which could remain in sludge applied to agricultural lands and not cause problems if properly applied.

EPA also issued proposed criteria classifying solid waste disposal facilities and providing guidelines for sludge use and disposal in the February 6, 1978, Federal Register. Sewage sludge application to land used for producing food chain crops was discussed in detail and limits were placed on the amount of cadmium from solid waste, including sludge, that could be applied to land. EPA's intent was to minimize the movement of cadmium from solid waste applied to land into the food chain.

Other sludge management activities EPA has underway include developing regulations governing the giveaway and sale of sludge to the public under the December 1977 FWPCA amendments. These regulations are expected to be issued in early 1979. In addition, EPA is developing a comprehensive municipal sludge strategy document for issue in 1978 as part of its implementation of RCRA and the FWPCA amendments. Briefly, the strategy document will clarify EPA's policy on municipal wastewater treatment sludge and will describe its plans to comply with legislative mandates and cope with existing Federal, State, and local capabilities and resources. In addition, the 1977 FWPCA amendments require EPA to report to the Congress by October 1, 1978, on the status and use of municipal secondary effluent and sludge for agricultural and other purposes using the nutrient value of treated wastewater.

WILL INDUSTRIAL PRETREATMENT OF WASTEWATER REDUCE SLUDGE TOXICITY AND MAKE IT SAFE FOR AGRICULTURAL USE?

What effect industrial pretreatment will have on sludge disposal is uncertain. Many Federal and municipal officials do not believe pretreatment will reduce contaminants in sludge to levels considered safe for agricultural use, while others

believe it will be extremely effective. Most probably, pretreatment will reduce heavy metal and toxic organic chemical concentrations to safe levels in some sludges but not others because such concentrations in municipal sludge can come from domestic as well as industrial sources.

Under provisions of the 1972 FWPCA amendments, EPA must establish a pretreatment program for industrial wastes before they are discharged into publicly owned sewer systems. Under such a system, contaminants are removed from sewage at the wastewater source. EPA, however, has not decided how to enforce its overall industrial pretreatment program.

Only pollutants which would not be removed from sewage during treatment by publicly owned treatment works or which would interfere with plant operations were covered by the 1972 pretreatment requirements. However, the 1977 FWPCA admendments additionally required that pretreatment regulations be issued to prevent discharge of any pollutant which would contaminate sludge or reduce possible sludge used into a publicly owned treatment works. Also, pursuant to a June 1976 settlement agreement with five environmental groups, EPA must promulgate regulations establishing pretreatment standards for 21 industries and covering 65 toxic substances by December 31, 1979.

Heavy metal and organic chemical concentrations in sewage sludge can greatly affect the safety of applying sludge to agricultural land as well as other sludge disposal options. The following chart shows the possible environmental effects of contaminants in sludge.

Impact of Industrial Chemicals on Sludge Disposal Options

Municipal sludge disposal option	Major environmental concerns
Landspreading	Metal content of sludge may injure or contaminate crops. Toxicant may enter the agricultural food chain.
Lagooning and landfilling	Metals and organics in leachates may contaminate ground and surface waters.
Incineration and landfilling	Air emissions may cause pollution (for example, metals such as mercury). Leachate generation from disposal of ash may cause water pollution.
Composts and fertilizers	Metals and/or pathogenic organisms may contaminate product.

Pretreatment, therefore, could improve sludge quality and provide more options for sludge disposal. EPA anticipates that pretreatment would considerably reduce cadmium in many sludges and thus increase agricultural land application opportunities.

EPA believes industrial pretreatment can greatly influence the sludge disposal options available to a municipality. Since sewage sludge represents the concentrated residue of wastewater, heavy metals and organic chemicals tend to accumulate in sludge. EPA has reported that heavy metal concentrations in municipal sludge may be as high as 4,000 times the concentrations in the wastewater itself. Data for three industrialized communities--Buffalo, Dallas, and Los Angeles County--shows that as much as 70 percent of the metals in the treatment plant influent was contributed by industry. In addition, an EPA-funded study of the Los Angeles area's sludge disposal alternatives, published in April 1977, indicated that industrial pretreatment was expected to produce further improvement in sludge quality. The report estimated that it may be possible for source control measures to achieve as much as a 50-percent reduction in heavy metals.

Some municipal officials, including those responsible for disposing of sewage sludge in New York City and Chicago, question whether industrial pretreatment will greatly reduce

heavy metal concentrations. New York City officials concluded in a 1974 report that even if discharges of heavy metals from industrial sources were eliminated entirely, 94 percent of the zinc and 84 percent of the cadmium in New York City's wastewater would remain, since they emanate from other than industrial sources.

Chicago's Metropolitan Sanitary District already has a pretreatment program which, according to Chicago officials, has reduced certain heavy metal discharges by more than 70 percent. Still, cadmium levels in the sludge exceed 70 parts per million, more than three times the maximum level FDA recommended for sludge applied to agricultural land where strict management controls are not practiced. Also, one wastewater plant with primarily nonindustrial contributors produced sludge with cadmium levels higher than FDA's recommended maximum.

Opinions on the effects industrial pretreatment will have on reducing levels of toxic heavy metals and thereby facilitating safe application of sludge on agricultural lands differ. These differences should be resolved as EPA's industrial pretreatment program is implemented. Until then, however, it is questionable whether communities should plan to apply sludge with high cadmium levels to agricultural land with the hope of later reducing sludge toxicity to acceptable levels through industrial pretreatment.

APPLICATION OF SLUDGE ON NONAGRICULTURAL LAND--A SENSIBLE SOLUTION

Because sludge can be a health hazard if used to grow crops and pretreatment does not represent an immediate solution to the heavy metals problem, a more sensible approach is to apply sludge to land which will not be used for food production. In this way, sludge can be used to condition publicly owned lands, including parks, lawns, and golf courses, and to restore disturbed lands, such as highway medians, construction sites, and strip-mined land.

Nonagricultural land application of sludge is one of the least hazardous disposal methods. The method also eliminates the problem of heavy metals uptake in crops, provided the land is not later used for food production.

Application of sludge to nonagricultural lands has been successfully demonstrated. Several projects have shown that use of sludge in this manner could have wide application. The U.S. Park Service, Department of the Interior, used more than 9,000 tons of composted sludge from a demonstration

project at Beltsville, Maryland (see fig. 2), in creating Constitution Gardens, the 42-acre bicentennial park in Washington, D.C. According to Park Service officials, using this sludge saved the Government from having to spend more than $200,000 for top soil.

The U.S. Forest Service, Department of Agriculture, is using sludge from Chicago to reclaim land in the Shawnee National Forest in southern Illinois. The Palzo Restoration Project, as this activity is known, has successfully demonstrated the feasibility of reclaiming highly acidic mine spoils with municipal sewage sludge. To date, 36 acres have been reclaimed. Figure 3 on page 21 illustrates the results of this sludge application.

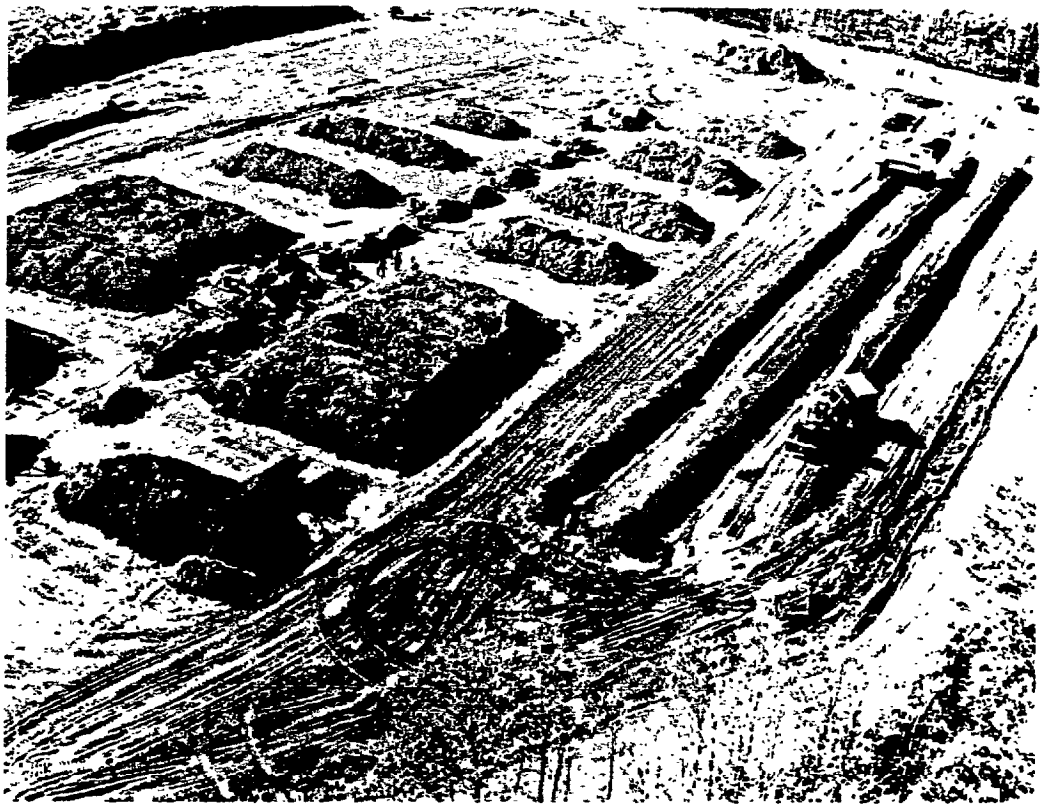
Potential for greater application of sludge on public lands

Currently, Federal agency involvement in such projects is very limited, but potential for more involvement is great because the Federal Government owns more than 760 million acres of land in the United States, or one-third of all its land. For example, coal production on Federal lands will increase to help the Nation's energy problems, and recently enacted Federal legislation requires operators to reclaim strip-mined land. The Soil Conservation Service estimated in a 1974 report that more than 2 million acres of strip-mined lands exist in the United States. In addition to Federal land, State and local government land could be used for disposal. For example, New Jersey is considering the use of composted sludge as a conditioner for State land and as a daily covering on solid waste landfills.

Various reasons have been given for not using sludge on public lands. Officials fear it will contaminate water supplies and otherwise affect the environment. Some are repulsed by the notion of sludge being applied to public parks, while others do not realize the merits of sludge as a land conditioner. In addition, institutional, political, and legal barriers often discourage and sometimes prohibit sludge disposal on public lands. For example, some State laws require approval of all political jurisdictions through which sludge must pass en route to disposal sites, including lands. Needed approvals are frequently almost impossible to obtain, especially when several jurisdictions are involved. Also, costs for transporting sludge to disposal sites can be high, although they can be offset if the sludge is used as a substitute for other land conditioners.

FIGURE 2

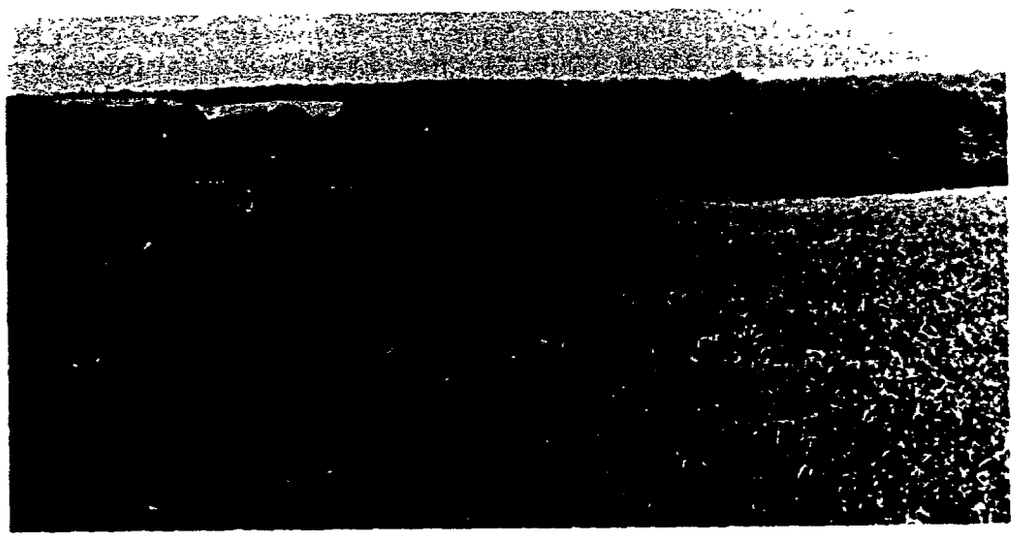
SLUDGE BEING COMPOSTED
BELTSVILLE, MARYLAND



Source: Department Of Agriculture, Agricultural Research Service

FIGURE 3
SLUDGE USED TO RESTORE STRIP–MINED LAND
PALZO RESTORATION PROJECT, SHAWNEE NATIONAL FOREST
DEPARTMENT OF AGRICULTURE, FOREST SERVICE

PALZO SITE BEFORE RESTORATION



PALZO SITE AFTER RESTORATION

Source: Department Of Agriculture, Forest Service

Opportunities to encourage and perhaps require sludge use for nonagricultural purposes on public lands or to reclaim strip-mined lands exist, but they have not been taken. Thus, nonagricultural land application of sludge has been limited.

EPA recently issued guidance covering sludge use and disposal on nonagricultural as well as agricultural lands. EPA's November 2, 1977, technical sludge management bulletin encourages sludge use as a land conditioner and fertilizer when it is supported by an environmental assessment. Proposed classification criteria for solid waste (including sludge) disposal facilities published on February 6, 1978, provide minimum Federal standards for all land disposal. In addition, EPA's draft municipal sludge strategy document discusses, among other things, the benefits and risks of this use. These documents provide or will provide needed guidance on sludge disposal and use and are an important step forward in promoting use of sludge as a resource.

THERMAL COMBUSTION OF SLUDGE--AN ALTERNATIVE?

A number of thermal combustion sludge disposal methods exist. In fact, thermal combustion of sludge as a disposal method has been used successfully in Europe for years and is used in or planned for plants in Franklin, Ohio; Duluth, Minnesota; Glencove, New York; Memphis, Tennessee; and Harrisburg, Pennsylvania; among others. We limited our review, however, to a discussion of two of the better known thermal combustion methods--pyrolysis and copyrolysis. (See glossary.) Other thermal combustion methods, including codisposal, will be discussed in another GAO report.

Pyrolysis feasibility

Pyrolysis, a controlled combustion process, is the thermal decomposition of matter in an oxygen-free or oxygen-starved environment. It occurs in a closed system which allows gases given off to be easily collected and recycled as energy or processed to reduce possible air pollution. It is not as energy-intensive as other combustion disposal methods. In fact, it may produce more energy than it uses, thus offsetting much of the system's operation costs. Pyrolysis can be performed using partially dewatered sludge alone or using a combination of sludge and solid waste (copyrolysis).

For large metropolitan areas where existing landfills are running out of space, sludge pyrolysis may be a viable disposal method. In these same areas, using sludge on land may be prohibited due to the nonavailability of land and the heavy metal levels of the sludge.

As an alternative to ocean dumping for the New York area, the Interstate Sanitation Commission recommended that five pyrolysis plants be constructed within the New York area. These five plants, according to ISC, would cost about $206 million to construct and could handle more than 900 dry tons of sludge a day by the mid-1980s.

ICS's recommendation of pyrolysis was not widely accepted. New York and New Jersey State officials, as well as New York City officials, said that pyrolysis reliability has not been sufficiently demonstrated and that further large-scale pyrolysis demonstration is needed before widespread adoption. They indicated that such demonstrations should be made by EPA. Another concern is that communities may have difficulty funding their share of the high cost of pyrolysis units.

Pyrolysis was also considered as a sludge disposal option for the Los Angeles area. However, the probability of implementing pyrolysis in Los Angeles is low, according to preliminary results of an EPA-funded study, dated May 1977.

EPA headquarters officials were unable to say what was needed to encourage communities to adopt pyrolysis. However, they agreed that the lack of large-scale pyrolysis demonstrations poses a risk to a municipality desiring to implement a pyrolysis system.

Results of EPA-funded pyrolysis projects

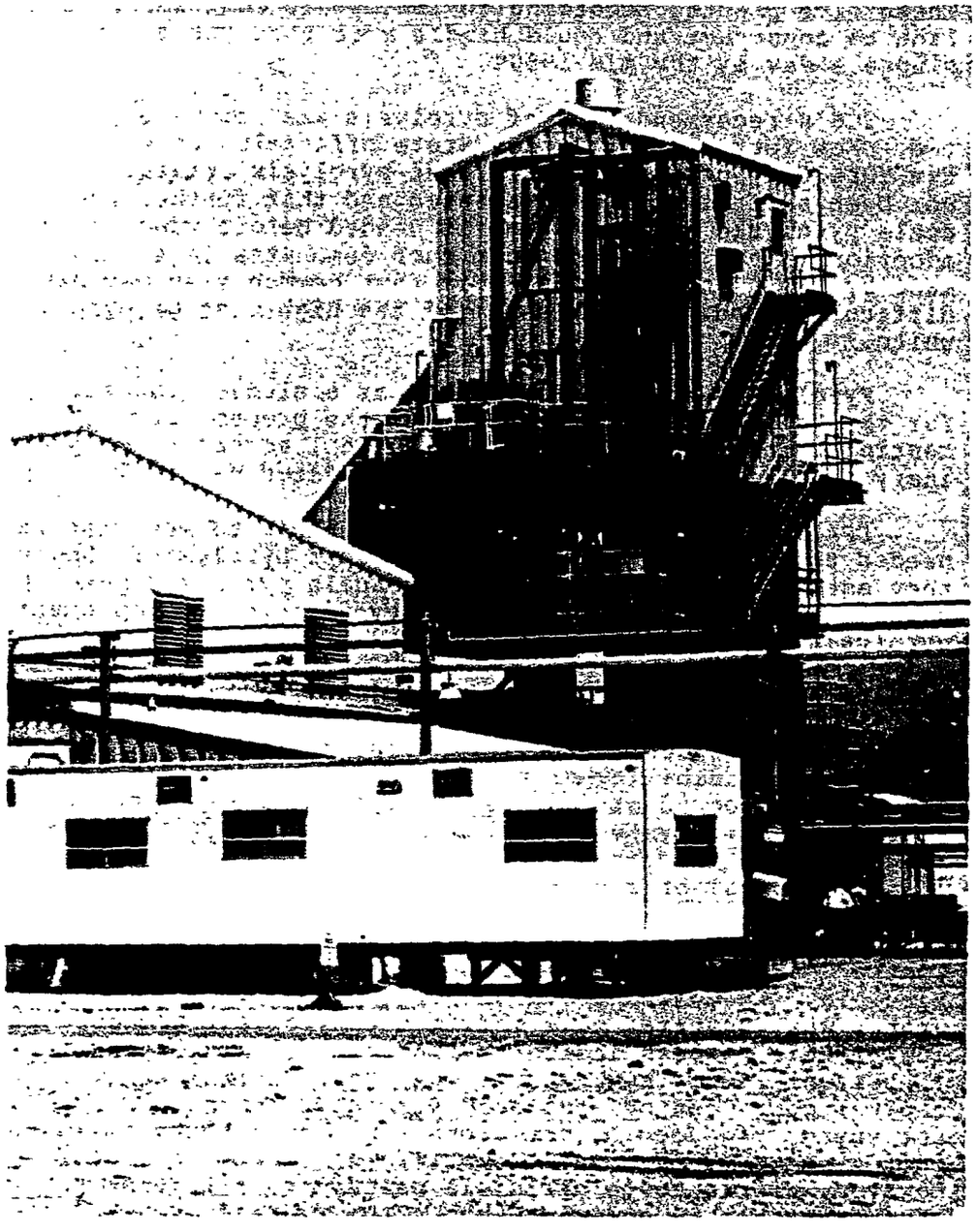
EPA has funded a number of pyrolysis systems to demonstrate the feasibility of pyrolysis as a sludge disposal method. We looked at four of these projects--two copyrolysis systems and two systems which pyrolyze sludge only.

Codisposal of sludge and solid waste

Codisposal of sludge and solid waste has been tested in Contra Costa County, California, and South Charleston, West Virginia. In Contra Costa, an existing multiple-hearth incinerator was converted to a modified copyrolysis process. Testing of this process indicates that copyrolysis can achieve a 95-percent energy saving over conventional incineration and its capital costs can be recovered within 20 years. In addition, the energy produced by the process may adequately fill the energy needs of the overall wastewater treatment process. However, Contra Costa officials believe that further continuous operation is needed to prove the system's feasibility.

FIGURE 4

COPYROLYSIS PLANT
(200-TON A DAY CAPACITY)



Source: Union Carbide Corporation

The South Charleston copyrolysis demonstration project showed that it not only produced four times the energy needed to sustain the process but also produced a nonleaching residual, which a project official believed could be used as a roadfill. The amount of energy produced depends on the mixture of sludge and solid waste and can range from no energy production to many times the energy used in the process.

However, Federal financial aid to municipalities to install copyrolysis systems is not comparable to that of other sludge disposal systems. The Federal Government funds 75 percent of the eligible cost of sludge disposal systems (or 85 percent for innovative technologies), but it does not fund any of the cost of solid waste disposal systems. Therefore, a large part of any codisposal system must be paid by local and State governments. Officials of the company which manufactures the South Charleston pyrolysis system believe that the system has been adequately demonstrated but that the municipality's share of the system's capital costs may discourage its full-scale use. For example, these officials estimate that for a system designed to serve a population of 750,000, about 65 percent of its capital costs of $100 million must be funded by the municipality or the State.

EPA headquarters officials also believe that EPA's funding formula for the codisposal system may restrict the system's development. They said there may be a need for EPA to provide more incentive to encourage the use of copyrolysis.

Pyrolysis of sludge alone

EPA-funded demonstrations of dewatered sludge pyrolysis have been carried out in Belle Meade, New Jersey, and Orange County, California.

The project in Belle Meade involved burning dewatered sewage sludge in a multiple-hearth furnace converted to the pyrolytic mode. The objective of this small pilot project was to develop a workable design for converting a multiple-hearth sludge incineration system to a pyrolysis operation.

Sewage sludge from selected communities in the New York area has been pyrolyzed during three test runs. Analyses are being performed on the ash, filter cake, and stack exhaust, with special emphasis on heavy metals and organics composition. Study results showed that pyrolysis can be used as a thermal combustion process without using fuel. The project also concluded that, generally, pyrolysis is a commercially feasible and cost-effective process. Studies of heavy metal concentrations were continuing as of September 1978.

The Orange County Sanitation District is operating a 1-million-gallon-per-day pilot plant which tests an activated carbon treatment system developed by the National Aeronautics and Space Administration's Jet Propulsion Laboratory. The Laboratory system is an integrated wastewater treatment and sludge disposal system. The sludge is pyrolyzed so that gases, carbon, and ash are produced. The gases can be used as a fuel, the carbon is activated and used to treat the wastewater, while the ash is removed and used as landfill. The test has been completed; problems encountered concern the proper materials to use in the pyrolysis unit, the energy balance that will be able to be obtained, and the ability of the system to produce enough carbon to treat the wastewater. Further demonstration is needed before the pilot project can be expanded to full-scale operation.

Results of pyrolysis to date show that it may be a viable sludge disposal method, especially for heavily populated areas lacking land accessibility. Since the burning occurs in a closed system, potential air pollution from the resulting gases may be reduced. In addition, the system can be designed to be a net producer of energy.

However, local officials are reluctant to accept the results of EPA-funded pyrolysis demonstrations because, in their opinion, the size of the operations is not comparable to what would be required in actual practice. They have said that the costs and consequent risks involved in large-scale operations are too great to enter into without additional Federal support. Further, copyrolysis systems will probably not receive adequate local consideration because the level of Federal funding is not comparable to that of other sludge disposal systems.

EPA officials are not sure if communities actually need large-scale demonstrations to evaluate the effectiveness of pyrolysis, but they agree that the lack of such demonstrations increases the communities' risk. These officials also agree that some type of incentives may be needed to make copyrolysis systems competitive with other sludge disposal options.

The 1977 FWPCA amendments may provide the incentive needed to encourage local development and use of thermal combustion methods. The Congress set aside funds for the specific purpose of developing and implementing innovative and alternative technologies, including sludge management. Also, the amendments provide 100-percent funding for cost evaluations, training, and disseminating technical information on innovative and alternative technologies. Further, funding of

such technologies may be given higher priority. EPA is required to publish guidelines for innovative and alternative treatment processes and technologies by June 30, 1978.

In our opinion, the current state of affairs is not conducive to the adoption of pyrolysis and copyrolysis sludge disposal methods. However, if the 1977 FWPCA amendments are implemented properly and funds are available, the situation should change and viable sludge disposal alternatives to ocean dumping, incineration, and landfill should become available in the not too distant future.

CONCLUSIONS

To cope with the rapidly increasing sludge volume, a fundamental change in the Nation's approach toward sludge disposal and use is necessary. Historically, sludge has been viewed generally as a useless byproduct of wastewater treatment that must be disposed of as cheaply and quickly as possible. This approach was acceptable in the past, but with increasing concerns about possible adverse environmental effects from generally accepted sludge disposal methods and subsequent regulations and restrictions on their use, it is no longer true. Landfill sites are dwindling, air pollution standards are restricting use of incineration, and ocean dumping has endangered human and marine life. In short, many of the previously accepted disposal methods are no longer viable solutions. New ones must be developed and the Federal Government, particularly EPA, must take the lead in this effort.

Use of sludge as a resource, such as a land conditioner or fertilizer or an energy source, has the best potential as a viable solution to the problem. Sludge use for this purpose has been limited, however, because Federal and State authorities cannot agree and guidance was lacking for some time on the safe uses of sludge as a land conditioner and fertilizer. Further, institutional, political, and legal barriers often discourage and sometimes prohibit use of agricultural and nonagricultural lands for sludge disposal. In addition, while use of sludge as an energy source in pyrolysis and copyrolysis systems has been demonstrated in small-scale pilot projects, its feasibility in large-scale operations has not been proven mainly because the related costs and risks involved are too great for communities to bear without substantial Federal support. As a result, sludge use as a resource has not been widely accepted.

In our opinion, the principal reasons sludge has not been used as a resource are that such use was not encouraged,

guidance was lacking, and a comprehensive national sludge disposal policy does not exist. Consequently, advantage has not been taken of the many opportunities available to use sludge as a resource.

EPA has made considerable progress in this area since July 1977 when no guidance for using sludge as a resource was available. Since then, EPA has issued guidance on agricultural and nonagricultural land application of sludge. In addition, it has proposed regulations covering sludge disposal and use. EPA is also in the process of developing a municipal sludge strategy document and regulations governing the sale and giveaway of sludge. Further, as a result of the 1977 FWPCA amendments, emphasis and priority has been given to funding innovative and alternative sludge disposal technologies. This is a good beginning; however, more needs to be done.

To increase sludge use as a resource, a comprehensive national sludge disposal policy encouraging such use and effective Federal leadership promoting its merits are needed. To fulfill this leadership role, numerous actions could be taken, such as identifying and providing information on agricultural and nonagricultural land disposal opportunities to Federal, State, and local agencies; studying ways to reduce transportation costs and improve sludge distribution systems; exploring possibilities for requiring private operators on public lands to use sludge in restoring lands they disturb; and funding development and use of innovative and alternative technologies. All of the documents discussed above should be an integral part of a national sludge management document.

RECOMMENDATIONS

We recommend that the EPA Administrator develop a national sludge management policy emphasizing sludge use as a resource. Such a policy statement should, at a minimum, discuss agricultural and nonagricultural land uses, sludge sales and giveaways, and the feasibility of thermal combustion systems. We also recommend that the Administrator

--fund full-scale demonstration projects if the engineering consensus within EPA is that the feasibility of thermal combustion cannot be determined on the basis of current demonstration projects;

--communicate the results of successful demonstrations to interested communities; and

--monitor the growth and development of systems which have been successfully demonstrated to determine the need, if any, for additional Federal support of these systems.

AGENCY COMMENTS

In commenting on our report, EPA said the conclusions and recommendations were well derived and should serve to encourage Federal initiatives in these areas. (See app. IV.)

APPENDIX I

SLUDGE PROCESSING METHODS

Processes	Functions
Thickening	Water removal Volume reduction Post process efficiencies Blending
Stabilization	Pathogen destruction Volume and weight reduction Odor control Gas production
Composting	Pathogen destruction Volume and weight reduction Odor control Water removal Utilization
Conditioning	Improve dewatering or thickening rate Improve solids capture Improve compactability Stabilization
Dewatering	Water removal Volume and weight reduction Change to damp cake Reduces fuel requirements for incineration/drying
Heat drying	Water removal Sterilization Utilization
Reduction	Destruction of solids Water removal Sterilization Conversion
Final disposal	Cropland use Energy use Land reclamation use Landfill Ocean

Source: Environmental Protection Agency.

APPENDIX II

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

COMMUNITY AND ECONOMIC DEVELOPMENT DIVISION

B-166506

The Honorable Douglas M. Costle
Administrator, Environmental
Protection Agency

MAY 23 1977

Dear Mr. Costle:

We are currently reviewing the Environmental Protection Agency's management of sewage sludge disposal practices. Our review includes a study of the municipal sewage sludge management systems of Chicago, Los Angeles, and New York-New Jersey metropolitan areas. Our objective is to determine whether current sewage sludge disposal practices emphasize beneficial uses of sludge which are safe and environmentally acceptable.

We have identified a potentially hazardous situation which we believe warrants your immediate attention. Sewage sludge products having high amounts of cadmium are being sold or given away to the public for uncontrolled use. We appreciate the difficulties communities have in disposing of the increasing volume of sludge; however, this practice represents a potential health hazard.

As you know, cadmium is a toxic heavy metal which has been classified by the Occupational Safety and Health Administration as a suspected carcinogen. The Food and Drug Administration believes that the levels of cadmium in the American diet are close to the tolerable weekly intakes developed by the World Health Organization and the Food and Agricultural Organization of the United Nations.

In June 1976 EPA published for comment a draft technical bulletin on municipal sewage sludge management. The bulletin stated that numerous conditions affect the level of heavy metals that may be toxic to plants or taken up by crops and eventually consumed by humans. It recommended that projects using sludge on croplands conform to any limitations recommended by the Food and Drug Administration (FDA) or the Department of Agriculture (USDA).

CED-77-78

B-166506

FDA recommended in its comments on the technical bulletin that sludges containing more than 20 parts per million (ppm) of cadmium not be used on agricultural land and crops in the food chain. USDA scientists recommended that sludges containing more than 25 ppm of cadmium not be applied to privately owned agricultural land unless the cadmium-to-zinc ratio of the sludge is less than or equal to 1.5 percent. In commenting on the draft technical bulletin, EPA's Office of Solid Waste Management suggested maximum allowable cadmium levels similar to those recommended by USDA scientists.

We found that sewage sludge products with cadmium levels substantially higher than the levels suggested above are available nationwide to the public for possible use on agricultural land, including home vegetable gardens. Some of these sludge products contain approximately 3 to 7 times the maximum level of cadmium recommended by FDA and exceed the cadmium-to-zinc ratio suggested by USDA scientists. The literature or labeling for the products we have identified do not caution against use on croplands and, in fact, a brochure for one sludge product indicates that the product would be beneficial for use in vegetable gardens.

In addition to the current sale and the give-away programs of sludge products, municipalities are considering other programs which would result in the use of sludge to grow crops. Your Agency's April 1976 report, "An Overview of the Sludge Management Situation", recognized that large communities are becoming more interested in the land application of sludge and the possibility of selling crops grown on such land to help offset sludge disposal costs.

Sludge products containing toxic materials may eventually be defined as hazardous wastes and regulated under the Resource Conservation and Recovery Act of 1976 (42 U.S.C. 6901). However, we believe that, in view of the substantial margins by which some sludge products currently available to the public exceed maximum suggested levels, EPA should take immediate action to define which of these products could be used to produce food. Action is also needed to inform the public of potential health hazards involved and to assist communities considering adopting sludge disposal systems which use sludge in food production.

APPENDIX II

B-166506

RECOMMENDATIONS

We recommend that you provide interim guidance on sludges that are acceptable for agricultural purposes, including use on home vegetable gardens, until such time as the requirements of the Resource Conservation and Recovery Act are implemented. We recommend also that you provide for public notification of the potential health hazard associated with using sludge products which are given away or sold and are deemed unacceptable for agricultural use.

We shall appreciate receiving your comments on this letter and on any actions you plan to take. As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions he has taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

Copies of this letter are being sent to the Chairmen, Senate Committees on Governmental Affairs; Environment and Public Works; and Appropriations, Subcommittee on HUD-Independent Agencies; to the Chairmen, House Committees on Government Operations; Appropriations; and Public Works and Transportation; and to the Director, Office of Management and Budget.

Sincerely yours,

Henry Eschwege

Henry Eschwege
Director

APPENDIX III

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

AUG 16, 1977

THE ADMINISTRATOR

Dear Mr. Chairman:

As required by Public Law 91-510, we are submitting this statement of Agency actions taken in response to the General Accounting Office (GAO) letter report of May 23, concerning the disposal of sewage sludge containing high levels of cadmium.

We recognize the importance of the problem addressed by GAO's letter report. Approximately 20 percent of all sewage sludges (over 1 million dry tons per year) are now applied to land used for agricultural purposes. The uncontrolled application of sludges that contain excessive levels of cadmium has been shown to increase the cadmium content of crops and the Food and Drug Administration has indicated that all cadmium increases in foods, no matter what the source, are undesirable.

It is important to point out, however, that the cadmium content of the sludge is only one of several factors that influence the extent of crop uptake of cadmium. Proper site management--including controls on the cadmium application rate, the crop being grown, and soil pH--has been demonstrated to significantly reduce the uptake of heavy metals and consequently reduce the relative risk inherent in the land application of sludge. Some research indicates that these site management controls are as important as specific controls on sludge metal concentrations in limiting metal uptake in plants. Attention must also be given to the effects on crops of background levels of cadmium in the soil and in supplemental fertilizers.

We agree with the GAO letter report indicating a need for control and guidance on heavy metals and organic compounds in sewage sludge. The Environmental Protection Agency (EPA) has several activities now underway which we believe will meet some of the needs raised in the GAO letter report. I would like to discuss these briefly.

APPENDIX III

Under Subtitle C of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, we will be regulating the management of hazardous wastes through the use of a manifest and permit system. It is likely that some highly contaminated sludges will be controlled by this program, which is scheduled to be promulgated in April of 1978. Under Section 4004(a) of Subtitle D of the Act we will be developing criteria for the classification of solid waste disposal facilities. These criteria will be used to identify those sites that provide "no reasonable probability of adverse effects on health and the environment." Landspreading practices will be covered in these criteria, with attention given to the unacceptable cadmium contamination of food chain crops. We plan to include cadmium application rates in these regulations, which are scheduled for promulgation later this year. Further, we will be preparing specific guidelines for sludge disposal under Section 1008 of the Act. These guidelines, which will stress desirable operating practices for sludge management, will be published in the fall of 1978.

As indicated previously, the Agency recognizes the need for timely issuance of guidance on land application of sludges, both to address the concerns raised in CAO's letter report and to comply with the deadlines of the Solid Waste Disposal Act. It must be recognized, however, that differences of opinion on the specific impacts of sludge landspreading practices on levels of heavy metals and toxic organics in the diet have delayed efforts by the Agency to issue such guidance. The technical bulletin on municipal sludge management being prepared by our Office of Water Program Operations is an excellent case in point. The bulletin has evolved from efforts initiated by the Agency four years ago to issue a policy statement on sludge management. Specific contaminant levels which would establish the acceptability of sludges for land application were included in earlier versions of the bulletin. These limitations were criticized as being too restrictive by some and too permissive by others. Complicating this situation is the difficulty that many cities face in financing acceptable options for the disposal of their wastewater treatment sludges. The technical bulletin will nevertheless provide examples of acceptable cadmium application rates for the utilization of sludge on land.

In addition to the sludge management programs described above, we anticipate that implementation of the pretreatment strategy now under development will substantially reduce

APPENDIX III

the cadmium content of many wastewater treatment sludges. This will improve the acceptability of these sludges for use on agricultural land. By this emphasis on prevention of the problem, we hope to move toward our goal of waste recovery and recycling.

The criteria for defining acceptable disposal practices to be developed under Subtitle D of the Solid Waste Disposal Act will address the application of sewage sludge to cropland. We believe that these criteria, supplemented at a later date by the Technical Bulletin, the hazardous waste regulations and the sludge disposal guidelines, will provide adequate guidance on the management of cadmium-containing sludges when applied to the soil.

With respect to your concern over home vegetable garden uses of sewage sludge, we plan to address this topic in both the hazardous waste regulations and sludge guidelines. We realize, however, that these documents are not scheduled for promulgation until April and October of 1978 respectively. Therefore, we have assigned high priority to the development and issuance of an information bulletin on home uses of sewage sludge. Recognizing the lack of concensus in the scientific community on the specific allowable level of cadmium application, we may find it necessary to revise this planned document as more information becomes available. The interim document will nevertheless receive wide distribution through the EPA's Regional Offices, and will be prepared for municipalities as well as for the general public.

Sincerely yours,

Douglas M. Costle

Honorable Abraham A. Ribicoff
Chairman, Committee on Government Operations
United States Senate
Washington, D.C. 20510

APPENDIX IV

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D C 20460

JUN 19 1978

OFFICE OF
PLANNING AND MANAGEMENT

Mr. Henry Eschwege
Director, Community and Economic Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

The Environmental Protection Agency has reviewed the revised draft report entitled "Sewage Sludge--How Do We Cope With It?" We consider this to be a timely report on a problem area of unique significance to the efforts of environmental improvement. The conclusion and recommendations are well derived and should serve to further encourage ongoing Federal initiatives in these areas.

The report's emphasis on the use of sludge is fully in concert with our Agency's position on sludge management. Beneficial uses of sludge as a fertilizer or soil conditioner and in energy production systems are all uses we are actively encouraging. Further, we are in agreement that application of sludge to agricultural land should be carefully controlled through proper management to reduce potential health risks posed by contaminants. As the report has stated, pretreatment can be a valuable tool for further encouraging beneficial utilization of sludge. Although pretreatment is not an "immediate" solution to controlling the contaminant levels of all sludges, we believe that within a few years many communities can achieve sludge qualities which will allow beneficial utilization of sludge as a resource.

The document tends to describe incineration as an unattractive approach while pyrolysis is an option to be pursued. This striking contrast is an oversimplification, as these two processes are closely related and must be evaluated for each planned installation to determine their respective pluses and minuses.

APPENDIX IV

We appreciate the opportunity you have given us to review this report, prior to its submission to Congress.

Sincerely yours,

William Drayton, Jr.
Assistant Administrator
for Planning and Management

(08746)