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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Industrial Wastes: An Unexplored Source Of Valuable Minerals

U.S. industries generate millions of tons of waste each year. These wastes typically take the form of slag, scale, sludge, slime, slurry, dust, and dross. And they also contain large amounts of minerals.

Unfortunately, recovering minerals from industrial wastes has received scant attention by the Government. Even though the identification, evaluation, and promotion of resource recovery programs for all types of wastes are required by the Resource Conservation and Recovery Act of 1976, little action has taken place for industrial wastes.

The Congress should increase its oversight to make sure that legislated resource-recovery objectives are pursued for industrial wastes.

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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 points out that industrial wastes often contain valuable metals, and are often disposed of in ways that preclude the future recovery of mineral values. Although Congress passed the Resource Conservation and Recovery Act of 1976 to, among other objectives, improve the recovery of usable materials from waste, the Executive Branch has done little to enhance mineral recovery, especially from industrial wastes.

Copies of this report are being sent to the Director, Office of Management and Budget; the Secretaries of Commerce and the Interior; the Attorney General; and the Administrator of the Environmental Protection Agency.

Comptroller General
of the United States

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COMPTROLLER GENERAL'S REPORT
TO THE CONGRESS

INDUSTRIAL WASTES: AN UNEXPLORED SOURCE OF VALUABLE MINERALS

D I G E S T

The Environmental Protection Agency (EPA) estimates that U.S. industries generate over 344 million metric tons of waste annually. Recent industry studies indicate that large amounts of such minerals as iron, copper, and aluminum remain in the wastes. Unfortunately, the wastes are often disposed of in ways that preclude the future recovery of mineral values. Industry officials say that they do not recover more of these minerals because it is not profitable to do so.

Industry has spent and will spend billions of dollars disposing of their wastes in ways that meet the standards established by the EPA and other Government agencies. Increasingly stringent environmental controls over waste disposal continue to escalate costs and cause related problems for industry.

The Council on Environmental Quality estimates that private industry spent approximately $22 billion on pollution control (including waste disposal) in 1978, and that almost half of these expenditures were in response to environmental legislation. Furthermore, many costs associated with the most recent legislation and regulations are not reflected in these figures.

Yet as disposal costs rise, mineral recovery from wastes should become more attractive. For example, the increased recovery of minerals could, in some cases, offset some of the costs of meeting existing and proposed environmental standards, and at the same time, have a number of related benefits such as reduced pollution, and less dependence on imports. Unfortunately the Executive Branch has not adequately addressed the potential for a Federal role in

enhancing the recovery of minerals from industrial wastes.

THE CONGRESS HAS CALLED FOR ACTION

The Congress, recognizing that resource-recovery objectives need to be coordinated with environmental goals, passed the Resource Conservation and Recovery Act of 1976. Among the act's objectives are the preservation of the environment not only by improved management and regulation of hazardous materials, but also by the improved recovery of usable materials from waste. Although the Executive Branch has taken steps under this and other legislation to regulate pollution, it has done little to study the enhancement of mineral recovery, especially from industrial wastes.

Identification, evaluation, and promotion of resource-recovery programs for all types of waste are required by the Resource Conservation and Recovery Act of 1976. However, little has taken place for industrial wastes for a number of reasons:

--EPA has received limited funding under the act, and the appropriated funds have been largely directed toward hazardous waste regulation and to some extent municipal waste recovery. EPA has had to rely on waste disposal regulations to promote resource recovery. (See p. 40.)

--There is a dearth of information available on the nature, location, and recoverable contents of industrial wastestreams; (see p. 11).

--The Department of Commerce, which has critical responsibilities under the act, has been unable to obtain funding; (see p. 45).

--The interagency Resource Conservation Committee, established by the act to evaluate resource recovery strategies, was not effective; (see p. 42).

--The Bureau of Mines and other involved agencies have conducted little research on recovering minerals from industrial wastes. (See p. 46.)

EXAMPLES OF INDUSTRIAL WASTE RESOURCE-RECOVERY

U.S. industries are doing a fairly good job of recovering minerals, as long as it remains profitable. In Japan, however, where the government has also enacted stringent environmental controls, there is much more recovery from steel and electroplating wastes, two industries that produce the greatest volume and some of the most toxic industrial wastes. While it is true that the Japanese steel industry is different from the United States, part of Japan's improved recovery performance in this area can also be attributed to government programs designed to help industry meet environmental objectives and simultaneously enhance the recovery of minerals from wastes. (See pp. 20-34.)

NEED FOR LEADERSHIP AND COORDINATION TO ACCOMPLISH RESOURCE RECOVERY OBJECTIVES FOR INDUSTRIAL WASTES

In a February 1979 report, "Conversion of Urban Waste to Energy: Developing and Introducing Alternate Fuels From Municipal Solid Waste" (EMD-79-7), GAO concluded that the lack of attention to energy resource recovery from municipal wastes also resulted from the low priority given to it under the Resource Conservation and Recovery Act. GAO recommended that EPA develop and submit to the Congress a detailed 10-year plan describing a Federal Urban Waste-to-Energy Program. If EPA did not act responsibly in developing this recommended plan, Congress should consider a change in leadership. The very limited consideration given to the potential for enhancing industrial waste recovery is another example of EPA's lack

of attention to an important resource recovery opportunity. Accordingly, reorganization of the leadership for resource recovery under the Act remains a future consideration.

EPA has only very recently initiated plans for a new interagency committee to coordinate resource-recovery objectives. EPA now hopes that the committee will develop a 5-year resource program plan by September 1980. Thus, it still remains to be seen if, after over 3 years of fragmented, low-level emphasis, mineral recovery objectives will be vigorously pursued.

GAO's report recommended that EPA remain the lead agency for resource recovery. But GAO attributed the lack of progress toward the resource recovery objectives of the Resource Conservation and Recovery Act to assigning EPA responsibilities that could be more appropriately pursued elsewhere. EPA is primarily a regulatory agency and its experience lies in environmental protection. Enhancing and conducting research for resource recovery and identifying opportunities for recovery research is also closely related to the traditional functions of the Bureau of Mines, Department of the Interior and the Department of Commerce. Resource recovery might receive greater attention and might be accomplished in a healthier Government-industry climate, if the roles of these two agencies were enlarged.

The interagency committee could prove useful by fostering effective coordination among EPA, and the Departments of Commerce, Interior; and Energy, and will allow Commerce and Interior to contribute their expertise toward resource recovery goals. (See pp. 52-55.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

The enhancement of resource recovery, from industrial wastes, has received scant attention by the Government, primarily because of the necessary priority given to the development

of a Federal hazardous waste disposal policy and a shortage of staff and funding resources. However, opportunities for increased coordination and cooperation among executive agencies have also been neglected. Thus, GAO believes that increased congressional oversight is necessary to insure that resource recovery objectives of the existing legislation are adequately pursued. Accordingly, GAO urges the Congress to closely monitor EPA and the new interagency resource recovery committee to insure that the resource recovery objectives of the Resource Conservation and Recovery Act are pursued.

Presently, of course, restraints on the budget are very severe throughout the Government. The Congress will have to determine if increased Federal spending for resource recovery is presently appropriate. However, GAO believes that until such time as increased funding is specifically made available, the EPA, the Department of Commerce, and the Bureau of Mines will not be able to markedly enhance resource recovery.

RECOMMENDATION TO THE ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY

The Administrator of the Environmental Protection Agency should continue to pursue the establishment of the new interagency committee to coordinate Executive Branch actions toward legislated resource recovery objectives. EPA should increase its information collection activities, and encourage the collection and coordination of information by other member agencies to (1) obtain data on resource recovery opportunities, and (2) identify problem areas on which the Bureau of Mines should concentrate its research and development efforts.

The Administrator also should see that the new interagency resource recovery committee include representatives from the Department of the Interior's Bureau of Mines, so that resource recovery research can be effectively coordinated. Other agencies, such as the Department

of Treasury also should participate, while relevant issues, as tax policy, are being considered.

In addition, GAO recommends that the Department of Commerce be given the responsibility for analyzing potential new resource recovery activities, and suggesting actions to the committee for recommendation to the Congress when appropriate. These analyses should identify those industrial sectors where the benefits of additional recovery could most effectively offset environmental compliance costs.

RECOMMENDATION TO THE SECRETARY OF COMMERCE

The Secretary of Commerce should work with the Department of Justice to develop guidelines to industry, for the establishment of joint resource recovery ventures that will be compatible with the Department of Justice's antitrust concerns.

RECOMMENDATIONS TO THE SECRETARY OF THE INTERIOR

The Secretary of the Interior should explore ways to enhance its industrial waste recovery research. Specifically, the Bureau of Mines should work closely with the Department of Commerce and the Environmental Protection Agency to support resource recovery activities and to seek assistance in the identification of recovery opportunities for technical research. The Bureau of Mines also needs to do more to assure the potential application of specific projects by demonstrating to industry, through pilot plants or other means, the economic worth of developed technologies.

AGENCY COMMENTS

The Department of Commerce believes that GAO's overall conclusions are valid. (See p. 57 and app. II.)

The Department of the Interior said that GAO's recommendations were inappropriate

because of their on-going concern for industrial waste research. Even though the Bureau of Mines has been a leader in conducting waste recovery research, GAO believes that an increase in this type of research is needed and that more needs to be done to ensure that new techniques are implemented.

Interior also said that our report was structured around two arguments: (1) that the Resource Conservation and Recovery Act of 1976 has not been implemented, thereby reducing the potential for Federal regulation of industrial wastes and subsequent increased mineral recovery; and (2) except for a few types of wastes, a substantial increase in recovery will require Federal subsidies.

It is not this report's intention to imply that industrial wastes be regulated to enforce recovery, nor that a Federal subsidy program be initiated. The message of the report is that there appears to be a large potential for recovery from industrial wastes, and that the Federal responsibility to encourage and support recovery through existing programs and to evaluate alternative new actions has not been carried out. (See p. 57 and app. III.)

EPA did not provide written comments in time for us to include and discuss in the final report. EPA officials did comment orally on the draft report.

They believe that the tone of the report is too critical of EPA in light of the agency's resource recovery programs, budget limitations and priority work on hazardous wastes.

EPA officials also informed us that they have recently embarked on a comprehensive industry studies program, that will include an examination of present industry resource recovery activities and assess recovery levels with and without Government intervention. EPA is also promoting the inclusion of industrial waste as a qualifying material for a tax credit under the Energy Tax Act.

GAO believes that these are steps in the right direction. However, GAO still believes that the Congress should be alerted to the fact that the resource recovery objectives of the Resource Conservation and Recovery Act, especially for industrial wastes, have received little attention.

For a complete discussion of EPA's comments see page 58.

Contents

ABBREVIATIONS

BOS	Bureau of Standards
DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
OMB	Office of Management and Budget
RCRA	Resource Conservation and Recovery Act of 1976

CHAPTER 1

INDUSTRIAL WASTES: AN OVERVIEW

The Environmental Protection Agency (EPA) estimates that U.S. industries generate about 344 million metric tons of solid wastes annually. Of this total, over 100 million metric tons are produced during smelting 1/ and refining ore concentrates into primary metals and into such related products as steel. Tons of valuable minerals remain in industrial wastestreams because, according to industry, they cannot be economically extracted.

Industrial wastes must be disposed of in an environmentally-acceptable manner, as prescribed by numerous laws and Government regulations. Industries spend millions of dollars disposing of their wastes in ways that meet standards established by EPA and such other regulatory agencies as the Office of Safety and Health Administration (OSHA). Unfortunately, the wastes are sometimes disposed of in ways that preclude future recovery of mineral values.

In addition to its environmental protection responsibilities, the Federal Government has the mandate under the Resource Conservation and Recovery Act of 1976 (RCRA) to enhance and accelerate resource recovery from all solid wastes. RCRA requires EPA, the Department of Commerce, and an interagency Resource Conservation Committee to aid State and local governments in the development of resource recovery programs.

WHAT ARE INDUSTRIAL WASTES?

Industrial wastes can be broadly defined as all process and pollution control residue from manufacturing and utility plants, except scrap metal. Industrial wastes can be solid, liquid, or gaseous and typically take the form of slag, scale, sludge, slime, slurry, dust, dross, mud particulates, and grindings.

1/The reader is invited to refer to the glossary (app. I) for a definition of technical, metallurgical-processing terms that are used throughout this report.

Wastes are produced in the metal industries during

--smelting ore concentrates into crude metals,

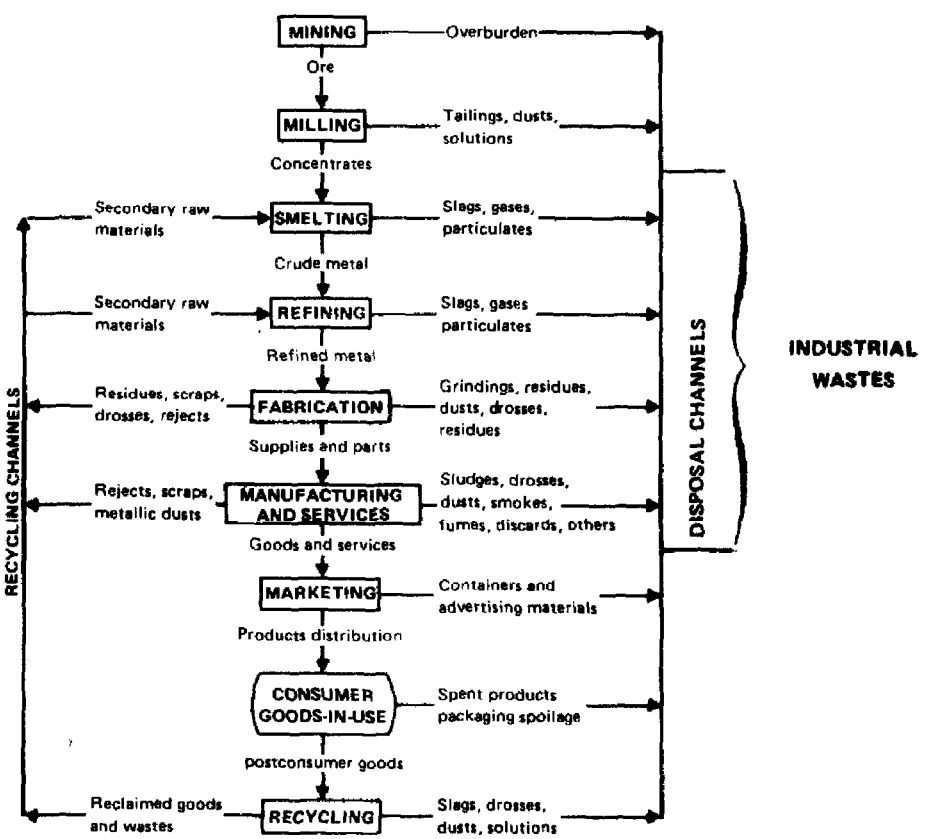
--refining crude metals,

--fabricating the refined metals into components, and

--assembling the components into finished products.

Figure I shows the minerals' cycle from raw materials' extraction through consumer disposal of finished metal goods. Typical industrial wastes are shown entering the disposal channels from smelting, refining, fabrication, and manufacturing. While many wastes are disposed of, some enter recycle (recovery) channels.

Figure 1: The production, use, disposal, and recycling of metal products.



SOURCE: The Bureau of Mines

The term "waste" is generally applied to a material because it is not usable or is undesirable in a particular process. Scrap metal is not referred to as a waste in this report because, for many years, there has been some economical way to return it to the processing cycle. Generally, scrap is either recycled within the firm, sold in established scrap metal markets, or disposed of in the municipal wastestream.

WASTE DISPOSAL

Mineral-processing companies dispose of their wastestreams in a number of ways.

--Such solid residues as slags are generally open dumped on the industrial site.

--Such wet wastes as sludges are normally placed in unlined settling pits and lagoons.

--Liquid electroplating wastes are sometimes merely diluted with water and dumped into local sewage systems.

--Gases are released into the atmosphere. Such particulate matter as dusts may be separated to meet environmental standards and disposed of on site.

--Solid and liquid wastes are sometimes illegally dumped into rivers and sewers.

Wastes that are now disposed of in open dumps, settling pits, and lagoons are potential candidates for future recovery. Naturally, minerals that enter rivers and sewers cannot be recovered. Also, in some cases, once the waste has been treated for its potential negative environmental effect, resource recovery is not possible or becomes more expensive. For example, there is no recovery technology that will recover plating minerals after they have been precipitated into a harmless sludge.

Small amounts of industrial wastes are recycled in order to recover at least part of the mineral values. EPA estimates that 7 percent of the material in industrial processes has been obtained from recycling or recovery, but that most of this is scrap metal recycled to the smelter.

Recycling or recovery can follow a number of patterns. Wastes can be

--recycled back through the same process that generated the wastes for further mineral extraction;

--recycled through additional recovery processes at the same facility;

--shipped to other company facilities that have process technology to recover the residual mineral values;

--sold to another domestic industrial concern that recovers mineral values;

--listed with a waste exchange or broker;

--sold to foreign concerns that recover the values; or

--disposed of in such a way that when subsequent recovery procedures become economically feasible, they can be applied to the wastes.

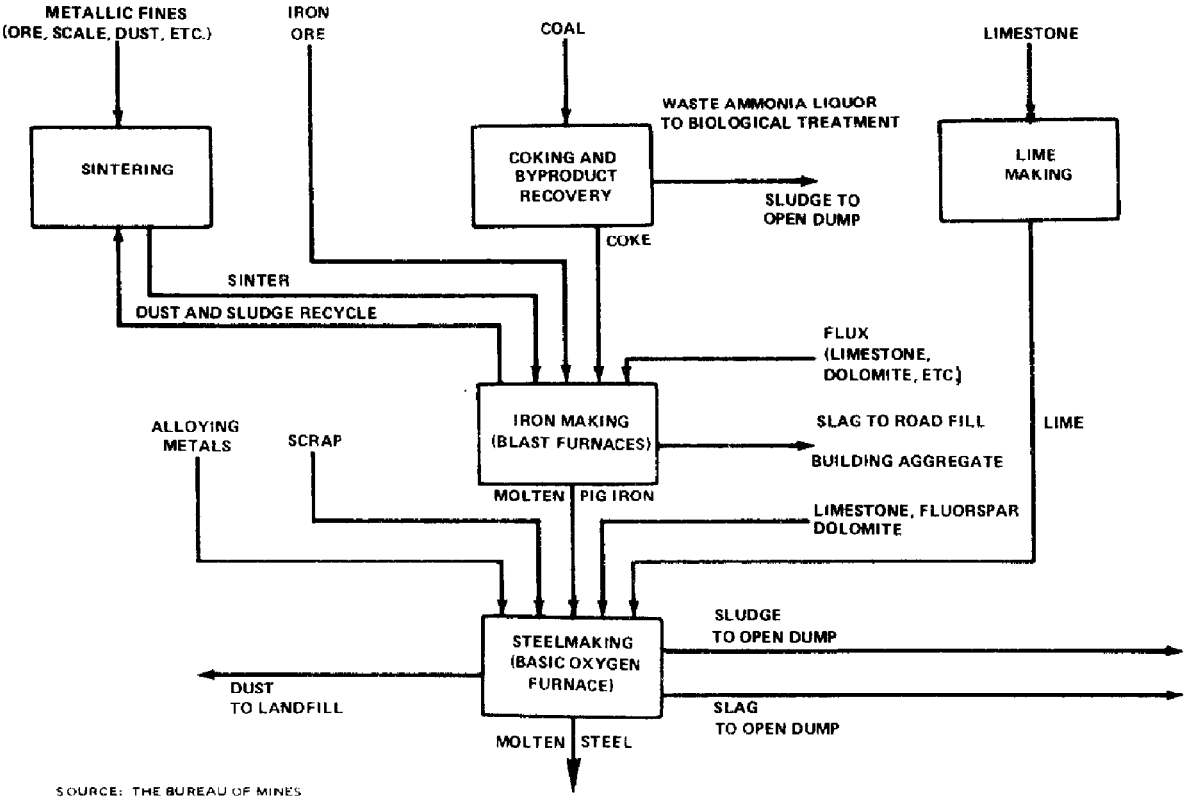
MINERAL VALUES CONTAINED IN INDUSTRIAL WASTESTREAMS

The process wastes generated by metal smelting, refining, or manufacturing industries contain silicates, sulfates, sulfites, hydroxides, oxides, chloride, and carbonates. Minerals found in industrial wastestreams include iron, copper, lead, zinc, aluminum, manganese, nickel, chromium, arsenic, cadmium, antimony, mercury, gold, silver, molybdenum, cobalt, magnesium, and tin. Furthermore, the United States is dependent on imports for 11 of these 18 minerals.

Many of the minerals lost in industrial wastestreams are not only important because of import dependence, but also often cause environmental problems if disposed of improperly. Nine of the metals cited above are classified as toxic pollutants by EPA, and at least one other is potentially hazardous. Therefore, increased recovery of mineral values from industrial wastestreams would extend our supply of minerals and also substantially help to protect the environment.

A typical industrial process--steelmaking with a basic oxygen furnace--illustrated in figure 2, is a good example of the range of minerals found in industrial wastestreams. Inputs to the furnace can include molten pig iron, alloying metals, scrap limestone, fluorspar, dolomite, and lime. Outputs of the furnace are molten steel and wastestreams in the form of sludge, slag, dust, and exhaust gas. Wastestreams represent about 20 percent of the volume of input or about 20 million tons each year. Minerals contained in these wastes include iron, manganese, chromium, zinc, copper, and nickel. Mineral concentrations range from less than 1 percent of the waste to over 55 percent in the case of iron content in the sludge.

FIGURE 2: STEEL MAKING PROCESS



SOURCE: THE BUREAU OF MINES

THE ROLE OF THE FEDERAL GOVERNMENT

Environmental regulation

Many industries produce significant quantities of potential pollutants. Pollution in its various forms has been an environmental concern in the United States for many years. Federal policy has gradually envolved to dealing with pollution on a national basis, culminating in the following comprehensive pieces of legislation enacted by the Congress during the 1970s.

--The Clean Air Act of 1970;

--The Federal Water Pollution Control Act Amendments of 1972;

--The Safe Drinking Water Act of 1974;

--The Toxic Substances Control Act of 1976;

--The Resource Conservation and Recovery Act of 1976.

The procurement, installation, and operation of pollution control equipment required by these laws and subsequent regulations have resulted in substantial capital investment by the minerals industries. For example, the President's Council on Environmental Quality estimates that if carried out, current laws, including RCRA, will require expenditures of up to $711 billion over the next decade by taxpayers, consumers, industrial firms, and municipalities. One recent study 1/ measured the incremental cost of meeting environmental regulations in 1977 alone for selected primary metal processing firms to be $221 million. This figure does not include such secondary costs as production delays, nor does it include the potential costs of meeting the yet-to-be-released RCRA solid waste disposal regulations.

1/Anderson, Arthur, "The Cost of Government Regulation: A Study for the Business Roundtable," Mar. 1979.

Enhancing resource recovery

The past experience of fuel and materials' shortages and the rising concern for environmental protection have turned congressional concern toward resource recovery as a means to conserve limited resources and to reduce the negative environmental effects of waste disposal. Since 1965, the Congress has enacted a number of laws that contain language directing resource-recovery research and the establishment of resource-recovery goals as a priority of the Nation's environment program. These include

--The Solid Waste Disposal Act of 1965;

--The Resource Recovery Act of 1970 (an amendment to The Solid Waste Disposal Act of 1965);

--The National Science and Technology Policy Act of 1976;

--The Resource Conservation and Recovery Act of 1976; and

--The National Energy Conservation and Policy Act of 1978.

Each of these laws contains general reference to the desirability of conserving the Nation's resources and the development of the recycling and recovery capabilities in the United States. However, because of the general language, which did not establish specific programs, and a corresponding lack of funding, few specific resource recovery programs have been initiated. One exception to this is the Department of Energy's program to establish industrial recycling targets under the National Energy Conservation and Policy Act.

The only significant Federal resource-recovery initiatives prior to 1976 were EPA's technical assistance of municipal waste recycling programs and a number of Bureau of Mines' and EPA research projects that were also largely directed toward municipal wastes. This Federal emphasis on recovery from municipal wastes, which still continues, happens because municipal wastes are the most visible form of waste generation whereas 80 percent of industrial wastes are disposed of on industrial sites. Municipal waste disposal is also the responsibility of State and local governments and thus becomes a political problem with resultant

pressures brought to bear on the Federal Government. Even so, industrial processes produce more waste than cities and the minerals recovery potential from them appears to be much greater.

Not until the passage of the Resource Conservation and Recovery Act (RCRA) did the Congress incorporate significant resource-recovery objectives into environmental legislation. (See ch. 4.) RCRA requires the Administrator of EPA to regulate hazardous solid wastes and also authorizes measures that could enhance and accelerate the recovery of minerals from all solid wastes including industrial wastes. In fact, RCRA is the first law to define solid wastes as those including industrial and mining as well as municipal wastes.

To conserve valuable minerals, RCRA authorizes the Government to:

--Provide technical and financial assistance to State and local governments and interstate agencies for the development of solid waste management plans including resource-recovery and resource conservation systems.

--Provide for the promulgation of guidelines for solid waste collection, transportation, separation, and recovery.

--Promote a national research-and-development program for new and improved methods of collection, separation, recovery, and recycling of solid wastes.

--Promote the demonstration, construction, and application of solid waste management, resource recovery, and resource conservation systems that preserve and enhance the quality of air, water, and land.

--Establish a cooperative effort among the Federal, State and local governments, and private enterprise in order to recover valuable materials from solid waste.

The Department of the Interior has additional related responsibilities for encouraging private industry to reclaim minerals. For example, the Secretary of the Interior

is responsible for the promotion of a national research-and-development program for recovery and recycling of solid wastes. The Department's mineral resource-recovery research is conducted by the Bureau of Mines.

Unfortunately, as we detail in chapter 4, little Federal effort has been expended to accomplish or enhance resource recovery, especially from industrial wastes, partly because of budget constraints, and other priorities. EPA resource recovery strategy for industrial wastes has consisted almost entirely of increased environmental regulation to eventually spur additional recovery. Much more needs to be done to analyze and develop means to encourage increased recovery, the results of which could offset environmental costs and alleviate disposal problems.

SCOPE OF REVIEW

We made this review in order to determine (1) the extent to which mineral values are recovered from industrial wastestreams; (2) the potential for greater recovery; (3) impediments to further recovery; and (4) actions to be taken by the Federal Government to accelerate and increase mineral recovery. To meet these objectives, we interviewed officials of the EPA, and the Departments of the Interior and Commerce, and reviewed relevant files and documents. We also visited the EPA's Industrial Environmental Research Laboratory as well as the Bureau of Mines' research centers, and EPA's regional offices. Appropriate congressional staff members were also interviewed.

We focused our review on the steel, electroplating, copper, aluminum, lead, zinc, stainless steel, and secondary recovery industries. We visited a total of 54 companies in 13 states in order to determine their recovery practices and the potential for further recovery, as well as to solicit views on what actions might increase the recovery of mineral values from wastestreams. We also solicited data and opinions from 13 mineral industry trade associations and 9 industry consultants. We visited State and municipal agencies responsible for industrial waste disposal and/or resource recovery in Pennsylvania, Illinois, Texas, and Minnesota. In addition, we reviewed the activities of four recently-established, industrial waste exchange services.

For comparative purposes and in order to obtain first-hand knowledge of resource recovery from industrial wastes in Japan, we interviewed and obtained data from Japanese industry officials. We visited four Japanese steel companies, three types of electroplating activities, three copper firms, two lead and zinc smelters, one nickel smelter, and a firm specializing in recovering zinc from electric steelmaking dust. In addition, we obtained information from the Japanese Light Metal Smelters Association and the Japanese Iron and Steel Federation. We also contacted officials in the Japanese government in order to determine their policies relating to mineral recovery.

Chapter 2 discusses the potential benefits of increased recovery and existing information on recoverable minerals in industrial wastes. Chapter 3 describes existing waste recovery and disposal practices, and chapter 4 discusses Government efforts directed toward additional recovery. Chapter 5 contains our conclusions and recommendations.

CHAPTER 2

POTENTIAL FOR AND BENEFITS OF MINERAL RECOVERY

The Government knows very little about the contents of industrial wastes. Unlike existing efforts to evaluate the contents and to develop the recovery potential of municipal wastestreams, few attempts have been made for industrial wastes, even though almost three times more industrial than municipal wastes are generated in the United States. Industries, also, to a large extent, do not want the Government or their competitors to know the contents of their waste.

When compiled, however, even the limited data on industrial wastes indicates that substantial amounts of minerals are left in these wastestreams. We believe that, conservatively, at least 10 million tons of such minerals as iron, copper, and aluminum are lost each year.

GOVERNMENT KNOWLEDGE IS LIMITED

In 1973, the Bureau of Mines contracted for a study that would provide an overview of the volume, availability, and composition of metal-working wastes, sludges, and dusts in order to determine their value as a national resource. The contractor found that data was not readily available and that industrial inquiries produced a minimal amount of information. Many firms were reluctant to reveal exactly what was in their wastes for fear of disclosing industrial processing secrets. He concluded that funding of specific industry data-gathering projects should be required as a part of any broad waste disposal/recovery program.

We found that the situation has not changed much since 1973. Little has been done to collect additional data. Only recently have EPA efforts been initiated under RCRA for specific industries. EPA, however, being a regulatory agency, has had an oftentimes adversarial relationship with industries. Many firms are reluctant to turn over complete information on their wastes, because they believe they could be singled out for additional regulatory control.

It appears that most of EPA's work to date has been devoted to identifying hazardous wastes, which are estimated to be only about 10 percent of the industrial wastestream. An EPA program manager told us that if the contractors preparing the reports identify nonhazardous contents of a wastestream, there is little concern given to quantifying

their potential for mineral recovery. For example, one EPA report does not show the quantity of iron in a table of components of a basic-oxygen steel furnace sludge stream. Yet iron makes up over 50 percent of the wastestream and represents an industrial loss of over 1 million tons per year.

EPA officials believe that once the hazardous waste regulations are finalized better information will be obtained. EPA and State officials will have access under Sec. 3007 of RCRA to examine all sites where hazardous wastes are generated and/or stored.

The States also have very little data on industrial wastestreams, even though they are required by RCRA to structure solid waste management plans, including a profile of industries within each State and their waste contents and generation rates. A 1973 resource evaluation study of certain industrial metal and mineral wastes, found that Texas was the one State preparing a comprehensive breakdown of its industrial wastes. During our review, Texas officials told us that they had almost completed their inventory of wastestreams and that it would provide a large data base of industrial wastestream generation rates and composition. Other State representatives we talked to indicated that they have little or no information on the waste generated by industries.

QUANTITATIVE ASSESSMENTS OF MINERAL VOLUMES

While we were unable to locate a comprehensive study or survey that adequately determined the annual volume (or value) of the minerals that remain in industrial wastes, we did find a number of recent industry studies initiated by EPA, the Office of Technology Assessment (OTA), and the Bureau of Mines that focused on a number of the large primary metal industries, primarily steel, in an attempt to quantify the magnitude of industrial wastes. Unfortunately, the most comprehensive of these--an EPA report on 14 ferrous and nonferrous industries--was initiated primarily to determine the hazardous components of these wastestreams. Thus, other valuable minerals may not have received the attention needed to fully identify their recovery potential. Data in these studies along with material gathered from industrial

contacts enabled us to put together the table on pages 14-15. Care must be taken in drawing conclusions from the table because:

--Comparable data was not always available for the same year.

--Extrapolation of data from a specific plant to the industry may not be accurate because the composition of wastestreams varies from sample to sample and from plant to plant.

--Industry estimates neither consider the relative quality of mineral content nor the possibility that recovery technology may exist.

In spite of these difficulties, we believe that the data in the table to be a conservative but useful estimate of mineral recovery potential. Indications are that the mineral content of numerous streams generated by these selected industries has not been fully identified or evaluated. Also, our projection is based on a cross section only of metal industries and does not include a number of other industries, for example, tungsten, manganese, and nickel operations, or numerous industrial manufacturing and utility operations. The industries considered in our table only produce about 80 million tons of waste compared to the 344 million tons estimated to be produced by all of industry.

We did not attempt to place a value on the amount of recoverable minerals left in the wastestreams we examined, although comparable tonnages obtained from virgin material would have a value of approximately $3 billion. Presently, these minerals are left in the wastestream because generally it would cost more to recover them than extracting them from virgin ores.

Estimates of Annual Volumes of Minerals Lost in Selected Industrial Wastestreams

Industry	Waste stream (type)	Waste amount (tons)	Mineral content	Mineral amount (tons)
STEEL				
Blast Furnace	Slag	36,118,665	Manganese	108,291
			Chromium	1,578
			Copper	791
			Lead	856
	Sludge	2,528,955	Zinc	29,504
			Manganese	9,358
	Dust	1,679,486	Iron	500,486
Basic Oxygen Furnace	Slag	17,982,030	Iron	4,171,830
			Manganese	748,052
			Chromium	23,191
	Sludge	2,145,422	Iron	1,228,265
			Manganese	22,064
			Zinc	21,640
			Lead	5,334
	Dust	1,294,700	Manganese	14,759
			Lead	9,515
			Zinc	4,336
			Iron	737,979
Open Hearth	Slag	436,181	Iron	93,343
			Calcium	147,429
			Manganese	32,277
			Magnesium	16,575
	Dust	322,850	Manganese	1,552
			Lead	3,761
			Zinc	36,483
			Iron	148,511
Electric	Slag	3,564,000	Manganese	108,279
			Chromium	17,167
	Dust	380,000	Iron	118,990
			Zinc	36,412
			Manganese	16,216
			Lead	9,207
STAINLESS STEEL	Mill-scale	60,000	Chromium	4,800
			Nickel	2,100
			Iron	18,000

Industry	Waste stream (type)	Waste amount (tons)	Mineral content	Mineral amount (tons)
	Dust	20,000	Chromium	1,400
			Nickel	300
			Iron	8,000
ELECTRO-PLATING	Sludge/ Rinse Water	109,355	Iron	3,460
			Copper	2,560
			Zinc	3,718
			Nickel	5,000
			Aluminum	1,651
			Chromium	6,357
			Calcium	591
			Lead	756
LEAD	Slag	354,712	Zinc	25,640
			Lead	11,011
			Copper	613
			Magnesium	385
ZINC				
Electric	Sludge	9,213	Zinc	2,030
			Lead	141
Pyro	Retort	385,015	Zinc	13,200
			Copper	571
	Sludge	44,701	Zinc	13,695
COPPER				
Smelting	Slag	5,275,050	Chromium	58,026
			Copper	39,211
			Zinc	21,276
			Manganese	1,471
			Tin	1,372
			Lead	751
	Sludge	272,544	Copper	76,137
			Zinc	7,593
			Lead	2,174
	Dust	29,892	Copper	1,108
ALUMINUM				
Refining	Mud	6,735,300	Iron	1,561,241
			Aluminum	651,095
Reduction	Spent-Potliners	256,568	No Data	
	Sludge	564,903	No Data	
	Skim	26,632	No Data	
	Dust	36,324	Copper	440
			Lead	57
		80,632,498		10,971,962

ADVANTAGES OF RESOURCE RECOVERY

Increased recovery of valuable minerals remaining in industrial wastestreams could benefit the United States by

- --conserving minerals and thereby reducing the rate of depletion of domestic natural resources,
- --reducing or possibly eliminating pollution problems by removing potential pollutants from the environment,
- --reducing waste disposal problems,
- --reducing the United States' dependency on foreign raw materials, and
- --conserving water supplies and reducing energy demand.

Conserving mineral supplies

The United States is faced with the challenge of producing minerals and metals from increasingly lower-grade resources as higher grade ore bodies are depleted. Furthermore, our mineral consumption is growing. One forecaster states that our mineral needs may triple in the next 25 years.

The importance of extending mineral supplies through recovery from wastestreams is most obvious for those minerals on which the country is import dependent. For example, this Nation depends on large imports of chromium and nickel. We found that the wastestreams of four of the seven industries we reviewed contain large amounts of chromium and two contained a substantial amount of nickel. Over 58,000 tons of chromium are contained in the slags generated each year by U.S. copper smelters. However, only one company we visited has recognized the potential for extending chromium and nickel supplies and is building a recovery plant.

Pollution abatement

EPA officials believe that the best way to control industrial pollution (other than nongeneration of wastes) is to

recover and recycle industrial wastes. An assessment of industrial hazardous waste practices in the metal smelting and refining industries, performed for EPA in 1977, concluded that adequate health and environmental protection from nine different wastestreams in the copper, lead, zinc, iron, and aluminum industries could be attained through resource recovery. Increased resource recovery would reduce the volume of wastes requiring disposal, eliminate harmful substances from wastestreams, and reduce the need to extract virgin resources.

Many industry officials believe that the prevention/conservation concept might be the key to taking much of the economic pain out of pollution abatement and perhaps generating profits from otherwise lost by-products. For example, the president of the corporation that is establishing a central plant to recover minerals from stainless steel wastestreams, said that a major benefit to specialty steel companies was the elimination of an environmental problem. (See p. 29.)

The Bureau of Mines' secondary resource-recovery research has, as its goal, the protection of the environment through increased resource recovery. Its research projects have often demonstrated that mineral recovery effectively controls pollution and is often the preferred solution. For example:

--The phosphate solution used to coat new steel products can be hazardous to the environment when it is discarded. A promising process developed by the Bureau of Mines recovers zinc and nickel from the spent solution and permits the recovery of the phosphate.

--The Bureau also developed alternative methods to recover molybdenum from industrial waste-water discharge. The recovery results in the waste water meeting water purity regulations.

--Waste electroplating solutions are often unacceptably dumped into waterways, municipal sewers, and deep wells. The Bureau of Mines has developed a procedure that allows recovery of such valuable minerals as chromium, nickel, copper, and zinc from the waste solutions and renders the solutions safe for disposal through normal means.

Reducing waste disposal problems

The Nation's industrial concerns are finding it increasingly difficult and costly to find environmentally acceptable disposal sites. For example, proposed RCRA hazardous waste disposal standards that will become effective in 1980, may force many small electroplating firms out of business. The problem is that most small platers do not have suitable land space for on-site disposal and more stringent waste transportation regulations will increase the cost of interstate shipments for disposal.

In some areas, suitable sites for land disposal have been exhausted or are not available. For example, in Michigan, most of the land area is of a sandy consistency making it unsuitable at least without preventive measures for disposal of potentially hazardous wastes. Furthermore, State law prohibits the landfilling of hazardous wastes. In other States, public opposition to landfills may preclude locating a disposal site. Many firms have informed EPA of the untenable situation that occurs when solid waste created by compliance with Federal regulations is not allowed to be disposed within a State or is prevented from disposal by public opposition.

Along with disposal-site problems, disposal costs are escalating rapidly. An executive of a Minnesota disposal service estimated that costs could rise more than fivefold in the next few years. Much of this increase will result from the following proposed regulations relating to the establishment of disposal sites.

--A trust fund must be established to adequately cover all shutdown costs if the site is abandoned.

--The owner of the site must carry liability insurance in the amount of $5 million.

--A multimillion trust fund must be established to insure that the site is properly maintained.

Increased recycling of industrial waste materials to recover mineral values would reduce the amount of waste to be disposed of and resolve some of the attendant environmental and economic problems.

Other benefits

Increased minerals' recovery from industrial wastes would save water, and reduce energy consumption.

Increased recovery from industrial wastewater sometimes permits recycling of the water and results in tremendous savings in water consumption. For example, a consultant for the electroplating industry estimated that a closed-loop recovery system would use 75 percent less water. An official of another electroplating company reported that the investment in equipment to remove metals from processing water would be paid for in about 1 year through water savings alone. One modern aluminum plant we visited continuously recycled processing water and had no discharge or need for make-up water.

The Departments of Commerce and Energy believe that increased recovery would, in some industries reduce energy consumption. This would be contingent on the energy cost of recovery basis minus that needed to develop that same material from its virgin sources. The Department of Energy has underway a number of industrial studies designed to determine actual energy savings potential.

CHAPTER 3

MINERAL RECOVERY:

TECHNIQUES AND IMPEDIMENTS

We contacted a representative group from each of the major U.S. mineral-processing industries to determine (1) how much industrial mineral recovery is now taking place and (2) what incentives or disincentives exist to facilitate or impede recovery. Because Japan is reported to use advanced recovery techniques, we also contacted a number of major Japanese mineral processing firms. A direct comparison of industrial waste recovery rates in the two countries is not possible because of differing political, sociological, and geographical conditions. However, in one important aspect, the circumstances are similar. The Japanese government and the United States have enacted stringent environmental and waste-disposal laws. A major difference exists, however, in their implementation.

The Japanese government along with its tough pollution-control laws, has adopted a number of measures to vigorously encourage private sector investment in pollution control and resource recovery equipment. These programs are an essential part of their attempt to achieve national mineral conservation and to satisfy environmental goals. Such incentives and assistance are only occasionally available to U.S. firms. There are strong forces in the United States opposed to governmental assistance of private industry, as well as strict anti-trust laws against the collusion of separate enterprises for any common purpose, including resource recovery.

In spite of this difference, we found that U.S. industries are doing a fairly good job of recovering minerals as long as it remains profitable. However, we found much greater recovery of steel processing wastes and electroplating wastes in Japan.

The superior recovery rate from steel processing and electroplating wastes in Japan is impressive for two reasons:

1. The volume of wastestreams from the steel industry is over four times greater than that of the stainless steel, lead, zinc, copper, and aluminum industries combined.

2. Wastestreams from electroplaters are considered highly hazardous by the EPA and in many cases, they easily and directly enter water sources.

This chapter discusses (1) mineral recovery in Japan and the United States, (2) impediments cited by U.S. industries that limit resource recovery, and (3) ways in which industrial waste recovery is promoted in Japan and other industrialized countries.

MINERAL RECOVERY IN THE UNITED STATES AND JAPAN

The steel industry

The carbon steel industry is the largest industrial waste producer in the United States. The value of these wastes, the cost of recycling, and the method of disposal available usually determine what is done with them. The following table shows the mineral-bearing wastestreams generated by a major steel corporation, and their disposition.

The Disposition of Steel Wastes

Type of wastestream	Disposition
Blast furnace dust	Sintered and recycled
Blast furnace slag	Sold as road ballast, concrete, or fill material
Blast furnace sludge	Sintered and recycled
Open-hearth dust	Sold to a reprocessing firm
Open-hearth slag	Landfilled or recycled
Basic oxygen furnace dust	Landfilled or pelletized
Basic oxygen furnace sludge	Landfilled, sold and/or processed to recover iron
Basic oxygen furnace slag	Landfilled or sold
Electric furnace dust	Landfilled
Electric furnace sludge	Landfilled
Electric furnace slag	Landfilled or sold
Millscale	Sintered and recycled

The U.S. steel industry does only a fair job of recovering minerals from its wastestreams. The majority of the wastes that are recycled are processed through a sintering plant and fed back into the blast furnace. The sintering plant fuses furnace wastes with a high iron content--blast furnace dusts, sludges, and fine millscale--into a material that can be recycled back to the blast furnaces. A steel corporation official told us that his firm sinters to the maximum extent feasible, but that only about 50 percent of the furnace dusts and millscale are suitable for recycling.

The relatively low rate of mineral recovery from steel industry wastestreams may be reduced even further because sintering at older facilities causes virulent air pollution unacceptable to EPA. EPA standards have already caused the cessation of sintering at a number of steel plants and additional closures are likely. For example, sintering was stopped at one steel plant in late 1975 because the cost of pollution controls on the antiquated sintering plant almost exceeded the cost of virgin ore. Since then, over 180,000 tons of waste material containing up to 50-percent iron, have had to be landfilled. Recently, as the result of an agreement with EPA, U.S. Steel announced that it was closing several of its sintering operations. However, modern sinter plants have been built that can meet current emission standards.

In contrast, Japanese steel companies using technology considered uneconomical in the United States, recover mineral values from most of their industrial dusts. The Japanese steel industry produced 4.7 million metric tons of dust in 1975, of which about 3.4 million tons (72 percent) were recovered and reused in the iron-making process.

The four Japanese steel firms we contacted were recycling dust from their steelmaking operations. In some instances, the dust was processed in such a way that such harmful impurities as zinc and lead, were removed and the residue reduced into 75 percent metallic iron pellets.

In another case, a consolidated dust processing firm was established by 25 small electric steelmaking companies. The consolidated processing plant was built in 1974 and cost about 1.7 billion yen 1/, approximately $6.8 million. It was

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1/Yen converted to dollars throughout this report at the rate of 251 = $1.00 (exchange rate as of March 3, 1980).

financed with funds from member companies, loans obtained from commercial banks, and a low-interest loan from the Government of Japan. It should be noted that such a program could be precluded in the United States through the stringent application of antitrust laws.

The recovery technology used by the Japanese firms is well known in the U.S. industry and dates back to 1910. But, U.S. industry officials say that the Japanese government's financial and tax policies (see p. 33), allow their steel companies to use recovery processes that are not profitable here. They also say that the industry concentration in Japan also provides an economic advantage in that large quantities of dust are available in a small area. There are certain areas in this country, however, where steelmaking is sufficiently concentrated to yield large quantities of dust.

The electroplating industry

The U.S. metal finishing industry is composed of about 20,000 job shops and captive operations (one of many processes performed by a finished goods manufacturer) throughout the United States. Major concentrations of electroplaters exist in Michigan, California, Ohio, and Illinois. The plating of copper, nickel, chromium, and zinc is estimated by an industry consultant to be 80 percent of the industry's operations.

Recovery of mineral values from plating wastes seems to be limited to a few large firms who find it profitable to recover metals only from certain of their plating wastes. One industry consultant estimates that, of those plating firms in the Chicago area who treat their wastes, about 90 percent use a detoxification and disposal technique rather than mineral recovery. A number of the remaining firms merely dilute their wastes and dump them into the sewage system.

A study by an independent laboratory concluded that about 24,000 tons of metals with a potential value of about $40 million are left in the wastestreams of electroplaters each year. A breakdown of these minerals and their approximate values are shown in the table on the following page.

Annual Loss Of Minerals In Electroplating Wastes

Mineral	Amount	Value/Ton	Total value
	(metric tons)		
Iron	3,460	$ 77	$ 266,420
Copper	2,560	791	2,024,960
Zinc	3,718	748	2,781,064
Nickel	5,000	4,000	20,000,000
Aluminum	1,651	1,060	1,750,060
Chromium	6,357	2,000	12,714,000
Lead	756	462	349,272
Total	23,502		$39,885,776

The industry consultant estimated that it would be technically possible to recover about 80 to 90 percent of the copper, 30 to 40 percent of the zinc, 90 to 95 percent of the nickel, and 70 to 75 percent of the chromium. Economic feasibility is the prime obstacle.

We visited a number of plating firms of various sizes to determine the reasons why metal recovery was or was not taking place. Basically, company officials did not think recovery was profitable, and they were also concerned that quality controls would suffer when using recycled wastes.

We visited one major automobile firm that was recovering metals from plating operations but at only one plant. There, the waste solution was highly concentrated with chromium, thereby making the operation profitable. The company also runs the world's largest plating operation at another plant, but does not recover from these wastes because a company study found it not economically feasible.

The success with recovering materials from plating wastes in the United States contrasts sharply with our observations of the plating industry in Japan. There, plating shops had been relocated to five Government-subsidized industrial parks.

For example, the municipal government of Tokyo recently provided financial aid, about $2 million, to 11 platers and two associated firms to relocate their facilities in an industrial park. The primary purpose of the relocation project is to control pollution, but consolidation also provides a means to recover minerals that the individual firms were not recovering by themselves.

The recovery center and in-plant treatment facilities process about 1,800 metric tons of wastewater per month and recover about 600 kilograms of copper and other material that are sold to defray a portion of the annual operating costs.

The copper industry

The U.S. copper industry does a good job of extracting mineral values while processing copper ore. Industry officials are confident that their present operations recover almost all values within economic and technological parameters. Although metallurgists are in general agreement that large amounts of mineral values are lost in the wastes, when the values are compared to the total tonnage processed, they become rather insignificant.

Production of copper is a complex process in which additional recovery of values is continuously taking place. The large copper producers are usually vertically-integrated from mining ore to fabricated products. The table on the following page illustrates the various mineral values lost and recovered by a typical integrated producer in each productive process from mined ore to final product.

Minerals Found in Copper Processing Wastestreams

Process	Values recovered	Values not recovered
Vat leaching	Acid soluble copper	Non-acid soluble copper
Concentration	Gold Silver Selenium Iron sulfide Molybdenum	Iron (Hematite) Iron sulfide Gold (trace) Silver (trace)
Dump leaching	Copper by cementation	Uranium (trace) Iron (entered process in concentration) Sulfur (entered process in sulfuric acid used in leaching)
Smelting	Copper Gold Silver Selenium Sulfuric acid	Zinc Lead Molybdenum
Refining	Copper Gold Silver Selenium Nickel Tellurium	Nickel (1 gram per liter) Lead Gold Silver very Selenium small Tellurium concentrations
Rod plant	Copper rod Copper scrap	None

Although Japan has some copper resources, it imports about 90 percent of its needed copper concentrates. The concentrates are first smelted in a furnace to produce copper matte and slag. The matte is then transferred to converters where iron and sulfur impurities are oxidized, leaving a crude copper that undergoes further refining.

Slag is formed in both the furnace and converters. Furnace slag is pulverized and shipped to cement manufacturers. Converter slag is recycled to the smelter and the residue also used to make cement.

We were told by one company official that U.S. copper smelters are not selling their slag for use in cement because (1) there are numerous disposal sites, and (2) the transportation costs are higher due to the longer distances between U.S. copper smelters and cement manufacturers.

The lead industry

The U.S. lead industry also does a good job of recovering mineral values while processing ore concentrates into refined products. Mineral processes in the lead industry recover about 85 percent of the mineral values. Zinc, copper, nickel, silver, gold, and cadmium are also recovered as co- or by-products.

Some lead process wastes are shipped overseas for the recovery of copper and nickel, because domestic firms object to the toxic lead in the wastes. One waste that does tend to accumulate at lead smelters is blast furnace slag. Typically, this slag contains 2 percent lead, and over 10 percent zinc. One lead plant we visited has a 1.4 million ton slag pile containing lead and zinc with a potential value of over $100 million. However, a company official estimated that with existing technologies, the price of zinc would have to increase over one-third before recovery would be profitable.

The lead smelters we visited in Japan also do a very good job of recycling and recovering from wastes. At one Japanese lead smelter we contacted, slag is sold for a minimal amount to cement manufacturers because dumping is costly. Also at this smelter, dust containing about 50 percent lead and 10 percent zinc is collected in the sintering process and returned to the raw material stockpile. While producing about 2,500 tons of electrolytic lead a month, about 1,000 tons of dust are recycled. Company officials told us that the cost of recovery approximates the value of the recovered material.

In addition to processing their own wastestreams, some Japanese lead smelters process the wastes of other industries. For example, we visited one copper smelter where 300 tons of dust were generated each month. The dust, which contained about 30 percent lead and 25 percent zinc, was transported 100 to 200 kilometers to zinc and lead smelters for processing.

The aluminum industry

In the United States, the production of aluminum from imported bauxite ores is a two-step process. Aluminum oxide (alumina) is separated from other materials in bauxite ore and then smelted to produce aluminum.

Alumina plants produce only one major wastestream--ore-bearing red mud. For each ton of alumina produced, about 1 ton of red mud is generated. At the one plant we visited, the red mud was transferred by pipelines to drying areas about 10 miles from the plant. The mud settles in diked enclosures covering about 2,000 acres, and the surface water is piped to the plant for reuse. The mud separated at this plant contains 52 percent iron oxide, 15 percent alumina, 7 percent calcium oxide, 7 percent titanium, 2 percent silica, and other values in trace amount such as sodium oxide, phosphorous, and manganese oxide. About 7.7 million tons of the red mud are produced each year. A 1976 study, by a leading U.S. laboratory, concluded that despite extensive studies made to develop the means to utilize the mud, no technology has been developed that would enable economic processing.

Lesser quantities of waste are produced in reducing alumina to aluminum. The greatest potential for recovery is presented by spent potliners. Today, the major portion of potliner waste is stored or landfilled. The industry generates about 250,000 tons of spent potliners per year. This waste material contains about 22,000 tons of aluminum fluoride. An industry official said that there are literally mountains of spent potliners in industrial dumps.

Research has been directed toward recovering values from potliners since 1958. At one time, an industry task force was formed to study the problem. It was determined that a recycling plant at each reduction plant would not be cost effective, but regional processing plants might present economies of scale necessary for recycling. An independent firm did

develop a promising process but the industry dropped the project because antitrust action was feared.

Japan imports little bauxite, so it has no large red mud problem. Aluminum is mainly produced in Japan by a reduction process similar to that used in the United States. Imported alumina is dissolved in molten cryolite, and the aluminum and oxygen are separated in an electrolytic cell. Waste products generated in the reduction process are contained in a gas emitted from the reduction cell. The gas contains carbon dioxide, carbon monoxide, and other impurities. The impurities are primarily fluoride compounds, cryolite, and a small amount of alumina dust.

Due to the amount of contamination in the dust, Japanese companies do not recover the alumina. However, synthetic cryolite is manufactured from recovered cell gas, reducing the consumption of expensive natural cryolite.

The stainless steel industry

The U.S. stainless steel industry provides a good example of industry cooperation. Until recently, the stainless steel industry was doing a poor job of recovering minerals from their wastestreams. On-site recovery was limited to ingot scraps, stainless steel grindings, and customer turnings, all of which were recycled to the steelmaking furnaces.

Two stainless steel firms we visited had, for some time, studied the feasibility of recovering values from wastes customarily landfilled. Both found that it was not economically feasible. It was cheaper to landfill the wastes, because they did not generate a sufficient quantity of waste separately to justify recovery. This problem of economies of scale has been solved for these two producers and a number of others by centralized processing.

The concept of recovering metal values from stainless steel wastes was developed in the research laboratories of a leading U.S. metal processor. The Bureau of Mines had also concluded research recovery from stainless steelmaking dusts, and super alloy wastes, and information provided by the Bureau was instrumental in the developer's decision to proceed with a centralized system. A pilot plant with a 4,000-ton-annual-input capacity was built and it was determined that 50 percent of the waste could be recovered in the form of nickel, chromium, and iron.

After the pilot demonstration, an independent company selected a central site in Pennsylvania, constructed a plant, and obtained long-term commitments from stainless steel companies to deliver wastes.

The stainless-steel waste facility opened in late 1978 and processed dusts, millscales, and oily grindings. Contracts have been signed with most of the major stainless steel industries within a 500-mile radius of the recovery plant. Under the contracts, the recovery company:

--arranges for pick-up of wastes and pays for all transportation charges from the industry to the recovery facility.

--processes and returns to each firm ingots of at least 18 percent chromium, 8 percent nickel, and 64 percent iron.

--charges the stainless steel firms the current market value of the ingot returned.

The benefits to the stainless steel industry and the public from this centralized operation include the following:

1. Thousands of tons of wastes will no longer be landfilled, thus relieving industry of a costly practice and eliminating a source of potential pollution.

2. A new source of chromium, nickel, and iron is provided.

3. The stainless steel industry will receive a material that can be charged into their furnaces at a cheaper price than the raw material. Energy savings result from the conversion of oil in the wastes into heat during the reduction process.

IMPEDIMENTS IN INCREASING MINERAL RECOVERY AND INDUSTRY'S SUGGESTED ACTIONS

During our industry survey, we solicited opinions from U.S. industrial officials on the reasons why more recovery is not pursued. According to most officials, the major reason is economic. For example, several steel company officials told us that recovered iron could not compete with virgin ore and steel scrap, and process improvements leave less

recoverable values in the wastestreams. These officials also emphasized that the industry lacks the capital for investing in mineral recovery research and facilities. Most of the available capital is invested in regulatory compliance and process improvements. Other officials in the copper and electroplating industries told us they had the same problem.

Although by far the most frequently mentioned reason as to why additional recovery efforts were not made, profitability was not the only impediment cited. Others named by industry officials included

--inadequately developed recovery technology or technology that is not applicable to similar wastestreams in the same industry; and also, current technology is energy intensive in some cases;

--such advantages as depletion allowances inherent in the use of virgin ores; and

--the fear of antitrust action.

In several instances, the lack of adequate technology appeared to be a major impediment to increased recovery. In almost all cases more cost effective technology is needed. For example, no technology has been developed to economically recover the considerable amount of minerals in the red mud generated by the aluminum industry. (See p. 28.)

Several industry officials told us that the Government should increase resource recovery research by: (1) funding more demonstration and pilot projects; (2) providing better opportunities for joint research ventures with Government and among companies; (3) providing research grants to industry trade associations; and (4) funding markets for waste products.

An executive of a company that collects, processes, and disposes of industrial wastes also affirmed that certain factors favor the use of virgin ore over recovered minerals. First, the use of virgin nonrenewable resources may be subsidized by favorable freight rates, though no definite data exists to support this contention. Secondly, vertically-integrated mineral companies select virgin materials based on their internal costs of extracting and processing rather

than on prevailing market prices. An EPA official claims that the depletion allowance provided for the extraction of native ores is the paramount disincentive to recovering minerals from industrial wastes. Virgin ore industries enjoy depletion allowances ranging from 15 to 22 percent, while the recycling of minerals provides no tax incentive of any kind.

Officials of the steel and aluminum industry also said that antitrust laws preclude a number of companies from building a common recovery complex. The same laws also preclude joint recovery research projects. An EPA official also told us that fear of antitrust actions is a major concern of industries who contemplate cooperative recovery efforts. Industry officials have commented on a number of occasions that they met with regional Department of Justice officials who discouraged them from pursuing cooperative efforts.

An official of the Department of Justice Antitrust Division in Washington told us that cooperative recovery efforts would probably be examined for their effects on competition. He is of the general opinion that the economies of scale are not so great that the large metal processing firms have to pool their resources in order to run a viable recycling operation. However, according to the Justice official no company or group of companies has even taken the preliminary step of contacting the Department of Justice at the Washington level for advice on potential actions that would or could be accepted or sanctioned by the Antitrust Division.

FOREIGN PROMOTION OF MINERALS RECOVERY

As a result of our contacts with Japanese officials and a review of available literature, we identified four methods used in other countries to encourage mineral recovery or recycling from industrial wastes. None of these is widely used in the United States. They are

1. financial assistance,
2. waste exchanges,
3. centralized treatment of electroplating wastes, and,
4. favorable tax treatment of investment made in recovery research and facilities.

Financial assistance for pollution control and waste recycling facilities

Like the United States, Japan's emphasis on pollution control and the passage of various pollution-related laws, have made it necessary for private companies to invest in resource recovery equipment to remove pollutants before they enter the environment. Such Japanese government agencies as the Environmental Pollution Control Service Corporation, the Japan Development Bank, and the Small Business Finance Corporation, provide financial assistance to facilitate investment. All of the plants we visited in Japan had received some type of financial aid for the installation of pollution control and related recovery equipment.

In the United States, the EPA and such other agencies as the Small Business Administration and the Commerce Department's Economic Development Administration have provided loan guarantees and pollution control bonds for certain sectors of the economy, for example, the steel industry. These guarantees have been used by industries and municipalities to obtain funds which have been spent in part on pollution control measures. We know of no instance however, where resource recovery was encouraged or required as a part of these programs.

The only other form of financial assistance to U.S. firms by the Government for recycling is a capital investment tax credit available under the Energy Tax Act (P. L. 95-618). In general, however, the level of assistance to U.S. firms is much less than that available to Japanese firms.

A description of the major Japanese financial assistance programs follows.

Environmental Pollution Control Service Corporation

The Environmental Pollution Control Service Corporation, established in Japan in October 1965, undertakes land development and construction projects and finances various pollution projects to prevent industrial pollution. After completing a project, the Corporation sells it at cost on a long-term, low-interest basis.

The Corporation also extends loans to finance the installation of various pollution-prevention facilities. Facilities eligible for loans include dust prevention facilities, designated pollutants' disposal facilities, and industrial waste disposal facilities.

An air pollution control system that recovers lead in a smelter is one example of a project financed by the Corporation. The system was installed to control dust from the smelters' sintering plant operations. This dust contains about 50 percent lead and about 1,000 metric tons are recycled per month. The dust is returned to the raw material stockpile and reused in the lead smelting process.

Small Business Finance Corporation

The Small Business Finance Corporation provides similar financial aid to small businesses. Eligible firms can borrow up to 60 million yen ($239,000) for 10 years at 6.5 percent interest for the first 3 years. After the third year, the interest rate increases to 7 percent. From April 1974 to March 1975, loans of 1.8 billion yen ($7.2 million) were made to 81 firms for industrial waste disposal and reclamation facilities. From April 1976 to March 1977, this increased to 2.7 billion yen ($10.7 million) and the number of firms rose to 93.

Japan Development Bank

The Japan Development Bank also extends loans for pollution prevention and waste recycling projects. Projects must be recommended by the Ministry of International Trade and Industry. The interest rate is currently fixed at 7.6 percent. In fiscal year 1977, the bank disbursed about 2.6 billion yen ($10.3 million) for 12 such loans. The bank loans are made primarily to big business.

One of Japan's largest electrolytic lead smelters is an example of the type of projects financed by the bank. This firm obtained a loan to build a fuming plant to recover zinc and lead from their blast furnace slag. Slag containing about 3 percent lead and 18 percent zinc is processed through the fuming plant. About 3 tons of crude lead and 12 tons of zinc slabs are recovered daily.

Waste exchanges in Europe and Canada

A waste materials' exchange allows the wastes or by-products of one company to become available to other potential users. The objectives of an exchange are to.

--save valuable raw materials,

--save energy by not having to process raw materials, and

--prevent environmental damange by avoiding waste disposal.

There are two types of waste exchanges: information clearinghouses, and materials exchanges. An information clearinghouse receives offers and requests for waste materials, lists both anonymously, and publishes the lists for members and interested nonmembers of their sponsor association. Interested traders contact the clearinghouse, which refers them to a source but takes no active role in negotiations which may lead to transfer. In contrast, materials exchanges actually buy or accept wastes, analyze their properties, identify potential users, reprocess them as needed, and sell them at a profit.

Major waste exchanges had their beginnings in Europe in early 1972. By 1975, waste exchanges existed in the Netherlands, Belgium, Germany, Austria, Switzerland, Italy, Norway, the United Kingdom, and France. Existing waste exchanges are operated by industrial societies, Chambers of Commerce, commercial magazines, government, and independent laboratories with government sponsorship. All waste exchanges have, to date, been subsidized by the governments involved.

Experience indicates that about 10 percent of the wastes listed with a clearinghouse or waste exchange are ultimately transferred to another company for recovery or recycling. However, the German clearinghouse, which pursues a strict policy of not listing wastes that are clearly useless, transfers about 20 percent of its listings. In the United Kingdom, savings to industry by clearinghouse-assisted transfers are estimated to be about $3.6 million, vastly exceeding the clearinghouse's operating cost.

Canada, after a detailed study, established a national Waste Materials Exchange in 1978. This exchange is sponsored

and subsidized by Fisheries and Environment Canada, a government agency, and operated by the Ontario Research Foundation. It was fairly successful during its first year of operation. Of 772 industrial wastes listed, 553 or 72 percent generated at least one inquiry. In the first year, 62 waste exchanges were recorded. Approximately 40,000 tons of material with a value of $1.5 million were exchanged. Ten to 15 percent of the wastes transferred were moved over 1000 miles.

Waste exchanges are in their infancy in the United States. The first one was established in St. Louis in 1975 listing local industrial waste. There are presently over a dozen in operation in the United States. Their geographic coverage ranges from a single Standard Metropolitan Statistical Area to statewide. Most of the businesses we contacted were in favor of these exchanges.

We visited three domestic exchanges. All of the managers thought that a national waste exchange was both desirable and feasible. EPA has provided some assistance to a few regional exchanges, but has not funded a national exchange. EPA thinks that a national exchange is a potentially good idea but that exchanges should first be established at the local or regional level. EPA is also concerned about the effect of high transport costs and the problems associated with transferring hazardous wastes.

Centralized treatment of plating wastes

A central treatment plant similar in concept to the Japanese industrial parks mentioned earlier, (see p. 24), has been established in the United Kingdom to handle the waste streams of several metal finishing firms. The recovery process is not economically feasible for an individual plater, but becomes profitable when inputs are increased by centralization. Similar central treatment and recovery centers in Germany and Switzerland have also proven viable on both an environmental and commercial basis.

A central treatment plant in West Germany handles the wastes of 200 metal finishers. The capital cost ($800,000) was shared by the Department of Sewage Treatment, city, and regional government. The waterworks, industry, and municipalities each pay one-third of the operating costs. Although the facility was built for environmental protection, the sale of recovered metals reduces operating costs.

We found no centralized treatment and recovery from plating wastes in the United States, although just about all of the operating managers of the plating firms we visited said they would like to see central recovery facilities established to take advantage of economies of scale.

Favorable tax treatment

Japan has a special income and corporate tax depreciation system for investment in nonpolluting production and waste-recycling facilities. The initial year's depreciation rate is set at one-fourth of costs. In addition, property taxes are reduced for waste recycling facilities for such wastes as acid and plastics.

The tax climate in Canada, as in Japan, favors investments in recovery facilities much more than in the United States. Taxes in Canada on capital investment for recovery equipment are waived for the first 3 to 5 years and investments can be amortized over a 3-year period. In addition, 150 percent of the research-and-development costs can immediately be written off for tax purposes.

CHAPTER 4

LEGISLATED SOLID WASTE, RESOURCE-RECOVERY OBJECTIVES HAVE NOT BEEN MET FOR INDUSTRIAL WASTES

In chapter 3, we identified a number of problems that inhibit additional industrial waste resource recovery by private concerns. Most often cited is the absence of economic incentives. U.S. industries are simply not prepared to invest further in resource recovery from existing wastestreams because they claim there presently is no profit motive. Thus, Federal and State governments, through the promotion of comprehensive resource recovery programs and new economical recovery technologies, appear to be the only entities that can influence additional major recovery efforts. Unfortunately, as this chapter examines in detail, minimal Federal efforts have been made in response to legislation directed at enhancing resource recovery.

THE RESOURCE CONSERVATION AND RECOVERY ACT OF 1976

RCRA is the first major piece of environmental legislation to emphasize resource recovery as a major objective. The dual objectives of RCRA are to protect the environment from the deleterious effects of solid waste disposal and to conserve valuable material and energy resources contained in wastes. EPA is charged with accomplishing these objectives and is authorized under the act to

--develop criteria for identifying and listing hazardous wastes;

--regulate the treatment, storage, transportation, and disposal of hazardous wastes that have adverse effects on health and the environment;

--examine current land disposal operations and determining their acceptability;

--provide for the promulgation of state guidelines for solid waste collection, transport, separation, recovery, and disposal practices and systems;

--promote a national research-and-development program for improved solid waste management and resource conservation techniques, more effective organizational

arrangements, and new improved methods of collection, separation, recovery, and recycling of solid wastes;

--establish a cooperative effort among the Federal, State, and local governments and private enterprise in order to recover valuable materials and energy from solid waste; and

--conduct various specific studies including the examination of the possibilities for recovering glass and plastic waste.

Although EPA has the primary responsibility for implementing RCRA, the Department of Commerce was given specific responsibilities including the development of specifications for recovered materials which would make them more acceptable in industrial, commercial, or government applications.

RCRA also established an interagency Resource Conservation Committee to conduct a complete study of the economic, social, and environmental consequences of resource conservation. The committee was to stand for 2 years following passage of the act and was to report back to the Congress on a series of issues.

LEGISLATED RESOURCE-RECOVERY OBJECTIVES HAVE NOT BEEN PURSUED FOR INDUSTRIAL WASTES

RCRA's resource-recovery mandate has not been pursued by EPA, the Resource Conservation Committee, or the Department of Commerce. Few resource-recovery programs or alternative strategies for the urban wastestream have been proposed, evaluated, or implemented, and even fewer for industrial wastes.

Specifically:

--The limited resources appropriated to EPA for RCRA have primarily been directed toward developing hazardous waste regulations. EPA has had to rely on an indirect approach to resource recovery, i.e., increase hazardous waste disposal costs through regulatory action.

--The lack of information on the sources and contents of industrial wastes continues to impede progress.

--The Resource Conservation Committee established by RCRA to develop and evaluate resource recovery strategies has not been effective.

--The Department of Commerce has not received funding to pursue its responsibilities.

--Research on new technologies to increase industrial waste resource recovery has been limited.

EPA is indirectly approaching industrial waste recovery with limited resources

As we reported in our February 1979 report, "Conversion of Urban Waste to Energy: Developing and Introducing Alternate Fuels from Municipal Solid Waste" (EMD-79-7), EPA and Commerce budget requests for meeting their responsibilities under RCRA have frequently been cut, or in some cases, disallowed by the Office of Management and Budget. EPA's 1980 estimated budget is over $5 billion. Of this, only a very small amount--about $88 million (1.9 percent)--was appropriated or directed to solid waste disposal programs under RCRA. And of this, only a very small amount is directed to the resource recovery objectives of RCRA.

In addition to the limited funding accorded to RCRA, EPA's progress toward RCRA's resource recovery objectives has been limited because of the priority given to developing the hazardous waste regulation aspects of the act. EPA officials say that their main responsibility is to protect the environment from health hazards and that with limited resources it must focus on this area first. The official view within EPA is that RCRA resource-recovery objectives can be accomplished indirectly by requiring that solid wastes be disposed of in an environmentally sound manner. According to EPA officials, disposal costs will thereby rise dramatically, providing the incentive to industries to either produce less waste initially, or to recycle or recover from these wastes.

As costs rise, mineral recovery from wastes will become more economical. However, we question whether this approach will accomplish the resource recovery goals of the act for a number of reasons. First, even if EPA's strategy is effective, it will take years for it to have an impact. For example, EPA is not expecting to issue regulations on the disposal of hazardous wastes until mid-1980, even though RCRA required them to be issued by April 1978. Those wastes that are not deemed hazardous will be controlled by State solid waste plans. The guidelines for State solid waste plans were not finalized until July 1979.

Second, there are many impediments to resource recovery other than presently available cheap land disposal. (See ch. 3.) For example, while there are resource recovery technologies available for most solid wastestreams, a number of uncertainties and unknowns regarding their performance and economies still exist.

Third, EPA's indirect approach to resource recovery relies almost totally on the States to monitor and enforce industrial compliance with established solid waste guidelines. This is especially true for the estimated 80 to 90 percent of industrial wastes that are not hazardous. According to EPA, none of the State solid waste disposal plans has advanced to the point of adequately considering industrial wastes.

We also question the ability of States, which in many cases are already financially strapped, to undertake any such enforcement programs. In fact, in a recent GAO report, "Hazardous Waste Management Programs Will Not Be Effective: Greater Efforts Are Needed," (EMD-79-14, January 23, 1979) we reported that neither EPA nor the States have the resources to operate hazardous waste programs effectively, let alone resource-recovery programs for all solid wastes.

The lack of information continues to impede progress

According to EPA, a major problem in getting programs started under RCRA is its wider scope compared with previous solid-waste legislation. Prior to RCRA, the emphasis in EPA was on the processing and disposal of municipal solid waste and wastewater treatment sludge. With the enactment of RCRA, EPA gained increased responsibility for other wastes, including industrial and mining wastes, and other disposal practices, including surface impoundment. Some time will be required for EPA and State solid-waste management agencies to gain the necessary expertise and to collect relevant information in order to be truly responsive to these new areas of responsibility. Because there has been little additional Federal and State staffing (even though additional workload has resulted from the passage of RCRA), resource recovery has not received the attention necessary to generate a meaningful data base. (See ch. 2.) Even with regard to land disposal of municipal solid wastes and municipal wastewater treatment sludge, there are many gaps in the available knowledge. Much work remains to be done in researching all these problems, and in translating the data into practical guidelines.

Recognizing that almost all of its previous resource recovery expertise was in the municipal waste area, and that it had limited data on industrial wastes, EPA established the Industrial Waste Task Force in the EPA Office of Solid Waste in January 1978, over a year after the passage of RCRA. The Task Force's objective was to coordinate the EPA activities under RCRA in industrial wastes (excluding hazardous wastes). The Task Force was charged with (1) data collection, (2) the development of guidelines for the recovery of industrial wastes, (3) the promotion of industrial waste exchanges, and (4) the development of State industrial waste management programs. Following a recent reorganization, the activities and responsibilities of the Task Force have been aligned within the Resource Recovery Division within the Office of Solid Waste.

The Task Force had initially awarded four $100,000 contracts for studying solid waste generation, disposal problems, and possible recovery alternatives in four industries: nonferrous metals; inorganic chemicals; ferrous metals; and coal-fired utilities. The contract studies lagged behind schedule and were not finalized until July 1979. Four more industry surveys have also been recently initiated. At the conclusion of the fact-finding stage, the EPA plans to write a comprehensive strategy for industrial waste disposal and recovery.

We agree with the approach taken by the EPA Industrial Waste Task Force, i.e., initially obtaining better information about industrial waste generation. However, much, if not all, of the emphasis on data collection seems to be placed on determining the environmental impact of the waste. Much more needs to be done to identify potential resource recovery possibilities from nonhazardous as well as hazardous industrial wastes.

The Resource Conservation Committee

RCRA established an interagency Resource Conservation Committee to conduct studies and prepare reports to the Congress on resource conservation policies over a 2-year period following passage of the act. The Administrator of EPA chaired the committee that included the Secretaries of Commerce, Labor, Treasury, Energy, and the Interior, the Chairmen of the Council of Environmental Quality, and the Council of Economic Advisors, and a representative from the Office of Management and Budget. The Committee formally

met every 6 months, while the working committee met every 2 to 3 weeks. A supporting staff of about 10 was made up of EPA personnel.

It appears to us that the Congress, rather than spelling out specific resource recovery programs in the legislation, was seeking guidance from this committee as to what role the Government should play in this area.

The Congress authorized a $2-million budget for the committee and required it to conduct a "full and complete investigation and study of all aspects of the economic, social, and environmental consequences of resource conservation with respect to

1. the appropriateness of recommended incentives and disincentives to foster resource conservation;

2. the effect of existing public policies (including subsidies and disincentives, percentage depletion allowances, etc.) upon resource conservation;

3. the appropriateness of employing solid waste management charges on consumer products; and

4. the need for further research, development, and demonstration in the area of resource conservation."

No funds were specifically appropriated for the committee. EPA funded the committee from its own appropriation--but at about $2 million.

The Committee's output consisted of four reports. The first was the Committee's implementation plan; the second proposed a national container deposit plan; the third reported on waste disposal charges; and the fourth was the final report, examining Federal policies affecting materials conservation. A number of small contracts were awarded to examine related matters during the course of the committee's existence, resulting in about 70 contractors' reports and technical memoranda.

We believe that the Resource Conservation Committee did not meet RCRA's mandate to conduct a complete analysis of all aspects of resource conservation, because the great majority of the committee's work evaluated a few proposed strategies affecting municipal waste. Very little evaluation effort

was directed at industrial wastes. The committee did not completely analyze the effects of conservation incentive or subsidy programs on industrial wastes.

None of the Committee's reports mentioned industrial wastes or mining wastes. Only one small, about $50,000, contract was awarded in August 1978 to study resource recovery from industrial wastes. The consultant's report resulting from the study concluded that only by raising disposal costs, will the necessary economic leverage be provided to encourage additional recovery or recycling. This conclusion mirrors EPA's resource recovery strategy (see p. 40). The report's conclusion, was based largely on the study of industrial scrap, a material that we do not consider to be an industrial waste, and is not representative of the problems and potential associated with sludge, dusts, and other industrial wastes.

Another example of the committee's incomplete examination of conservation issues is its required analysis of the effect of Federal tax policy on recycling. For this study, the committee primarily relied on a Department of Treasury report entitled "Federal Tax Policy and Recycling of Solid Waste Materials." This report concluded that existing tax policies do not negatively affect the recycling of solid waste. The study, however, was based solely on an analysis of industrial scrap metal and municipal solid wastes. Except for so-called obsolete scrap metal products that enter the municipal waste stream when discarded, the majority of scrap metal, as cited on page 3, is already recycled. So assuredly the effect of existing tax policy is minimal. Thus, there still remains a need to conduct a comparable analysis for industrial wastes.

The requirement that the committee examine economic incentives for resource recovery and that recommendations be made to the Congress on particular incentives to spur conservation was potentially the most significant step that could affect resource conservation activities. The committee, however, spent the majority of its efforts evaluating beverage container deposits and municipal solid waste disposal charges. The final committee report entitled "Choices for Conservation," did contain a short discussion on subsidies for resource recovery. The committee identified 10 different forms that a subsidy might take, for example, construction and equipment grants, or investment tax credits, but did not attempt to analyze in depth, any questions of policy design or cost effectiveness. Even so, the committee found

that subsidies designed specifically for resource recovery could be effective, although potentially costly.

A majority of the committee members joined in calling for additional research, before firmer conclusions are drawn. Unfortunately, the committee disbanded at the conclusion of its statutory functions after the final report was submitted and no agency has followed up on its recommendations.

The Department of Commerce role

Sections 5001 to 5004 of RCRA assign certain authorities and responsibilities to the Department of Commerce. Broadly these are to

--develop guidelines for specifications for recovered materials,

--stimulate the development of markets for secondary materials,

--identify the economic and technical barriers to the use of recovered materials, and

--promote proven resource recovery technology and dissemination of related information.

Because of the lack of funding, only very preliminary work has been done by the Department of Commerce and the Bureau of Standards on any of their prescribed areas of responsibility. The Department requested funding for fiscal years 1978-79, but the OMB rejected their request each year. OMB reasoned that RCRA is EPA's responsibility and that EPA should transfer part of its appropriation for RCRA to Commerce. Commerce has not been successful in obtaining funds from EPA.

The Commerce Department has developed a plan to implement its responsibilities under RCRA. The Commerce plan would incorporate such approaches as:

1. municipal/industrial agreements to consolidate wastes;

2. industrial parks to consolidate and recover wastes and energy;

3. industrial waste exchanges;

4. cooperative technology teams to aid a particular industry with its waste disposal and recovery problems; and

5. a resource recovery committee to analyze and coordinate Federal agency programs in the area of resource recovery and to serve as a clearinghouse for Federal resource recovery and waste exchange information and issues.

In addition to this overall plan, Commerce has initiated a small internal project with the objective of defining new approaches and programs for resource recovery from industrial wastes. The project began in July 1979.

Commerce believes that the Congress recognized, when it enacted RCRA, that any successful resource recovery effort requires expanded and stable markets for materials recovery from waste and that this function best resides with Commerce. Commerce has the greater expertise to guide private sector involvement in resource recovery and use of recovered materials. According to Commerce officials, the Congress realized this, and therefore delegated the research and regulation responsibilities to EPA and the promotion function to Commerce. However, to date, Commerce has been thwarted in attempts to gain funding.

Federal industrial waste resource recovery research is limited

Expenditures on resource recovery research has been miniscule compared to those for energy and environmental issues and small even when compared to other materials research activity. For example, the Committee on Materials in its April 1976 report entitled, "Inventory and Analysis of Materials Life Cycle Research and Development," found that of the $961.3 million spent by the Federal Government in 1976 on materials research and development projects, only about $93.8 million, or about 11 percent, was spent on waste disposal. Of that amount, only $23.2 million was spent on recycling or recovery of values. Most of this money was spent on researching the recovery of energy from municipal solid waste.

EPA admits that the technology required to successfully implement RCRA has not been fully developed or optimized. We learned that an internal planning document does state that research, development, demonstration, evaluation, and the gathering of technical information should receive priority consideration in all program areas. EPA resource-recovery research expenditures for industrial wastes to date, however, have been limited. Furthermore, EPA has not coordinated its programs with the Bureau of Mines, DOE, or Commerce for the purpose of suggesting or instigating specific resource recovery research projects.

In 1978 only four EPA staff years were allocated to resource recovery research, and only a small part of that centered on industrial wastes. The research projects were mainly data analysis or collection efforts--and not laboratory work.

No money is being spent by EPA's Office of Solid Waste, the office responsible for RCRA, for industrial waste research. However, EPA's Office of Research and Development does perform research for other EPA offices which impacts on industrial waste recovery. For example, that office has completed and is planning a number of research projects examining the recycling of industrial waste water.

DOE's Alternative Materials Utilization Branch, with a $4.3 million 1980 budget, researches and demonstrates new technologies for industrial energy conservation. Several of the Branch's projects examine the recycling of waste materials to conserve energy. The Bureau of Mines is the only other agency directing funds into research for new technologies to increase resource recovery from industrial wastes.

Bureau of Mines' industrial waste recovery research

Metallurgy research conducted by the Bureau of Mines seeks new and improved processes to extract, recover, purify, fabricate, and recycle metallic and nonmetallic materials. The metallurgy research activity budget is divided among the following four subactivities:

1980 Bureau Of Mines Metallurgy Research Budget
(in millions)

Advancing mineral technology	$12.1
Effecting pollution abatement	8.5
Secondary resource recovery	2.1
Minimizing mineral and metal needs	4.5
Total	$27.2

Of the $2.1 million allocated to resource recovery research, about 20 percent is spent on municipal waste recovery; the rest is for the recovery of mineral values from mining and industrial wastes. Also, a few of the pollution abatement projects funded by the Bureau have resource recovery implications. However, less than 5 percent of the Bureau's total 1980 budget ($135 million) is allocated to industrial waste resource recovery projects and the total amount allocated to metallurgy research has declined in the past 2 years.

Following passage of the Solid Waste Disposal Act of 1965 the Bureau of Mines' resource recovery programs began to investigate projects in order to alleviate the problems of waste disposal, pollution control, and the short supply of minerals and energy. Resource recovery research has increased in the Bureau of Mines since then, but still occupies a very small niche in its operations.

The Bureau's resource recovery projects have been directed to all phases of the materials cycle including projects for municipal waste recovery, the utilization of waste materials, and the recovery of valuables from industrial and mining wastes. For example, the Bureau has researched the recovery of copper from mill tailings as well as the recovery of material values from junked automobiles.

A review of 22 Bureau of Mines' completed resource recovery projects reveal that about 60 percent were related to industrial wastes. Examples of these projects, include

--the reclamation of valuable constituents from electroplating and etching wastes,

--the recovery of nickel and zinc from waste phosphate solutions, and

--the recovery of alloys from stainless steel flue dusts.

New, innovative research offers opportunities for significant advances in the technology of recycling and recovery. But only through extensive communication can the knowledge gained be put to optimum use. Most large mineral processing companies we contacted had their own research capabilities, and were aware of the Bureau's recovery research. However, many of the small firms, for

example, independent electroplaters were not aware of the Bureau's recovery research or of specific projects connected with its industry. Nearly 60 percent of 33 industrial firms we contacted were not aware of the Bureau's resource recovery program.

Firms familiar with the Bureau's research felt that it was doing a good job considering its limited funding, but they expressed the need for the followup of laboratory research with full-scale pilot plants. The Bureau has had limited funds for pilot projects and private firms are often unable or unwilling to invest large amounts of capital on risky pilot demonstrations.

NEED FOR LEADERSHIP AND INTERAGENCY COORDINATION

In our February 1979 report "Conversion of Urban Waste to Energy: Developing and Introducing Alternate Fuels From Municipal Solid Waste" (EMD-79-7), we discussed the Federal Government's efforts to develop waste-to-energy systems. Some of the legislated responsibilities for promoting the recovery of energy from solid waste falls under RCRA. In that report, we identified many of the same problems for energy recovery from municipal wastes as we discuss in this report for mineral recovery from industrial wastes. That is, that resource recovery under RCRA is underfunded, understaffed, and has received low priority in EPA, that various agencies' research and development programs are fragmented and uncoordinated, and that there is a lack of overall strategy.

In that report, we concluded that the best way to focus more attention on energy resource recovery was to recommend that EPA submit a 10-year plan for action to the Congress by September 30, 1979. Both the Department of Energy and Commerce wanted to take the lead on such a program plan, but we concluded at that time that EPA should be responsible, since it was the implied lead agency for resource recovery under RCRA. We did state, however, that should EPA not act responsibly in developing this plan, then a leadership change should be considered by the Congress.

At congressional hearings in July 1979, EPA announced that it had assumed the lead role in establishing a new interagency committee, that would include Energy and Commerce. The new committee is to act as a focal point for the coordination of Federal activities in the resource recovery

area. The committee was also to complete a 5-year action plan by March 1, 1980; however, that deadline was not met.

It remains to be seen if this new committee will, however, actively and adequately focus on the resource-recovery objectives of RCRA. It is worth noting that the present commitee membership does not include a representative from the Department of the Interior, yet the Bureau of Mines is the only agency conducting technical industrial waste recovery research. That is a significant organizational deficiency, but one that can be easily corrected. If the EPA-chaired committee is to develop a sound 5-year plan for promoting resource recovery, we believe Interior (Bureau of Mines) must be a serious collaborator. We were told by agency officials that this new committee is in a formative stage, and that other agencies will be invited to participate.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The Congress expressed belief in passing the Resource Conservation and Recovery Act of 1976 (RCRA) that millions of tons of recoverable materials that could be saved and used are needlessly lost each year, and that methods were available to separate usable materials from solid waste. RCRA required a number of actions designed to identify programs with the objective of increased resource-recovery from all solid wastes, and required these programs to be incorporated within an environmentally sound waste disposal policy. However, progress towards the resource-recovery objectives of this act, especially for industrial wastes, has been slow. We believe that much more could be done by the Government toward developing and enacting programs to aid and encourage industries to extract the mineral values from their wastestreams, and to identify those areas where recovery could best offset the costs of meeting current and new environmental regulations.

INDUSTRIAL WASTES: AN UNTAPPED MINERAL SOURCE

U.S. industries generate an estimated 344 million metric tons of waste annually. Although available data on the mineral content of industrial wastestreams is sketchy and fragmented, we conservatively estimate that there are over 10 million more tons of minerals left in selected industrial wastes each year. (See pp. 14-15.) Fewer than 15,000 tons of minerals are now being recaptured annually by U.S. industries.

We found that U.S. industries, for the most part, are unwilling to invest in additional recovery efforts because they do not consider them profitable. Economic factors include: (1) the amount of waste generated (whether sufficient quantities are located at one place to make a recovery operation feasible); (2) the lack of sufficient capital for investment in recovery equipment; (3) the availability of lower cost virgin minerals (sometimes from company-owned mining operations); and (4) expensive extraction processes. The absence of adequate recovery technology also impedes recovery programs.

Because Japan has enacted tough pollution legislation similar to the United States and is reported to use advanced

recovery techniques, we examined the resource recovery activities of its industries. We learned that under Japanese law a number of economic incentives are provided to its industries to promote their processing of industrial wastes. These incentives are provided partly as an attempt to ease the financial burden of Japan's strict environmental regulations and land shortage problems.

We found that U.S. industries are doing a fair job of recovering mineral values from their wastestreams, as long as it is profitable. However, in Japan we found significantly greater recovery of minerals from steel processing wastes and electroplating wastes--two industries that have very large and/or hazardous wastestreams. Incentives and subsidies provided by the Japanese government, in conjunction with their environmental program, have encouraged additional resource recovery. Few such programs are available to U.S. firms.

If resource recovery were to increase from industrial wastes in the United States, a number of advantages would accrue, including (1) the reduction of pollution problems; (2) the conservation of mineral, energy, and water resources; and (3) the reduction of disposal costs.

THE EXECUTIVE BRANCH HAS NOT PURSUED LEGISLATED INDUSTRIAL WASTE RESOURCE-RECOVERY OBJECTIVES

With the passage of RCRA, the Congress gave EPA the responsibility and authority to formulate and evaluate resource recovery programs and to incorporate these programs within an environmentally acceptable solid waste disposal policy. RCRA also established an interagency Resource Conservation Committee to identify and study various alternative resource conservation policies including incentive programs and assigned specific responsibilities to the Department of Commerce.

As described in detail in chapter 4, efforts directed toward accomplishing the resource recovery objectives of RCRA have been lagging behind. This is especially true for industrial wastestreams. Federal emphasis on resource recovery has been limited to municipal wastes and even so, recovery has been minimal.

The lagging Federal effort seems to have been brought about by the following circumstances:

1. There is a dearth of information available on the nature, location, and recoverable contents of industrial wastestreams. EPA has initiated some efforts in this area but primarily for the purpose of identifying hazardous environmental effects.

2. EPA's implementation of RCRA has been impeded by lack of funding. Furthermore, EPA has focused primarily on the environmental regulatory aspects of the legislation to the exclusion of recovery objectives (especially to other than those that concern municipal wastes).

3. The Resource Conservation Committee did not meet its mandated objectives of defining and evaluating alternative resource-recovery strategies. The committee was particularly weak in exploring the recovery potential and opportunities from industrial wastestreams.

4. The lack of adequate funding has stymied the Commerce Department's pursuit of RCRA responsibilities. The lack of funding has also limited the pursuit of RCRA objectives within EPA and the initiation of resource-recovery research efforts by the Bureau of Mines. Total funding is miniscule when compared to these agencies' overall budgets.

In short, EPA and other responsible agencies have done very little to enhance resource recovery from industrial wastes. Little effort has been made to examine the possibilities and the Federal cost of reducing industries' recovery costs and encouraging more recovery. The cost of doing this would vary greatly from industry to industry depending on

--available technology,

--the efficiency of the industry's operations and what remains in the wastes,

--disposal alternatives (i.e., whether or not the waste is hazardous), and

--available markets for recovered materials.

Much more needs to be done to identify those industries where investment in resource recovery incentives or research could most effectively be pursued.

In our earlier report on the conversion of urban waste to energy (see p. 49) we concluded that the lack of attention to energy resource recovery from municipal wastes also resulted from lethargic implementation of RCRA. In that report we recommended that, because of the lack of attention and low priority given to energy resource recovery from municipal wastes, EPA should develop and submit a detailed 10-year plan describing a Federal Urban Waste-to-Energy Program. However, we also stated that should EPA not act responsibly in developing the recommended plan, then a change in leadership should be considered by the Congress. The very limited consideration given to the potential for enhancing industrial waste recovery is another example of EPA's lack of attention to an important resource recovery opportunity. Accordingly, reorganization of the leadership for resource recovery under RCRA remains a future consideration.

EPA has only very recently initiated plans for a new interagency committee to coordinate resource recovery objectives. EPA now hopes that the committee will develop a 5-year resource-recovery program plan by September 1980. Thus, it remains to be seen if, after 3 years of fragmented, low-level emphasis, RCRA mineral recovery objectives will be vigorously pursued.

While in our earlier report we did recommend that EPA remain the lead agency for resource recovey, we also believe that the lack of progress toward the resource recovery objectives of the Resource Conservation and Recovery Act may be attributable to having assigned EPA responsibilities that could be more appropriately pursued elsewhere. EPA is primarily a regulatory agency and its experience lies in environmental protection. Enhancing and researching resource recovery is more closely related to the traditional functions of the Bureau of Mines and Department of Commerce. We believe that the matters discussed in this report might receive greater attention and might be accomplished in a healthier Government-industry climate if the roles of these two organizations were enlarged.

We hope that the interagency committee will prove to be a useful tool that will allow effective coordination among EPA, Commerce, Interior, and Energy, and will allow Commerce, and Interior, to contribute their expertise toward RCRA's

goals. We believe, for example, that through such a committee, Commerce could effectively develop and evaluate resource-recovery programs, and that the Bureau of Mines could more effectively direct its research based on recommendations from EPA and Commerce. Commerce, we believe, should also work with the Department of Justice on antitrust matters to develop guidelines outlining conditions where joint resource recovery ventures would be acceptable.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The enhancement of resource recovery, especially from industrial wastes, has received scant attention by the Government, primarily because of the necessary priority given to the development of a Federal hazardous waste disposal policy and a shortage of staff and funding resources. However, opportunities for increased coordination and cooperation among executive agencies have also been neglected. Thus, we believe that increased congressional oversight is necessary to insure that resource recovery objectives of the existing legislation are adequately pursued. Accordingly, we urge the Congress to closely monitor EPA and the new interagency resource recovery committee to insure that the resource recovery objectives of the Resource Conservation and Recovery Act are pursued.

Presently, of course, constraints on the budget are very severe throughout the Government. The Congress will have to determine if increased Federal spending for resource recovery is presently appropriate. However, we believe that until such time as increased funding is specifically made available, the EPA, the Department of Commerce, and the Bureau of Mines will not be able to markedly enhance resource recovery.

RECOMMENDATIONS TO THE ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY

We recommend that the Administrator of the Environmental Protection Agency continue to vigorously pursue the establishment of the new interagency committee to coordinate Executive Branch actions toward legislated resource recovery objectives.

In fulfilling its lead agency responsibilities we recommend that EPA increase its information collection activities, and encourage the collection and coordination of information by other member agencies with the objectives of (1) obtaining

much needed data on resource recovery opportunities, and (2) identifying those problem areas where the Bureau of Mines should concentrate its research and development efforts.

We also recommend that the Administrator ensure that the new interagency resource recovery committee include representation from the Department of the Interior's Bureau of Mines, so that ongoing resource recovery research be effectively coordinated, and that such other agencies, as the Department of Treasury, participate while such relevant issues as tax policy are being considered.

In addition, we recommend that the Department of Commerce be given the responsibility for analyzing potential new resource recovery activities, and to suggest actions to the committee for recommendation to the Congress. These analyses should identify those industrial sectors where the benefits of additional recovery could most effectively offset environmental compliance costs.

RECOMMENDATION TO THE SECRETARY OF COMMERCE

The Secretary of Commerce should work with the Department of Justice to develop guidelines to industry, for the establishment of joint resource recovery ventures that will be compatible with the Department of Justice's antitrust concerns.

RECOMMENDATIONS TO THE SECRETARY OF THE INTERIOR

We recommend that the Secretary of the Interior explore ways to enhance its industrial waste recovery research. Specifically, the Bureau of Mines should work closely with the Department of Commerce and the Environmental Protection Agency to support resource-recovery activities and to seek assistance in the identification of recovery opportunities that require technical research. The Bureau of Mines also needs to do more to assure the potential application of specific projects by demonstrating to industry through pilot plants or other means, the economic worth of developed technologies.

AGENCY COMMENTS

Comments on our report ranged from "very thorough and clear" from the Department of Commerce to "misleading and unfair" by EPA. Appendices II and III contain the written comments of the Departments of Commerce and the Interior. EPA

did not give us written comments on the report in time for us to include and discuss in the final report. Appropriate officials did provide us with oral comments.

The Department of Commerce

The Department of Commerce believes that our overall conclusions are solid. It did cite the overall economic health of an industry as a significant factor which must be addressed when discussing an individual firm's plans for mineral waste recovery. Commerce also noted that the new interagency coordinating committee for resource recovery is still in the formative stage, and that other agencies will be invited to participate. Commerce also made a number of specific comments of a technical nature that were incorporated into the report.

The Department of the Interior

The Department of the Interior believes that "much of the material in our report is good," and agrees with several of our suggestions. However, it does believe that the recommendations to the Secretary of the Interior are inappropriate. Specifically, Interior's comments imply that our first recommendation to enhance industrial waste research is not necessary because of ongoing concern for this type of research. It did welcome our suggestion to EPA and Commerce in the area of resource recovery research activities, but stated that these agencies are not as well suited to assist in the identification of recovery technologies as they are suited to assist in the identification of recovery opportunites.

We did not remove the recommendation because we believe that an increase in industrial waste recovery research is warranted and that research should be better coordinated among EPA, Commerce and Interior. Because the Bureau of Mines has been a leader in this area, our recommendation is directed toward it specifically. Even though Interior's industrial waste recovery research is now about 80 percent of its resource recovery budget, its overall budget is still very small (see p. 48). One must remember, however, that overall responsibility for coordinating and managing resource recovery research is assigned to EPA.

Interior also believes that our second recommendation to move to ensure the potential application of specific research projects overlooks the Bureau's successful efforts in helping industry develop and use economical methods for recovering waste. We note that Bureau officials have made efforts in this regard. However, our industry survey leads us to believe

that industry's hesitancy to adopt only proven technology is a major problem, and requires that more emphasis be placed on demonstration plants, pilot plants, and joint research ventures. On this point, Interior agrees with us, and we feel this would go a long way toward improving technology transfer for industrial waste recovery.

Interior also commented that it felt our report is structured around two arguments: (1) that RCRA has not been implemented, thereby reducing the potential for Federal regulation of industrial wastes and subsequent increased mineral recovery; and (2), except for a few types of wastes, a substantial increase will require Federal subsidies.

It was never our intention to imply that industrial wastes be regulated to enforce recovery, nor that a Federal subsidy program be initiated. The message of the report is that there appears to be a large potential for recovery from industrial wastes, and that the Federal responsibility to encourage and support recovery through existing programs to evaluate alternative new actions has not been carried out.

The Environmental Protection Agency

Although EPA was afforded ample opportunity to formally comment on this report, it did not provide us with a written statement in time for us to include and discuss in the final report. We did meet with various EPA officials who provided us with verbal comments on the draft. Many of these comments have been incorporated into the report.

Basically, EPA officials believe that the tone of the report is too critical of the EPA because EPA: (1) has (or will) initiate a number of projects to promote resource recovery; and (2) has done all it could have expected to do with the limited resources available to it. These officials emphasize that there are a number of reasons why little attention has been directed to resource recovery from industrial wastes and that EPA, under RCRA, is not empowered to directly assist industries.

EPA officials informed us that they have started a study of electroplating industrial parks based on the Japanese and German experience in hopes of demonstrating this form of pollution control and resource recovery in the United States. They also informed us that EPA is about to embark on a million dollar industry studies program and that part of these studies will focus on present industry resource recovery activities. These studies will also

assess potential resource recovery levels with and without Government intervention and, if effective and appropriate Government intervention in the form of research and development is indicated, EPA will attempt to carry out such research and development. In addition, EPA is also recommending to the Internal Revenue Service the inclusion of industrial waste as an example of a qualifying material for tax credits under the Energy Tax Act of 1978 (see p. 33). To date it appears that the Internal Revenue Service's narrow interpretation of the term solid waste may exclude capital investments to recover from certain industrial wastes, such as electroplating wastes, from eligibility for the credit.

We believe that these are important steps in the right direction, as EPA seeks to carry out its mandate for enhancing resource recovery for all wastes under RCRA. However, we still believe that this report accurately reflects the degree of attention EPA has directed to industrial wastes, and portrays EPA's priority attention given to the regulatory aspects concerning hazardous wastes under RCRA. While we have no quarrel with the resources directed toward hazardous wastes, we believe that the Congress should be alerted to the fact that the resource recovery objectives of RCRA have received little attention. In particular, EPA has not properly evaluated the potential for a Government role in promoting or developing resource recovery techniques for industrial wastes. We acknowledged that under RCRA, EPA cannot directly aid industries or establish incentives or subsidy type programs. But it does have a responsibility to examine and develop programs to aid recovery from industrial wastes. This important first step has not been pursued by EPA.

EPA officials are also concerned that we misrepresent EPA policy and program issues. They emphasize that they have always encouraged resource recovery as a means to reduce waste streams, and that there is no policy as we imply in our report that EPA's resource recovery strategy is limited to increased regulation of the disposal of wastes.

Part of the confusion here is caused by the lack of any official internal document outlining EPA's resource recovery strategy. Again, we hope that this omission will be solved by the stated resolve of the new resource conservation committee under EPA's direction, to develop a 5-year resource recovery plan. However, we believe that whether or not this is EPA's official policy, certainly its actions and lack of attention to resource recovery, especially for industrial wastes, indicate that this is the effective policy.

APPENDIX I

GLOSSARY

Dross	--Waste product or impurities formed on the surface of molten metal during smelting.
Electrolytic Cell	--A cell containing an electrolyte through which an externally generated electric current is passed by a system of electrodes in order to produce an electrochemical reaction.
Electroplating	--To coat or cover with a thin layer of metal by electrodeposition.
Potliner	--Carbon material used to line aluminum reduction "pots." Acts as the anode during the reduction of alumina and often absorbs fluorides and other materials used during the process.
Precipitated	--To chemically cause a solid substance to be separated from a solution.
Scale	--A flaky oxide film formed on a metal, as on iron, heated to high temperature.
Sintering	--A process that fuses ore fines, flue dust, mill scale, and flux material into a material that can be charged in the blast furnace.
Slag	--The vitreous mass left as a residue by the smelting of metallic ore.
Sludge	--Wastestream in the form of mud, mire, or ooze.

APPENDIX I

Slurry --A thin mixture of a liquid, especially water, and any of several finely divided substances.

Smelt --To melt of fuse ores in order to separate the metallic constituents.

APPENDIX II

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C 20230
(202) 377-3111

November 14, 1979

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

Dear Mr. Eschwege:

The concerned agencies of the Department of Commerce have reviewed the proposed General Accounting Office (GAO) report entitled "Industrial Waste: An Unexplored Minerals Source," which you forwarded to Secretary Kreps on October 22. General comments ranged from "acceptable" to "very thorough and clear." While the overall conclusions are considered valid by the reviewers, the following detailed comments are offered for GAO's consideration:

GENERAL COMMENTS

The report frequently mentions the importance of economic feasibility in determining the success of a firm's waste recovery program. However, in many cases, the overall status or health of the industry is a significant factor which should be addressed when discussing a firm's plans for mineral waste recovery.

The report states that the new Interagency Coordinating Committee for Federal Conservation and Recovery Activities (pages 50&57) includes as members representatives from the Environmental Protection Agency (EPA), the Department of Energy (DOE), and the Department of Commerce (DOC), but does not include a representative from the Department of the Interior. A reviewer has pointed out that this new Committee is still in a formative stage, and that other Federal Agencies will be invited to participate. In addition, S.1156, which was passed last June 4 (although a similar bill has not yet passed the House), specifically directs the Administrator of EPA, who chairs the Committee, to include members of other Federal agencies which have programs or responsibilities affecting resource conservation and recovery.

SPECIFIC COMMENTS

Page 2, Figure 1 - Cooling water should be added to the list of wastes from the smelting and refining steps, and solutions should be added as a waste from the fabrication and manufacturing steps. Residues, scraps, drosses, and rejects should be added as recycled materials from the smelting and refining steps. Marketing should be deleted as a step in the materials cycle. Finally, the figure should clearly indicate that spent products, packaging, and spoilage are not industrial wastes.

See GAO note, p. 68.

Page 3, Line 6 - Should read, "Generally, scrap is either recycled within the firm, sold in established metal scrap markets, or is disposed of in the municipal waste stream."

Page 3, Lines 23 and 24 - It is recommended that an explanation on how proposed Federal and state laws will impede future recovery be included.

Page 3, Lines 31 and 32- The statement implies that the ability to recover plating metals and/or minerals after they have been precipitated into a harmless sludge will depend on the minerals. We question the accuracy of that inference and recommend that an explanation be provided. Also, the term "minerals" in the report should be changed to "metals and/or minerals" in most places throughout the report.

Page 4, Line 18 - In this particular case, "Minerals" should be changed to "Metals" or "Elements."

Page 5, Lines 4 to 6 - It is unusual for a combination of limestone, dolomite, and lime to be charged to a basic oxygen furnace. Normally, only lime is used. The source of the sludge should be identified and exhaust gas should be included as a waste.

Page 7, Lines 30 and 31 - Bureau of Mines research on industrial wastes is much more extensive than noted here. Also, this statement seems to contradict the third paragraph on page 48.

Page 7, Last Paragraph - Add as a fourth point to this paragraph, which continues on page 11, "resource recovery from municipal solid waste was a virgin area in which much progress could be made, whereas industrial wastes have been studied for more than half a century."

Page 11, Sentence 1 - We believe this sentence may be in error. EPA has had a substantial amount of work done on the composition and distribution of industrial wastes. While these reports tend to focus on the hazardous elements, it is precisely these elements which are both recoverable and worth recovering.

Page 11, Last paragraph - This study did not receive sufficient funding and the contractor attempted to do more than was required by the scope of work.

Page 11, Lines 26 to 28 - See comment concerning page 15, sentence 1.

Page 16 - Add to list of Advantages of Resource Recovery, "--Conserving or reducing energy consumed in producing semi-fabricated products and/or ingots."

Page 18, Lines 13 to 14 - There are ways to eliminate the problem of porous soils, e.g., an impermeable barrier under the landfill.

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Page 21, Lines 4 and 5 - There should be some discussion as to the contributions of industrial attitudes verses government incentives and anti-trust laws to the greater resource recovery from steel processing wastes and electroplating wastes in Japan.

Page 21, Table - Blast-furnace slag should be added to the type of waste streams. Also, under the heading "disposition," there appears to be an error for open-hearth slag. The correct disposition is "landfilled" whereas "landfilled or pelletized and recycled" is correct for basic oxygen furnace dust. The disposition for basic oxygen furnace slag should read "landfilled, sold, and/or processed to recover metallic iron."

Page 22, Lines 20 to 24 - The statement regarding closing of sintering plants applies only to older facilities which are either uneconomic to retrofit with pollution control equipment or have been retrofitted with some of the less expensive equipment available. This less expensive equipment has either proved unsatisfactory from initial installation or has resulted in the inclusion of "blue smoke" emissions as particulates. However, modern sinter plants have been built which can meet current emission standards (see for example Steiner and Rower, Ironmaking Proceedings, 31, p59, Chicago, 1972, AIME). Note that half of the capital invested in this plant was for pollution control equipment.

Page 23, line 15 - There are certain regions in this country, e.g., Gary, Indiana; Pittsburgh, Pennsylvania; and Cleveland, Ohio, where steelmaking is sufficiently concentrated to yield large quantities of dust.

Page 23, Paragraph 4 - The value of $40 million for the metals left in electroplating wastes is inconsistent with the $3 million figure in the second paragraph on page 13.

Page 26 - The following changes should be made under the column heading "Values Recovered": For concentration - delete "Non-acid soluble copper." Copper ore is not leached prior to concentration. For dump leaching - delete "solvent" as this is a material not present in the original ore.

Under the column heading "Values Not Recovered" delete "Non-acid soluble copper" for the reason stated above. Also, it should be noted that this stream has a very low copper content which probably never will be recoverable.

Page 29, Lines 4 to 5 - The fear of anti-trust action as a result of joint efforts to recover resources from industrial wastes needs more discussion.

Page 29, Lines 4 to 5 - Does the statement mean that Japan uses different technology from that of the United States to produce aluminum?

Page 29, Paragraph 5 - The research conducted by the Bureau of Mines on stainless steelmaking dusts and on superalloy wastes deserves mention.

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Page 31, last paragraph - While this statement is true, studies have shown that removal of depletion allowances would have a minimal effect on the price of metals. One such study was done for EPA by Robert Anderson of the Environmental Law Institute.

Page 32, Lines 8 to12- Furthermore, it should be noted that minerals companies have formed consortiums to mine ore without fear of anti-trust action.

Page 33, Lines31to 39 - What is the annual budget of Japan's Environmental Pollution Control Service Corporation?

Page 34, Line 29 - $12.9 million is a very small annual expenditure for the purpose indicated.

Page 46, Line 2 - Should read, "(4) cooperative technology teams to aid a particular State/municipality/industry with its waste disposal and recovery problems; and"

Page 45, Line 13 - Should read "--stimulate the development of markets for secondary materials;"

Page 45, Line 33 - Should read, "(2) industrial parks to consolidate and recover wastes and energy;"

Page 48, Line 2 - The Bureau of Mines in FY 1980 will spend half less than of its resource recovery allocation on municipal solid waste.

Page 49, Paragraph 2 - The need for funds to support pilot plants and full scale demonstrations is worth stressing. These are good points.

* * * * * *

The DOC appreciates having the opportunity to review and comment on this draft report. With the exception of the above comments, the DOC concurs with the tenor and conclusions of this proposed GAO report. If we can be of any further assistance to you, please let us know. Will you please forward us six copies of the report when it is published.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

DEC 1 1979

Mr. J. Dexter Peach
Director, Energy and Minerals
Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

Thank you for sending us your draft report "Industrial Wastes: An Unexplored Minerals Source" for review. A copy of this draft marked with some technical corrections and suggestions is enclosed.

The report is structured around two arguments. First, existing legislation, especially the Resource Conservation and Recovery Act, has not been implemented, thereby reducing the potential for Federal regulation of industrial waste streams and subsequent increased mineral recovery. Second, except for a few types of waste for which no recovery technology has been developed, a substantial increase in mineral recovery from industrial waste will require Federal subsidies. These arguments are fundamentally different, and should be discussed separately.

In our view, any program must start with estimates of minerals recovery process costs. Such cost estimates, in combination with industry supply functions, should be used to determine the costs to industry of Federally regulated minerals recovery as well as the cost of government subsidies necessary to achieve given levels of recovery. Either the regulatory or the subsidy approach or a combination of both must be evaluated in terms of cost effectiveness. Without this information, it is not possible to judge the usefulness of any of the potential courses of action proposed.

Bureau of Mines research accomplishments in industrial waste treatment are presented accurately; however, some clarification of the Bureau of Mines role in resource recovery should be included in a final report. An expanded review of the Bureau's programs will show that the recommendations made to the Secretary of the Interior on page 56 are inappropriate. The Bureau has conducted far more than a "little research on recovering minerals from industrial wastes." Industry has been applying Bureau of Mines-developed process for recovering mineral values from their wastes for decades. Perhaps the most significant recognition of the success of Bureau technology-transfer efforts was the presentation by the Bureau International de la Recuperation (B.I.R.), a 39-nation association of secondary material reclaimers, of their first award for outstanding performance in the field of recycling to the Bureau of Mines. It is the opinion of B.I.R. that "the spectacular industrial development of reclamation in all its forms would not have taken place, certainly at the current pace, without the support and guidance of the Bureau. The USBM had made the fruits of its research freely available to the entire world. Its program involved recycling of materials found in consumer wastes, and the

recovery of valuable metals and minerals from metallurgical slags, flue dusts and drosses."

The first of the two recommendations made in this draft suggests the Secretary "enhance...industrial waste recovery research." For several years Bureau research was funded under authority of the Solid Waste Act of 1965, which permitted it to expand its established secondary metals research program to include resource recovery from municipal refuse. Funds were authorized for the Department of the Interior under the Resource Recovery Act of 1970 but none were appropriated. The work was continued by drawing on funds made available for metallurgy research in the Bureau's annual appropriations. However, the amount spent for municipal waste recovery never approached one half of the money budgeted for the total resource recovery program as suggested on page 72 of the report. Since industry has adopted the Bureau's technology in large municipal resource recovery facilities (up to 2,000 tpd, as in Monroe County, N.Y.), the funding of municipal waste research projects has decreased to approximately 10 percent of the FY-80 resource recovery budget. The major share of that budget is being used to fund research on industrial wastes of the type addressed in the GAO report and research on complex post-consumer scrap. We welcome the suggestion that the Department of Commerce and the Environmental Protection Agency "support resource-recovery activities," but it must be pointed out that these agencies are not as well suited to "assist in the identification of recovery technologies" as they are suited to assist in the identification of recovery opportunities.

The second suggestion made to the Secretary, that the Bureau of Mines do more to assure the transfer of recovery technology, overlooks the Bureau's successful efforts in helping industry develop and use economically and environmentally sound methods for recovering minerals from waste. For example, the section on the stainless steel industry (pp. 29-30) describes the development and operation of a plant in Pennsylvania for the centralized processing of stainless steel wastes from a number of stainless steel companies. The Bureau of Mines began research on recovery from stainless steel wastes in 1972 and the industrial developer of the centralized processing operation visited the Bureau, prior to development of their system, in order to gain knowledge of our research in this area. The information provided by the Bureau was instrumental in the industrial developer's decision to proceed with the centralized processing system. Since that time, the Bureau has developed an on-site (decentralized) process that we believe is economical. Joslyn Stainless Steel Company, Fort Wayne, Indiana, adopted the Bureau's process and is installing equipment to process a maximum of 15 tons per day. This will provide a good test of the economics of small-scale recycling of stainless steel wastes.

The problems associated with transfer of technology developed by the Bureau are referred to in several places in the report. The Bureau has always published results of its research in official Bureau series and technical journals. Bureau researchers make frequent presentations at technical society meetings and other appropriate

APPENDIX III

symposia. In the area of resource recovery, the Bureau has made very deliberate attempts at technology transfer. In 1968, the Bureau initiated the Mineral Waste Utilization Symposium which it has continued to sponsor since that time. This is recognized as one of the most successful of all forums dealing with recycling of solid wastes. An additional effort was made for a number of years by cosponsoring the Eco-Tech meetings with the National Association of Secondary Materials Industries (now the National Association of Recycling Industries). In order to improve the effectiveness of this relationship, in 1978 the Bureau and NARI entered into a formal agreement under which joint committees were established for the major secondary metals commodities. So far this is proving to be an extremely helpful association in regards to technology transfer. The Bureau is also well represented on the various subcommittees of the American Society for Testing and Materials E-38 Committee on Resource Recovery.

On pages 30 and 36 of the draft, an industry official suggests that resource recovery research can be improved by "providing better opportunities for joint research ventures with Government and among companies." We agree. Proposals to enter into joint ventures are carefully evaluated, particularly those which go from laboratory to pilot plant scale.

Much of the material necessary for a good report is in this draft. We suggest that the regulatory and subsidy approaches be treated separately, and that the cost effectiveness of some representative actions be estimated. Such estimates would provide a background for a discussion of the potential benefits of increased Federal research and development and other assistance programs.

Sincerely,

Sgd. [illegible]

Assistant Secretary
Policy, Budget and Administration

Enclosure

GAO note: The page numers in appendices II and III have been changed to conform with the page numbers in the final report.

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