THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Legal Compilation

Statutes and Legislative History
Executive Orders
Regulations
Guidelines and Reports

Supplement II
Volume I
Solid Waste

JANUARY 1974

RUSSEL E. TRAIN
Administrator

For sale by the Superintendent of Documents, U.S. Government Printing Office,
Washington, D.C. 20402. Price $2.20.
Stock Number 5500-00125

FOREWORD

America's journey to environmental awareness has been a relatively recent one. Not so many years ago Americans were still living under the illusion that a land as vast as ours was blessed with indestructible natural resources and beauty.

We continued the exploitation of those resources and scattered unplanned communities across huge areas of open space. Large amounts of fuel were needed for the autos that took us to work from distant suburbs, and the air became laden with their dense emissions. Pesticides were used indiscriminantly by persons unaware of their effects on the food chain of plants and animals. Our rivers became contaminated with waste from homes and industries. Our landscape was marred by litter.

As the environmentalist movement gained impetus, attention was focused on these matters. Rachael Carson's book, *Silent Spring,* in 1962 awakened Americans to the hazards of pesticides. The oil spills of the Torrey Canyon in 1967 and at Santa Barbara, California in 1969 dramatized another environmental hazard. The first Earth Day on April 20, 1970, a coordinated program of teach-ins across the nation, helped to focus Congressional attention on the strength of the environmental movement.

Congress responded by approving the President's Reorganization Plan No. 3 which expanded the federal commitment to environmental concerns and consolidated 15 Federal organizations under the Environmental Protection Agency.

At the same time, Congress began enacting far-reaching legislation to provide EPA with specific authority for controlling pollution. These measures included the Clean Air Amendments in 1970, and the Federal Water Pollution Control Act Amendments, Federal Environmental Pesticide Control Act, the Noise Control Act, and the Marine Protection, Research and Sanctuaries Act, all in 1972. Congress also passed the Resource Recovery Act in 1970 and extended the Solid Waste Disposal Act in 1973.

As the Agency began taking action under these laws, Americans gradually realized that very real changes were required in our accustomed ways of doing business. We realized that our effort frequently conflicted with powerful and legitimate interests in both the public and private sectors. Our administrative, judicial and political processes now have the task of resolving these conflicts.

They must do so by weighing all the interests which are affected in a sensitive and informed manner. Quick access to the legal dimensions of these problems is essential if conflicts are to be efficiently and fairly resolved.

The work of the present day environmentalist is less glamorous than that of four or five years ago, but it is essential if we are to face the continuing challenge of protecting our fragile and perishable natural resources—and ultimately ourselves—from destruction. I hope you will find this manual helpful as we strive to create a society where we can live and work in harmony with the natural world surrounding us.

Russell E. Train
Administrator
U.S. Environmental Protection Agency

PREFACE

Reorganization Plan No. 3 of 1970 transferred 15 governmental units with their functions and legal authority to create the U.S. Environmental Protection Agency. Since only the major laws were cited in the Plan, it was decided that a compilation of EPA legal authority be researched and published.

The publication has the primary function of providing a working document for the Agency itself. Secondarily, it will serve as a research tool for the public.

It is the hope of EPA that this set will assist in the awesome task of developing a better environment.

LANE R. WARD, J. D.
Office of Executive Secretariat
Office of Administrator
U.S. Environmental Protection Agency

INSTRUCTIONS

The goal of this text is to create a useful compilation of the legal authority under which the U.S. Environmental Protection Agency operates. These documents are for the general use of personnel of the EPA in assisting them in attaining the purposes set out by the President in creating the Agency. This work is not intended and should not be used for legal citations or any use other than as reference of a general nature. The author disclaims all responsibility for liabilities growing out of the use of these materials contrary to their intended purpose. Moreover, it should be noted that portions of the Congressional Record from the 93rd Congress were extracted from the "unofficial" daily version and are subject to subsequent modification.

EPA Legal Compilation consists of the Statutes with their legislative history, Executive Orders, Regulations, Guidelines and Reports. To facilitate the usefulness of this composite, the Legal Compilation is divided into the seven following chapters:

A. General
B. Air
C. Water
D. Solid Waste
E. Pesticides
F. Radiation
G. Noise

SUPPLEMENT II

This edition, labelled "Supplement II," contains the additions to and alterations of EPA legal authority not included in the original set or Supplement I of the EPA Legal Compilation. Therefore, this edition updates the Compilation through the 93rd Congress, First Session.

SUBCHAPTERS

Statutes and Legislative History

For convenience, the Statutes are listed throughout the Compilation by a one-point system, i.e., 1.1, 1.2, 1.3, etc., and Legislative History begins wherever a letter follows the one-point system. Thus, any 1.1a, 1.1b, 1.2a, etc., denotes the public laws comprising the 1.1, 1.2 statute. Each public law is followed by its legislative history. The legislative history in each case consists of the House Report, Senate Report, Conference Report (where applicable), the Congressional Record beginning with the time the bill was reported from committee.

Example:

1.4 Amortization of Pollution Control Facilities, as amended, 26 U.S.C. §169 (1969).
    1.4a Amortization of Pollution Control Facilities, December 30, 1969, P.L. 91-172, §704, 83 Stat. 667.
        (1) House Committee on Ways and Means, H.R. REP. No. 91-413 (Part I), 91st Cong., 1st Sess. (1969).
        (2) House Committee on Ways and Means, H.R. REP. No. 91-413 (Part II), 91st Cong., 1st Sess. (1969).
        (3) Senate Committee on Finance, S. REP. No. 91-552, 91st Cong., 1st Sess. (1969).
        (4) Committee of Conference, H.R. REP. No. 91-782, 91st Cong., 1st Sess. (1969).
        (5) Congressional Record, Vol. 115 (1969):
            (a) Aug. 7: Debated and passed House, pp. 22746, 22774-22775;
            (b) Nov. 24, Dec. 5, 8, 9: Debated and passed Senate, pp. 354586, 37321-37322, 37631-37633, 37884-37888;
            (c) Dec. 22: Senate agrees to conference report, p. 40718;*
            (d) Dec. 22: House debates and agrees to conference report, pp. 40820, 40900.

This example not only demonstrates the pattern followed for legislative history, but indicates the procedure where only one section of a public law appears. You will note that the Congressional Record cited pages are only those pages dealing with the discussion and/or action taken pertinent to the section of law applicable to EPA. In the event there is no discussion of the pertinent section, only action or passage, then the asterisk (*) is used to so indicate, and no text is reprinted in the Compilation. In regard to the situation where only one section of a public law is applicable, then only the parts of the report dealing with that section are printed in the Compilation.

Secondary Statutes

Many statutes make reference to other laws and rather than have this manual serve only for major statutes, these secondary statutes have been included where practical. These secondary statutes are indicated in the table of contents to each chapter by a bracketed cite to the particular section of the major Act which made the reference.

Citations

The United States Code, being the official citation, is used throughout the Statute section of the Compilation. In four Statutes, a parallel table to the Statutes at Large is provided for your convenience.

EXECUTIVE ORDERS

The Executive Orders are listed by a two-point system (2.1, 2.2, etc.).

REGULATIONS

The Regulations are noted by a three-point system (3.1, 3.2, etc.). Included in the Regulations are those not only promulgated by the Environmental Protection Agency, but those under which the Agency has direct contact.

GUIDELINES AND REPORTS

This subchapter is noted by a four-point system (4.1, 4.2, etc.). In this subchapter is found the statutorily required reports of EPA, published guidelines of EPA, selected reports other than EPA's and inter-departmental agreements of note.

UPDATING

Periodically, a supplement will be sent to the interagency distribution and made available through the U.S. Government Printing Office in order to provide a current and accurate working set of EPA Legal Compilation.

CONTENTS

VOLUME I

SOLID WASTE

Statutes and Legislative History

1.1 THE SOLID WASTE DISPOSAL ACT, AS AMENDED

42 U.S.C. §3251 *et seq.*

§ 3259. Authorization of appropriations

(a) (1) * * *

* * * * * * * * * *

(2) There are authorized to be appropriated to the Administrator of the Environmental Protection Agency to carry out the provisions of this chapter, other than section 3254b of this title, not to exceed $72,000,000 for the fiscal year ending June 30, 1972, not to exceed $76,000,000 for the fiscal year ending June 30, 1973, and not to exceed $76,000,000 for the fiscal year ending June 30, 1974.

(3) There are authorized to be appropriated to the Administrator of the Environmental Protection Agency to carry out section 3254b of this title not to exceed $80,000,000 for the fiscal year ending June 30, 1972, not to exceed $140,000,000 for the fiscal year ending June 30, 1973, and not to exceed $140,000,000 for the fiscal year ending June 30, 1974.

(b) There are authorized to be appropriated to the Secretary of the Interior to carry out this chapter not to exceed $8,750,000 for the fiscal year ending June 30, 1971, not to exceed $20,000,000 for the fiscal year ending June 30, 1972, not to exceed $22,500,000 for the fiscal year ending June 30, 1973, and not to exceed $22,500,000 for the fiscal year ending June 30, 1974. Prior to expending any funds authorized to be appropriated by this subsection, the Secretary of the Interior shall consult with the Secretary of Health, Education, and Welfare to assure that the expenditure of such funds will be consistent with the purposes of this chapter.

* * * * * * * * * *

As amended Pub.L. 93–14, Apr. 9, 1973, 87 Stat. 11.

1.1e SOLID WASTE DISPOSAL ACT EXTENSION

April 9, 1973, P.L. 93–14, 87 Stat. 11.

An Act

To extend the Solid Waste Disposal Act, as amended, for one year.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That (a) paragraph (2) of subsection (a) of section 216 of the Solid Waste Disposal Act, as amended (84 Stat. 1234), is amended to read as follows:

"(2) There are authorized to be appropriated to the Administrator of the Environmental Protection Agency to carry out the provisions of this Act, other than section 208, not to exceed $72,000,000 for the fiscal year ending June 30, 1972, not to exceed $76,000,000 for the fiscal year ending June 30, 1973, and not to exceed $76,000,000 for the fiscal year ending June 30, 1974."

(b) Paragraph (3) of subsection (a) of section 216 of the Solid Waste Disposal Act, as amended (84 Stat. 1234), is amended to read as follows:

"(3) There are authorized to be appropriated to the Administrator of the Environmental Protection Agency to carry out section 208 of this Act not to exceed $80,000,000 for the fiscal year ending June 30, 1972, not to exceed $140,000,000 for the fiscal year ending June 30, 1973, and not to exceed $140,000,000 for the fiscal year ending June 30, 1974."

(c) Subsection (b) of section 216 of the Solid Waste Disposal Act, as amended (84 Stat. 1234), is amended by striking "and not to exceed $22,500,000 for the fiscal year ending June 30, 1973." and inserting in lieu thereof ", not to exceed $22,500,000 for the fiscal year ending June 30, 1973, and not to exceed $22,500,000 for the fiscal year ending June 30, 1974."

[p. 1]

1.1e(1) HOUSE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE, H.R. REP. NO. 93–78, 93RD CONG., 1ST SESS. (1973)

SOLID WASTE DISPOSAL ACT EXTENSION

MARCH 15, 1973.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

---

Mr. STAGGERS, from the Committee on Interstate and Foreign Commerce, submitted the following

REPORT

[To accompany H.R. 5446]

The Committee on Interstate and Foreign Commerce, to whom was referred the bill (H.R. 5446) to extend the Solid Waste Disposal Act, as amended, for 1 year, having considered the same, report favorably thereon without amendment and recommend that the bill do pass.

SUMMARY OF LEGISLATION

H.R. 5446 provides a 1-year extension of the Solid Waste Disposal Act of 1967 (as amended by the Resource Recovery Act of 1970) by extending for 1 year at constant dollar amounts the authorizations of appropriations in the act which would otherwise expire June 30, 1973.

BACKGROUND

Hearings were held on the proposed legislation on February 26, 1973, at which time all testimony heard was favorable to the legislation. The bill was ordered reported from the House Committee on Interstate and Foreign Commerce without amendment by unanimous voice vote.

COST OF LEGISLATION

The authorizations of appropriations adopted by the committee for fiscal year 1974 are identical to those in the present law for fiscal year 1973, as follows:

Authorizations of appropriations

Sec. 216(a).	General authority	$ 76,000,000
Sec. 208.	Research and development grants	140,000,000
Sec. 216(b).	Department of the Interior	22,500,000
	Total	238,500,000

[p. 1]

NEED FOR LEGISLATION

The funding authorizations for the Solid Waste Disposal Act expired on June 30, 1973. The Committee on Interstate and Foreign Commerce plans extensive oversight and legislative hearings on this act to examine the many policy issues which have arisen since passage of the act in 1970. Adequate time for responsible hearings is not available before June 30, 1973. Therefore, the committee feels that a 1-year extension of the programs provided for in the act is necessary to allow their careful and responsible consideration.

The committee also feels that clarity as to the fiscal year 1974 funding authorizations is necessary, as early in the 93d Congress as possible, to provide guidance to the administration and the Congress in budgeting and appropriating funds for these very important programs.

SECTION-BY-SECTION ANALYSIS

The legislation reported extends at constant authorizations each of the three funding authorizations in the Solid Waste Disposal Act by adding an authorization for fiscal year 1974 after each authorization for 1973 which in each case is identical to the 1973 authorization. The legislation also substitutes reference to the Administrator of the Environmental Protection Agency for reference to the Secretary of Health, Education, and Welfare to recognize and conform to the changes effected by Reorganization Plan No. 3 of 1970.

AGENCY REPORTS

Agency reports are not yet available on H.R. 5446. However, the following report concerning H.R. 4306 also applies to H.R. 5446 in that the provisions for extension of the Solid Waste Disposal Act contained in H.R. 4306 are identical to those in the reported legislation.

U.S. ENVIRONMENTAL PROTECTION AGENCY,
Washington, D.C., March 9, 1973.

Hon. HARLEY O. STAGGERS,
Chairman, Committee of Interstate and Foreign Commerce, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is in reply to your request for the comments of the Environmental Protection Agency on H.R. 4306, "To extend the Solid Waste Disposal Act, as amended, and the Clean Air Act, as amended for 1 year."

We recommend that the bill be enacted.

On Monday, February 26, 1973, David D. Dominick, Assistant Administrator for Categorical Programs, Environmental Protection Agency, testified before your Subcommittee on Public Health and the Environment on the matter of extending the Solid Waste Disposal Act, and on February 28, I testified before the same subcommittee on the Clean Air Act extension. The statements Mr. Dominick and I made, articulated our position on the extension proposed by H.R. 4306. Copies of these statements are enclosed.

Sincerely yours,

WILLIAM D. RUCKELSHAUS,
Administrator.

Enclosures.

[p. 2]

CHANGES IN EXISTING LAW MADE BY THE BILL, AS REPORTED

In compliance with clause 3 of rule XIII of the Rules of the House of Representatives, changes in existing law made by the bill, as reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italic, existing law in which no change is proposed is shown in roman):

SOLID WASTE DISPOSAL ACT

* * * * * * *

TITLE II—SOLID WASTE DISPOSAL

* * * * * * *

APPROPRIATIONS

SEC. 216. (a) (1) There are authorized to be appropriated to the Secretary of Health, Education, and Welfare for carrying out the provisions of this Act (including, but not limited to, section 208), not to exceed $41,500,000 for the fiscal year ending June 30, 1971.

(2) There are authorized to be appropriated to the [Secretary of Health, Education, and Welfare] *Administrator of the Environmental Protection Agency* to carry out the provisions of this Act, other than section 208, not to exceed $72,000,000 for the fiscal year ending June 30, 1972, [and] not to exceed $76,000,000 for the fiscal year ending June 30, [1973.] *1973, and not to exceed $76,000,000 for the fiscal year ending June 30, 1974.*

(3) There are authorized to be appropriated to the [Secretary of Health, Education, and Welfare] *Administrator of the Environmental Protection Agency* to carry out section 208 of this Act not to exceed $80,000,000 for the fiscal year ending June 30, 1972, [and] not to exceed $140,000,000 for the fiscal year ending June 30, [1973.] *1973, and not to exceed $140,000,000 for the fiscal year ending June 30, 1974.*

(b) There are authorized to be appropriated to the Secretary of the Interior to carry out this Act not to exceed $8,750,000 for the fiscal year ending June 30, 1971, not to exceed $20,000,000 for the fiscal year ending June 30, 1972, [and] not to exceed $22,500,000 for the fiscal year ending June 30, [1973.] *1973, and not to exceed $22,500,000 for the fiscal year ending June 30, 1974.* Prior to expending any funds authorized to be appropriated by this subsection, the Secretary of the Interior shall consult with the Secretary of Health, Education, and Welfare to assure that the expenditure of such funds will be consistent with the purposes of this Act.

* * * * * * *

[p. 3]

1.1e (2) CONGRESSIONAL RECORD, VOL. 119 (1973):

1.1e(2)(a) March 21: Considered and passed House, pp. H2000–H2007

SOLID WASTE DISPOSAL ACT EXTENSION

Mr. MATSUNAGA. Mr. Speaker, by direction of the Committee on Rules, I call up House Resolution 315 and ask for its immediate consideration.

The Clerk read the resolution as follows:

H. RES. 315

Resolved, That upon the adoption of this resolution it shall be in order to move that the House resolve itself into the Committee of the Whole House on the State of the Union for the consideration of the bill (H.R. 5446) to extend the Solid Waste Disposal Act, as amended for one year. After general debate, which shall be confined to the bill and shall continue not to exceed one hour, to be equally divided and controlled by the chairman and ranking minority member of the Committee on Interstate and Foreign Commerce, the bill shall be read for amendment under the five-minute rule. At the conclusion of the consideration of the bill for amendment, the Committee shall rise and report the bill to the House with such amendments as may have been adopted, and the previous question shall be considered as ordered on the bill and amendments thereto to final passage without intervening motion except one motion to recommit.

The SPEAKER. The gentleman from Hawaii (Mr. MATSUNAGA) is recognized for 1 hour.

Mr. MATSUNAGA. Mr. Speaker, I yield 30 minutes to the gentleman from Tennessee (Mr. QUILLEN) pending which I yield myself such time as I may consume.

(Mr. MATSUNAGA asked and was given permission to revise and extend his remarks.)

Mr. MATSUNAGA. Mr. Speaker, House Resolution 315 provides for consideration of the bill H.R. 5446, which, as reported by unanimous voice vote from our Committee on Interstate and Foreign Commerce, would extend the Solid Waste Disposal Act for 1 year and authorize appropriations for fiscal year 1974 at the fiscal year 1973 level. The current law, which expires on June 30, 1973, authorizes appropriations in three categories:

First, the sum of $76 million to the Environmental Protection Agency for the development of new recycling and waste disposal techniques and for grants to State and local agencies for the development of areawide disposal plans;

Second, the sum of $140 million for grants to States and municipalities for the demonstration of resource recovery systems and for the construction of solid waste disposal facilities; and

Third, the sum of $22.5 million to the Department of the Interior for research and demonstration projects on the disposal of mining wastes.

Because the committee plans extensive oversight and legislative hearings on the Solid Waste Disposal Act to examine in depth the many policy issues which have arisen since the act was last amended in 1970, the 1-year extension is necessary to allow the committee's careful and responsible consideration of these issues. Adequate time is not available to the committee before June 30, 1973.

The committee also believes that in order to give uninterrupted life to the solid waste disposal programs, the funding authorization for fiscal year 1974 should be established as early in the 93d Congress as possible.

Passage of H.R. 5446 is imperative

[p. H2000]

for the continued improvement of our environment. If we should allow funding of these programs to lapse until committee hearings can be held, we would be making a grave mistake. And if the President refuses to adequately fund solid waste disposal programs after Congress authorizes and appropriates for such expenditures, he will be negligent in providing for the Nation's needs. In this regard, it is to be noted that the administration, while favoring the continuation of the Solid Waste Disposal Act, budgeted only $6.2 million to carry out the various programs under that act in fiscal year 1974.

Mr. Speaker, House Resolution 315 provides an open rule with 1 hour of general debate, the time to be equally divided and controlled by the chairman and ranking minority member of the committee on Interstate and Foreign Commerce, after which the bill shall be read for amendment under the 5-minute rule. At the conclusion of the consideration of the bill for amendment, the Committee of the Whole House shall rise and report the bill to the House with such amendments as may have been adopted, and the previous question shall be considered as ordered on the bill and amendments thereto to final passage without intervening motion except one motion to recommit.

Mr. Speaker, I urge the adoption of House Resolution 315 in order that H.R. 5446 may be considered.

(Mr. QUILLEN asked and was

given permission to revise and extend his remarks.)

Mr. QUILLEN. Mr. Speaker, I yield myself such time as I may consume.

Mr. Speaker, House Resolution 315 provides an open rule with 1 hour of general debate for the consideration of H.R. 5446.

The purpose of H.R. 5446 is to provide a 1-year extension of the Solid Waste Disposal Act. The present authorization expires on June 30, 1973.

The bill provides fiscal year 1974 authorizations at the same level as fiscal year 1973. The cost of this bill for fiscal year 1974 is $238,500,000.

The 1-year extension will allow the Committee on Interstate and Foreign Commerce sufficient time to hold extensive hearings before altering present programs.

The administration supports this 1-year extension of the present program.

Mr. Speaker I urge adoption of this resolution.

Mr. Speaker, I have no requests for time, and I reserve the balance of my time.

Mr. MATSUNAGA. Mr. Speaker, I move the previous question on the resolution.

The previous question was ordered.

The resolution was agreed to.

A motion to reconsider was laid on the table.

Mr. STAGGERS. Mr. Speaker, I move that the House resolve itself into the Committee of the Whole House on the State of the Union for the consideration of the bill (H.R. 5446) to extend the Solid Waste Disposal Act, as amended, for 1 year.

The SPEAKER. The question is on the motion offered by the gentleman from West Virginia (Mr. STAGGERS).

The motion was agreed to.

IN THE COMMITTEE OF THE WHOLE

Accordingly the House resolved itself into the Committee of the Whole House on the State of the Union for the consideration of the bill H.R. 5446, with Mr. FOLEY in the chair.

The Clerk read the title of the bill.

By unanimous consent, the first reading of the bill was dispensed with.

The CHAIRMAN. Under the rule, the gentleman from West Virginia (Mr. STAGGERS) will be recognized for 30 minutes, and the gentleman from Minnesota (Mr. NELSEN) will be recognized for 30 minutes.

The Chair recognizes the gentleman from West Virginia.

Mr. STAGGERS. Mr. Chairman, I would like briefly to explain the bill. It came out of the subcommittee unanimously, out of the full committee unanimously, and when this act was passed in 1970 there was a rollcall taken and the vote was 337 to 0, so we can see that it has universal support.

We are not here to discuss the bill because all we are asking for is an extension. I will briefly discuss what the bill has, although I do not think it is necessary at this time, because all we are asking for is a simple extension of the act as it was passed in 1970 since it expires July 1 of this year. We would not have time to go into it comprehensively and make the changes that are probably needed, hear the witnesses, and then bring the bill up in time to get it passed.

I might say that the Senate has passed an identical bill, and sent it over to us. All we are asking is for this extension, as I say, until July 1 of 1974.

When we passed the bill in 1970, we had a Commission appointed, the National Commission on Materials Policy, to make a complete study of this subject throughout the United States and report back to the Congress by July 1 of this year. We do not have the advantage of having that report yet and will not until July 1. That is another reason why we are not attempting to pass a new bill now but simply an extension to give us time until we get the report back.

Mr. Ruckelshaus appeared before the committee and was in complete support of the bill. He recommended its passage. The money and everything in the bill is identical with the reading of the bill as it was in 1970, with the exception that we changed the dates to 1974 instead of 1973.

I will just briefly explain what the bill does. It gives a certain amount of money to the States to set up their own systems of disposal of solid waste material. Several States have their plans now in working order and several have their plans in the planning stage yet. Part of the bill also goes to help, through technical assistance, cities and communities which are planning their own solutions to their own problems, and part of the bill goes toward setting up demonstration plants across the country; research and demonstration plants.

An example of one of these cities is Cleveland which is working very well. The Federal Government through its representatives helped Cleveland to go over its whole system for collection of garbage and waste material day by day and devise ways to dispose of it more efficiently and at less cost. This is working well as one of the demonstrations.

We also have a demonstration working in St. Louis. There, one of the public utilities, I believe the St. Louis Electric Power Co., is demonstrating the use of waste material to generate electrical energy. They are converting waste material into something useful through this project.

We are trying to do these things all over the country in fact. In other projects glass is being recycled and is being used in the building of roads. We are also trying to utilize the old cars in America in useful ways. Tin and aluminum cans are being brought in to be recycled. Some of the paper I have on my desk here is recycled paper. These are concrete examples we see as to how effective the program has been. It is useful. That is the reason we are asking Congress today to extend this for 1 year.

Just by simple arithmetic we can comprehend how the amount of solid waste produced in America by the year 2000 would not leave us any place to go or any useful way of living if we did not convert it in some way. It would run into the billions of pounds per year. The problem had gotten to such a point in 1965, when we passed the original bill, that we recognized something must be done to cope with the increasing wastes in America. We have already developed additional ways of using the disposable bottles and cans and the old automobiles that are left in this country, as well as the garbage produced in our homes.

As I say, this has been a very useful program, one that has already proven it is useful and needed, and for that reason the committee recommends passage of this bill.

Mr. ROUSSELOT. Mr. Chairman, will the gentleman yield?

Mr. STAGGERS. I yield to the gentleman from California.

Mr. ROUSSELOT. Mr. Chairman, I know that the distinguished chairman of this committee is very conscientious about making sure that the Interstate and Foreign Commerce Committee offers bills authorizing only those that are realistically close to needed appropriated dollars. I know the Appropriations Committee is very concerned about this matter. It is my understanding that the administration is planning or thinking of asking roughly between $5 and $6 million to be actually spent in this particular program. Why is the committee asking for an authorization of $238 million? Is that not the kind of "overpromise" and "overcommitment" that we are trying to avoid?

Mr. STAGGERS. I suggest the gentleman look at the realities of the situation.

Mr. ROUSSELOT. I am trying to.

Mr. STAGGERS. If the gentleman will bear with me, the Senate has passed a simple extension. We are doing this because we are waiting for a report which will be coming in on July 1 this year from the Commission. The

[H 2001]

administration does not have control of that and neither do we. The President appointed everyone of those members with the approval of the Senate. We hope this is what the administration is waiting for. The administration and the gentleman and I know this is one of the most important methods we have today of taking care of the solid waste disposal problem.

Mr. ROUSSELOT. I do not think any of us disagree on that subject, but we are talking about the dollars actually needed.

Mr. STAGGERS. I will get to that. If we start changing this now from what it was, regardless of what the Committee on Appropriations comes up with, and I hope they will come up with more money than they did last year since the need for it is there and it has been shown by some of the examples which I stated heretofore that it is a useful thing; that it is doing good for the land; we certainly would want to, during the next year when we are going to study the problem and come back with new legistation after we have had the recommendations of the Commission which has studied this problem for 3 years then we want to be sure it is funded enough to take care of that.

Mr. ROUSSELOT. Mr. Chairman, will the gentleman yield?

Mr. STAGGERS. I yield to the gentleman from California.

Mr. ROUSSELOT. I thank the gentleman for yielding. I do not disagree with the idea of extending this act for 1 year. I do not disagree with the wisdom of the committee in waiting for the additional studies to be completed and wanting to have additional hearings to see what is really needed. But what I do not understand and where I think we as a Congress err, is when we constantly ask in an authorizing bill for so many millions of dollars more than are actually needed, and then when the Committee on Appropriations comes along and only appropriates, say $5 or $10 million for this in the authorizing bill, and the whole House have asked for $238 million, it makes us look just plain stupid.

Mr. STAGGERS. Just a minute. I do not like that word.

Mr. ROUSSELOT. Well, all right. That is my word. As to the position it places this body, when nobody seems to actually believe that amount of $238 million is needed.

Mr. STAGGERS. We are being realistic. We do not know what they are going to ask for later and what they are going to need. We are not changing the law. All we are asking for is to extend this for 1 year.

Mr. ROUSSELOT. I said that I agree with the chairman, that the act should be extended for 1 year.

Mr. STAGGERS. Why should we start changing it?

Mr. ROUSSELOT. Why should we ask, though, for $238 million?

Mr. STAGGERS. Who is the gentleman from California to say what we are going to ask for? Does the gentleman mean to say that if we had to have it—

Mr. ROUSSELOT. We can refer to the actual dollars spent this year under this act. It is no where near $238 million.

Mr. STAGGERS. I have heard that story too many times; too late and too little.

Let us have it. If they do not need it they will not use it and it will not cost the Government anything; it will not cost the gentleman's taxpayers 1 cent more, or any place in the country.

The gentleman might call it stupid if he wants to.

Mr. ROUSSELOT. I believe that is stupid to ask for $238 million in an authorization bill when we know in advance that we are only going to spend $5 *to* $6 *million.*

Mr. STAGGERS. We do not know that at all.

Mr. ROUSSELOT. That is the report that has been given to me as to what has been asked for in the budget.

Mr. STAGGERS. I know what is asked for, but we do not know what is going to be spent before the end of the year. If the gentleman from California does know, he is a wiser man than I am.

Mr. ROUSSELOT. My understanding is that this is all that will be spent of this authorization.

Mr. STAGGERS. Is the gentleman speaking for the Committee on Appropriations?

Mr. ROUSSELOT. No, I certainly am not.

Mr. STAGGERS. In that case, I should not be speaking at all; not saying anything about it.

Mr. ROUSSELOT. I have never pretended to speak for the Committee on Appropriations. I am merely looking at the record of actual expenditure this last year and what the administration says it will spend this year.

Mr. STAGGERS. Is the gentleman speaking for the administration?

Mr. ROUSSELOT. No, I am asking a question of the gentleman from West Virginia (Mr. STAGGERS). He is an able legislator and man of facts.

Mr. STAGGERS. How does the gentleman know what the Committee on Appropriations is going to do?

Mr. ROUSSELOT. My understanding is—

Mr. STAGGERS. From whom?

Mr. ROUSSELOT. It was made clear that the rough amount of dollars which will be needed to institute this program will be roughly between $5 and $6 million.

Mr. STAGGERS. The gentleman understands that from whom?

Mr. ROUSSELOT. Well, if the gentleman wishes me to say, by able colleagues here on the committee, on the *gentleman's subcommittee.*

Mr. STAGGERS. Let me state that the appointee of the President appeared before the committee and recommended the passage of this bill as it is now.

Mr. ROUSSELOT. I understand that they primarily testified for a straight extension of the act.

Mr. STAGGERS. Yes, an extension, and not to change it, and that is all we are doing.

Mr. ROUSSELOT. But that does not mean that we cannot ask questions.

Mr. STAGGERS. That is right. I do not mind the gentleman asking questions.

Mr. ROUSSELOT. I said that it appears to me to be very stupid to ask for $238 million when only $5 or $6 million will be used.

Mr. STAGGERS. What would the gentleman do when we change the bill, when they said they wanted an extension?

Mr. ROUSSELOT. This agency is *only going to spend $5 or $6 million.*

Mr. STAGGERS. I am asking the gentleman a question. I want to ask, what would the gentleman do if he had been asked to extend the bill by the administration? What would he do?

Mr. ROUSSELOT. I would be happy to respond. I would extend the act for a year and include $10 or $15 million authorization, which would be more than adequate to cover any unusual contingencies.

Mr. STAGGERS. Oh, the gentleman is going that way.

Mr. ROUSSELOT. If the gentleman will yield further, it would provide the extra amount of authorization, even above what is being asked for, without a recommendation.

Mr. STAGGERS. It would not be an *extension.* That would be a substantive change in the bill. What we have done is just exactly extend it for 1 year.

Mr. ROUSSELOT. I thank the gentleman for yielding. I am sorry; I do not really feel I obtained an answer to my reasonable question.

Mr. ROGERS. Mr. Chairman, will the gentleman yield?

Mr. STAGGERS. I am happy to yield to the gentleman from Florida, the chairman of the subcommittee.

(Mr. ROGERS asked and was given permission to revise and extend his remarks.)

Mr. ROGERS. Mr. Chairman, I rise in support of H.R. 4292, which will provide a simple, 1-year extension of the Solid Waste Disposal Act. The funding provisions of the act expire on June 30, 1973, and it simply will be impossible for the Subcommittee on Public Health and Environment to afford ample consideration to substantive changes in the act prior to that time.

This is true for two reasons, Mr. Chairman. In the first place, there are 12 health bills under the jurisdiction of the subcommittee that expire at the end of this fiscal year. Many of these programs are the subject of intense attack from the executive branch. In fact, in some instances, the administration is seeking to dismantle these programs before the subcommittee can act to extend, revise, or terminate them. In order to protect the prerogatives of the Congress, our subcommittee must commit the next 3 months to these health programs.

Secondly, Mr. Chairman, this action is necessary because of the tardiness of a series of reports to the Congress which were to serve as aids to the subcommittee in developing new solid waste disposal legislation. One series, mandated by section 205 of the act, was to be on resource recovery. The first annual report was not released until 28 months after enactment of the law and 16 months after the report was due. It was completed by EPA last summer, forwarded to the Office of Management and Budget on August

[H 2002]

24, 1973, held up by OMB for more than 6 months, and finally submitted to the subcommittee on February 22 of this year. The section 210 report was to have been submitted to the Congress in October of 1971. It was submitted in January of 1973. The section 212 report, due October 1972, is scheduled to be submitted to the Congress on June 30, 1973, hardly in time for the subcommittee to use its information and recommendations to develop new legislation.

The administration has submitted to the Congress both through its budget and recommended new legislation its recommendations for solid waste disposal activities. In simple terms the administration's legislative program proposes Federal guidelines for State and local solid waste disposal programs but no new money for demonstration programs. It provides that the Federal Government would provide only technical assistance for the development of new waste disposal systems.

The EPA budget for fiscal year 1974 in the solid waste field is the most substantial reduction in the history of environmental legislation. It has decreased from over $30 million last year to under $6 million this year. My initial impression of the administration proposal is that it certainly needs substantial review and probably is inadequate to deal with the problem. I assure my colleagues that the Subcommittee on Public Health and Environment will consider the problems of solid waste disposal and resource recovery at length later this year.

Now, with respect to the remarks of the gentleman from California, I should like to point out to the gentleman, in conjunction with what the chairman has said, that we simply are proposing extending this bill in order to give the committee time to look and see what needs to be done.

Mr. ROUSSELOT. I want to make

it clear, I do not disagree with the simple extension of this act at all.

Mr. ROGERS. I would hope the gentleman would not. He has problems in California, and he knows that funds properly invested here might even help the California situation with respect to air pollution.

Mr. ROUSSELOT. Fine.

Mr. ROGERS. The gentleman probably does not know that production of paper from secondary fibers, through recycling, instead of production from virgin wood pulp, takes about 60 percent less energy and will dump some 15 percent less pollutants into the water and 60 percent less into the air. In steel production, by using scrap, air pollution is cut 86 percent. We find this can be done in so many areas.

The gentleman comes from a State where they have one of the most severe air pollution problems in the Nation.

Mr. ROUSSELOT. I understand that.

Mr. ROGERS. I would think the gentleman would urge this committee to extend the law. Then, if we find it is necessary to come to the House, we perhaps might go over the $5 million recommended in the budget. The gentleman might support it and support it strongly, even to the amount the Administrator himself has supported by this extension.

Mr. ROUSSELOT. Mr. Chairman, will the gentleman yield?

Mr. ROGERS. I hope the gentleman understands the position of the committee very clearly.

Mr. ROUSSELOT. Will the gentleman yield?

Mr. ROGERS. Certainly, I yield to the gentleman from California.

Mr. ROUSSELOT. I am familiar with much of the material from which the gentleman was quoting. I have read the same article.

I am in complete agreement that this is a high priority area. We are very aware of it in California.

Of course, when we talk about air pollution, in respect to this bill that is really another covered by other acts because we are talking about solid waste disposal in the bill before us. I am not speaking as to whether we do or do not extend the act. I favor extending the act.

I believe the gentleman from Florida might be able to help us, because it was his subcommittee which considered this bill. My question was why it is necessary to authorize $238 million when it is very likely only $5 or $6 million will actually be spent. The chairman of the committee very graciously asked me what I would do. My answer to his question is, were I on the committee I believe I would move to strike the figure $238 million and to make it $15 or $20 million, because that would be more than adequate as an excess above the $5 or $6 million that is to be spent.

Mr. ROGERS. Would the gentleman permit an interruption at that point?

Mr. ROUSSELOT. Certainly.

Mr. ROGERS. Does the gentleman know the Congress appropriated $36 million last year?

Mr. ROUSSELOT. Yes.

Mr. ROGERS. And we are now going to hold them to $15 million?

Mr. ROUSSELOT. Yes.

Mr. ROGERS. We may want to go to $36 million. We may want to go to $200 million, if we find there are breakthroughs.

Mr. ROUSSELOT. Can we not come back to the basic question?

Mr. ROGERS. This is what we want to consider.

Mr. ROUSSELOT. I know the gentleman is a very able legislator. Could we not come back to obtain that that kind of increase. We are only talking about a 1-year extension.

Mr. ROGERS. This is in conformance with what the administration asked, which was just to give them a 1-year extension, until the committee can consider this.

Mr. ROUSSELOT. Let me make my point once more.

Mr. ROGERS. Yes.

Mr. ROUSSELOT. I believe the charge is made that sometimes Congress, in its deliberations and in its process of authorizing and writing programs, over asks for dollars that it is not going to spend. I believe it makes a mistake in doing it that way, and it puts added pressure, in my opinion, on the Appropriations Committee, which I do not believe is warranted. It also creates a misleading impression with the general public.

That is the only point I was trying to make.

Mr. ROGERS. I understand the gentleman. I believe the gentleman supported the bill when it was before the House previously.

Mr. ROUSSELOT. I did.

Mr. ROGERS. With all these figures in it. He could have offered amendments at that time.

Mr. ROUSSELOT. Would the gentleman from Florida disagree to an amendment that would be offered to amend the figure down in this bill, to reduce it down to $38 million as an authorization?

Mr. ROGERS. At this time I would oppose that.

Mr. ROUSSELOT. That is difficult reasoning to understand.

Mr. ROGERS. This is a very important extension. Now, we are not sure what revisions are necessary yet —we are waiting for the reports which are late coming in—and the administration may want to come in with a supplemental request as soon as the reports are in.

Mr. ROUSSELOT. I know the gentleman from Florida is a very able legislator. However, there is a tremendous difference between $5 and $6 million and $238 million. I am sure, with his able staff and his able committee, they can come up with a better estimate as to what will be needed than this figure of $238 million, which is way above $5 or $6 million.

Mr. Chairman, this is my only point.

Mr. ROGERS. Mr. Chairman, I understand the gentleman's point, and I simply say it is not valid at this time.

Mr. NELSEN. Mr. Chairman, will the gentleman yield?

Mr. ROGERS. I yield to the gentleman from Minnesota (Mr. NELSEN).

Mr. NELSEN. Mr. Chairman, I think the colloquy has been valuable, because many times an authorization in an act leads people to assume money to be available that really finally turns out not to be available. However, I would like to suggest that we pass this proposal in its present form for these reasons:

No. 1, it is only a 1-year extension; and No. 2, on the second page of the report, the committee states very plainly that we plan oversight on this program, and with the idea that it needs clarification to determine whether this program should continue.

Next, we have the recommendation from Mr. Ruckelshaus suggesting the 1-year extension.

Mr. Chairman, all of these things point toward what my good friend, the gentleman from California (Mr. ROUSSELOT) talked about, as to the total budget, as to his thinking that we ought to look at it a little more reasonably when making the final decisions.

Mr. Chairman, I do hope the bill passes in its present form, and I recommend its passage.

Mr. WYLIE. Mr. Chairman, will the gentleman yield,

Mr. ROGERS. I yield to the gentleman.

Mr. WYLIE. The gentleman has in-

[H 2003]

dicated this bill provides just a 1-year extension in authorization.

Mr. NELSEN. Yes.

Mr. WYLIE. And that was the suggestion made by the able chairman of the committee, Mr. STAGGERS.

I wonder if the gentleman would clarify something for me on funding procedures, which I do not understand.

In H.R. 5446, on the first page it says:

There are authorized to be appropriated . . . not to exceed $72,000,000 for the fiscal year ending June 30, 1972—

Which has already passed—

not to exceed $76,000,000 for the fiscal year ending June 30, 1973——

Which ends on June 30 of this year—

and not to exceed $76,000,000 for the fiscal year ending June 30, 1974.

Mr. Chairman, that refers to paragraph 2. Then the same procedure is repeated in the other two paragraphs.

May I ask the gentleman, did we authorize $72,000,000 for the fiscal year ending June 30, 1972, and if so, why do we need to have it repeated here?

Mr. NELSEN. I will yield later to the chairman of the committee, if he would in detail explain this. However, it is my understanding that the way the bill was drawn, it was just a means of feathering out the dollars that are in the authorization. It is a matter of drafting style only.

Mr. Chairman, I will defer to the chairman of the committee for a further explanation.

Mr. STAGGERS. Yes. I would say to the gentleman that this is exactly what was in the original bill, and we just repeated it for those purposes.

Mr. WYLIE. Mr. Chairman, I understand that, but those fiscal years have already passed, at least one of them has already passed, and there has been an appropriation pursuant to that authorization which has been spent.

Now, is this an add-on ratification procedure so that we can say there is this much money being authorized, and, therefore, we have to meet the full funding need through the appropriations procedure?

If this is a simple extension, why did the committee not just add one authorization for the fiscal year ending June 30, 1974?

Mr. STAGGERS. I might say this to the gentleman: We are just simply repeating the language of the law as it is now in order to make clear what has passed and what is taking place here.

Mr. Chairman. I think the explanation is that in order to make the legislative process clear, as the legislative counsel has told me, this is the way they would write the bill in order to make it clear as to what has happened.

Mr. WYLIE. Well, Mr. Chairman, as I say, I do not understand the authorization procedure. If this is a simple 1-year extension, and I go along with that, why do we need to refer to passed years? Why are authorizations for prior years included in this bill? We have already authorized money for fiscal year 1972, and money has been appropriated pursuant to the authorization for the program, beginning in 1967, as a matter of fact.

Mr. Chairman, I am not opposed to the bill.

I want the assurance, I guess, of the chairman, then, that when we note that about $41.5 million was appropriated and spent for fiscal year 1972 that we do not now by authorizing $72 million add another $30 million, which can be carried over to the present.

Mr. STAGGERS. I can assure the gentleman it does not mean that at all. The reason why we did not change it is we could not change it. We wanted to write the law as it is, because they were just asking for an extension. I can assure the gentleman it does not have anything to do with that. We wanted to write this legislation as an extension in the way the original law was written.

Mr. WYLIE. I thank the gentleman.

Mr. ROUSSELOT. Will the gentleman yield?

Mr. NELSEN. I yield to the gentleman.

Mr. ROUSSELOT. If I might ask an additional question of the chairman? Mr. Ruckelshaus asked for the extension of this legislation. Again, I wish to make it clear I agree with that concept. But did Mr. Ruckelshaus ask for a $238 million authorization?

Mr. STAGGERS. If the gentleman will yield to me, let me put it this way. He asked for a simple extension, and the amount of money is in the original bill, so we just extended it as it was for the past year.

Mr. ROUSSELOT. So the answer to the question is that he did not specifically ask for $238 million?

Mr. STAGGERS. But he asked for an extension, and when he did that I think he asked for what was given last year to be continued.

Mr. ROUSSELOT. What did we spend last year on this program?

Mr. STAGGERS. $31 million.

Mr. ROUSSELOT. $31 million. So we are roughly $200 million over authorized in this bill.

Again I wish to make the point that I think our authorizing legislation should not ask for so much additional funding when we are not even coming close to such a spending level today. That is my point.

I believe that the Congress as a whole makes itself look very ridiculous and even borders on stupidity when we authorize so much more money than that which is actually needed. That is my point.

Mr. STAGGERS. I am glad the gentleman made it clear. I believe I understood him correctly when he said that we were not stupid; and he did not believe it was the whole Congress. I disagree with him on the amount of the extension, because I know of no other procedure to follow in this instance, because when you ask for a simple extension, unless you go in and change the bill comprehensively, which would require a study of what you think is needed, then we would have to go along with what we had before. We did not undertake to conduct this study, because this is to be done for next year's authorization. We simply have a simple extension of the bill this year with the same authorization.

Mr. ROUSSELOT. I thank the gentleman.

Mr. DON H. CLAUSEN. Mr. Chairman, one of the most serious environmental problems facing this Nation is that of solid waste disposal.

In 1920, this Nation had to dispose of 2.75 pounds of solid waste per person. By 1970, that figure had increased to 5.3 pounds per person while there were, of course, almost twice as many persons.

Experts tell us that by 1980 we will be faced with 8 pounds per person.

More explicitly, today's rate of solid waste production for this country is 3.5 billion tons.

Continuing and increased efforts to research and develop the means of recycle solid wastes are vital if we are to prevent the pollution of our environment. Solid wastes are now causing air pollution, water pollution and land pollution but I am convinced that we can find the ways to end these problems and convert these wastes to our benefit. This can only be done if we devote our concentrated energies to this task.

Let me take this opportunity, however, to remind the American people that their growing awareness of this problem must be coupled with growing action in response to it. This bill before us today provides Federal support for research efforts but it cannot come close to doing the job alone.

For example, the most recent estimate of the cost of removing litter is $500 million annually. One-half billion dollars each year. Every month American motorists drop an average of 1,300 pieces of litter on every mile of the

Nation's vast network of primary highways, or nearly 16,000 pieces of litter per mile per year.

There is no monetary cost in saving ourselves the half-billion annual cost of littering. The answer, quite simply, is discipline. That is all it takes. Discipline on the part of all of us. Overnight we could wipe out a $500 million annual debt.

Therefore, Mr. Chairman, I strongly endorse extension of the Solid Waste Disposal Act and simultaneously urge each person to take it upon himself to help fight this problem through his own efforts.

Mr. KYROS. Mr. Chairman, I rise in strong support of H.R. 5446, which would extend for 1 year, at the current authorization rate of $238,500,000, the Solid Waste Disposal Act.

This bill was considered on February 26 by the Public Health and Environment Subcommittee, under the able leadership of Chairman PAUL ROGERS, and it was quite evident at that time that responsible and thorough consideration of the Federal Government's effort and proper role in this important field could not be accomplished before the end of the current fiscal year, when the funding authorization for this act expires. The Public Health Subcommittee intends to hold extensive hearings on this act to examine carefully the many and varied issues which have arisen since original passage of the act 3 years ago.

Mr. Chairman, the cost of sanitary landfills and other effective solid waste disposal mechanisms looms as a tremendous financial burden on many small communities throughout my

[H 2004]

State of Maine and the Nation. Our country currently produces some 256 million tons of municipal waste each year. Most of this waste is now handled by open dumping or burning, in spite of the fact that this will be in violation of most States' air quality standards within a short time.

Effective solid waste programs must be made financially practical, which they certainly are not at the present time in most of our rural areas. The Congress should have the time necessary to carefully consider this major national problem, and for that reason, I urge adoption of this 1-year extension.

Mr. PRICE of Illinois. Mr. Chairman, I support H.R. 5446, the 1-year extension of the Solid Waste Disposal Act.

This extension provides the Interstate and Foreign Commerce Committee the opportunity to undertake extensive oversight hearings on the act. Also, it maintains program continuity.

The bill before us authorizes $238.5 million for fiscal year 1974. This is the same funding level authorized in fiscal year 1973. The bill authorizes $140 million for demonstration and construction grants to States and municipalities for resource recovery systems and solid waste disposal facilities; $76 million for the Environmental Protection Agency to develop new recycling and waste disposal techniques and to award grants to State and local agencies for developing area-wide waste disposal plans; and $22.5 million for the Interior Department for research and demonstration projects on the disposal of mining wastes.

The importance of this legislation should not be overlooked. Unfortunately, the administration has budgeted only $6.2 million to fund solid waste disposal programs in fiscal year 1974. I feel this action is shortsighted. This country faces a growing energy crisis. Our research efforts must be accelerated as to how recoverable materials and waste can be utilized to meet this crisis.

For example, the Environmental Protection Agency recently funded a household trash recycling program in the St. Louis metropolitan area. The program involves the Union Electric Co. in St. Louis and the Granite City Steel Co. in Illinois. The utility is purchasing trash and converting it to energy. The steel company is purchasing the scrap metal and cans to produce new steel. While this is a pilot program, it is the type of research that needs to be undertaken.

Mr. DONOHUE. Mr. Chairman, it is my very earnest belief that the House should overwhelmingly adopt the measure presently under consideration, H.R. 5446, the Solid Waste Disposal Act extension.

As you know, Mr. Chairman, this bill is specifically designed to extend the Solid Waste Disposal Act for a period of 1 year and authorizes appropriations for fiscal year 1974 at the very same funding level previously authorized for fiscal year 1973. Under the various provisions of this measure, our States and municipalities will continue to receive grants for the demonstration of resource recovery systems and for the construction of solid waste disposal facilities. The measure also provides funds for the Environmental Protection Agency to continue work on the development of new recycling and waste disposal techniques and to award grants to State and local agencies to assist them in developing areawide waste disposal plans.

Mr. Chairman, there can be no question whatever concerning the critical importance of solid waste disposal facilities for a great many areas throughout our country, including my own State of Massachusetts. I feel very certain that we all recognize the need for continuing, without any unnecessary interruption, reasonable and effective programs which substantially contribute to wholesome improvement in the quality of our environment. Since this legislative measure responsibly extends existing solid waste disposal programs, while extensive oversight and legislative hearings carefully examine the many policy issues which have arisen since the bill was originally enacted, and since the measure represents a wholly substantial and prudent attempt to continue the fight to improve, protect, and preserve our threatened environment, I urge this House, in the overall national interest, to resoundingly approve the measure.

Mr. ANNUNZIO. Mr. Chairman, cleaning up our environment and establishing practices that will insure a healthy environment for future generations is one of our Nation's highest priorities today. We have embarked on an ambitious multibillion-dollar program to clean our waters by 1985, and progress in the fight for clean air has already been reported in a number of communities across the country. However, we are losing ground in our struggle with another, perhaps slightly less glamorous form of pollution.

I am referring to our efforts to halt environment degradation caused by inefficient, antiquated solid waste management practices that are unnecessarily expensive and result in the loss of valuable natural resources. Unless this Congress takes decisive action soon, we will not just continue to lose ground slowly in the solid waste pollution fight—indeed, we will be in full-scale retreat.

In 1970, the Congress enacted the Resource Recovery Act—Public Law 91-512—amending the Solid Waste Disposal Act of 1965—Public Law 89-272. This legislation indicated Congress desire to see environmentally offensive solid waste disposal practices halted and the policy of resource recovery adopted. This legislation, which is just beginning to bear profitable results, will expire at the end of the current fiscal year unless we vote to extend the Solid Waste Disposal Act. It is for this reason that I rise today in support of H.R. 5446, a bill introduced by the distinguished chairman of the House Interstate and Foreign

Commerce Committee, Hon. HARLEY O. STAGGERS, of West Virginia, to extend the 1965 Solid Waste Act, as amended by the 1970 Resource Recovery Act.

Already, as we debate this issue today, the administration is dismantling the programs within the Environmental Protection Agency which are designed to combat an increasingly serious solid waste problem. Even though this Congress has not yet acted, the Office for Solid Waste Management Programs, the Federal unit administering the Solid Waste Disposal Act, is being decimated as its staff is reduced from 320 to 120.

Mr. Chairman, conservative estimates place our total annual bill for collecting and disposing municipal solid wastes at $5 billion. Through the technical assistance provided by the Federal solid waste program this figure could be significantly decreased, without any reduction in the level of collection and disposal services. In Cleveland, Ohio, waste collection costs were cut in half after a new system, designed with the aid of Federal experts, was installed.

Meanwhile, our Nation is headed toward a solid waste crisis. Already 5 billion tons of solid wastes are produced annually and per capita waste generation is increasing at a rate of 4 to 6 percent—3 times the population growth rate. Most municipal wastes are disposed of in ways harmful to the environment, primarily by open dumping. Only 1 percent of municipal wastes are now recycled. The proportion of recycled materials relative to virgin materials going into the production of new goods has been declining since World War II.

Through the Solid Waste Disposal Act, we are beginning to reverse the trend. Open dumps are being closed or converted into sanitary landfills. Air-polluting incinerators are being equipped with control devices. New technologies to separate and recycle municipal wastes into useful byproducts are being developed and demonstrated. In some cases, municipal trash and garbage is actually being converted to a low-sulfur fuel—a commodity in much demand today.

Mr. Chairman, we cannot afford to give up the solid waste fight now. What might result in some savings now will cost us much more in years to come. I urge my colleagues to support H.R. 5446.

Mr. NELSEN. Mr. Chairman, I have no further requests for time.

Mr. STAGGERS. I have no further requests for time.

The CHAIRMAN. The Clerk will read.

The Clerk read as follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That (a) paragraph (2) of subsection (a) of section 216 of the Solid Waste Disposal Act, as amended (84 Stat. 1234), is amended to read as follows:

"(2) There are authorized to be appropriated to the Administrator of the Environmental Protection Agency to carry out the provisions of this Act, other than section 208, not to exceed $72,000,000 for the fiscal year ending June 30, 1972, not to exceed $76,000,000 for the fiscal year ending June 30, 1973, and not to exceed $76,000,000 for the fiscal year ending June 30, 1974."

(b) Paragraph (3) of subsection (a) of section 216 of the Solid Waste Disposal Act, as amended (84 Stat. 1234), is amended to read as follows:

"(3) There are authorized to be appropriated to the Administrator of the Environmental Protection Agency to carry out section 208 of this Act not to exceed $80,000,000 for the fiscal year ending June 30, 1972, not to exceed $140,000,000 for the fiscal year ending June 30, 1973, and not to exceed $140,000,000 for the fiscal year ending June 30, 1974."

(c) Subsection (b) of section 216 of the Solid Waste Disposal Act, as amended (84 Stat. 1234), is amended by striking "and not

[H 2005]

to exceed $22,500,000 for the fiscal year ending June 30, 1973." and inserting in lieu thereof ", not to exceed $22,500,000 for the fiscal year ending June 30, 1973, and not to exceed $22,500,000 for the fiscal year ending June 30, 1974."

Mr. STAGGERS (during the reading). Mr. Chairman, I ask unanimous consent that the bill be considered as read, printed in the RECORD, and open to amendment at any point.

The CHAIRMAN. Is there objection to the request of the gentleman from West Virginia?

There was no objection.

(Mr. CARTER asked and was given permission to revise and extend his remarks.)

[Mr. CARTER addressed the Committee. His remarks will appear hereafter in the Extensions of Remarks.]

Mr. GROSS. Mr. Chairman, I move to strike the next to the last word.

(Mr. GROSS asked and was given permission to revise and extend his remarks.)

(Mr. ROUSSELOT asked and was given permission to revise and extend his remarks.)

Mr. GROSS. Mr. Chairman, I, too, have some question about this bill, although I think an authorization is necessary.

I do not understand why we should be asked to authorize an expenditure of $238.5 million. I believe that is the proposal before the House, when all the evidence seems to indicate that not more than $5 or $6 million will be necessary to fund the program that is being proposed.

I would like to call the attention of the members of this committee and the Members of the House to the old saying which goes something like this:

> Nothing is easier than the expenditure of public money. It does not appear to belong to anybody. The temptation is overwhelming to bestow it on somebody.

This offers the temptation to spend much more—and I repeat—spend much more than might otherwise be prudent or provident.

So I regret that the committee comes in with an authorization for $238.5 million when all the testimony indicates a fraction of that amount will be sufficient. I regret that the committee came out with the figure it did, and I hope that next year when we get to the authorization for fiscal 1975 it will not find that a considerable amount of money has been expended that the committee did not contemplate. I would suggest, too, that the Appropriations Committee take note of the debate that has taken place here today and limit the appropriation to conform to the assurance that only a fraction of the authorization will be needed.

I would also like to say to the distinguished chairman of the Committee on Interstate and Foreign Commerce that I hope there will not be the accusation in this case that the President has impounded the difference between $6 million and $238 million; that no one will rise on the floor of the House and try to make the point that the difference between the two has been impounded by the President, and therefore charge it up to the total amount that the President has impounded.

I will yield to the gentleman from West Virginia if he would like me to yield.

Mr. STAGGERS. I thank the gentleman from Iowa for his remarks. I think they are well stated, but I think that the gentleman knows also that we are simply extending the bill from 1973 to 1974, and we used the same language and everything else, all we did was just to change the date.

The CHAIRMAN. Under the rule, the Committee rises.

Accordingly the Committee rose; and the Speaker having resumed the chair, Mr. FOLEY, Chairman of the Committee of the Whole House on the State of the Union, reported that that Committee having had under consideration the bill (H.R. 5446) to extend the Solid Waste Disposal Act, as amended, for 1 year, pursuant to House Resolution 315, he re-reported the bill back to the House.

The SPEAKER. Under the rule, the previous question is ordered.

The question is on the engrossment and third reading of the bill.

The bill was ordered to be engrossed and read a third time, and was read the third time.

The SPEAKER. The question is on the passage of the bill.

The question was taken; and the Speaker announced that the ayes appeared to have it.

Mr. WYDLER. Mr. Speaker, I object to the vote on the ground that a quorum is not present and make the point of order that a quorum is not present.

The SPEAKER. Evidently a quorum is not present.

The Sergeant at Arms will notify absent Members.

The vote was taken by electronic device, and there were—yeas 392, nays 2, not voting 38, as follows:

[Roll No. 54]

YEAS—392

Abdnor
Abzug
Adams
Addabbo
Alexander
Anderson, Calif.
Anderson, Ill.
Andrews, N.C.
Andrews, N. Dak.
Annunzio
Archer
Arends
Armstrong
Ashbrook
Ashley
Bafalis
Baker
Barrett
Beard
Bennett
Bevill
Biaggi
Biester
Blackburn
Blatnik
Boland
Bolling
Bowen
Brademas
Brasco
Bray
Breaux
Breckinridge
Brinkley
Brooks
Broomfield
Brotzman
Brown, Calif.
Brown, Mich.
Brown, Ohio
Broyhill, N.C.
Broyhill, Va.
Buchanan
Burgener
Burke, Calif.
Burke, Fla.
Burke, Mass.
Burleson, Tex.
Burlison, Mo.
Burton
Butler
Byron
Camp
Carey, N.Y.
Carter
Casey, Tex.
Cederberg
Chamberlain
Chappell
Clancy
Clark
Clausen, Don H.
Clawson, Del.
Clay
Cleveland
Cochran
Cohen
Collier
Collins
Conable
Conlan
Conte
Corman
Coughlin
Crane
Cronin
Culver
Daniel, Dan
Daniel, Robert W., Jr.
Daniels, Dominick V.
Danielson
Davis, S.C.
Davis, Wis.
de la Garza
Delaney
Dellenback
Dellums
Denholm
Dennis
Dent
Derwinski
Devine
Dickinson
Diggs
Donohue
Dorn
Downing
Drinan
Dulski
Duncan
du Pont
Eckhardt
Edwards, Ala.
Edwards, Calif.
Erlenborn
Esch
Eshleman
Evans, Colo.
Evins, Tenn.
Fascell
Findley
Fisher
Flood
Flowers
Flynt
Foley
Forsythe
Fountain
Fraser
Frelinghuysen
Frenzel
Frey
Froehlich
Fulton
Fuqua
Gaydos
Gettys
Giaimo
Gibbons
Gilman
Ginn
Goldwater
Gonzalez
Goodling
Grasso
Green, Oreg.
Green, Pa.
Griffiths
Gross
Grover
Gubser
Gude
Gunter
Guyer
Haley
Hamilton
Hammerschmidt
Hanley
Hanna
Hanrahan
Hansen, Idaho
Hansen, Wash.
Harrington
Harsha
Hastings
Hawkins
Hays
Hechler, W. Va.
Heckler, Mass.
Heinz
Helstoski
Henderson
Hicks
Hillis
Hinshaw
Hogan
Holifield
Holt
Holtzman
Horton
Howard
Huber
Hudnut
Hungate
Hunt
Ichord
Jarman
Johnson, Calif.
Johnson, Colo.
Johnson, Pa.
Jones, Ala.
Jones, N.C.
Jones, Okla.
Jones, Tenn.
Jordan
Kastenmeier
Kazen
Keating
Kemp
Ketchum
Kluczynski
Kuykendall
Kyros
Landrum
Latta
Lehman
Lent
Litton
Long, La.
Long, Md.
Lott

Lujan
McClory
McCloskey
McCollister
McCormack
McEwen
McFall
McKay
McKinney
McSpadden
Macdonald
Madden
Madigan
Mahon
Mailliard
Mallary
Mann
Maraziti
Martin, Nebr.
Martin, N.C.
Mathias, Calif.
Mathis, Ga.
Matsunaga
Mayne
Mazzoli
Meeds
Melcher
Metcalfe
Mezvinsky
Michel
Milford
Miller
Mills, Ark.
Mills, Md.
Minish
Mink
Mitchell, Md.
Mitchell, N.Y.
Mizell
Moakley
Mollohan
Montgomery
Moorhead, Calif.
Morgan
Mosher
Moss
Murphy, Ill.
Murphy, N.Y.
Myers
Natcher
Nedzi
Nelsen
Nichols
Nix
Obey
O'Brien
O'Hara
O'Neill
Owens
Parris
Passman
Patman
Patten
Pepper
Perkins
Pettis
Peyser
Pickle
Pike
Poage
Podell
Powell, Ohio
Preyer
Price, Ill.
Pritchard
Quie
Quillen
Railsback
Randall
Rarick
Rees
Regula
Reid
Reuss
Rhodes
Riegle
Rinaldo
Roberts
Robinson, Va.
Robison, N.Y.
Rodino
Roe
Rogers
Roncalio, Wyo.
Rose
Rosenthal
Rostenkowski
Roush
Roy
Roybal
Runnels
Ruppe
Ruth
Ryan
St Germain
Sandman
Sarasin
Sarbanes
Satterfield
Scherle
Schneebeli
Schroeder
Sebelius
Seiberling
Shipley
Shoup
Shriver
Shuster
Sikes
Skubitz
Slack
Smith, Iowa
Snyder
Spence
Staggers
Stanton, J. William
Stanton, James V.
Stark
Steed
Steele
Steelman
Steiger, Ariz.
Steiger, Wis.
Stephens
Stokes
Stratton
Stubblefield
Stuckey
Studds
Sullivan
Symington
Symms
Talcott
Taylor, N.C.
Teague, Calif.
Teague, Tex.
Thompson, N.J.
Thomson, Wis.
Thone
Thornton
Tierman
Towell, Nev.
Treen
Udall
Van Deerlin
Vander Jagt
Vanik
Veysey
Vigorito
Waggonner
Waldie
Walsh
Wampler
Ware
Whalen
White
Whitehurst
Whitten
Widnall
Williams
Wilson, Bob
Wilson, Charles H., Calif.
Wilson, Charles, Tex.
Winn
Wolff
Wright
Wyatt
Wydler
Wylie
Wyman
Yates
Yatron
Young, Alaska
Young, Fla.
Young, Ga.
Young, Ill.
Young, S.C.
Young, Tex.
Zablocki
Zion
Zwach

NAYS—2

Landgrebe
Rousselot

NOT VOTING—38

Aspin
Badillo
Bell
Bergland
Bingham
Carney, Ohio
Chisholm
Conyers
Cotter
Davis, Ga.
Dingell
Ellberg
Fish
Ford, Gerald R.
Ford, William D.
Gray
Harvey
Hebert
Hosmer
Hutchinson
Karth
King
Koch
Leggett
McDade
Minshall, Ohio
Moorhead, Pa.
Price, Tex.
Rangel
Roncallo, N.Y.

[H 2006]

Rooney, N.Y.
Rooney, Pa.
Saylor
Sisk
Smith, N.Y.
Taylor, Mo.
Ullman
Wiggins

So the bill was passed.

The Clerk announced the following pairs:

Mr. Rooney of New York with Mr. Fish.
Mr. Hebert with Mr. Gerald R. Ford.
Mrs. Chisholm with Mr. Leggett.
Mr. Bergland with Mr. Bell.
Mr. Koch with Mr. King.
Mr. Bingham with Mr. Harvey.

Mr. Moorhead of Pennsylvania with Mr. McDade.
Mr. Badillo with Mr. Hosmer.
Mr. Dingell with Mr. Conyers.
Mr. Eilberg with Mr. Minshall of Ohio.
Mr. Gray with Mr. Price of Texas
Mr. Rangel with Mr. William D. Ford.
Mr. Carney of Ohio with Mr. Roncallo of New York.
Mr. Cotter with Mr. Aspin.
Mr. Davis of Georgia with Mr. Smith of New York.
Mr. Karth with Mr. Taylor of Missouri.
Mr. Rooney of Pennsylvania with Mr. Hutchinson.
Mr. Sisk with Mr. Saylor.
Mr. Ullman with Mr. Wiggins.

The result of the vote was announced as above recorded.

A motion to reconsider was laid on the table.

[H 2007]

1.1.e (2)(b) MARCH 27: CONSIDERED AND PASSED SENATE, P. 55703

EXTENSION OF SOLID WASTE DISPOSAL ACT

Mr. MANSFIELD. Mr. President, I ask the Chair to lay before the Senate a message from the House on H.R. 5446.

The PRESIDING OFFICER laid before the Senate H.R. 5446, an act to extend the Solid Waste Disposal Act, as amended, for 1 year, which was read twice by title.

Mr. MANSFIELD. Mr. President, I ask unanimous consent that the Senate proceed to the immediate consideration of the bill.

There being no objection, the Senate proceeded to consider the bill.

The PRESIDING OFFICER. The bill is open to amendment.

If there be no amendment to be offered, the question is on the third reading of the bill.

The bill was ordered to a third reading, read the third time, and passed.

[S 5703]

Executive Orders

[RESERVED]

Regulations

3. Regulations

3.1 General Grant Regulations and Procedures, Environmental Protection Agency, 40 C.F.R. §§ 30.100–30.1001—3 (1972)
[See General 3.11 for subsection listing]

3.2 State and Local Assistance, Environmental Protection Agency, 40 C.F.R. §§ 35.300–35.340 (1972)

§ 35.300 Purpose
§ 35.301 Authority
§ 35.302 Definitions
§ 35.302—1 Intermunicipal Agency
§ 35.302—2 Interstate Agency
§ 35.302—3 Municipality
§ 35.303—4 Solid Waste
§ 35.302—5 Solid Waste Disposal
§ 35.302—6 State
§ 35.304 Solid Waste Planning Projects
§ 35.304—1 Management Planning
§ 35.304—2 Special Purpose Planning
§ 35.305 Grant Limitations
§ 35.310 Eligibility
§ 35.315 Application
§ 35.315—1 Preapplication Procedures
§ 35.315—2 Application Requirements
§ 35.320 Criteria for Award
§ 35.320—1 All Applications
§ 35.320—2 State Applications
§ 35.320—3 Local and Regional Applications
§ 35.330 Reports
§ 35.330—1 Progress Reports
§ 35.330—2 Report of Project Expenditures
§ 35.330—3 Final Reports
§ 35.340 Continuation Grants

3.3 Research and Demonstration Grants, Environmental Protection Agency, 40 C.F.R. §§ 40.100–40.165 (1973)

§ 40.100 Purpose of Regulations
§ 40.105 Applicability and Scope
§ 40.110 Authority
§ 40.115 Definitions
§ 40.115—1 Construction

§ 45.105—1 Professional Training
§ 45.105—2 Scholarship
§ 45.105—3 Stipend
§ 45.105—4 Technician Training
§ 45.115 Eligibility
§ 45.125 Application Requirements
§ 45.130 Evaluation of Applications
§ 45.135 Supplemental Grant Conditions
§ 45.140 Project Period
§ 45.145 Allocation and Allowability of Costs
§ 45.150 Reports
§ 45.150—1 Interim Progress Reports
§ 45.150—2 Final Progress Reports
§ 45.150—3 Report of Expenditures
§ 45.150—4 Equipment Reports
§ 45.155 Continuation Grant

3.4b Manpower Forecasting (RESERVED)

Guidelines and Reports

4.9 ANNUAL REPORT TO CONGRESS AS REQUIRED BY 42 U.S.C. § 3253.

4.9a Report to Congress on Resource Recovery by the Environmental Protection Agency, February 1973.

PREFACE

Section 205 of the Solid Waste Disposal Act (P.L. 89–272) as amended requires that the U.S. Environmental Protection Agency (EPA) undertake an investigation and study of resource recovery. This document represents EPA's Report to the President and the Congress summarizing the Agency's investigations to date and reporting the manner in which the Congressional mandate is being carried out.

The findings of this report are based on a number of contractual efforts and analyses by the Agency staff carried out since the passage of the Resource Recovery Act. Extremely valuable assistance in these investigations has been provided to EPA by The Council on Environmental Quality.

The report is organized into a summary, four major sections, and an appendix. The first section discusses the problem to which resource recovery is the potential solution. Next, key findings related to resource recovery are presented. A section outlining major options follows. The report concludes with a discussion of EPA's program activities in resource recovery.

The appendix presents summaries of information about the status of resource recovery by major materials categories and a listing of existing resource recovery facilities.

A number of typographical errors that appeared in the first printing have been corrected in the April 1973 printing, and the references have been restyled.

CONTENTS

SUMMARY

• This report presents an exploration of resource recovery as a method of solid waste management and resource conservation. Information developed over the past several years is summarized and the many questions surrounding the complex subject of resource recovery are discussed.

• The emphasis of the report is on the recovery of materials and energy from mixed municipal wastes and other "post-consumer" wastes that are discarded outside the normal waste collection channels. Although only 5% of the total national solid waste load, these wastes tend to have the most frequent population impact in that they occur in the nation's urbanized places. More than 50% of the total waste load comes from agriculture and is usually returned to the soil. More than 40% of the total burden is mining waste, which occurs in the hinterland.

• Nearly all major materials are recovered to some extent by recycling. Most recovered materials are derived from industrial fabrication wastes. Post-consumer wastes are also recovered to some extent (waste paper, old automobiles); post-consumer recycling has grown in an absolute sense. However, the proportion of the nation's materials requirements satisfied from recycling materials has remained constant or has declined in most instances.

• The level of recycling depends almost entirely on economics. Recycling takes place to the extent that it is the most efficient use of resources. In the absence of artificial economic subsidies for "natural" or "virgin" materials more secondary or recycled materials would be used. The economics of recycling are also influenced by apparently inequitable freight rates—both ocean and rail—which make the transportation of secondary materials relatively more costly than the movement of virgin resources.

• There has been sufficient technology development to allow extraction of materials and energy from mixed municipal wastes. However, few full scale recovery plants exist. The Environmental Protection Agency is funding the demonstration of the most significant conceptual alternatives.

• The costs of recovery plants are estimated to be relatively high, making recovery by technological means attractive only in areas where high disposal costs prevail and local markets for the waste materials exist. There is evidence that recovery by separate collection is not only feasible but economically attractive provided that the collection makes use of an existing transport system and markets for the collected materials exist.

• Preliminary research and analysis indicates that, when com-

pared with virgin materials extraction and processing, resource recovery results in lower quantities of atmospheric emissions, waterborne wastes, mining and solid wastes, and energy consumption. There is substantial disagreement among experts about the extent of such differential effects over time, particularly as strengthened environmental constraints on use of both virgin and secondary materials begin to narrow the differentials that now exist.

• Recycling should become more economical relative to other solid waste disposal options during the next several years. Energy costs are rising, making energy recovery more attractive and more economical. As pressures increase to bring about environmentally sound waste disposal, the costs of disposal will rise and recovery will become more attractive as an alternative. Finally, to the extent that air and water pollution control regulations are intensified, the incentives of industry for using secondary materials will improve.

• Other incentives for recycling also exist under existing Federal policies. The General Services Administration does not purchase paper unless it contains a specified amount of recycled paper. The military services are exploring procurement policies to reduce waste quantities or to mandate inclusion of secondary materials. The Treasury Department has determined that tax exempt industrial revenue bonds may finance the construction of recycling facilities built by private concerns to recycle their own wastes.

• Additional Federal incentives for recycling are not considered desirable at this time. Studies to date indicate that the effectiveness of specific incentive mechanisms that can be formulated is extremely difficult to predict. New tax incentives may well distort the economics of resource utilization much as preferential treatment of virgin materials distorts them today.

• There is an obvious need for further exploration of the complex issues of materials utilization in the Nation in the context of total resource utilization. Resource recovery is an important part —but only a part—of the larger picture. Before additional Federal policies are developed—aimed possibly at overcoming institutional and market imperfections in some areas—a better understanding of the complex materials and energy situation must be developed.

Section 1

THE PROBLEM

U.S. Materials-Use Pattern. Resource recovery in its varied aspects must be seen as part of a much larger economic structure—the total materials and energy use patterns of the nation. Today the recovery of waste materials supplies a very small part of the total material and energy requirements of the U.S. population, and while both population and materials consumption are increasing, the use of materials from waste sources is declining relative to overall consumption.

In 1971, the U.S. economy used an estimated 5.8 billion tons of materials for its total activity, equivalent to 28 tons for each man, woman, and child. Of this total approximately 10 percent comes from agriculture, forestry, fishing, and animal husbandry (food and forest products); 34 percent is represented by fuels; and 55 percent comes from the minerals industries in the form of metals, construction materials, and other minerals.[1]

Materials use is growing at a rate of 4 percent to 5 percent yearly. Per capita consumption was 22 tons in 1965, 24.7 tons in 1968, and 28 tons in 1971.[2] During the same period, population grew at a rate of 1.3 percent annually.

A high rate of materials and energy consumption means a high rate of waste generation. Approximately 10 to 15 percent of annual inputs to the economy represents accumulation of materials in use (in structures, plant, and equipment, etc.); the rest of the tonnage is used consumptively with residues discharged to the land, water, and air, or is used to replace obsolete products and structures which in turn become waste.[3]

Nearly all of the materials and energy required in the U.S. comes from virgin or natural resources. The tonnage of fabrication and obsolete wastes recycled is approximately 55 to 60 million tons,[4] equivalent to less than 1 percent of total minerals tonnage required overall by the nation.

If we disregard food and energy substances, the estimated 1971 demand for nonfood, nonenergy materials was 3.6 billion tons, and waste recovery satisfied 1.5 to 1.7 percent of the total requirement.

Environmental Consequences of Materials Use. Any form of materials use has environmental consequences. Materials resources

[p. 1]

must be extracted, purified, upgraded, processed, and fabricated into products; in addition, there are transportation steps between most of these steps.

At every point, solid, waterborne, and airborne wastes are generated and either enter the environment or are removed from processing steps at some expense.

The production of 1,000 tons of steel, for instance, results in 2,800 tons of mine wastes, 121 tons of air pollutants, and 970 tons of solid wastes.[5] Similar waste flows are associated with every materials flow, although, of course, the magnitudes vary depending on the types of materials obtained. The sheer growth in materials consumption per capita indicates that more pollution and waste is generated per citizen today than was generated in years past.

As will be discussed, reports at this time indicate that the amounts of air pollution, water pollution and waste that result from production systems that use recycled wastes are lower than the effluents from production systems that rely on virgin resources. Thus, any decrease in resource recovery relative to total consumption means an increase in the quantity of residuals generated.

Solid Waste Generation. Ever-increasing per capita materials consumption necessarily means that more solid waste is generated. This can be illustrated graphically by trends in packaging consumption since packaging is a short-lived product category which becomes waste immediately after use.

Per capita packaging consumption (in pounds per capita) has been increasing steadily as shown below.[6]

1958	*1960*	*1962*	*1964*	*1966*	*1970*
404	425	450	475	525	577

The situation in packaging is merely an illustration of a general phenomenon of waste generation resulting from a materials consumption rate which grows faster than population.

The total quantity of waste generated in 1971 is estimated to have been 4.45 billion tons, up nearly 1 billion tons from 1967. The make-up of this waste is shown below:

	Million Tons
Municipal* [7]	230
Industrial [8]	140
Mineral wastes [9]	1700
Animal wastes [10]	1740
Crop wastes [10]	640
	4450

* Includes residential, commercial, demolition, street and alley sweepings and miscellaneous (e.g., sludge disposal).

[p. 2]

The 230 million ton municipal waste load plus that portion of industrial waste occurring in large metropolitan areas constitute what is normally referred to as the "solid waste problem" in popular discussion.

One reason for the growing solid waste burden is that resource recovery has declined relative to total materials consumption. A second reason is the substitution of material-intensive practices (practices which result in consumption of large amounts of raw materials) for less materials demanding practices, e.g., one-way containers for returnable bottles, paper towels for cloth towels, and disposable one-time use products of all sorts—in the home, the office, the hospital, etc.—for products designed for reuse.

The resulting solid waste load is especially burdensome in urban areas because of greater population concentrations and because disposal in urban area is particularly difficult. The urban population, for example, has grown from 64 percent of the total population in 1950 to 74 percent in 1970, thereby increasing the quantity of solid waste in urban areas by a substantial percentage. Additionally, urban populations generate more waste than nonurban residents—approximately 20 percent more per capita.[11]

Disposal in urban areas is an especially difficult problem because in the city, waste disposal is, at the same time, an environmental, economic, and political problem. Waste collection is labor intensive, labor costs are rising rapidly, and the productivity of most municipal waste collection systems is low. In many urban areas, land suitable for waste disposal has disappeared or is rapidly being used up. Movement of the waste across the boundaries of the political jurisdiction where it occurs is difficult and sometimes impossible. As cities are required to travel longer distances to dispose of their wastes or alternatively are forced to process them to achieve volume reduction, the costs of waste management are increased. To eliminate potential air and water pollution from landfills and incinerators, the waste processing facilities must be properly designed, located, and operated, and must include proper pollution control devices. This degree of control is technologically possible but often costly, particularly in the case of incineration.

Given these circumstances, many cities increasingly are viewing resource recovery as both an environmentally and economically desirable alternative to disposal. Unfortunately, this option is most often not available because demand for materials from wastes is nonexistent or severely limited.

The Recovery Rate. Nearly all major materials are recovered to some extent by recycling. The recovery rate varies from nearly 100

TABLE 1
RECYCLING OF MAJOR MATERIALS (1967)

Material	Total consumption (million tons)	Total recycled (million tons)	Recycling as percent of consumption
Paper	53.110	10.124	19.0
Iron and steel	105.900	33.100	31.2
Aluminum	4.009	.733	18.3
Copper	2.913	1.447	49.7
Lead	1.261	.625	49.6
Zinc	1.592	.201	12.6
Glass	12.820	.600	4.7
Textiles	5.672	.246	4.3
Rubber	3.943	1.032	26.2
Total	191.220	48.108	25.2

Source: Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. p. xvii.

percent for solid lead (50 percent for all lead),* 50 percent for copper, 31 percent for iron and steel, and 19 percent for paper and

[p. 3]

board, to 4.2 percent for glass (Table 1). The percentages refer to the proportion of total consumption of the materials satisfied from both wastes recovered in fabrication steps in industry and wastes recovered from obsolete products like junk automobiles and old newspapers.

Consumption of major materials—iron and steel, paper, nonferrous metals, glass, textiles, and rubber—was taking place at a rate of 190 million tons in the 1967–1968 period. During this period the total recycling tonnage of the same materials was 48 million tons, equivalent to 25 percent of consumption of these materials.

Historical data in this aggregated form are not available for all materials. In general, however, for most materials, the portion of total consumption of that material derived from waste sources has been declining. Consumption of these waste materials has generally not kept pace with total consumption.

- Paper waste consumption as a percent of total fiber consumption has declined from a rate of 23.1 percent in 1960 to 17.8 percent in 1969.[12]
- Iron and steel scrap consumption as a percent of total metallics consumption has declined slightly overall from the 1959–1963 to the 1964–1968 period, from 50.3 to 49.9 percent. Purchased scrap

* A substantial proportion of lead is used in gasoline as an anti-knock additive; this lead is dispersed and is unrecoverable.

consumption,* representing the recycling of fabrication and obsolete wastes, has been losing ground: in the 1949–1953 period it was 44.9 percent of total scrap; in the 1964–1968 period, 40.0%.[13]

• Rubber reclaiming is a declining activity both absolutely and in relation to total rubber consumption. In 1958 reclaim consumption was 19% of total rubber consumption, in 1969, 8.8%.[14]

• The major nonferrous metals—aluminum, copper, and lead—are reused at a composite rate of around 35% of total consumption and this percentage has remained fairly constant over time.[15]

Historical data on other materials are not readily available in aggregate form, but declining recovery is generally the rule.

It is reasonable to assume that a secondary material, one that has already been processed, should be a more attractive raw material to industry than a virgin material that must be extracted or harvested and processed. The secondary material is already purified and concentrated; scrap steel, for instance, is nearly 100 percent steel while the iron ore from which it is made contains high proportions of silicate materials which must be removed. Why, then, the relatively low recycling rate found in the United States today? The low rate is the result of the action of a number of forces, among them the following:

(1) The delivered price of virgin raw materials to the manufacturer is almost as low in many cases as the cost of secondary materials, and virgin materials are usually qualitatively superior to salvaged materials. Consequently, demand for secondary materials is limited.

(2) Natural resources are abundant and manufacturing industries have directed their operations to exploit these. Plants are generally built near the source of virgin materials (e.g., paper plants near pulpwood supplies). Technology to utilize virgin materials has been perfected; due to the adverse economics, similar technology to exploit wastes has not been developed.

(3) Natural resources occur in concentrated form while wastes occur in a dispersed manner. Consequently, acquisition of wastes for recycling is costly, and is particularly sensitive to high transportation costs.

(4) Virgin materials, even in unprocessed form, tend to be more homogeneous in composition than waste materials, and sorting and upgrading of mixed wastes is costly.

---

* In the iron and steel industry, distinctions are made between "home" scrap, a process waste in furnaces and in mills; prompt scrap, occurring in fabrication plants; and obsolete scrap, from discarded products or obsolete structures. Purchased scrap is the combination of the last two categories.

(5) The advent of synthetic materials made from hydrocarbons, and their combination with natural materials, cause contamination of the latter, limiting their recovery. The synthetics themselves are virtually impossible to sort and recover economically from mixed waste.

(6) There are artificial economic barriers which favor virgin material use over secondary material use. For example, depletion allowances, favorable capital gains treatments, and apparently favorable freight rates are available to virgin materials processors but not to secondary materials processors. Also, producers presently do not have to internalize all costs of environmental pollution.

Section 2

KEY FINDINGS

The key findings of this report can be reduced to four major points:

(1) The use of recycled materials appears to result in a reduction in atmospheric emissions, waste generated, and energy consumption when compared with virgin materials utilization.

(2) The recovery of materials from waste depends largely on economics. The cost of manufacturing products from secondary materials is generally as high or higher than manufacturing products from virgin materials, and consequently only high quality and readily accessible waste materials can find a market. Artificial economic advantages available to virgin materials users (e.g., depletion allowances and capital gains treatments, and inability of the traditional market to internalize pollution and resource depletion costs) appear to have been major contributors to this economic situation.

(3) There has been sufficient technology development to allow extraction of materials from mixed municipal wastes. However, the cost of extraction is high, making recovery processes attractive only in areas where high disposal costs prevail and favorable local markets exist for the materials.

(4) Recovery of materials (as opposed to energy) from mixed municipal wastes, while conceptually the best alternative to disposal, cannot be instituted on a large scale in the absence of: a substantial reduction in processing costs and/or upgrading in quality, which is simply unattainable given reasonable projection of technology; and/or a major reordering in relative virgin and

secondary materials prices, to make secondary materials more economically attractive.

A more detailed discussion of each of these findings follows.

Environmental Impacts. The environmental impacts of recycling are of major importance. Studies conducted to date indicate that resource recovery generally results in reduced consumption of energy and materials and reduced effects of air and water pollution.

Resource recovery has three major environmental benefits: (1) recovery and reuse of a material conserves the natural resources from which that material is derived; (2) recycling of materials eliminates disposal, thus, the negative environmental effects of inadequately controlled solid waste disposal are reduced; (3) substitution of waste materials for virgin materials in the production system results in decreased energy requirements and decreased air and water effluents (based on studies of glass, paper, and ferrous metals) and avoids other kinds of environmental degradation, particularly in the extraction phase (e.g., strip mining). Data to substantiate these points are presented below.

Glass. Environmental impacts occur at every step of glass manufacturing from the mining of raw materials to final waste disposal. Changes in the amount of cullet (glass scrap) in the raw materials batch are responsible for significant changes in environmental effects.

Comparing the environmental impact of glass manufacturing using 15 and 60 percent cullet mixes, it is clear that increased cullet usage results in reduced quantities of residual discharge. Table 2 illustrates the impact changes for the two cullet mixes. A 60 percent cullet batch would result in over 50 percent less mining and postconsumer waste, 50 percent less water consumption, and up to 22 percent less atmospheric emissions. The energy requirements either increase 3 percent or decrease 6 percent depending on the recovery system used for obtaining the cullet.

Paper. There are significant changes in environmental impact when waste paper is substituted for virgin wood pulp in the production of paper products. Table 3 summarizes the environmental impacts produced by manufacturing 1,000 tons of pulp from recycled fiber rather than from virgin wood pulp. The recycled fiber case requires 61 percent less water and 70 percent less air pollutants.

If deinking and bleaching are required to upgrade the secondary fibers for high quality finished products, recycling still produces environmental benefits in almost every category. Table 4, which compares virgin pulp with recycled deinked pulp, indicates that

15 percent less water and 60 percent less energy are required, and 60 percent less air pollutants are generated. However, the waterborne wastes increase significantly. The increase in solid wastes generated in processing is more than offset by the recovery of paper from municipal solid waste.

Ferrous Metals. There are also substantial changes in environmental impact from utilizing recycled steel rather than producing steel from iron ore. A comparison of the impacts of producing 1,000 tons of steel reinforcing bars from virgin ore and from scrap indicates that 74 percent less energy and 51 percent less water are used in the recycling case. Additionally, air pollution effluents are reduced by 86 percent and mining wastes by 97 percent (Table 5).

The results presented in Tables 2–5, were derived from surveys conducted from 1968–1970 and represent pollution in a relatively uncontrolled situation. As air and water pollution control legislation and implementing regulations become more effective, some of the costs of environmental degradation will be internalized. This might result in an improvement in the environmental impacts of virgin material utilization and decrease the cost advantage of virgin versus secondary materials. EPA is carrying out further analysis of this process and the attendant costs and results will be presented in subsequent reports to Congress.

The results presented indicate that in most cases studied the atmospheric effluents, waterborne wastes, solid wastes, energy and water consumption are substantially lower for resource recovery as compared to virgin material utilization. However, the full environmental impact of this result is difficult to assess completely. Resid-

TABLE 2

SUMMARY OF CULLET DEPENDENT ENVIRONMENTAL IMPACTS FOR 1,000 TONS OF GLASS CONTAINERS, BY IMPACT CATEGORY

Environmental impact	15% Cullet	60% Cullet	% Change [a]
Mining wastes	104 tons	22 tons	−79%
Atmospheric emissions (all sources)	13.9 tons	13 tons	−6% [b]
		10.9 tons	−22% [c]
Water consumption (intake minus discharge)	200,000 gals.	100,000 gals.	−50%
Energy use	$16,150 \times 10^6$ BTU	$16,750 \times 10^6$ BTU	+3%
		$15,175 \times 10^6$ BTU	−6%
Virgin raw materials consumption	1,100 tons	500 tons	−54%
New post-consumer waste generation	1,000 tons	450 tons	−55%

[a] Negative numbers represent a decrease in that impact resulting from increased recycling.

[b] Calculated for the Black-Clawson wet recovery system for cullet recovery from municipal waste.

[c] Calculated for the Bureau of Mines incinerator residue recovery system for cullet recovery from municipal waste.

[d] Based primarily on surveys conducted in 1967–1969.

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

TABLE 3

ENVIRONMENTAL IMPACT COMPARISON FOR 1,000 TONS OF LOW-GRADE PAPER

Environmental effect	Unbleached kraft pulp (virgin)	Repulped waste paper (100%)	Change from increased recycling (%) [a]
Virgin materials use (oven dry fiber)	1,000 tons	-0-	−100
Process water used	24 million gallons	10 million gallons	−61
Energy consumption	17,000 × 10⁶ BTU	5,000 × 10⁶ BTU	−70
Air pollutants [b] effluents (transportation, manufacturing, and harvesting)	42 tons	11 tons	−73
Waterborne wastes discharged—BOD [b]	15 tons	9 tons	−44
Waterborne wastes discharged—suspended solids [b]	8 tons	6 tons	−25
Process solid wastes generated	68 tons	42 tons	−39
Net post-consumer wastes generated	850 tons [c]	−250 tons [d]	−129

[a] Negative numbers represent a decrease in that category, or a positive change from increased recycling.

[b] Based primarily on surveys conducted in 1968–1970.

[c] This assumes a 15% loss of fiber in the papermaking and converting operations.

[d] *This assumes that 1,100 tons of waste paper would be needed to produce 1,000 tons of pulp. Therefore* 850–1100 = 250 represents the net reduction of post-consumer waste.

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

TABLE 4

ENVIRONMENTAL IMPACTS RESULTING FROM THE MANUFACTURE OF 1,000 TONS OF BLEACHED VIRGIN KRAFT PULP AND EQUIVALENT MANUFACTURED FROM DEINKED AND BLEACHED WASTEPAPER

Environmental effect	Virgin fiber pulp	Deinked pulp	Increased recycling change (%) [a]
Virgin materials use (oven dry fiber)	1,100 tons	-0-	−100
Process water used	47,000 × 10³ gallons	40,000 × 10³ gallons	−15
Energy consumption	23,000 × 10⁶ BTU	9,000 × 10⁶ BTU	−60
Air pollutants (transportation, manufacturing, and harvesting) [b]	49 tons	20 tons	−60
Waterborne wastes discharged—BOD [b]	23 tons	20 tons	−13
Waterborne wastes discharged—suspended solids	24 tons	77 tons	+222
Process solid wastes	112 tons	224 tons	+100
Net post-consumer waste disposal	*850 tons* [c]	−*550 tons* [d]	−165

[a] Negative number represents a decrease in that category resulting from recycling.

[b] Based on surveys conducted in 1968–1970.

[c] This assumes a 15% loss of fiber in paperworking and converting operations.

[d] This assumes that 1,400 tons of waste paper is needed to produce 1,000 tons of pulp. Therefore, 850–1,400 = −550 represents the net reduction in post-consumer solid waste.

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

TABLE 5
ENVIRONMENTAL IMPACT COMPARISON FOR 1,000 TONS OF STEEL PRODUCT

Environmental effect	Virgin materials use	100% waste use	Change from increased recycling (%) [a]
Virgin materials use	2,278 tons	250 tons	−90
Water use	16.6 million gallons	9.9 million gallons	−40
Energy consumption	23,347 × 10⁶ BTU	6,089 × 10⁶ BTU	−74
Air pollution effluents	121 tons	17 tons	−86
Water pollution	67.5 tons	16.5 tons	−76
Consumer wastes generated	967 tons	−60 tons	−105
Mining wastes	2,828 tons	63 tons	−97

[a]Negative numbers represent a decrease in that category resulting from recycling.
Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

uals and wastes produce different degrees of environmental damage depending both upon their composition and the location in which they are released. Emissions in high population areas could affect public health and welfare, while in rural areas, plant and wildlife ecology could be altered. Further research and analysis is needed to evaluate the overall environmental impact of the different mix and different location of emissions brought about by increased levels of recycling.

Economics. There are a number of historical, technical, locational, attitudinal, and other reasons for the decline of resource recovery, all of which can be translated into relatively high *total* costs for waste recovery compared with virgin materials processing. Secondary materials derived from municipal waste in almost every instance have a higher cost to the material user than virgin materials.

Again glass, paper, and ferrous metals provide illustrations.

Glass. Cost comparisons of glass manufacture from either waste glass (cullet) or virgin raw materials depend primarily on the delivered cost to the plant of each raw material. Glass can be made from cullet in existing plants with minor and inexpensive process changes. The production costs are essentially the same with either raw material. Similarly, a new plant designed to use cullet would be very similar to a plant based on virgin materials and would be no more costly to construct.

Table 6 compares the cost of using virgin materials with the cost of using cullet. The lower end of the cullet price range reflects a transportation distance of 25 miles or less. As distance from the glass plant increases, the price obviously rises. Since most recovered glass would need to be moved more thn 25 miles, the upper end of the range provides the best estimate.

TABLE 6

COST COMPARISON FOR GLASS ($/TON)

Cost component	Virgin materials	Cullet (waste glass)
Raw materials delivered	$15.48	$ 0
Cullet delivered	0	17.77 – $22.77
Fusion loss	2 95	0
Incremental handling costs at glass plant	0	.50 – 1.00
TOTAL	$18.43	$18.27 – $23.77

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

Glass manufacturers are not likely to make even the minor process changes required to increase cullet consumption where the cost of using the virgin materials from well established sources with predictable supplies and prices is equal to or less than that of bringing an unfamiliar, possibly contaminated substitute.

Paper. The comparative economics of using supplemental waste paper in existing mills for manufacturing certain paper products are shown in Table 7. These examples are by no means exhaustive of the many paper industry products, but these cases representing three products with different economic characteristics support what would seem to be obvious from the current industry orientation. The cost penalty for increasing the use of paperstock is $2.50/ton for corrugating medium, $3.75/ton for linerboard (corrugating medium and linerboard are the materials used to make corrugated boxes), and $20–$30/ton for printing/writing paper. The latter cost differential is the result of substantial upgrading of waste paper that would be required in the printing/writing grade of paper. The cost of newsprint manufacture, however, is lowered

TABLE 7

COMPARATIVE ECONOMICS OF PAPER MANUFACTURE FROM RECYCLED AND VIRGIN MATERIALS

Product	Linerboard	Corrugating medium	Printing/ writing paper	Newsprint
Baseline case (recycled fiber content)	0%	15%	0%	0%
Baseline average operating cost	$78.50/ton	$79.50/ton	$80–$120/ton	$125/ton
Supplemental fiber use (recycled fiber content).	25%	40%	100	100
Operating cost with increased use of recycled fiber.	$82.25/ton	$82.00/ton	$100–$150/ton	$98/ton
Net cost of increased recycled fiber usage	$3.75	$2.50	$20–$ 30/ton	–$27

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

by using 100 percent recycled fiber (deinked newsprint). This has been the only major new market for waste paper in recent years.

The economics of constructing new mills based on either virgin or secondary fibers also shows why the industry has preferred to build plants utilizing virgin fiber. An analysis of folding boxboard (combination board made from secondary fiber versus solid wood pulp board made from virgin pulp) found the return on investment for the virgin based plant to be 8.1% while that for a plant based on waste paper (combination board) was only 4.5%. Under such circumstances, construction of new combination board mills is highly unlikely.

Ferrous Metals. The cost to an integrated steel producer of using scrap versus ore is difficult to determine. The steel industry does not maintain or at least does not report such figures. Estimates have been made, however, which indicate that the cost of using high-grade scrap is higher than the cost of using ore.[16]

The point of equivalency of scrap and ore in the production process is the point where either hot molten pig iron or melted scrap is used to charge a basic oxygen furnace (BOF). The total cost of scrap at this point was estimated to be $44.00 per ton, including $33.50 purchase price of the scrap, $6.00 melting cost, $3.50 for scrap handling, and $1.00 for increased refractory wear caused by scrap usage. The cost of molten pig iron (which competes indirectly with scrap) was estimated at $37.50 per ton including $28.50 for the ore and associated raw materials, and $9.00 for melting cost. Thus, the cost of scrap ready for charging to a BOF is $6.50 per ton greater than the hot metal derived from ore at the same point. Thus, without a reduction in scrap cost of at least $6.00 to $7.00 per ton, it is unlikely that there will be a substantial increase in utilization of scrap by existing steel mills in BOF steel production.

Nonintegrated steel mills using electric furnaces (which operate on virtually a 100 percent scrap charge) of course, find scrap use economical. These scattered mills are usually located near metropolitan areas and transport cost of scrap is not a major expense.

The above cases illustrate the fundamental economic barriers to the increased utilization of secondary materials. The economics of recovery today result in the recovery of all waste materials that are of high quality and can be obtained from reasonably concentrated sources. Extraction of materials from solid waste is limited both by the relatively low quality of such wastes due to contamination and admixture with foreign materials, and by the relatively greater effort required to acquire such materials.

Economic Disincentives. A part of the cost differentials between secondary and virgin raw materials is in fact artifically created by public policy actions. Virgin materials enjoy depletion allowances and other subsidies such as favorable capital gains treatments. For example, due to the 15 percent depletion allowance on iron ore, the ore producer could lower his selling price by 13.5 percent without reducing his profit margin. Publicly controlled freight rates appear to discriminate against the movement of scrap materials. To a large extent, virgin materials prices do not reflect the full costs of environmental degradation the materials create. Furthermore, the fuels required for energy to extract and to process the virgin materials—which are high energy consumers—are also subsidized by depletion allowances.

Environmental regulations will tend to internalize pollution costs and may partially close the relative cost gap between use of virgin and recycled materials. However, the overall timing and impact of these measures is difficult to predict. Under the present market conditions, pollution regulations may in some cases work to the detriment of recycling. For example, in the paper industry many combination board mills (the major users of secondary paper) are already economically marginal operations and will find it difficult to absorb additional pollution control expenditures. Also, many types of environmental degradation resulting from virgin materials use, e.g., strip mining are not currently subject to controls.

Resource Recovery Technology. Technology to process mixed municipal wastes for recovery as materials, commodities and energy has been and is being developed by private industry, generally without Federal support.

EPA's resource recovery demonstration program, carried out under Section 208 of the Solid Waste Disposal Act, is designed to demonstrate the major technologies that have been developed in areas where both economic and market conditions for successful demonstration can be found.

The major technical options being considered are the following:

Materials separation into saleable components.
Composting of waste and production of soil modifiers.
Waste heat recovery in conventional incineration.
Waste heat recovery in high temperature incineration.
Direct firing of prepared waste as fuel.
Pyrolysis of waste to generate steam or gaseous, liquid, or solid fuel.

Of these options, a number have already been or are now being demonstrated.

Wet materials separation employing a system developed by the

Black-Clawson Company has been demonstrated at Franklin, Ohio, with EPA support. After shredding, metals, glass, and saleable pulp are separated.

A number of composting plants have been built and have been operated successfully from a technical point of view (See Appendix). The majority have failed, however, because markets for the compost products did not materialize. The rather high cost of producing compost is not sufficiently offset by income from its sale.

Waste heat recovery in conventional incineration has been demonstrated both here and abroad; this is also a well known practice. (See Appendix).

Direct firing of prepared waste as fuel is now being demonstrated in St. Louis, Missouri. Waste is shredded; ferrous metals are removed by a magnet; and the remaining waste, including nonferrous metals and broken glass, is introduced into a utility boiler where it is burned with coal to generate steam for the utility's turbines.

Partial separation of incinerator residues, i.e., the extraction of steel cans by magnets, has been demonstrated at a number of locations.

Major technical options or variants that have not yet been demonstrated include the following:

Total Incinerator Residue Separation as Developed by the Bureau of Mines. This system recovers glass, nonferrous metals and some fractions of the minerals in residues in addition to iron and steel. A pilot plant has been operated by the Bureau of Mines.

Dry Mechanical Waste Separation. Various components of such systems (such as shredders, magnets, grinders, conveyors, etc.) are commercially available. An air separator which performs a gross division of wastes into combustible and noncombustible fractions has been employed as part of an EPA contract with Combustion Power Equipment Co. in Los Angeles, California. Materials separators have been widely used in other industries such as mining and agriculture. To date application of these technologies to solid waste separation has not been fully exploited by industry because secure markets for output products do not exist.

Waste Heat Recovery in High Temperature Incineration. Several such incinerators have been developed; all operate in a similar manner.

Pyrolysis. Several systems have been developed by high-technology companies (Monsanto, Hercules, Garrett, Union Carbide). Like high temperature incinerators, these are also very similar in operation. They can be designed to yield outputs of fuel gas, oil, and char, or can be utilized directly to generate steam.

Economic data on the investment costs, operating costs, and revenues of major resource recovery system options have been developed by Midwest Research Institute under contract with EPA and the Council on Environmental Quality. All of the major systems examined show a net cost of operation: revenues are not sufficient to cover all operating costs. In a municipally owned plant with an input capacity of 1,000 tons per day, net costs will range from a low of $2.70 per ton for fuel recovery by direct waste firing to a high of $8.97 per ton for incineration with electrical generation (Table 8). While the costs indicate that resource recovery by processing is not a profitable venture in those communities where disposal costs are high, the lower cost resource recovery options offer a means of reducing disposal costs.

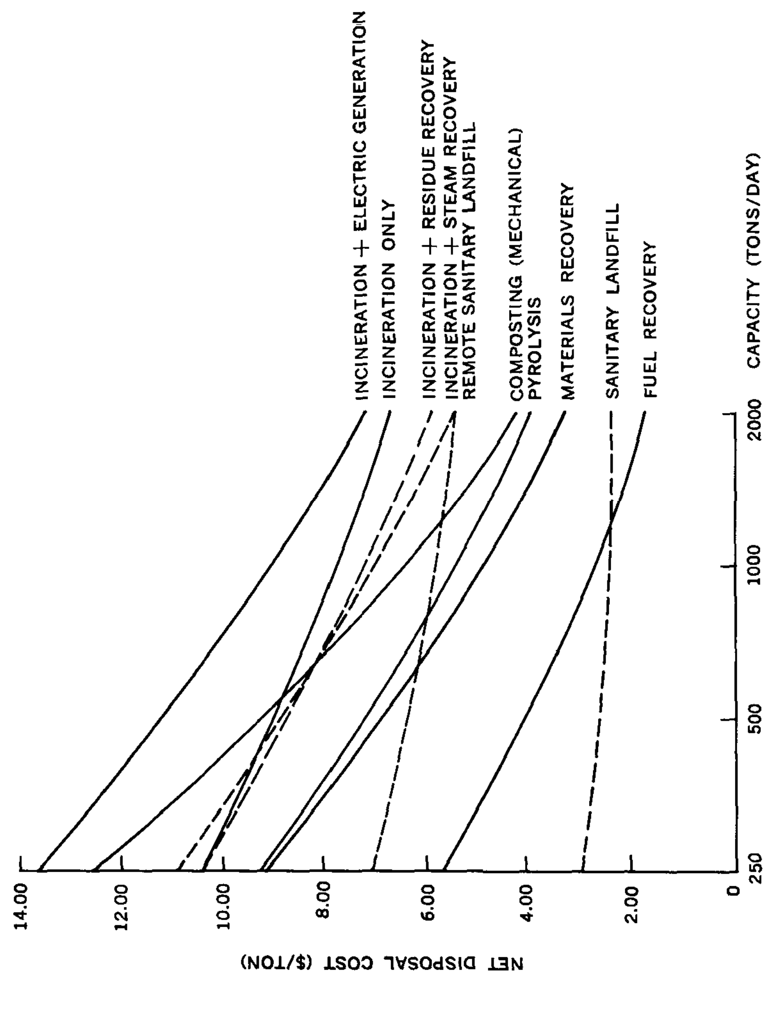
Figure 1 shows that recovery system economics improve with size. These data are based on current prices for secondary materials (Table 9). The results show that recovery by processing could be attractive in large cities generating large quantities of waste if the increased quantities of materials recovered do not drive secondary material prices down. Table 10 shows the sensitivity of system economics to the market price of recovered materials. It can be seen that, if higher prices are obtained, which may be the case if incentives for use of secondary materials are instituted, system economics are significantly improved. Using the case of materials recovery as an example, a 50 percent increase in prices results in a reduction of net costs from $4.77 per ton to $2.56 per ton. A materials price decrease of the same amount would raise net costs to $6.98.

The costs presented in Tables 8 and 10 suggest that resource recovery is a more economical option than incineration. The fact that there is no apparent move to install resource recovery systems is partially explained by the fact that the markets for recovered commodities are uncertain. Cities are unable to obtain purchase contracts with local buyers of waste materials at fixed prices. The failure rate of compost plants, due to lack of markets, has solidified feelings of market uncertainty. And finally, traditional municipal reluctance to undertake large scale capital investment, particularly where there is some element of risk, and other institutional problems have also contributed to the failure to move to resource recovery systems.

In summary, in most cases technology is available for implementing resource recovery through the processing of mixed municipal wastes. The technical processing route is costly but, in some of the technical options, costs approach those of other means of disposal. Although technological improvements would result in some

FIGURE 1

NET DISPOSAL COSTS ASSOCIATED WITH MUNICIPALLY-OWNED RESOURCE RECOVERY SYSTEMS AT VARIOUS PLANT CAPACITIES (20-YEAR ECONOMIC LIFE; 300 DAYS/YEAR OPERATION)



Source: Midwest Research Institute, Economic Studies in Support of Policy Formation on Resource Recovery, Unpublished report to the Council on Environmental Quality, 1972.

TABLE 8

SUMMARY OF RECYCLING SYSTEM ECONOMICS [a]

System concept	Primary type of recovery	Capital investment ($000)	Total annual cost ($000)	Resource value ($000)	Net annual cost ($000)	Net cost per input ton ($)
Materials recovery	Material	11,568	2,759	1,328	1,431	4.77
Residue recovery after incineration	Material	10,676	2,689	535	2,154	7.18
Incineration and steam recovery	Energy	11,607	3,116	1,000	2,116	7.05
Incineration and electrical generation	Energy	17,717	3,892	1,200	2,692	8.97
Pyrolysis	Energy	12,334	3,287	1,661	1,626	5.42
Composting (material/energy)	Energy	17,100	2,987	1,103	1,884	6.28
Fuel use (supplementary)	Energy	7,577	1,731	920	881	2.70
Incineration	Disposal	9,299	2,303	0	2,303	7.68

[a] Based on municipally owned, 1,000 TPD plant with 20-year economic life, operating 300 days/year, and interest at 5 percent.

Source: Midwest Research Institute. Resource recovery from mixed municipal solid wastes. Unpublished data, 1972.

cost reductions, technology is not likely to dramatically improve the marketability of products. If incentives for secondary materials consumption were instituted, and improved prices for waste-based commodities were established, further technology development by the private sector could be expected.

Recovery from Mixed Municipal Waste

In order to achieve recovery of materials from mixed municipal

TABLE 9

QUANTITY AND VALUE OF RECOVERABLE RESOURCES IN MIXED WASTE [1]

Resource	Yield [3]	Recovered quantity available [2]	Estimated unit value FOB plant ($/unit)	Total annual revenues ($)
Paper	45%	45,000 tons	15.00	675,000
Glass	70%	16,800 tons	10 00	168,000
Ferrous metals [4]	90%	20,400 tons	12.00	244,000
Nonferrous metals	67%	1,200 tons	200.00	240,000
Oil	100%	1,440,000 MBtu	.70	1,008,000
Fuel (as a coal substitute)	100%	2,700,000 MBtu	0.25	675,000
Steam	100%	2,000,000 M lb.	0.50	1,000,000
Electric energy	100%	200,000,000 kw-h	.006	1,200,000
Humus		75,000 tons	6.00	450,000

[1] Not all of these values are additive. For example if paper is reclaimed as fiber it cannot also be recovered as oil or fuel.

[2] Assumes a 1000 TPD plant operating 300 days per year or 300,000 tons of waste. Also assumes recovery rates based on technology assessment of available systems.

[3] Yield equals the percentage of the material or energy in the waste which can actually be recovered. In general, losses and technical limitations make this less than 100%.

[4] This assumes recovery from mixed waste. If recovery is from an incinerator residue, the value is assumed to drop to $10 per ton, and only 12,700 tons are recoverable.

Source: Midwest Research Institute Resource recovery from mixed municipal solid wastes. Unpublished data, 1972.

TABLE 10

SENSITIVITY OF SYSTEM ECONOMICS TO MARKET VALUE OF RECOVERED RESOURCES

System concept	Net cost per ton based on resource selling prices as a percent of base value			
	150 percent	100 percent	50 percent	No resource value recovered
Materials recovery	2.56	4.77	6.98	9.20
Incineration and residue recovery	6 29	7.18	8.08	8.96
Incineration and steam recovery	5 39	7.05	8.72	10.38
Incineration and electric generation	6.98	8.97	10.98	12.98
Pyrolysis	2 65	5.42	8.18	10.96
Composting	4.44	6.28	8.12	9.95
Fuel recovery	1.17	2.70	4.24	5.77

Source: Midwest Research Institute. Resource recovery from mixed municipal solid wastes. Unpublished data, 1972.

waste economics must be favorable at two key points. The municipality must find the cost of resource recovery competitive with disposal, and secondly, the user of the materials from these systems must find the cost of these secondary materials competitive with virgin materials substitutes. Recovery of materials from mixed municipal waste requires processing. With the exception of a score or so of very large cities, most communities have disposal costs which are lower ($2 and $3 per ton) than the resource recovery alternative. As shown above, recovery processing costs tend to exceed revenues from the sale of products, and the resulting net cost is higher in most places than current disposal costs.

Even in areas where disposal costs are already high—in excess of $5 per ton—resource recovery is limited because no markets can be guaranteed for recovery plant outputs at the tonnage levels at which they can be produced.

From the standpoint of the municipality, then, two changes that would bring about larger scale recovery of mixed municipal waste are (1) higher prices for recovery plant outputs or—alternatively—reduced recovery plant production costs and (2) an increase in demand for waste-based raw materials.

These requirements, however, are somewhat at odds with the requirements of the user who must purchase the outputs of such plants. As has been shown, the economics of virgin materials use are already more favorable than the economics of secondary material use. Lower waste prices are needed to change this situation. In order to insure a demand for secondary materials, they must either decrease in price or—alternatively—their use must be subsidized.

Section 3

DISCUSSION OF MAJOR OPTIONS

EPA's studies have progressed to a point where the major options available to bring about resource recovery at an increased rate—where such action can be justified on environmental and conservation grounds—are generally identifiable. The fundamental requirement is to create a situation wherein industrial materials users will substitute secondary materials for virgin materials to the extent this results in more efficient use of resources. This situation could be brought about by three types of activities: (1) actions to inhibit the use of virgin materials, (2) actions to create a demand for secondary materials, and/or (3) actions to create a supply of secondary materials of such quality and at such a price that they will appropriately satisfy the new demand.

Inhibitory mechanisms, timed at restricting the consumption of virgin materials, would normally take the form of disincentives or regulatory actions. Actions to create demand or supply would normally require the provision of positive incentives. An analysis of each of the major options follows.

Inhibition of Virgin Materials Use. If the supplies of virgin materials available to industry were denied or restricted, the cost of the remaining available portion would rise as a consequence of continuing demand. In relation to secondary materials, then, virgin materials would become more expensive, and more secondary materials would be used. Similarly, if the cost of virgin materials were raised artificially (by taxation, by removel of depletion allowances, capital gains treatment, or other means), the same consequence would reseult.

The desirability of major intervention into virgin materials use in order to increase recycling can be easily questioned on the grounds that a very large materials tonnage (5.8 billion tons) may have to be affected in order to increase a small portion (55 to 60 million tons).

Several "natural" events are likely to cause virgin materials to rise in cost without any form of government intervention. These events include: (1) tighter pollution control regulations and enforcement, resulting in higher pollution control costs; (2) increasing energy costs, which will affect virgin materials proportionately more because they are more energy-intensive than secondary materials; (3) depletion of high quality domestic reserves and the need to exploit lean ore deposits or to import raw materials across greater distances; (4) potentially adverse foreign trade policies; and others. The timing and impact of these market corrections are difficult to predict but are expected to be significant.

"Artificial" intervention is possible through the institution of virgin materials taxes and/or the removal or modification of favorable tax treatment of virgin materials and energy substances, regulation of virgin materials that are available from Federal land, denial of markets to virgin materials through Federal procurement policies, changes in transportation costs through Federal regulation of rail and ocean freight rates, changes in Federally mandated labeling regulations, and, at the extreme, the institution of national materials standards that would limit the use of virgin materials in major materials to some percentile below that now common.

The costs, benefits, and probable effectiveness of each major action listed above are under analysis. Based on initial findings, EPA sees justification for more aggressive Federal procurement policies to limit the use of virgin materials in products (with all the implied consequences of such a leadership posture), actions to remove freight rate disparities that appear to favor virgin materials, and removal of labeling regulations that discourage consumer purchasing of products that contain "waste" materials.

An example of Federal procurement changes already exists. The changes introduced in 76 paper product specifications by the General Services Administration under orders from the President are already having some impact on paper and board production. Intensification of such actions is certain to have beneficial impacts on resource recovery.

Fiscal measures (e.g., taxes to discourage virgin use) could be addressed to the artificial economic benefits which now favor virgin materials use. Such measures, however, would have a variety of other impacts as well, which are being evaluated to determine whether or not fiscal measures to inhibit virgin materials uses are cost effective. In light of a series of natural events that will raise virgin materials costs—especially rising energy costs—fiscal intervention may not appear either necessary or desirable.

Regulatory actions are viable alternatives for increasing resource recovery, but such actions, as related to virgin materials resource use, need further evaluation to determine their side effects, which may be adverse.

Demand Creation. EPA's investigations to date lead to the conclusion that positive economic incentives may be desirable in order to arrest the relative decline of materials recovery and to increase the proportion of total national materials needs satisfied from waste-based raw materials.

There is evidence that energy recovery from mixed municipal waste will become a very real option to both private and public sector waste management organizations without incentives of any sort and that limited materials recovery—steel, aluminum, and glass—will accompany such energy recovery activities.

The most efficient incentive for materials recovery would be one which results in the creation of new demand by industry for secondary materials, such as some form of tax incentive or subsidy payment to users of secondary materials. If an incentive results in a "demand pull" by industry, such demand will automatically result in changes in the way wastes are stored, collected, and processed. The key to increased recovery is the waste commodity buyer rather than the commodity supplier. Only if the buyer finds waste materials a more economical alternative than virgin materials will greater quantities be utilized. Incentives provided directly to the buyer are most likely to have the most dramatic effect on his actions.

Demand creation incentives can take a variety of forms. The particular form the incentive takes is important from the administrative and legal points of view. Also, different types of incentives have different efficiencies (cost—effectiveness). The important point—regardless of mechanism used—is that the materials producer (steel mill, paper mill, glass plant, etc.) should find himself in a situation where the use of secondary material is to his economic advantage.

Potentially, several types of incentives measures satisfy this criterion: investment tax credits, tax credits for use of secondary materials, subsidy payment or bounties, subsidy of plant and equipment for processing or using secondary materials, etc. If the incentive is made available to the materials consumer directly, a demand for waste materials will result.

Functionally, the incentive must be high enough so that—at the point of materials consumption—the cost of the secondary material to the buyer is at least the same (in the same quality range) as the cost of the virgin material. Investigations are underway to identify the level of necessary incentives. As shown in a previous section, it appears that the incentive required to "equalize" the costs of virgin and secondary materials would range from $2.50 to $30 per ton of material recovered. These values are based on a limited number of comparisons and should be viewed as somewhat tentative. It is estimated that an "across the board" incentive sufficient to result in substantial increases in resource recovery would range from $3 to $5 per ton of material recovered. A subsidy of this magnitude should be largely offset by savings in disposal cost since materials recycled would be removed from the waste stream and thus would not incur the cost of landfill or incineration. In addition, there would be important environmental benefits from increased recycling.

Supply Creation. Incentives for demand creation are viewed as sufficient inducement to bring about resource recovery at an accelerated rate. Such incentives, if appropriately designed, should spur private and public investment in resource recovery plants and systems, to deliver to industry the types and quantities of secondary materials it will demand.

As incentives bring about demand by consumers for increased quantities of secondary materials, the demand will reverberate down the chain of suppliers and will bring about some changes in supply patterns. It is likely, for example, that increased "skimming" of accessible wastes (removal from wastes before discard) such as newspapers, corrugated boxes, and office papers would occur from municipal and commercial sources and that such recovery would take place at lower overall costs than technological sorting.

Most of the solid waste materials that would be demanded by industry now pass through the hands of municipal solid waste management organizations who collect waste in mixed forms. In order to sell all proportions of waste now collected, these organizations face two alternatives: to collect waste fractions separately or to process mixed wastes into separate fractions.

Both alternatives have drawbacks. Separate collection of different waste fractions, while once widely practiced, has virtually disappeared. Combined waste collection using the more efficient compactor truck has become standard in residential, institutional, and commercial waste collection practice. Reinstitution of separate collection will require changes in practices and equipment.

The processing option is capital intensive. The economics of processing require large plant sizes in order to take advantage of economics of scale. In order for the economics to be attractive, plant sizes of 1000 tons per day of input or higher are required. There are few communities with such high generation rates.

If demand incentives result in higher secondary materials prices, public and private waste management organizations would be able to justify processing of municipal wastes for recovery in lieu of processing for disposal. Higher prices for waste-based commodities will also permit the use of smaller capacity plants; the higher prices will compensate for the higher processing costs of small plants.

In smaller communities, where recovery by processing is not likely to be economical, provision of supplies by separate collections is a possibility. The separate collection option, which was once practiced extensively, will require technical, institutional, and social changes to become a part of today's society. At this point, enough knowledge has been gained to see that citizen enthusiasm for resource recovery (expressed in the institution of thousands of neighborhood recycling centers), holds the potential for new and innovative options for solid waste collection. Furthermore, the successful experience of Madison, Wisconsin, where city crews collect newspapers separated from other wastes by the citizenry, indicates that alternatives to large scale recovery plants do indeed exist.

Such approaches to supply creation are still being analyzed as part of EPA's resource recovery studies program.

Other Options. In addition to action programs that would impact directly on resource recovery, a number of related activities are also under consideration whose consequences would be to attack the broader problem of "excessive materials consumption" in the United States rather than one aspect of that problem, low resource recovery rates.

Source reduction proposals are usually aimed at a particular product (beverage containers) or a class of products (packaging, appliances).

Source reduction options fall into four categories: (1) bans or other disincentives applied to a product or class of products; (2) performance standard setting that will result in longer-lived products, whereby more "use" or "service" is obtained from a given quantity of materials than is the case if rapid obsolescence is promoted; (3) substitution of production processes with low waste yields for waste-intensive processes, for instance, dry paper-making in place of wet pulping; and (4) substitution of products with low-materials requirements for those with high materials requirements, for instance, electronic calculators for the more material-intensive mechanical calculators or substitution of electronic communications media for media that require paper.

EPA's investigation of source reduction concepts is currently aimed at packaging and other disposables, products which are particularly significant in their contribution to solid waste quantities and whose consumption has been growing rapidly. An EPA study is underway to examine alternate taxing and regulatory measures for reducing the quantities of packaging materials consumed.

Such measures might be successful in either (a) reducing consumption of packaging and other disposables, (b) stimulating designs of more recyclable packaging or products, or (c) providing funds for defraying the litter clean-up, collection and disposal costs presently associated with these materials. The secondary effects of these measures, such as economic dislocations and employment disruptions are also being examined.

Of the various major options available for increasing the rate of recovery, intensified Federal procurement of waste-based products and further exploration of positive demand incentives appear most desirable in the long term, accompanied by activities to bring into line virgin and secondary materials freight rates. More information is needed about the necessity for and the effects, fairness, and workability of both source reduction and resource recovery incentive concepts before any such measures are implemented.

Demand creation would be achieved most efficiently by the direct route of rewarding the waste consumer for using secondary materials. Incentives for demand creation, if properly designed may bring about resource recovery at an accelerated rate and would probably spur private and public investment in resource recovery plants and systems to supply secondary materials. Certain changes in supply patterns may emerge which will result in some waste materials circumventing the recovery plants. "Skimming" of accessible wastes such as newspapers, corrugated boxes and office papers is such a change. For smaller communities where recovery by processing is not likely to be economical, provision of supplies by separate collection is a potential solution.

Actions aimed at removing certain artificial barriers are under serious consideration by EPA, especially Federal procurement policies to increase the use of secondary materials in products and actions to remove freight rate disparities that appear to favor virgin materials.

Taxes and regulation to reduce the consumption of certain product categories such as packaging to reduce the load on the solid waste stream are presently under investigation. Stimulation of more recyclable package designs and provision of funds for litter clean-up are secondary benefits of such actions.

Section 4

DISCUSSION OF PROGRAM ACTIVITIES

The foregoing presentation and preliminary conclusion as well as the data, information, and discussions of specific materials included in the Appendix are based on EPA resource recovery program activities, carried out both by in-house staff efforts and contract research in support of internal analysis.

An overview of the basic plan for carrying out the Congressional mandate is shown in Figure 2. The problem is defined in terms of the adverse environmental effects of materials processing and disposal and efficiency of resource utilization. The broad solutions identified to the problem are increased resource recovery and source reduction activities. A number of policy options available to achieve the solution are shown. Next, specific program activities to implement the policy option are shown arranged into "primary" and "secondary" priority emphasis categories. Finally, an evaluation procedure by which specific action programs will be selected for recommendation is outlined.

Figure 3 shows the various alternatives available for reaching the objective of increased waste utilization; Figure 4 illustrates the alternatives available to obtain the objective of source reduc-

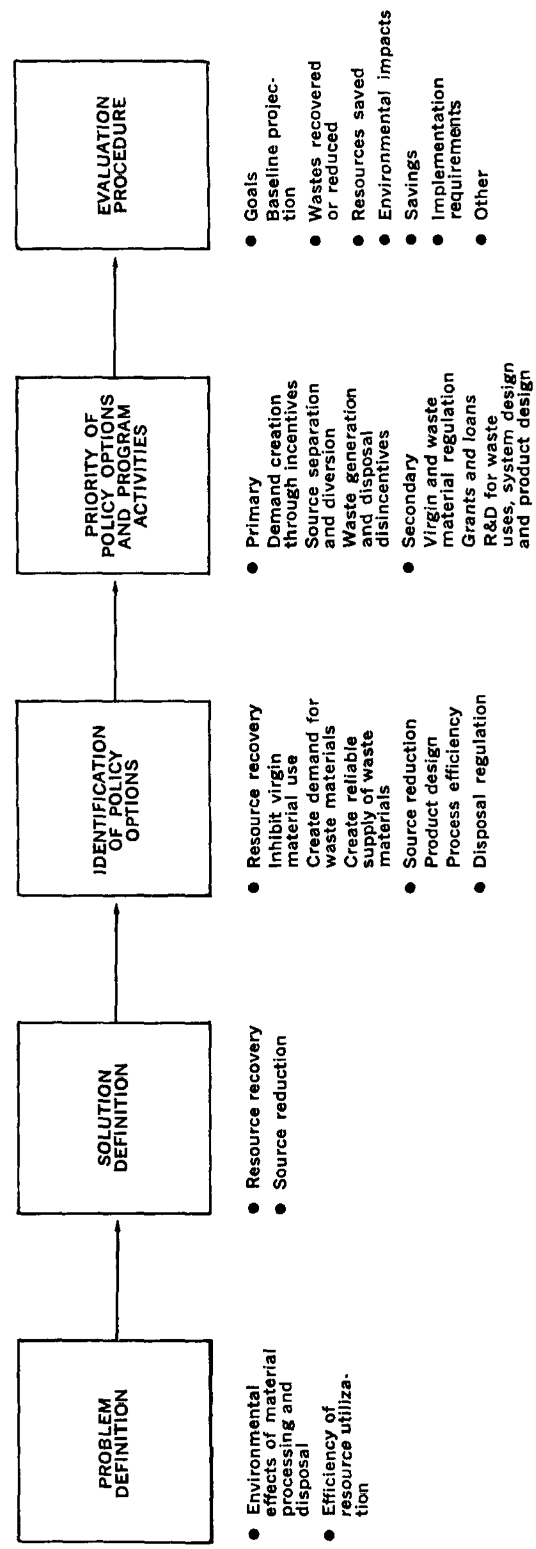
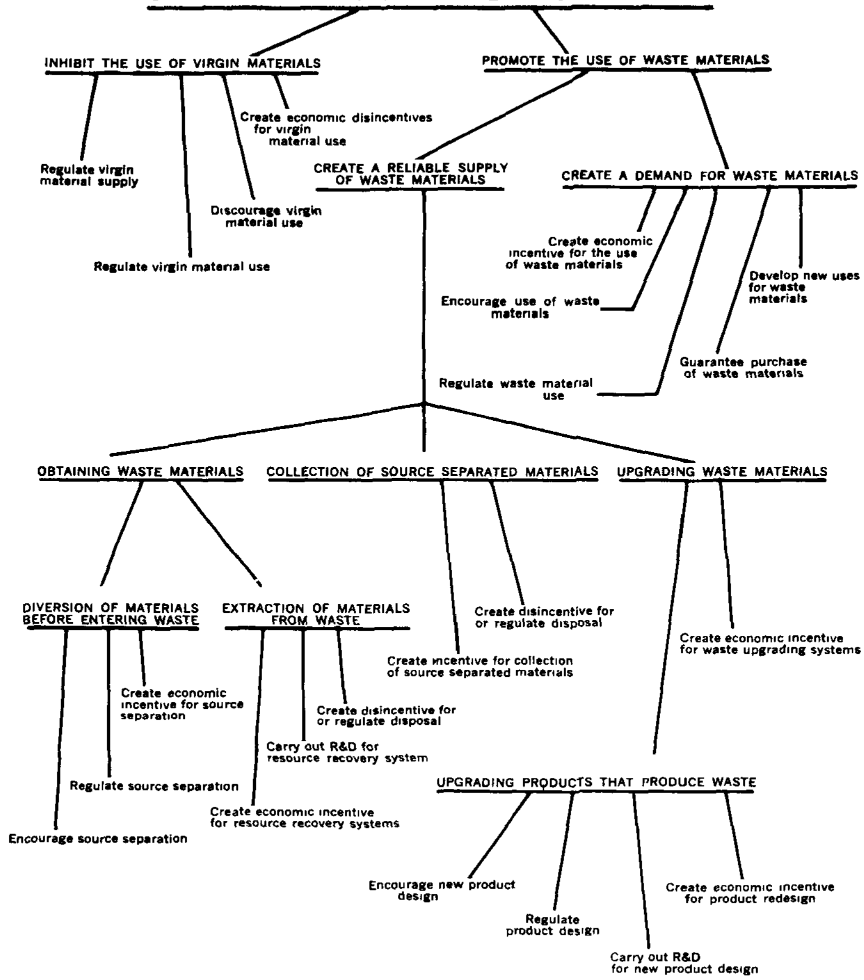


FIGURE 2
OVERVIEW OF A PLAN FOR RESOURCE RECOVERY AND SOURCE REDUCTION

FIGURE 3
OBJECTIVE: TO INCREASE UTILIZATION OF WASTE



RESOURCE RECOVERY POLICY OPTIONS

FIGURE 4
SOURCE REDUCTION POLICY OPTIONS:

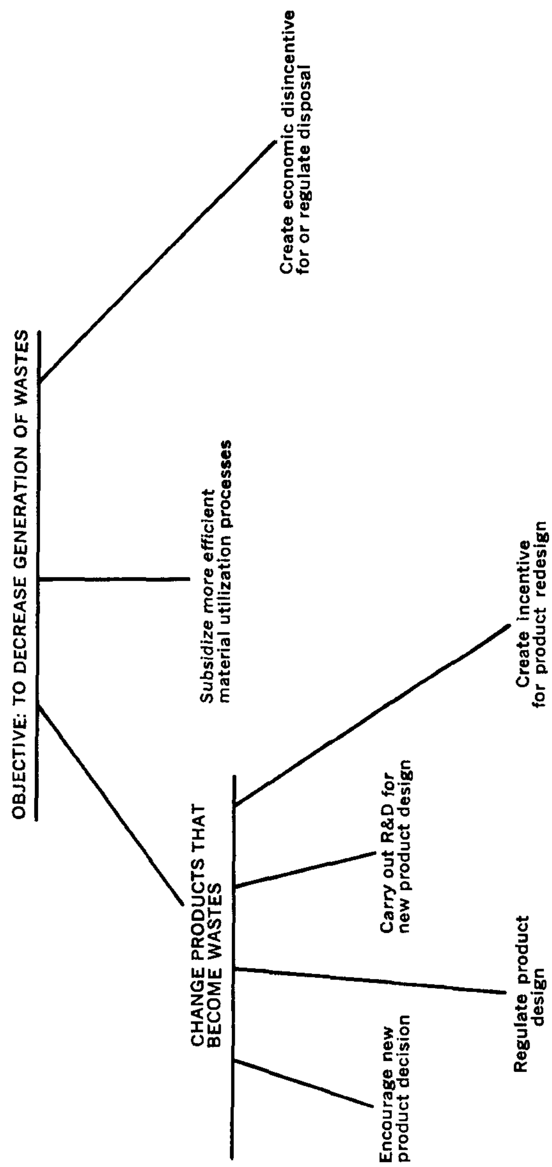
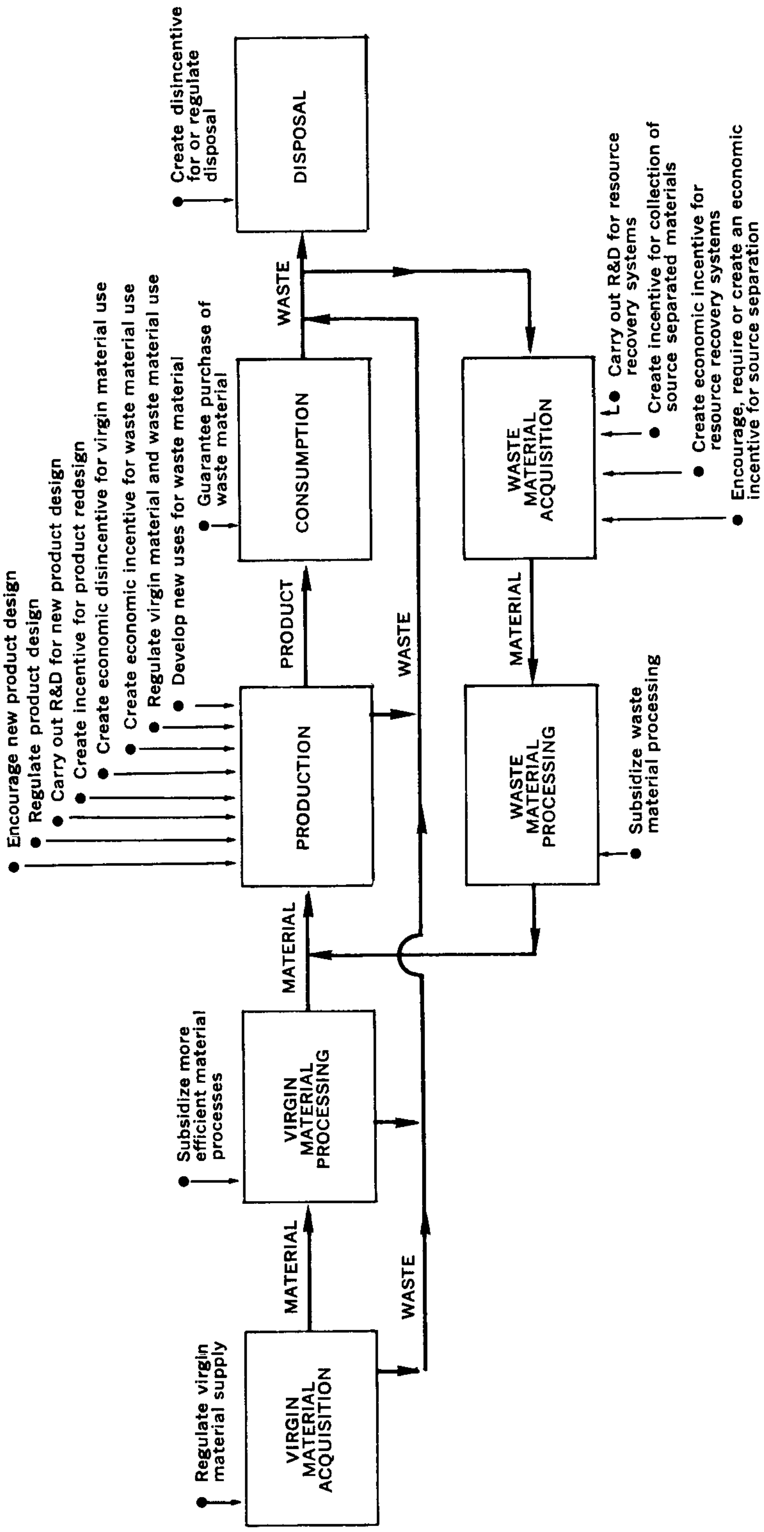


FIGURE 5
APPLICATION OF RESOURCE RECOVERY AND SOURCE REDUCTION POLICY OPTIONS



tion; and Figure 5 illustrates the points in the materials cycle where the various action program alternatives would have their impacts.

For purposes of discussion, EPA's program efforts can be classified into three types of activities: (1) background studies that provide for understanding the subject of resource recovery in its many facets; (2) studies to formulate and to analyze action programs; and (3) studies to evaluate the impacts and effectiveness of action programs that appear to have merit. In what follows, the various past, on-going, and projected activities of EPA will be discussed under these headings.

Background Studies. Background investigations include data collection, survey, and information classification in order to establish the status and trends of recycling and identify problems, barriers and opportunities for increased waste use. To date a number of background investigations have been completed and are nearing publication. A list of completed studies is presented on Table 11. These cover topics such as municipal resource recovery practices, secondary materials recovery, unit processes in resource recovery, and comprehensive recovery systems.

Review of this information is underway, data and information gaps have been identified, and the need for further background investigations has been established in the following areas:

(1) Recycling base line—In order to assess an incentive mechanism designed to increase recovery of wastes, it is first necessary to project future recycling that is likely to occur in the absence of the proposed incentive. Factors which could influence this base line are:

- Rising municipal disposal costs.
- Environmental legislation.
- Recovery technology development.
- Rising energy prices.
- Change in labor productivity.
- Private sector and local government actions.

An investigation is being carried out to forecast this base line in the absence of Federal Government activity.

(2) Available for recycling—It is also important to estimate the practical upper limit on recovery in order to assess the effectiveness of proposed recycling measures. It is not feasible to recover all of the solid waste generated. The amount available for recycling is determined by factors such as:

- Losses in processing, collection and handling.
- Amounts generated in remote areas.

- Self disposal activities.
- Materials dispersed in trace quantities.
- Materials concealed or mixed in products.

The practical limits on recycling are being projected to serve as a guide for evaluating recycling activities.

(3) Freight rates—Transport rates may have an unfavorable effect on the prices of secondary materials as compared to virgin materials. However, differences which exist may be justified by cost to the carrier. An investigation of the basis and structure of transport rates is being carried out in an attempt to:

- Compare actual freight rates for secondary and primary materials.
- Compare carrier cost of shipping and factors affecting this cost.
- Establish the effect of rates on the relative prices of virgin and waste materials.

(4) Source separation and collection—In order to analyze in-

TABLE 11

COMPLETED STUDIES AND INVESTIGATIONS

Background Studies

Salvage Markets for Commodities Entering The Solid Waste Stream—An Economic Study.
Midwest Research Institute, 1971

Studies to Identify Opportunities for Increased Solid Waste Utilization-Studies completed for Aluminum, Lead, Copper, Zinc, Nickel and Stainless Steel, Precious Metals, Paper and Textiles.
Battelle Memorial Institute and National Association of Secondary Materials Industries, 1971

Identification of Opportunities for Increased Recycling of Ferrous Solid Waste.
Battelle Memorial Institute and Institute of Secondary Iron and Steel, 1971

An Analysis of Federal Programs Affecting Solid Waste Management and Recycling.
SCS Engineers, 1971

Catalog of Resource Recovery Systems for Mixed Municipal Waste.
Midwest Research Institute and Council of Environmental Quality, 1971

Recovery and Utilization of Municipal Solid Wastes.
Battelle Memorial Institute, 1971

Formulation and Analysis of Action Programs

An Analysis of the Abandoned Automobile Problem.
Booz-Allen Hamilton, 1972

Incentives for Tire Recycling and Reuse.
International Research and Technology, 1971

An Analysis of the Beverage Container Problem with Recommendations for Government Policy.
Research Triangle Institute, 1972

The Economics of the Plastics Industry.
Arthur D. Little, 1972

Strategies to Increase Recovery of Resources from Combustible Solid Wastes.
International Research and Technology, 1972

Evaluation

Economic and Environmental Analysis—Studies completed for Paper, Ferrous Metals and Glass.
Midwest Research Institute and Council of Environmental Quality, 1971

Preliminary Report on a Federal Tax Credit Incentive for Recycling Post Consumer Waste Materials.
Resource Planning Associates, 1972

centives and policies to promote increased recycling, the reliability and costs of obtaining wastes from different sources must be known. There are three source separation techniques currently employed to collect wastes segregated at households or business establishments.

- Community recycling centers.
- Separate collections (by volunteer organizations, municipal or private collectors, and secondary material dealers).
- Separation of wastes during regular household collections.

An example of the latter type of operation exists in Madison, Wisconsin, where segregated newspapers are collected with other household wastes and placed in a separate bin hung below the collection vehicle.

In order to provide the background information needed to evaluate these techniques studies will be carried out to assess:

- Consumer attitudes to source separation techniques.
- Costs involved in collecting segregated materials and transporting them to users.
- Amounts of material that can feasibly be recycled through these channels.

Formulation of Action Programs. Work in this area involves identifying and formulating means of increasing recycling through demand creation, supply creation and inhibiting virgin material use. Studies of incentive alternatives that have been completed but not yet released are listed in Table 11. These involve incentives for automobile hulks, plastics, tires, beverage containers and combustible wastes. These studies are presently under internal review and, where appropriate, recommendations will be forthcoming. The contract reports will be available for public distribution when the review is complete.

Program plans are being developed for the following incentive and regulatory measures which will be analyzed and evaluated in the next year.

Economic Incentives:

- Recycling tax credit or subsidy for the use of post consumer waste.
- Investment credit or subsidy for recovery equipment.
- Virgin material tax to increase cost of virgin material use.
- Waste generation tax to reduce the amount of waste produced.
- Government procurement to create a demand for waste materials.
- Depletion allowance adjustment to increase costs of virgin materials.

Regulatory Measures:

- Transport rate adjustment to equalize freight rates.
- Material standards specifying waste use in certain products.
- Virgin resource control on Federal lands.
- Regulation of waste and virgin material imports and exports.

Evaluation. Evaluation of the programs listed above consists of determining:

1. The wastes recycled.
2. The resources conserved.
3. The environmental impacts.
4. The costs and savings.
5. The implementation requirements.
6. Other impacts such as employment, foreign trade, industrial dislocation, etc.

Work in this area involves first developing a methodology for carrying out the evaluation of the different aspects and secondly, applying the methodology to the specific incentive and regulatory measures. As indicated by the reports listed on Table 11, environmental impact analysis for paper, ferrous metals, and glass has been started and a preliminary cost effectiveness study has been carried out for one type of incentive—the recycling tax credit.

As will be discussed below, additional work is required in the areas of predicting waste recycling and estimating resource requirements and environmental impacts. The costs and savings follow directly from these measures. The implementation requirements and other impacts must be evaluated on an individual basis for each particular incentive or regulatory mechanism.

(1) Predicted recycling—In order to predict the amount of waste material that would be recycled as a result of an incentive or regulation it is necessary to estimate the elasticity of supply and demand with price for the waste and the competitive virgin material. This requires analysis of historical price-quantity data, financial analyses to determine the effect on profit, return and investment decisions, and analysis of material processing costs. Work is underway aimed at recycling through the major waste using industries (such as waste paper, scrap steel, and glass).

(2) Environmental impacts and resource consumption—Work in this area involves laying out the entire waste material use system from acquisition to disposal. At each element of the system the air and water pollution produced are calculated along with the energy, water and materials consumed. Comparisons are made with and without recycling and the net environmental impact is determined. The work completed for paper, ferrous metals and glass will be ex-

panded to include calculation of the pollution abatement cost savings due to recycling. Similar analyses will be carried out for aluminum, rubber, textiles and plastics.

In summary, evaluation of the regulatory mechanisms and incentives involves:

1. Determining the effectiveness of the measures proposed.
2. Comparing this to the recycling base line and practical upper limit.
3. Estimating costs and benefits.
4. Making an informed judgment as to the value of the measure.

Program activities described above are aimed at providing information necessary to formulate meaningful resource recovery policy. In the last half of the fiscal year ending June 30, 1973, recommendations will be made for measures to accomplish the goal of increased resource recovery on an environmentally, economically and socially sound basis. These measures will be described in the Second Annual Report to Congress.

REFERENCES

1. Ayres, R. U., and A. V. Kneese. Environmental pollution. *In* Resource Recovery Act of 1969 (part 2). Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, U.S. Senate, 91st Cong., 1st sess., S.2005, Serial No. 91–13. Washington, U.S. Government Printing Office, 1969. p. 821.
2. Ayres, and Kneese, Environmental pollution, p. 821. (Data for 1968 and 1971 are extrapolations from the 1963, 1964, 1965 base data.)
3. Ayres, and Kneese, Environmental pollution, p. 819.
4. Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. 187 p.
5. Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.
6. Darnay, A., and W. E. Franklin. The role of packaging in solid waste management, 1966 to 1976. Public Health Service Publication No. 1855. Washington, U.S. Government Printing Office, 1969. p. 105.
7. EPA extrapolation based on (1) data for 1967 from: Black, R. J., A. J. Muhich, A. J. Klee, H. L. Hickman, Jr., and R. D. Vaughan. The national solid wastes survey; an interim report. [Cincinnati], U.S. Department of Health, Education, and Welfare, [1968]. p. 13. (2) census data from: U.S. Bureau of the Census. Statistical abstract of the United States 1971. 92d ann. ed. Washington, U.S. Government Printing Office. 1,008 p.
8. EPA extrapolation based on data for 1965 from: Combustion Engineering, Inc. Technical-economic study of solid waste disposal needs and practices. Public Health Service Publication No. 1886. Washington, U.S. Government Printing Office, 1969. [705 p.]
9. EPA extrapolation based on (1) data for 1965 from: Air Pollution—1969. Hearing before the Subcommittee on Air and Water Pollution of

the Committee on Public Works, U.S. Senate, 91st Cong., 1st sess., Oct. 27, 1969. Washington, U.S. Government Printing Office, 1970. 244 p. (2) U.S. Bureau of Mines estimates.

10. EPA extrapolation based on (1) data for 1966 from: Air pollution—1969. (2) [Agricultural handbook, 1971.]

11. Black, Muhich, Klee, Hickman, and Vaughan, The national solid wastes survey, [1968], p. 13.

12. Darnay, and Franklin, Salvage markets, 1972, p. 35, 45–7.

13. Darnay, and Franklin, Salvage markets, 1972, p. 58–11.

14. Darnay, and Franklin, Salvage markets, 1972, p. 81.

15. Darnay, and Franklin, Salvage markets, 1972, p. 64–5.

16. Midwest Research Institute. Resource recovery from mixed municipal solid wastes. Unpublished data, 1972.

APPENDIX

PAPER RECYCLING

Status and Trends

Paper is one of the major manufactured materials consumed in the United States and the largest single component—35 to 45 percent by weight—of municipal waste collected. In 1969, the Nation consumed 58.5 million tons of paper, and by 1980 this is projected to increase to about 85.0 million tons (Figure A–1). Paper, paperboard, and construction paper and board are the three major paper categories and accounted for 51.5, 40.8, 7.7 percent respectively of the 1969 paper consumption.

Only 17.8 percent (10.4 million tons) of the paper consumed in 1969 was recovered for recycling compared with 23.1 percent in 1960 and 27.4 percent in 1950.[1] Most of the remainder was discarded as waste (put in landfills, or dumps, incinerated, or littered) and a portion was diverted, obscured, or retained in other products. Trends for disposal and recycling (Figure A–1), show that the percent recycled to consumption has been steadily decreasing. This downward trend in recovery ratio coupled with an increase in consumption has resulted in an accelerated rate of waste paper disposal. Between 1956 and 1967 waste paper disposal increased nearly 60 percent from 22 million tons/year to 35 million tons/year.[2]

Sources of Waste

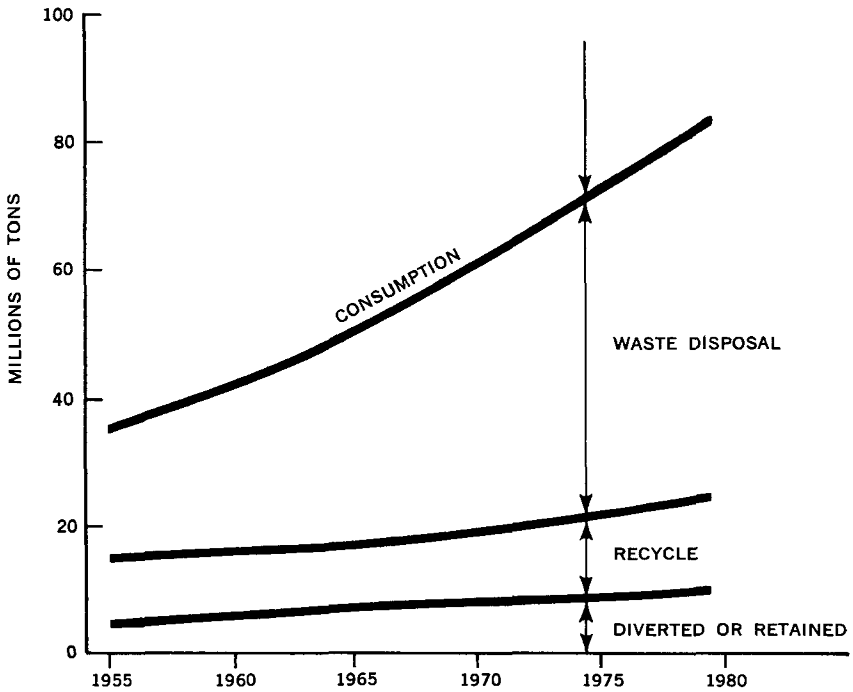
Waste paper can be classified into four major grades: mixed, news, corrugated, and high grades accounting for 27.4, 19.8, 32.6, and 20.2 percent respectively of the waste paper recovered in 1967. This waste paper comes from residential, commerical, and conversion sources accounting for 16.6, 43.6, and 39.8 percent respectively of the 1967 paper recovery. Table A–1 shows the relationships between the waste grades and sources. The recovery pattern of paper wastes follows directly from the characteristics of each waste paper source.

Waste paper generated in conversion operations, where paper and board are made into consumer products, is almost all recovered. It is easily accessible, generally uncontaminated, and almost half of such waste consists of the desirable high grades. This waste is often baled on site by the converter and never enters the waste stream.

Quite the opposite, paper waste from residential sources is widely dispersed and highly contaminated with adhesives and coatings and also with other materials in the waste stream. It is costly and difficult to remove by paper mills. Thus, almost none of the mixed paper in residential waste is recovered.

FIGURE A–1

PAPER TRENDS, CONSUMPTION, DISPOSAL AND RECYCLING



Source: Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. Chap. IV.

TABLE A–1
WASTE PAPER RECOVERY BY GRADE AND SOURCE, 1967
1,000 TONS

Grade	Residential	Commercial	Converting	Total
Mixed	70	1,860	850	2,780
News	1,610	50	345	2,005
Corrugated	—	2,300	998	3,298
High grades	—	200	1,841	2,041
TOTAL	1,680	4,410	4,034	10,124
Percent of total	16.6	43.6	39.8	100.0

Note: Net exports add another 176,000 tons derived from converting operations
Source: Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes Washington, U.S. Government Printing Office, 1972. p. 45–23.

The only paper recovered in significant quantities from residential waste is old news. Those newspapers recovered are kept separated from other waste by homeowners and usually collected by charitable organizations. Some municipalities have started experimenting with collecting the newspapers along with the regular refuse collection by placing them in special racks on the collection vehicles. This offers promise for increasing the recovery of old newspapers from residences.

Commercial waste consists largely of business papers, mail, and packaging materials, especially corrugated boxes and is usually concentrated at commercial/retail centers. It is obviously more accessible and desirable than mixed papers from residential sources but generally less so than conversion wastes. Corrugated boxes comprise about 52 percent of the commercial paper waste recovered. They are usually baled or at least kept separate from other waste by the store or office. Significant quantities of mixed papers are also recovered since they often occur at commercial establishments in high concentrations with few contaminants.

Additional quantities of waste are potentially recoverable from residential and commercial sources. Based on Midwest Research Institute estimates in 1967 there were 35.2 million tons of paper discarded as waste and not recovered—6.3 million tons were newspapers, 8.6 million tons were corrugated and 20.3 million tons were all other types.[3] Of course, not all of this waste is potentially recoverable. A portion of the waste is discarded in rural or remote locations and will never be practically recoverable. A portion is lost in litter or burned, and a portion would be unusable for technical reasons. The MRI study estimated that the most likely recoverable tonnage is 10.2 million tons or 29 percent of the presently unrecovered paper waste (Table A–2). Recovery of this additional amount would have meant an increase in recycling of over 100 percent in 1967.

Approximately half of the additional recoverable tonnage is made up of newspapers and corrugated board, two grades already recovered in substantial quantities. Recycling of these wastes can be facilitated by the creation of a demand for materials so that they will be collected prior to discard. Prior separation and separate collection of these wastes holds forth the possibility of a relatively quick and efficient means of increasing recycling of substantial quantities of wastes.

The remainder of the tonnage that is potentially recoverable is mixed paper which would require further processing before recycling.

A promising technology for recovery of paper from mixed residential waste has now been developed, however. This is the wet pulping process developed by the Black-Clawson Company which is currently being demonstrated in an Environmental Protection Agency project in Franklin, Ohio. In this process about 400 pounds of paper fiber are recovered for each ton of mixed waste input. Ferrous metals and glass are also recovered during the processing. The economic feasibility of large scale plants of this type looks promising.

Markets

From a waste utilization point of view the paper industry is made up of an integrated segment using primarily wood pulp and an independent segment using primarily waste paper (called paperstock by the industry). Most recycling takes place in the independent sector. Major products made from paper stock (and major products of the independent segment) include combination board (e.g. cereal, detergent, and shoe boxes), deinked newspapers, and construction paper.

Figure A–2 shows the consumption of wood pulp and paperstock

TABLE A–2
ADDITIONAL WASTE PAPER RECOVERY POTENTIAL FROM SOLID WASTE IN 1967
(million tons)

	Unrecovered and discarded as waste	Most likely recoverable	Recoverable as a % of presently unrecovered paper waste
Newspapers	6 3	2.2	35.0
Corrugated	8.6	3.0	35.0
All other	20.3	5.0	24.6
TOTAL	35.2	10.2	29.0

Source: Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. p. 45–24.

in the three major product grades of the paper industry—paper, paperboard, and construction paper and board. Paperboard accounts for 79.0 percent of paperstock consumption, paper 13.4 percent, and construction paper 7.2 percent of the total paperstock consumed. Thus, paper recycling is closely tied to trends in combination board consumption.

Combination board production has grown at a substantially slower rate than that of its direct competitor, solid wood pulp board, made almost entirely from virgin pulp. From 1959 to 1969, total paperboard production increased by 65%, solid wood pulp board by 112%, and combination board by only 5 percent.[4] Herein lies the major reason for the decrease in the waste paper recycling ratio.

There has been only one major new market for waste paper in recent years, the deinking of old newspapers to make newsprint. Newspaper deinking is a very promising market for old news and increased newspaper recycling will be influenced strongly by this market.

Major Issues and Problems of Paper Recycling

There are many interrelated factors that have contributed to the decline in the percentage of paper recycled; however, the two primary direct causes are the lack of new markets and the decline in combination board market share.

It is technically feasible to substitute paperstock for wood pulp in many paper products (Table A–3). However, this is not practiced extensively due to economic factors and the present high reliance of the dominant integrated industry on virgin pulp. Key items which discourage use of waste paper are listed below.

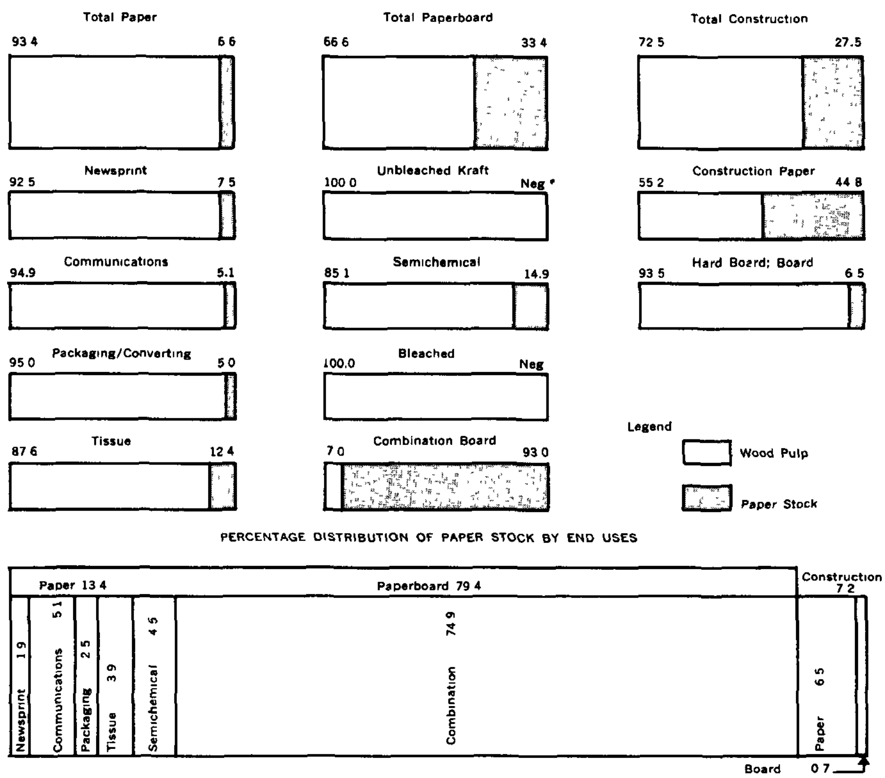
Logistics. Paper must be collected from diverse sources, transported to a processor, and then transported to a consuming mill. Combination board mills are usually within reasonable distances of waste paper sources, but the integrated mills are generally located in the South or West, near forests, but far from cities where waste is generated. Thus, the high costs of collection and transportation work to the detriment of paper recycling.

Contaminants in waste paper have affected recycling economics unfavorably, and also have influenced industry orientation. Separation of waste paper by grade and removal of contaminants are labor intensive and thus costly.

Waste paper prices have a history of wide fluctuation due to the relative rigidity of supplies and the marginal costs of acquiring new supplies in periods of demand upswing.

FIGURE A–2

WOOD PULP AND PAPER STOCK RELATIVE TO MAJOR GRADES PRODUCED—1967



Note: Other fibrous materials were excluded, expressed in percent of total wood pulp and paper stock Based on MRI estimates

*Small percentage of paper stock used but cannot be verified in statistics

Source Darnay, A., and W. E Franklin Salvage markets for materials in solid wastes Washington, U S Government Printing Office, 1972 p 45–2

TABLE A–3
TECHNICAL LIMITS FOR RECYCLED MATERIAL FOR PAPER AND PAPER BOARD

Paperboard	Recycle limits (% paperstock)
Unbleached kraft	10–25%
Semichemical pulp	100%
Bleached kraft	5–15%
Combination board	90–100%
Paper	
Newsprint	100%
Office, communications	10–80%
Publishing, printing, converting	10–80%

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

Improvements in wood pulping technology have enabled the paper industry to tap abundant virgin raw materials at increasingly lower costs.

Integration. Most paper mills own their own forests and most paper equipment installed since 1945 has been wood pulp based and located close to these virgin raw materials. The mills are designed as continuous operations starting with wood, going into pulp and ending with the finished product. By integration, paper mills have also been able to exercise control over the supply and price of their raw materials.

Tax Treatments. The cost of virgin wood pulp can be kept down significantly by two tax treatments—a cost depletion allowance (credit against income taxes based on timber owners' invested capital in a forest and percentage of reserves sold) and a capital gains allowance (profit from sales of timber is treated as a capital gain if the timber has been owned for more than six months).

Economics

Most of the above problems have a negative effect on the economics of waste paper use. If one examines the economics of using waste paper in the manufacture of certain paper and board products, it is obvious that increasing the amount of paperstock in these products increases the cost to manufacture them.

Table A–4 shows the comparative economics of using supplemental waste paper in existing paper mills for certain products. These examples are by no means exhaustive of the many paper industry products, but these cases support what would seem to be obvious from the current industry orientation. The cost penalty for increasing the use of paperstock is \$2.50/ton for corrugating medium, \$3.75/ton for linerboard (these are the materials used to

TABLE A-4
COMPARATIVE ECONOMICS OF PAPER MANUFACTURE FROM RECYCLED AND VIRGIN MATERIALS

Product	Linerboard	Corrugating medium	Printing/writing paper	Newsprint
Baseline case (recycled fiber content)	0%	15%	0%	0%
Baseline average operating cost	$78.50/ton	$79 50/ton	$80–$120/ton	$125/ton
Supplemental fiber use (recycled fiber content)	25%	40%	100	100
Operating cost with increased use of recycled fiber.	$82 25/ton	$82.00/ton	$100–$150/ton	$98/ton
Net cost of increased recycled fiber usage	$ 3.75/ton	$ 2.50/ton	$ 20–$ 30/ton	–$27/ton

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery Unpublished data, 1972.

make corrugated boxes), and $20–30/ton for printing/writing paper. The latter cost differential is the result of substantial upgrading of waste paper that would be required to produce a product of the present high standards. The cost of newsprint manufacture, however, is lowered by using 100 percent recycled fiber (deinked newsprint). This has been the only major new market for waste paper in recent years.

The economics of constructing new mills based on either virgin or secondary fibers also supports industry's trend toward use of more virgin fiber at the expense of secondary fiber. An analysis of folding boxboard (combination board made from secondary fiber vs. solid wood pulp board made from virgin pulp) found the return on investment from a virgin based plant to be 8.1 percent while that for a plant based on waste paper (combination board) was only 4.5 percent.[5] Under such circumstances, investments in new combination board mills are very unlikely. The reason for the shift in recent years of boxboard manufacture from combination board mills to virgin based mills is obvious.

FERROUS METALS RECYCLING

Status and Trends

Ferrous solid waste (primarily in the form of food and beverage containers and discarded consumer appliances) constitutes 7 to 8 percent of collected municipal solid waste and totalled roughly 14 million tons in 1970. However, a much more sizable amount of used and discarded ferrous products (an estimated 38–54 million tons) is generated annually and appears on our landscape in such visible forms as abandoned automobiles, discarded farm implements, out of service rail cars, construction and demolition waste, and other steel products.[6]

In 1967 American industry consumed about 83.5 million tons of iron and steel scrap and 7.6 million tons were exported (Table A–5). The domestic scrap consumption represented about 65 percent of the raw steel production (Fig. A–3). Fifty million tons of this domestic scrap consumption was "home" scrap that was generated in the iron and steelmaking process and was fed back into the furnaces. Excluding home scrap and exports, 35 million tons of scrap, or about 20 percent of the iron and steel consumption, was recycled in 1967.

For the past 25 years, scrap as a percent of total metallic input to steelmaking has remained essentially constant. However, the amount of this scrap purchased by the steel industry (originating from outside the steel plant) has been decreasing slightly while that generated within the steel mills has increased. As shown in Fig. A–4, purchased scrap as a percent of total scrap input to steelmaking has decreased from 44.9 percent for the period 1949–1953 to 40.0 percent from 1964–1968. In absolute terms while total steel production increased 35 percent over the period 1950–1969, and total scrap consumption increased 30 percent, scrap purchased increased only 8 percent.

Sources

There are two basic types of iron and steel scrap, "home" and "purchased."

"Home scrap", the ferrous waste product generated during iron and steel production, includes ingot croppings, sheet trimmings, and foundry gates and risers. Being generated in the steel mill, the scrap is of known composition and purity, and the total amount generated is normally consumed. Home scrap represented 60 percent of the domestic scrap consumption in 1967.[7]

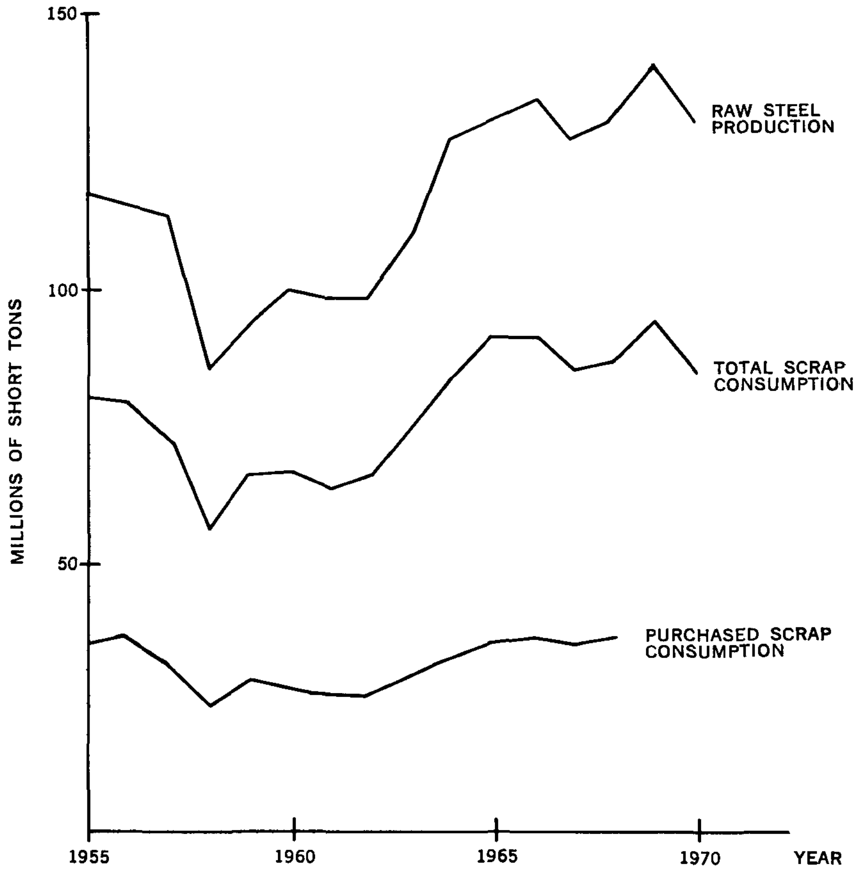
TABLE A–5
U.S. IRON AND STEEL SCRAP CONSUMPTION—1967
(Million short tons)

Domestic scrap consumption			85.4
Home scrap		50.2	
Purchased scrap		35.1	
Prompt	13.6		
Obsolete	21.5		
Exports			7.6
TOTAL			93.0

Source: Darnay, A., and W. E. Franklin. *Salvage markets for materials in solid wastes.* Washington, U.S. Government Printing Office, 1972. p. 49 and 58–11.

FIGURE A-3

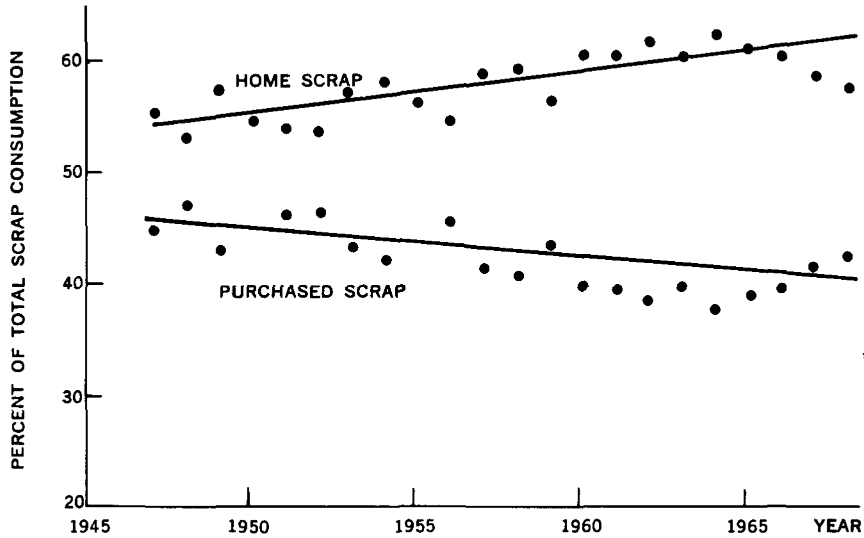
DOMESTIC RAW STEEL PRODUCTION AND SCRAP CONSUMPTION



Source: Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. p. 58–1 and 58–11.

FIGURE A-4

DOMESTIC HOME AND PURCHASED SCRAP CONSUMPTION



Source: Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. p. 58–11.

"Purchased" scrap is further classified as "prompt" or "obsolete."

"Prompt" industrial scrap is generated by metal working firms in their fabrication of products. Standard procedures have been developed for the recycling of prompt scrap and it never really enters the waste stream. At least 90 percent of the available prompt scrap is estimated to be recycled. The scrap is desirable because of its known composition, condition, and freedom from contaminants. In addition, it is considered a reliable material source because the quantities available are predictable and recycling channels have been established. Prompt scrap represented about 16 percent of the domestic scrap consumption in 1967.[8]

"Obsolete" scrap comes from discarded iron and steel products. Major sources are structural steel from building demolitions, ships, railroad equipment, and abandoned motor vehicles. Ferrous waste, of course, occurs in many other forms such as food and beverage cans and home appliances which are not generally recovered due to logistics, contamination, or other factors. Obsolete scrap represented about 25 percent of the domestic scrap consumption in 1967.[9]

Not all of the steel consumed flows immediately into the waste stream and is available as scrap. Considerable portions go into semi-permanent use (buildings, machinery, etc.) and enter the waste stream years later. It is estimated that the 21.6 million tons of obsolete scrap purchased or exported in 1967 was 43–56 percent of that available in the solid waste stream. Taking into account scrap located in remote locations and probably not recoverable and scrap disposed of by individuals, it is estimated that roughly another 24–39 million tons of ferrous scrap could feasibly have been recovered in 1967.[10]

Markets

The major markets for iron and steel scrap are the domestic steel industry, the domestic foundry industry, and exports. In 1969, the percentage of total scrap consumption by each was 73.8, 17.5 and 8.7 respectively.[11] However, in terms of purchased scrap (prompt and obsolete) foundries and exports weigh more heavily. For the steel industry about 35 percent of scrap consumed is purchased, while foundries purchase about 60 percent of their scrap consumption, and exports are naturally purchased scrap.

The American steel industry is composed of approximately 110 companies of which 21 are fully integrated (coke ovens, blast furnaces, and steelmaking furnaces), 9 operate mostly blast furnaces, and 80 operate only steelmaking furnaces, with electric steelmaking predominating. These 80 companies currently produce less than 10 percent of the nation's steel output, but are a significant outlet for ferrous solid waste.

The type of furnace used in steelmaking has a direct bearing on scrap usage. Three types of furnaces are used; open hearth, which uses approximately a 45 percent scrap charge, basic oxygen (30 percent scrap charge), and electric (100 percent scrap). (These charges are based on standard operating conditions which take into account both technological and economic factors). Basic trends have been: (1) the decline of the open hearth (from 87 percent of steel production in 1960 to 50 percent in 1968); (2) rapid rise of basic oxygen furnaces (from 3.3 percent of production in 1960 to 37.1 percent in 1968); and (3) moderate growth of electric furnace steel production (8.4 percent in 1960 to 12.7 percent in 1968). To date, declines in scrap requirements from decreased open hearth steelmaking have been balanced by increased scrap needs from rising electric furnace production.

In the foundry industry, scrap already accounts for about 85 percent of the metallic input, and product specifications dictate that pig iron be a portion of the charge in some cases. The cupola furnace which uses an 84 percent scrap charge dominates, comprises about 90 percent of the furnaces. Electric furnaces, which make up most of the remainder and use 100 percent scrap have been making inroads, however. Potential for increased scrap consumption by foundries is limited, but factors such as increasing trend toward replacement of cupola facilities with electric furnaces, geographic dispersion of foundries putting them closer to scrap sources, and a growth rate in excess of domestic steel production indicate that use of scrap by foundries should at least hold its own and may increase slightly. However, the foundries do not have potential as major markets for increased scrap consumption.

Exports are a significant market for iron and steel scrap, constituting 24 percent of total purchased steel in 1970. Exports are particularly important for movement of obsolete scrap, since a large portion of the exports are from obsolete sources. Japan is the largest consumer of export scrap, taking 48.8 percent of the market in 1970.

Copper precipitation is the major market for steel can scrap at present, but is quite limited. Only about 300,000 to 400,000 tons of old steel cans and can-making wastes, a small percentage of the estimated 5 million tons of cans produced each year, are consumed annually by this market.[12]

Issues and Problems

Differential Tax Treatment. Iron ore enjoys a 15 percent depletion allowance, and in addition iron ore producers are allowed to use certain capital costs as current deductions. Both of these policies reduce tax liability and thus the price at which the ore must be sold to maintain a given profit level. For example, the 15 percent depletion allowance permits a 13.5 percent decrease in the selling price without reducing the profit to the producer. The percentage depletion allowance continues as long as income is derived from the property, which is usually long after the capital investment in the property has been recovered. Thus, iron ore producers enjoy a major tax subsidy which is not available for secondary materials processors.

Steel Industry Structure. The integrated portion of the steel industry is iron ore oriented and has significant investment in ore processing equipment. The integrated steel manufacturers generally own virgin raw material sources and are able to exercise control over supply and price. Uncertainties in scrap price and availability are inconsistent with the steel industry practices of long range planning and long term commitments to equipment and raw materials.

Scrap Quality. Rigid steel production specifications require that scrap be processed in order to remove contaminants and impurities. Home and prompt scrap are from known sources and are generally higher quality than obsolete scrap (with the exception of certain obsolete scrap such as rail, ship, and structural). Cans present a special problem because of their contamination with tramp elements—aluminum from tops, lead from the seams and tin. For example, lead can be harmful to furnace refractories and too much tin causes undesirable properties in finished steel. Thus, except in periods of peak demand or hot metal shortages, the availability and low cost of higher quality raw materials tends to reduce the steel maker's incentive to use the lower quality portion of obsolete scrap.

Changing Iron and Steelmaking Technology. Replacement of open hearth furnaces by basic oxygen furnaces has tended to reduce scrap requirements. However, the increase in usage of electric furnaces has kept total scrap consumption roughly constant overall. Future scrap consumption is tied closely to continued increase in electric furnace melting. Investment decisions depend on comparative return on investment from various types of furnaces. The ROI from an electric furnace which uses 100 percent scrap is obviously strongly influenced by scrap prices.

The technical feasibility of using increasing scrap proportions in other steelmaking furnaces has been demonstrated. The BOF charge, for example, can be increased by preheating the scrap, but since this entails additional costs, it can only be justified if scrap cost decreases relative to ore cost.

Logistics. As with most materials occurring in solid waste, logistics is a significant deterrent to recycling. Collection and transport from diverse sources is costly. Recycling of large appliances, steel cans, and other ferrous materials in mixed municipal waste is strongly inhibited by high transport costs relative to scrap value.

Low Growth Rate of Consuming Industries. The domestic iron and steel industries are not growing as rapidly as the rest of the American economy, primarily due to increased imports, replacement of steel by other materials, and increased use of lighter, high strength steels. Over the past decade, while the United States economy has grown at an annual rate of over 5 percent, iron and steel production has grown at about 3 percent.

Economics

Most of the above issues add up to an unfavorable economic picture for scrap use in the steel industry, though their individual impact is difficult to measure. The total costs to an integrated steel producer of using scrap vs. ore in a BOF were estimated by Midwest Research Institute, in a study for the Council on Environmental Quality.[13] The comparative costs are difficult to determine, since the steel industry does not maintain or at least does not report such figures. Estimates have been made, however, which indicate that the cost of using scrap is slightly higher than the cost of using ore.

The chosen point of equivalency in the production process was the point where either hot molten pig iron or melted scrap could be used to charge a BOF furnace. The total cost of scrap at this point was estimated to be $44.00 per ton, including $33.50 purchase price of the scrap, $6.00 melting cost, $3.50 for scrap handling, and $1.00 for increased refractory wear caused by scrap usage. Molten pig iron cost was estimated at $37.50 per ton including $28.50 for the ore and associated raw materials, and $9.00 for melting costs. Thus, the cost of scrap ready for charging to a BOF is about $6.50 greater than the cost of hot metal derived from ore at the same point.

The mill operator may actually *perceive* an even higher relative cost of scrap usage since there will be a tendency for him to associate a loss with letting ore reduction facilities which are already in place sit idle. The mill operator will also associate a cost (in this case a real one) with the possibility that end products made from scrap may be rejected because they do not meet product specifications.

Thus, without a reduction in scrap cost of at least $6.00 to $7.00 per ton, it is unlikely that there will be any increased utilization of scrap in BOF furnaces by existing steel mills.

Usage Considerations

The reluctance of integrated steel industry to risk contamination in situations where specifications are demanding is understandable. However, for the small electric furnace operator serving the crude steel rebar market—and not participating in specification steel at all—there is no particular quality problem.

Table A–6 shows how well various steel products are suited for input of lower grades of scrap, and it shows their tonnage figures and percentages of total output in 1970. Rebars and hot rolled light shapes can be produced from miscellaneous waste scrap with no significant sacrifice in properties. In plants producing a considerable variety of products, including high specification items, low grade scrap would be unattractive even at low prices, since the trend is to produce steel furnace output which can meet a wide range of product specifications, and since low grade scrap could result in lower quality home scrap.

The total market for rebars and light shape raw material would be sufficient to handle the gatherable supply of low grade ferrous scrap if all of these products were produced by electric mini-mills. There is in fact a reasonably good fit between the ferrous solid waste problem and the mini-mill requirements—in price, material, and geography. However, the large integrated steel producers also share in the rebar and shape markets and as stated above they are reluctant to use the lower scrap grades.

NONFERROUS METALS RECYCLING

In 1969, a total of 10.5 million tons of aluminum, copper, zinc, and lead were consumed in the United States, and 3.2 million tons were recycled, an average of 30 percent of consumption. Figures A–5 through A–8 show consumption and amount of these materials recycled from 1960 to 1969. For 1969, recycling as a percent of consumption for each was 23 percent for aluminum, 46 percent for copper, 42 percent for lead, and 10 percent for zinc.[14]

Approximately 24 percent of the aluminum, and only about 4 percent of all the other major non-ferrous metals consumed occur

TABLE A-6
STEEL PRODUCT SUITABILITY FOR INCLUSION OF LOW GRADE SCRAP

Product	1970 net tons shipped (millions)	Percent of 1970 shipments	Suitability of low grade scrap as ingredient
Reinforcing bars	4.891	5.4	Excellent
Selected HR. light shapes	6.076	6.7	Excellent
Subtotal	10.967	12.1	*Excellent*
Selected wire rods	1.607	1.8	Very good
Selected rail accessories	0.440	0.5	Very good
Subtotal all above	13.014	14.4	Very good or better
Selected plates	7.777	8.6	Good
Subtotal all above	20.791	23.0	Good or better
Oil country goods	1.307	1.4	Fair
Heavy structural shapes	5.566	6.1	*Fair*
Steel piling	0.495	0.5	Fair
Subtotal all above	28.159	31.0	Fair or better
Hot rolled strip	1.293	1.4	Marginal
Hot rolled sheet	*12.319*	*13.6*	*Marginal*
Subtotal all above	41.771	46.0	Marginal or better
All other products	49.027	54.0	Generally unsuitable
Grand total all products	90.798	100.0	

Source: Midwest Research Institute. Economic studies in support of policy formation on resource recovery. Unpublished data, 1972.

in municipal waste. These four metals constituted less than one percent or roughly 1.2 million tons of collected municipal solid waste in 1968. Aluminum accounted for 83 percent of this total.[15]

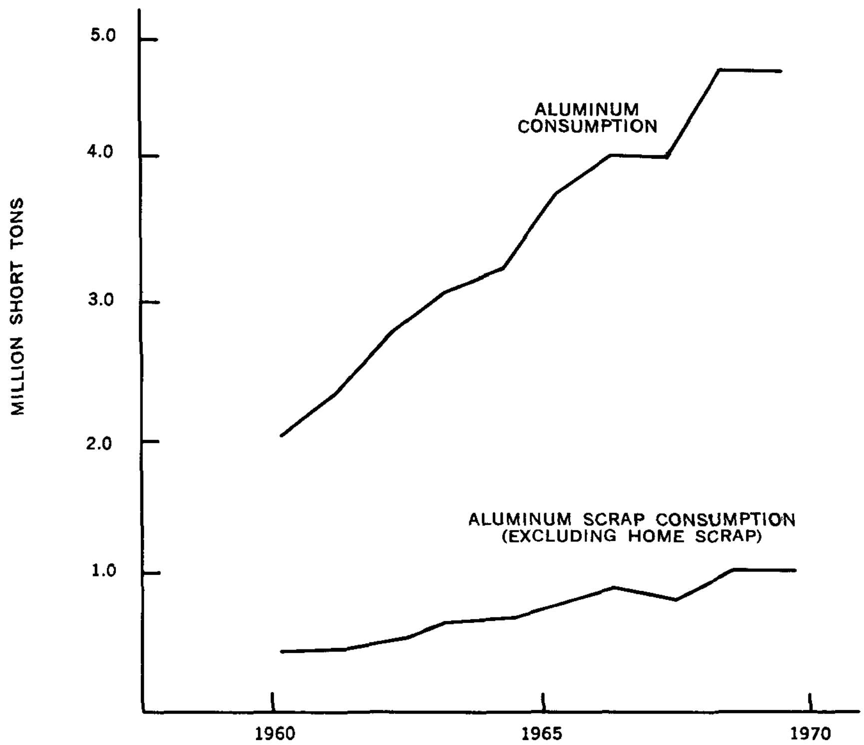
Sources and Markets

Table A-7 shows the amounts of each of the nonferrous metals recovered from prompt and obsolete sources. Copper and lead recovery from obsolete sources is a very important part of the recovery, while for aluminum and zinc little of the recovered scrap comes from obsolete sources. In all cases virtually all of the available prompt scrap from industrial fabrication is recovered. Recovery of the metals from obsolete sources is directly related to the form in which the scrap occurs and to its location. Thus, large quantities of lead are recovered from worn out batteries returned to dealers by consumers. Obsolete zinc which is widely scattered and usually appears in small quantities and in combination with other materials is largely unrecovered.

The aluminum can recycling programs of aluminum producers

FIGURE A–5

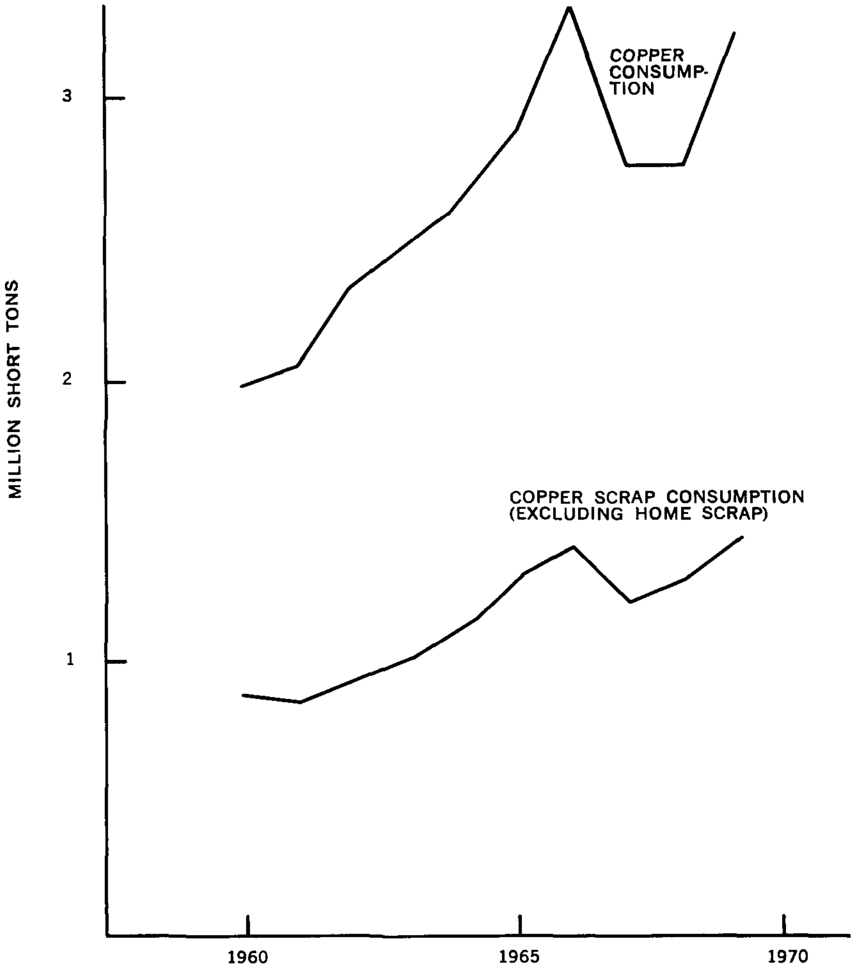
ALUMINUM AND ALUMINUM SCRAP CONSUMPTION



Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 1, v.2. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 729.]

FIGURE A-6

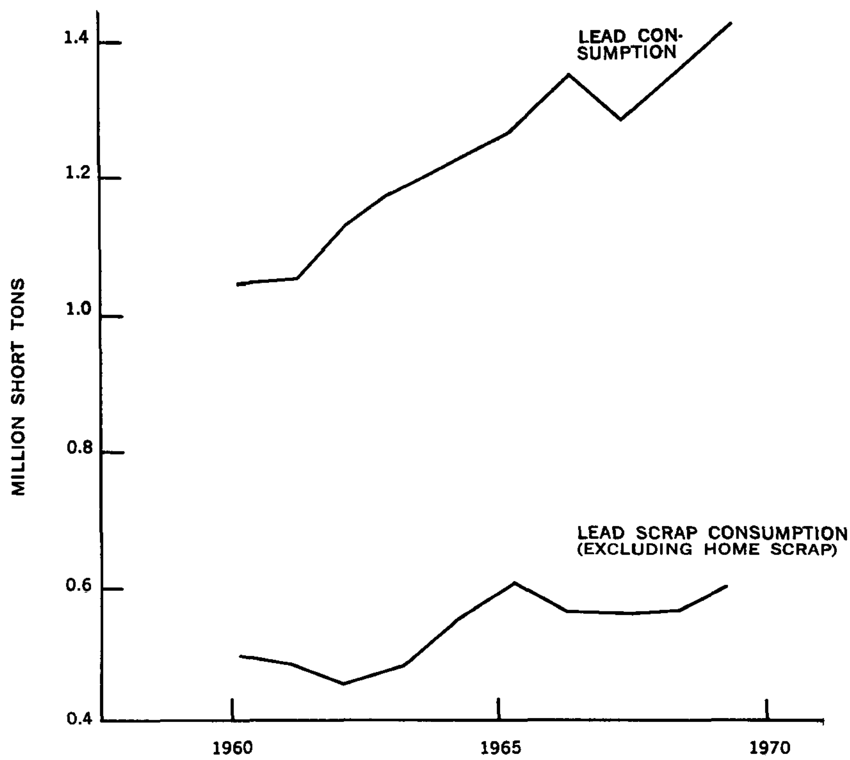
COPPER AND COPPER SCRAP CONSUMPTION



Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v.3. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

FIGURE A-7

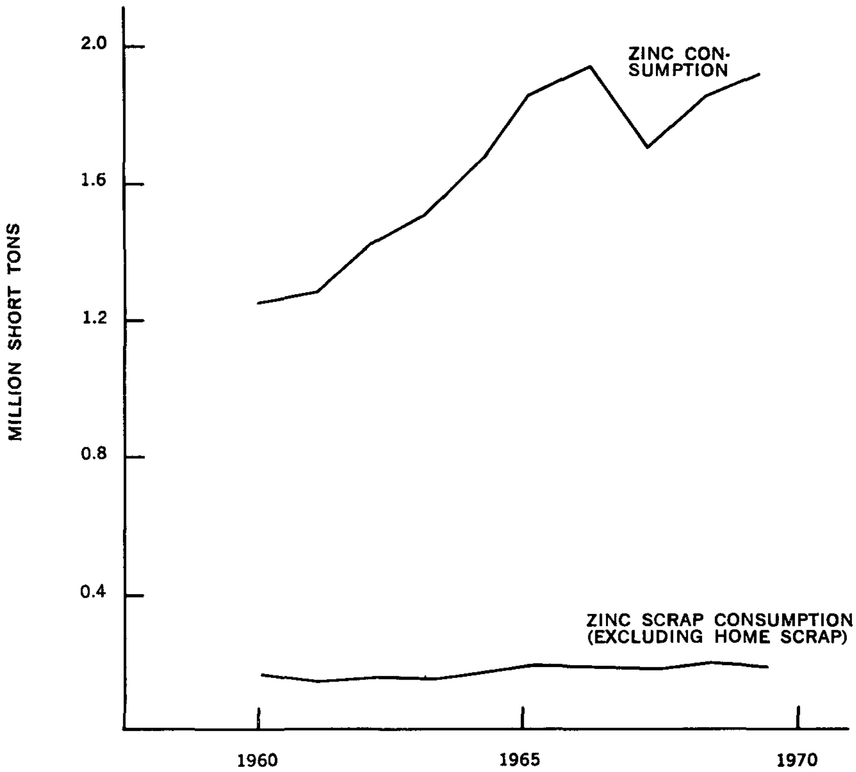
LEAD AND LEAD SCRAP CONSUMPTION



Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v.4. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

FIGURE A–8

ZINC AND ZINC SCRAP CONSUMPTION



Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v.5. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

TABLE A–7

AMOUNT OF OBSOLETE SCRAP RECOVERED FROM PROMPT AND OBSOLETE SOURCES, 1969

Material	Source	Amount recycled (1000 tons)
Aluminum	obsolete	175
	prompt	855
Copper	obsolete	657
	prompt	832
Lead	obsolete	497
	prompt	88
Zinc	obsolete	41
	prompt	141

Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v. 2–5. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

and soft drink producers have been the most visible effort to reclaim aluminum from municipal waste. In 1970, these programs resulted in the removal of about 2,875 tons of aluminum from the solid waste stream. This was 1.3 percent of the quantity of aluminum cans reaching the market.[16]

The feasibility of these programs depends on the continued voluntary delivery of aluminum cans to the centers at no more than $200/ton. Thus far, this price has proved to be sufficient incentive to persuade individuals, Boy Scout groups, and others to collect cans and bring them to the centers. It has been estimated by one of the major aluminum manufacturers participating in the recycling program that the quantity of aluminum cans ultimately recoverable by this method will be between 5 and 30 percent of that reaching the market.

The major sources and markets for recycled aluminum, copper, lead, and zinc, in terms of product type, are shown in Tables A–8, A–9, A–10, and A–11 respectively.

Issues and Problems

Nonferrous metals are high value materials for which a steady demand exists. Compared to other materials (paper, steel, glass, textiles and plastics) the cost of collecting, transporting, and processing nonferrous metal scrap is not as high a percentage of its value. In addition, costs of refining virgin nonferrous ores are high. Since handling nonferrous scrap does not run cost up inordinately, the scrap is considerably cheaper than virgin material. Thus, the scrap moves freely.

Probably the major reason that more nonferrous scrap is not

TABLE A-8

RECYCLING OF ALUMINUM SCRAP, 1969

Sources of Obsolete Aluminum Scrap

Source	Estimated available for recycling (1,000 tons)	Estimated amount recycled (1,000 tons)	Percent recycled
Building and construction	71 0	9.0	13.0
Transportation	329.0	100.0	30.0
Consumer durables	197.0	25.0	13.0
Electrical	7.0	6.5	93.0
Machinery and equipment	61.0	15.0	25.0
Containers and packaging	486.0	2.0	0.4
Other	183.0	17.5	9.2
TOTAL	1,334.0	175.0	13.1

Markets for Prompt and Obsolete Aluminum Scrap

Use	Scrap consumption (1,000 tons)	Percent
Casting alloys	741	69
Wrought aluminum products	255	24
Exports	77	7
TOTAL	1,073	100

Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v 2. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

TABLE A-9

RECYCLING OF COPPER SCRAP, 1969

Sources of Obsolete Copper Scrap

Source	Estimated available for recycling (1,000 tons)	Estimated amount recycled (1,000 tons)	Percent recycled
Electrical wire and copper tube	471.0	19.4	68
Magnet wire	158.0	13.5	9
Cartridge brass	112.1	35.4	31
Automotive radiators	53.0	48.5	91
Railroad car boxes	22.6	20.0	88
Other brass, cast and wrought	703.3	213.9	30
Alloying additives	96.9	0	0
Miscellaneous	6.1	6.1	100
TOTAL	1,623.2	656.8	40

Markets for Prompt and Obsolete Copper Scrap

Use	Scrap consumption (1,000 tons)	Percent
Wire and cable	292	20
Brass mill products	701	47
Brass/bronze foundries	369	25
Other	127	8
TOTAL	1,489	100

Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v.3. U.S. Environmental Protection Agency, 1972. [Disrtibuted by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

TABLE A-10
RECYCLING OF LEAD SCRAP, 1969

Sources of Obsolete Lead Scrap

Source	Estimated available [1] for recycling (1,000 tons)	Estimated amount recycled (1,000 tons)	Percent recycled
Batteries	485	350	72
Cable sheathing	130	32	25
Solder	65	9	14
Bearing metal	33	10	30
Type metal	29	29	100
Ammunition	80	5	6
Other	100	62	62
TOTAL	922	497	54

Markets for Prompt and Obsolete Lead Scrap

Use	Scrap consumption (1,000 tons)	Percent
Type	28	4.8
Tetraethyl lead	75	12.8
Batteries	400	68.4
Solder	31	5.3
Cable	19	3.2
Bearings	13	2.2
Other	19	3.2
TOTAL	585	99.0

[1] 271,000 tons of lead used in tetraethyl lead for gasoline and 125,000 tons of lead used in oxides and chemicals are not included since there is no possibility for its recovery.

Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v.4. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

recycled is the form and location in which it occurs. Most of the nonferrous scrap that is easily accessible is recycled. However, there are certain types of scrap that are too contaminated and too widely scattered to allow economical recovery despite the high value of the materials (dealer's buying prices range from $60 to $920 per ton). For example, copper in cartridge brass and lead in ammunition is usually widely scattered over the country-side. Zinc is usually used as an alloying agent and coating and thus is extremely difficult to separate. Aluminum occurring in consumer durables, transportation vehicles, and construction is often only a small part of the product and thus much of it is never recovered. Aluminum used in packaging and ending up in the municipal waste stream cannot be economically recovered at present. It could only be feasibly separated as part of a large reclamation system where other materials (constituting a higher percentage of the waste) were also recovered.

An interesting perplexity of nonferrous metals recycling is that for some of the metals, copper is a good example, the scrap dealers

TABLE A-11
RECYCLING OF ZINC SCRAP, 1969

Sources of Obsolete Zinc Scrap

Source	Estimated available for recycling (1,000 tons)	Estimated amount recycled (1,000 tons)	Percent recycled
Zinc base alloys	353	33	9
Old galvanized	390	0	0
Oxides and chemicals	190	0	0
Other	130	8	6
TOTAL	1,063	41	3.9

Markets for Prompt and Obsolete Zinc Scrap

Use	Scrap consumption (1,000 tons)	Percent
Slab zinc	76	41.7
Zinc dust	34	18.8
Alloys	27	14.8
Oxides and chemicals	45	24.7
TOTAL	182	100 0

Source: Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v.5. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

perceive that they are pulling in about all that is available. Their estimate of the recycling ratio would be much higher than the actual.

GLASS RECYCLING

Status and Trends

In 1967 the glass manufacturing industry produced 12.8 million tons of glass. This production was divided among the three major segments of the industry: containers, flat glass, and pressed and blown glass. Containers, the most significant segment, accounted for 8.9 million tons, while flat glass accounted for 2.1 million tons and blown glass for only 1.8 million tons.

Glass constitutes only 6 to 8 percent by weight of municipal solid waste. There is virtually no recovery of glass from mixed waste, but a small amount of glass is recycled through voluntary collection centers and cullet dealers. Compared to other materials, glass is among the lowest in recycling ratios (about 4.5 percent of consumption) when home scrap (scrap generated in the glass manufacturer's plant) is excluded. Of a total of 12.8 million tons of glass produced in 1967, purchased cullet consumption was approximately 580,000 tons.[17]

Sources and Markets

Only a minute portion of glass waste (almost exclusively flat glass), is associated with industrial sources. Thus, municipal waste is the main potential source for old glass for recycling. In 1968, there were about 11.6 million tons of glass in municipal solid waste.

The best sources of quality cullet have been declining. Clear glass milk bottles and returnable glass containers rejected from bottle washing operations, major sources of cullet in the past, are gradually disappearing. Sorting, collection, and delivery costs have risen, principally because these operations are highly labor intensive. Plants have not been maintained and equipment has not been purchased due to limited capital of the few dealers still in operation. As the quality and availability of purchased cullet has deteriorated, its use in the glass industry has declined.

The glass container segment of the industry, which accounts for over 70 percent of the total glass tonnage output, purchased only about 100,000 tons of cullet or 1 percent of its raw materials consumption in 1967. This percentage is significantly lower than in the other two segments of the industry, largely because of an increase in utilization of in-plant cullet. Flat glass producers purchased 10 percent, or 244,000 tons, and pressed and blown glass producers 12 percent, or 256,000 tons.[18]

In addition to the use of purchased cullet in glass furnaces, there are several alternatives for cullet utilization. The most widely publicized alternative is in "glasphalt," a road surfacing material in which cullet replaces part of the asphalt aggregate. Initial testing results at the University of Missouri indicate that glasphalt is equal to or superior to conventional asphalt. However, cullet would have to compete economically with asphalt aggregate, which ranges in price from $1.50 to $5.00 per ton delivered to the asphalt plant. Present cullet prices are significantly higher than this amount.

Other proposed uses for cullet include construction materials, such as glass-cement blocks, and cullet-terrazzo. Experiments to determine feasibility of cullet utilization in these products are currently underway.

Problems and Issues

The glass industry has certain characteristics that make high levels of recycling from waste much more favorable in the glass industry than other industries. First, the manufacture of glass containers is essentially a one-step process, starting with raw materials and ending with the finished product. And second, cullet can be substituted for virgin raw materials in large percentages, provided that the cullet meets minimum specifications of colors, cleanliness, and purity. From a technology standpoint, glass manufacture from 100 percent cullet appears possible.

There are, however, two problem areas: comparative economics and the recovery of cullet from mixed waste. With respect to economics the cost of virgin raw materials averages $15.48 per ton batch as compared to a range of from $16.00 to $22.50 per ton batch of cullet (both include freight charges to the plant). Processing cost differentials are not significant. The conversion of an existing plant to use increased quantities of purchased cullet would cost from $50,000 to $100,000, depending upon the plant, but the changeover could be accommodated within a framework of normal periodic plant improvements. A new plant designed to use cullet would be no more costly than a new plant designed for virgin materials.[19]

The recovery of large quantities of cullet from municipal waste is dependent on the development of a technical process for separation and upgrading of the cullet. However, the possibility of source separation of glass containers in the home for separate collections is an alternative that cannot be eliminated. Neither traditional cullet dealers nor voluntary citizen delivery of glass to recycling centers are likely to increase the cullet flow by more than a few percent.

Mechanical separation methods for removing glass from other components of municipal waste are still under development. One promising system that combines density classification and optical color sorting is currently being tested at Franklin, Ohio, while other methods, including one developed by the Bureau of Mines, are not yet ready for a comprehensive test.

Until the technology is further developed, utilization of purchased cullet on a large scale does not appear possible. Further, since glass is only a small percentage of solid waste, complete glass recovery from mixed waste is not likely to come about until full scale recovery centers, that are concerned with all major materials, are set up.

Unless source separation of glass containers is found to be feasible, utilization of purchased cullet on a large scale appears to be closely tied to development of full scale municipal resource recovery centers. The glass coming out of such systems will not be attractive to the glass industry on a cost basis, however, unless economic incentives are provided.

PLASTICS RECYCLING

Status and Trends

Plastics are becoming an ever more important material in our society as their growth rate continues at an impressive rate. From 1960–1970, plastics consumption increased at an average annual rate of 11.8 percent, and totalled 8.5 million tons in 1969. Consumption by 1980 is expected to reach 19 million tons.[20]

Today, plastics account for only about 2 percent by weight of municipal solid waste and by 1980 will average about 3 percent. Very little plastic scrap is recycled other than that reused within the manufacturing plant in which it is generated. This, however, is a fairly significant quantity. Plastics fabricators, for example, consumed internal scrap equal to about 1.5 million tons in 1970.[21] There is essentially no recovery of plastic waste from obsolete products.

The plastics reprocessor is the recycling channel for all industrial plastics recycled outside of originating plants. About 500,000 tons of waste plastics were handled by reprocessors in 1970. Of the plastics recycled through reprocessors about 55 percent came from resin producers, 30 percent from fabricators and 15 percent from converters.[22]

There are two types of plastics, thermoplastics and thermosetting plastics. The thermosetts—20 percent of plastics consumption—cannot be softened and reshaped through heating and are thus not recyclable. In addition, most of the plastics used as coatings and adhesives are impossible to recycle. Thus, about 75 percent of the plastics consumed are potentially recyclable.

Sources and Markets

Table A–12 shows the major markets for plastics. Packaging and construction are by far the most significant, accounting for 20 and 25 percent respectively of consumption in 1970. Plastics from packaging account for about 60 percent by weight of the plastics in the solid waste stream (much of the other plastic consumed is "held-up" in permanent and semi-permanent end uses). Although some of the waste generated in the various stages of plastics production is recycled, the portion that is not makes up about 15% of the plastic in the waste stream. Thus, packaging and industrial waste account for 75% of plastic waste.[23]

As a general rule scrap plastic has to be used in an end application having wider specification requirements than the product

TABLE A–12
CONSUMPTION OF PLASTICS, 1967 TO 1969, TOTAL AND SELECTED MAJOR END USE MARKETS, IN 1,000 TONS

	1967	1968	1969
Total consumption	6,550	7,558	8,535
Consumption in selected markets:			
Agriculture	75+	85	95
Appliances	198	238	234
Transportation	109	334	536
Construction	1,070	1,215	1,327
Electrical	396	452	567
Furniture	250+	273	328
Housewares	313	373	425
Packaging	1,121+	1,508	1,729
Toys	208	243	269

Source: Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. p.88–5.

yielding the scrap. The primary markets for scrap plastic include such items as hose, weather stripping, toys, cheap housewares, pipe, and similar applications where (1) plastic properties and performance are not paramount, (2) relatively noncritical processes are used (compression molding or heavy extrusion), and (3) where the cost of plastic resin is a high proportion of total product cost.

Plastics also have potential as a fuel supplement for energy generation due to their high BTU value of 11,500 BTU/lb. (The BTU content of paper is about 8,000 BTU/lb. and that of coal is about 12,000 BTU/lb.) This is particularly appealing for recovery of plastics (or value from plastics) in municipal waste, where plastics are hard to separate from other materials.

Issues and Problems

Technology. There is a fundamental difference between the nature of plastics recycling and that of metals, paper, glass, and other materials. Metals production, for example, begins with an impure ore which is progressively concentrated, smelted, refined and freed from impurities. Plastics production, on the other hand, begins with high purity virgin polymer to which various additives, colorants, and reinforcements are added. Thus, in the metals industries, there is a background of technology designed to purify and upgrade ores and concentrates. Such technology can also be applied to the upgrading of scrap. In the plastics industry, where the basic raw material is progressively "contaminated" in production, little technology has been developed which can be applied to purify waste plastics.

Compatibility. The principal difficulty in recycling plastics is that different polymers (polyethylene, polyvinyl chloride, etc.) are not compatible with each other and must be separated, a very difficult and costly task.

Economics. Continually decreasing cost of basic plastic materials has made scrap plastic less competitive with its main competitor, off-grade virgin resin. For example, since 1961, the price of low density polyethylene has decreased from 24 to 13 cents per pound. Scrap plastic, limited by rising labor and distribution costs, did not drop as rapidly, and the price of the scrap is now only about 1 cent per pound under the offgrade resin price, versus about 3 cents in 1961.

Logistics. This problem, common to recycling of all materials, is important to plastics recycling. The extremely low density of plastics makes transportation very costly.

Separation. Separation of plastics from other waste is extremely difficult, making recovery of plastics from municipal waste almost impossible unless the plastics can be diverted from the waste stream and kept separate.

TEXTILES RECYCLING

Status and Trends

The United States textile industry consumed approximately 5 million tons of textile fiber in 1970, an increase since 1960 of 61.5 percent. Far more significant to textile recycling was the change in the type of fiber consumed, with a major shift occurring from use of natural to man-made fibers. In 1960, natural fibers constituted 69 percent of fiber consumption, and man-made fiber 31 percent. In 1970, the figures were 39 percent for natural fibers and 61 percent for man-made. By 1980, the ratio of natural to man-made fiber is expected to be 25/75. The implications of this change are discussed below.[24]

In 1970, an estimated 0.8 million tons of waste textiles were processed by waste textile dealers and sold (recycled) to various markets.[25] In addition, an undetermined amount of used clothing which potentially would enter the waste stream was collected by social welfare agencies and redistributed.

There are not sufficient historical data available to show trends in textile recycling. However, it is known that secondary textile consumption in many traditional markets has been declining and that others such as the important wiping cloth market have been growing, at a slower rate than total textile consumption. Thus, it is almost certain that the rate of textile recovery (waste recovered vs. textile consumption) has been declining.

Textiles represent only a small portion of municipal solid waste. In 1968, textiles in collected municipal solid waste totalled 1.2 million tons, 0.6 percent of the total. Most of the textile consumption which does not appear in the municipal waste stream is either collected by social welfare agencies, disposed of or sent to secondary textile dealers by industry, or is being accumulated in households.

Sources and Markets

Fig. A–9 represents the major sources and markets for textile waste. The mill waste is the "home" scrap of the textile industry, the manufacturing waste the "prompt" portion and consumer discards "obsolete."

In contrast to most of the other materials discussed in this report, the "home" scrap (mill waste) is not reused within the generating plant, but instead passes through the secondary textile dealers. Mill waste accounted for about 1/3 of the material handled by waste textile dealers in 1970.

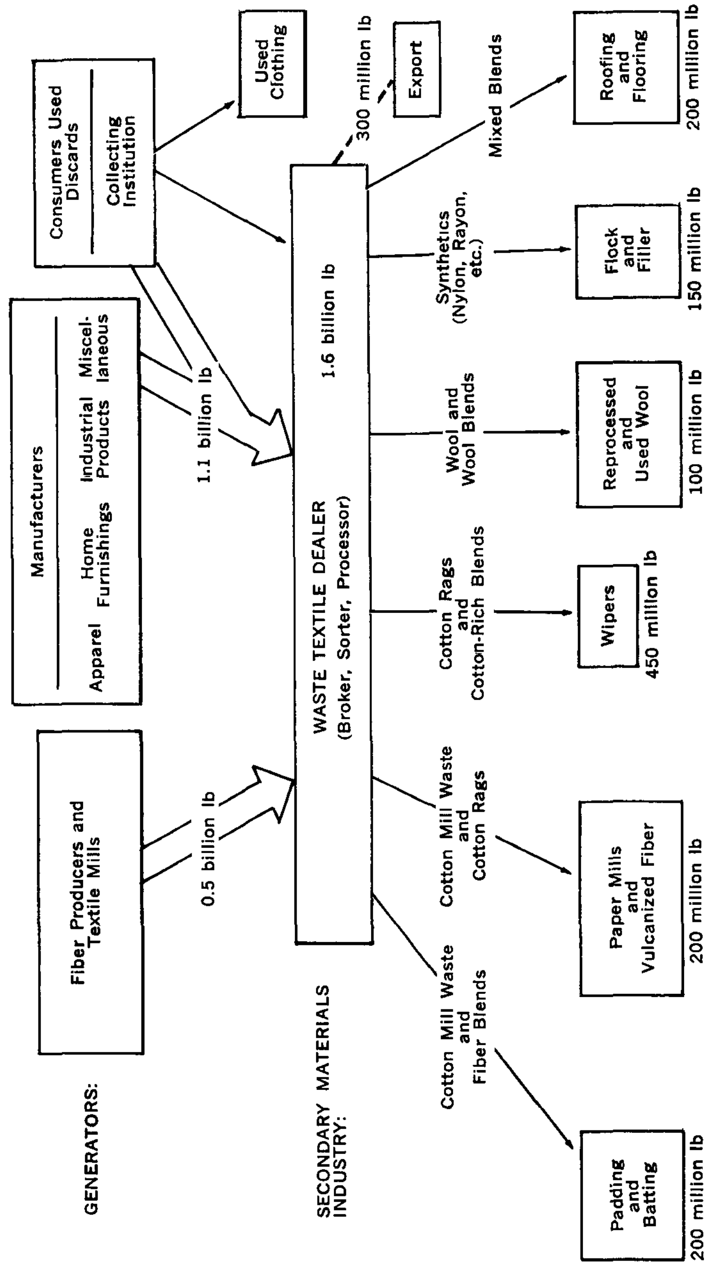
Waste from fabrication ("prompt") is a considerably less important source of recycled waste than in the case of many other materials. It has been estimated that waste recovered from fabrication is only about 60 percent of that generated.[26] Fabrication waste accounted for an estimated 20 percent of the waste handled by waste textile dealers in 1970.

Obsolete waste accounted for the remaining 45 percent of recycled textile waste. The waste is provided mostly by social welfare agencies and institutions (such as Goodwill Industries) from items deemed unsuitable for reuse as clothing.

Issues and Problems

The increasing trend toward use of cotton-polyester blends and wool-polyester blends probably represents the major problem of textile recycling of the 1970's. These blends are not only generally unusable in themselves, but they tend to become mixed with other usable waste textiles and thereby reduce the economic value of the total waste supply. This has caused problems particularly in the three major markets for cotton waste: (1) rag paper, (2) vulcanized fiber, and (3) wiping cloths.

FIGURE A-9
WASTE TEXTILE UTILIZATION FLOWS



Source: Battelle Memorial Institute, Columbus Laboratories, A study to identify opportunities for increased solid waste utilization. Book 3, v.9. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 731.]

In the case of the first two markets contamination of cotton is limited to a maximum of 1 to 2 percent. Thus, increases in blends means greater control by the textile processors, resulting in increased cost. It also greatly reduces the usable yield from used textiles.

Fiber blends have essentially the same effect on the wiping cloth business. Wipers are less sensitive to small percentages of polyester fiber, but fiber blends with over 50 percent polyester do not have satisfactory absorption characteristics. (Garments with polyester/cotton blends of 50/50 and 65/35 are extremely common.) The present percentage of such blends in mixed rag bundles is unknown, but the increased replacement of man-made fibers by synthetics is testimony that they are likely to increase, reducing usable yields.

Another major problem of textile recycling is that used textiles are losing ground in many traditional markets. Wool markets are one of the most serious problems, due mainly to the Wool Labeling Act (the effect has been a psychological one on consumers who perceive that virgin wool is cleaner or purer) and increased competition from secondary wool from foreign sources. Also, virgin based materials are replacing used textiles in some markets. The incentive for using secondary textiles as paddings, filler, etc. has traditionally been their low cost. Now, development of virgin based products such as urethane foams at competitive prices has resulted in fading used textile markets.

Resource Recovery Installations

TABLE A-13

MUNICIPAL SOLID WASTE COMPOSTING PLANTS IN THE UNITED STATES (1969)*

Location	Company	Process	Capacity ton/day	Type waste	Began operating	Status
Altoona, Pennsylvania	Altoona FAM, Inc.	Fairfield-Hardy	45	Garbage, paper	1951	Operating
Boulder, Colorado	Harry Gorby	Windrow	100	Mixed refuse	1965	Operating intermittently
Gainesville, Florida	Gainesville Municipal Waste Conversion Authority	Metrowaste Conversion	150	Mixed refuse, digested sludge	1968	Operating
Houston, Texas	Metropolitan Waste Conversion Corp.	Metrowaste Conversion	360	Mixed refuse, raw sludge	1966	Operating
Houston, Texas	United Compost Services, Inc.	Snell	300	Mixed refuse	1966	Closed (1966)
Johnson City, Tennessee	Joint USPHS–TVA	Windrow	52	Mixed refuse, raw sludge	1967	Operating
Largo, Florida	Peninsula Organics, Inc.	Metrowaste Conversion	50	Mixed refuse, digested sludge	1963	Closed (1967)
Norman, Oklahoma	International Disposal Corp.	Naturizer	35	Mixed refuse	1959	Closed (1964)
Mobile, Alabama	City of Mobile	Windrow	300	Mixed refuse, digested sludge	1966	Operating intermittently
New York, New York	Ecology, Inc.	Varro	150	Mixed refuse		Under construction
Phoenix, Arizona	Arizona Biochemical Co.	Dano	300	Mixed refuse	1963	Closed (1965)
Sacramento Co., California	Dano of America, Inc.	Dano	40	Mixed refuse	1956	Closed (1963)
San Fernando, California	International Disposal Corp.	Naturizer	70	Mixed refuse	1963	Closed (1964)
San Juan, Puerto Rico	Fairfield Engineering Co.	Fairfield-Hardy	150	Mixed refuse	1969	Operating
Springfield, Massachusetts	Springfield Organic Fertilizer Co.	Frazer-Eweson	20	Garbage	1954 1961	Closed (1962)
St. Petersburg, Florida	Westinghouse Corp.	Naturizer	105	Mixed refuse	1966	Operating intermittently
Williamston, Michigan	City of Williamston	Riker	4	Garbage, raw sludge, corn cobs	1955	Closed (1962) Closed (1965)
Wilmington, Ohio	Good Riddance, Inc.	Windrow	20	Mixed refuse	1963	

Source: Breidenbach, A. W., et al. Composting of municipal solid wastes in the United States. Washington, U.S. Government Printing Office, 1971. 103 p.

Resource Recovery Installations

TABLE A–14

INCINERATORS WITH MAJOR HEAT RECOVERY OPERATIONS

Location	Type of installation	Design refuse capacity TPD
Atlanta, Georgia	Volund	700
Chicago, Illinois (Southwest)	Refractory	1200
Miami, Florida	Refractory	900
Hempstead, L.I., N.Y. (Oceanside)	Refractory	600
U.S. Naval Station (Norfolk, Virginia)	Waterwall	360
Braintree	Waterwall	240
Providence, R.I.	Refractory	—
Oyster Bay, N.Y.	Refractory	—
Boston, Massachusetts	Refractory	—
Hempstead, L.I., N.Y. (Merrick)	Refractory	—
Chicago, Illinois (Northwest)	Waterwall	1600

Source: Systems study of air pollution from municipal incineration. 3 v. Cambridge, Arthur D. Little, Inc., Mar. 1970. (920 p.) (Distributed by National Technical Information Service, Springfield, Va., as PB 192 378 to PB 192 380.)

REFERENCES

1. Darnay, A., and W. E. Franklin. Salvage markets for materials in solid wastes. Washington, U.S. Government Printing Office, 1972. chap. 4. p. 35, 45–7.
2. Darnay, and Franklin, Salvage markets, 1972, p. 45–13 and 45–14.
3. Darnay, and Franklin, Salvage markets, 1972, p. 45–24.
4. Darnay, and Franklin, Salvage markets, 1972, chap. 4. p. 35.
5. Resource Planning Associates, Preliminary report on a federal tax incentive for recycling post-consumer waste materials. Unpublished data, 1972.
6. (1) Darnay, and Franklin, Salvage markets, 1972, p. 49. (2) Battelle Memorial Institute, Columbus Laboratories. Identification of opportunities for increased recycling of ferrous solid waste. U.S. Environmental Protection Agency, [1973]. p. 116. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 213 577.]
7. Darnay, and Franklin, Salvage markets, 1972, chap. 5. p. 58–2.
8. Darnay, and Franklin, Salvage markets, 1972, chap. 5. p. 49.
9. Darnay, and Franklin, Salvage markets, 1972, chap. 5. p. 58–11.
10. Darnay, and Franklin, Salvage markets, 1972, chap. 5. p. 49.
11. Battelle Memorial Institute, Identification of opportunities for increased recycling, [1973]. p. 118.
12. Battelle Memorial Institute, Identification of opportunities for increased recycling, [1973]. p. 167.
13. Midwest Research Institute, Economic studies in support of policy formation, 1972.
14. Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 2, v. 2–5. U.S.

Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 730.]

15. Darnay, and Franklin, Salvage markets, 1972, chap. 6. p. 59.
16. Battelle Memorial Institute, A study to identify opportunities, 1972, Book 2.
17. Darnay, and Franklin, Salvage markets, 1972, chap. 7. p. 65.
18. Darnay, and Franklin, Salvage markets, 1972, p. 66–67.
19. Midwest Research Institute, Economic studies in support of policy formation, 1972.
20. Darnay and Franklin, Salvage markets, 1972, p. 82, 83, 88–5.
21. Milgrom, J. [Arthur D. Little, Inc.] Incentives for recycling and reuse of plastics. U.S. Environmental Protection Agency, 1972, p. 3–18. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 214 045.]
22. Milgrom, Incentives for recycling, 1972, p. 3–15, and internal communications from A.D. Little.
23. Milgrom, Incentives for recycling, 1972, p. 3–57.
24. Battelle Memorial Institute, Columbus Laboratories. A study to identify opportunities for increased solid waste utilization. Book 3, v. 9, p. 10. U.S. Environmental Protection Agency, 1972. [Distributed by National Technical Information Service, Springfield, Va. as Publication PB 212 731.]
25. Battelle Memorial Institute, A study to identify opportunities, 1972, Book 3, v. 9, p. 16.
26. Battelle Memorial Institute, A study to identify opportunities, 1972, Book 3, v. 9, p. 26.

4.9b Report to Congress on Hazardous Waste Disposal by the Environmental Protection Agency, June 1973.

PREFACE

Section 212 of the Solid Waste Disposal Act (P.L. 89–272) as amended requires that the U.S. Environmental Protection Agency (EPA) undertake a comprehensive investigation of the storage and disposal of hazardous wastes. This document represents EPA's Report to the President and the Congress summarizing the Agency's investigations and recommendations in response to the Congressional mandate.

The findings of this report are based on a number of contractual efforts and analyses by Agency staff carried out since the passage of the Resource Recovery Act of 1970.

The report is organized into a summary, five major sections, and appendices. The first section discusses the Congressional mandate and the Agency's response to it. Next, the public health, technological, and economic aspects of the hazardous waste disposal problem are reviewed. A section detailing the case for hazardous waste regulation follows. The report concludes with a discussion of implementation issues, and findings and recommendations.

CONTENTS

SUMMARY AND CONCLUSIONS

• The management of the Nation's hazardous residues—toxic chemical, biological, radioactive, flammable, and explosive wastes —is generally inadequate; numerous case studies demonstrate that public health and welfare are unnecessarily threatened by the uncontrolled discharge of such waste materials into the environment.

• Based on surveys conducted during this program, it is estimated that the generation of non-radioactive hazardous wastes is taking place at the rate of approximately 10 million tons yearly.[1] About 40 percent by weight of these wastes are inorganic materials, 60 percent are organics; about 90 percent of the waste occurs in liquid or semi-liquid form.

• Hazardous waste generation is growing at a rate of 5 to 10 percent annually as a result of a number of factors: increasing production and consumption rates, bans and cancellations of toxic substances, and energy requirements (which lead to radioactive waste generation at higher rates).

• Hazardous waste disposal to the land is increasing as a result of air and water pollution controls (which capture hazardous wastes from other media and transfer them to land) and denial of heretofore accepted methods of disposal such as ocean dumping.[2]

• Current expenditures by generators for treatment and disposal of such wastes are low relative to what is required for adequate treatment/disposal. Ocean dumping and simple land disposal costs are on the order of $3 per ton[3] whereas environmentally adequate management could require as much as $60 per ton if all costs are internalized.

• Federal, State, and local legislation and regulations dealing with the treatment and disposal of non-radioactive hazardous waste are generally spotty or nonexistent. At the Federal level, the Clean Air Act, the Federal Water Pollution Control Act, and the Marine Protection, Research and Sanctuaries Act provide control authority over the incineration, water and ocean disposal of certain hazardous wastes, but not over the land disposal of residues. Fourteen other Federal laws deal in a peripheral manner with the management of hazardous wastes, and approximately 25 States have limited hazardous waste regulatory authority.

• Given this permissive legislative climate, generators of waste are under little or no pressure to expend resources for the adequate management of their hazardous wastes. There are few economic incentives (given the high costs of adequate management compared to costs of current practice) for generators to dispose of wastes in adequate ways.

• Technology is available to treat most hazardous waste streams by physical, chemical, thermal and biological methods, and for disposal of residues. Use of such treatment/disposal processes is costly, ranging from a low of $1.40/ton for carbon sorption, $10/ton for neutralization/precipitation and $13.60/ton for chemical oxidation, to $95/ton for incineration.[4] Several unit processes are usually required for complete treatment/disposal of a given waste stream. Transfer and adaptation of existing technology to hazardous waste management may be necessary in some cases. Development of new treatment and disposal methods for some wastes (e.g., arsenic trioxide and arsenites and arsenates of lead, sodium, zinc and potassium) is required.[5] In the absence of treatment processes, interim storage of wastes on land is possible using methods that minimize hazard to the public and the environment (e.g., secure storage, membrane landfills, etc.).

• A small private hazardous waste management industry has emerged in the last decade, offering treatment/disposal services to generators. The industry currently has capital investments of approximately $25 million and a capacity to handle about 2.5 million tons of hazardous materials yearly, or 25 percent of capacity required nationally. The industry's current throughput of hazardous waste is about 24 percent of installed capacity or 6 percent of the national total. The low level of utilization of this industry's services results from the absence of regulatory and economic incentives for generators to manage their hazardous wastes in an environmentally sound manner. This industry could respond over time to provide needed capacity if a national program for hazardous waste management, with strong enforcement capabilities, were created. This industry would, of course, be subject to regulation also.

• The chief programmatic requirement to bring about adequate management of hazardous wastes is the creation of demand and adequate capacity for treatment/disposal of hazardous wastes. A national policy on hazardous waste management should take into consideration environmental protection, equitable cost distribution among generators, and recovery of waste materials.

• A regulatory approach is best for the achievement of hazardous waste management objectives. A regulatory approach ensures adequate protection of public health and the environment. It will likely result in the creation of treatment/disposal capacity by the private sector without public funding. It will result in the mandatory use of such facilities. Costs of management will be borne by those who generate the hazardous wastes and their customers rather than the public at large and thus cost distribution will be equitable. Private sector management of the wastes in a competitive situation can lead to an approximate mix of source reduction, treatment, resource recovery and land disposal.

- A regulatory program will not directly create a prescribed system of national disposal sites, however, due to uncertainties inherent in the private sector response. EPA believes that the private sector will respond to a regulatory program. However, full assurance cannot be given that treatment/disposal facilities will be available in a timely manner for all regions of the Nation nor that facility use charges will be reasonable in relation to cost of services. Also, private enterprise does not appear well suited institutionally to long term security and surveillance of hazardous waste storage and disposal sites.
- Based on analyses performed to date, EPA believes that no Government actions to limit the uncertainties in private sector response are appropriate at this time. However, if private capital flow were very slow and adverse environmental effects were resulting from the investment rate, indirect financial assistance in forms such as loans, loan guarantees or investment credits could be used to accelerate investment. If facility location or user charge problems arose, the Government could impose a franchise system with territorial limits and user charge rate controls. Long term care of hazardous waste storage and disposal facilities could be assured by mandating use of Federal or State land for such facilities.
- EPA studies indicate that treatment/disposal of hazardous wastes at central processing facilities is preferable to management at each point of generation in most cases due to economies of scale, decreased environmental risk, and increased opportunities for resource recovery. However, other forces may deter creation of the "regional processing facility" type of system. For example, the pending effluent limitation guidelines now being developed under authority of the Federal Water Pollution Control Act may force each generator to install water treatment facilities for both hazardous and nonhazardous aqueous waste streams. Consequently, the absolute volume of hazardous wastes requiring further treatment at central facilities may be reduced and the potential for economies of scale at such facilities may not be as strong as it is currently.
- Given these uncertainties, several projections of future events can be made. Processing capacity required nationally was estimated assuming complete regulation, treatment and disposal of *all* hazardous wastes at the earliest practicable time period. Estimates were based on a postulated scenario in which approximately 20 regional treatment/disposal facilities are constructed across the Nation. Of these, 5 would be very large facilities serving major

industrial areas treating 1.3 million tons yearly each, and 15 would be medium size facilities each treating 160,000 tons annually. An estimated 8.5 million tons of hazardous wastes would be treated/disposed of away from the point of generation (off-site); 1.5 million tons would be pretreated by generators on-site, with 0.5 million tons of residues transported to off-site treatment/disposal facilities for further processing. Each regional processing facility was assumed to provide a complete range of treatment processes capable of handling all types of hazardous wastes, and, therefore, each would be much more costly than existing private facilities.

- Capital requirements to create the system described above are approximately $940 million. Average annual operating expenditures (including capital recovery and operating costs) of $620 million would be required to sustain the program. These costs are roughly estimated to be equivalent to 1 percent of the value of shipments from industries directly impacted. In addition, administrative expenses of about $20 million annually for Federal and State regulatory programs would be necessary. For the reasons stated earlier, however, capacity and capital requirements for a national hazardous waste management system may be smaller than indicated above, and more in line with the capacity and capital availability of the existing hazardous waste management industry.
- In summary, the conclusions of the study are that (1) a hazardous waste management problem exists and its magnitude is increasing; (2) the technical means to solve the problem exist for most hazardous waste but are costly in comparison with present practices; (3) the legislative and economic incentives for using available technology are not sufficient to cause environmentally adequate treatment/disposal in most cases; (4) the most effective solution at least direct cost to the public is a program for the regulation of hazardous waste treatment/disposal; (5) a private hazardous waste management service industry exists and is capable of expanding under the stimulus of a regulatory program; (6) due to inherent uncertainties, private sector response cannot be definitely prescribed; (7) several alternatives for government action are available, but, based on analyses to date, EPA is not convinced that such actions are needed.

The Environmental Protection Agency has proposed legislation to the Congress which is intended to fulfill the purposes of Section 212 of the Solid Waste Disposal Act as amended, and to carry out the recommendations of this report. The proposed Hazardous Waste Management Act of 1973 would authorize a regulatory program for treatment/disposal of EPA-designated hazardous wastes; the States would implement the program subject to Federal standards in most cases. All studies performed in response to Section 212 will be completed in time to serve as useful input to Congressional consideration of our legislative proposal.

Section 1

INTRODUCTION

The Congressional Mandate

In 1970, Congress perceived hazardous waste storage and disposal to be a problem of national concern. Section 212 of the Resource Recovery Act of 1970 (P.L. 91–512—an amendment to P.L. 89–272), enacted on October 26, 1970, required that the U.S. Environmental Protection Agency (EPA) prepare a comprehensive report to Congress on storage and disposal of hazardous wastes. That section stated:

> "The Secretary* shall submit to the Congress no later than two years† after the date of enactment of the Resource Recovery Act of 1970, a comprehensive report and plan for the creation of a system of national disposal sites for the storage and disposal of hazardous wastes, including radioactive, toxic chemical, biological, and other wastes which may endanger public health or welfare. Such report shall include: (1) a list of materials which should be subject to disposal at any such site; (2) current methods of disposal of such materials; (3) recommended methods of reduction, neutralization, recovery or disposal of such materials; (4) an inventory of possible sites including existing land or water disposal sites operated or licensed by Federal agencies; (5) an estimate of the cost of developing and maintaining sites including consideration of means for distributing the short- and long-term costs of operating such sites among the users thereof; and (6) such other information as may be appropriate."

The EPA Response

This document represents EPA's Report to the President and

[p. 1]

* The Secretary of Health, Education and Welfare; Reorganization Plan Number 3 of 1970 transferred authority to the Administrator, Environmental Protection Agency.

† EPA requested and received a time extension for submission of this report until June 30, 1973, since appropriation of funds to implement the Resource Recovery Act of 1970 was delayed for 8 months after enactment.

the Congress summarizing the Agency's investigations and recommendations concerning hazardous wastes in response to the Congressional mandate. All information required by the mandate is included in the report and its appendices. This report provides a definition of current status, issues and options. It does not purport to provide a complete solution to the hazardous waste management problem.

Section 212 requires an evaluation of a system of national disposal sites (NDS) for the storage and disposal of hazardous wastes as a solution to the hazardous waste problem. To evaluate the NDS concept properly, it is necessary to view it in the context of the total problem. On probing the problem, EPA determined that several means of accomplishing the NDS objective exist. To provide the Congress with maximum flexibility of action, EPA elected to investigate and evaluate several alternative solutions.

A series of interrelated contractor and in-house studies was undertaken for the specific purpose of complying with Section 212 of the Resource Recovery Act of 1970:

- The first study, upon which subsequent efforts were based, quantified the hazardous waste problem.[6] From a thorough literature survey and contacts with various trade and technical associations, government agencies, and industry, a list of hazardous materials was compiled, and each candidate substance on this list was rated according to the nature and severity of its hazardous properties. In addition, volume and distribution data (both by geography and by industry groups) was gathered, and current hazardous waste handling and disposal practices were surveyed. It was found that the magnitude of the hazardous waste problem was larger than originally anticipated, and that current disposal practices are generally inadequate.
- Next, a more detailed technical study on the properties of these materials and their treatment and disposal methods was conducted.[7] A "profile report" was written on each listed substance summarizing its physical, chemical, and toxicological properties, its industrial uses, and the hazards associated with proper handling and disposal methods. Each "profile report" incorporated a critical evaluation of currently used and available technology for the handling, storage, transport, neutralization, detoxification, reuse, and disposal of the particular substance. Also, advanced methods of hazardous waste treatment were surveyed, and research and development needs were formulated. The study showed that treatment and disposal technology is available for most hazardous wastes.

- A favorable public attitude is essential for the successful implementation of any nationwide hazardous waste management program. Therefore, a third study was undertaken to determine citizen awareness and attitudes regarding the hazardous waste problem, and reaction to the possibility of having a treatment and disposal facility located in the vicinity.[8] The majority of citizens sampled were found to be in favor of regional processing facilities for hazardous wastes since such facilities would increase environmental protection and stimulate the economy of the region.
- A fourth study analyzed and compared alternative methods of hazardous waste management.[9] It was concluded that there are three basic approaches: (a) process hazardous wastes "on-site," i.e., at the plant where they are generated; (b) process "off-site" at some regional facility (either public or private); (c) combine "on-site" pretreatment with "off-site" treatment and disposal. These basic alternatives were evaluated with respect to economics, risk, and legal and institutional issues. The study indicated that option (b) is preferable for most hazardous waste streams* and option (c) is preferable for dilute aqueous toxic metal wastes.
- A fifth comprehensive study examined the feasibility of a system of national disposal sites (NDS) for hazardous wastes.[10] Potential locations for regional processing and disposal sites were identified. Conceptual designs of hazardous waste treatment and disposal facilities were developed based on multi-component waste streams characteristic of industry. Capital and operational cost estimates were made, and funding and cost distribution mechanisms were examined.
- Lastly, a strategy analysis was performed, based on information from the previous studies. It was concluded that a regulatory program is the best approach to the hazardous waste problem.

The case for hazardous waste regulation is discussed in Section 3. Issues of implementation are evaluated in Section 4 and findings and recommendations are given in Section 5. A review of the hazardous waste disposal problem precedes these discussions.

* In this report the term "waste stream" refers to mass flow in the engineering process sense, and not necessarily to a liquid stream.

Section 2

IDENTIFICATION AND DISCUSSION OF THE PROBLEM

Inadequate hazardous waste management has the potential of causing adverse public health and environmental impacts. These impacts are directly attributable to the acute (short range or immediate) or chronic (long range) effects of the associated hazardous compound or combination of compounds, and production quantities and distribution.[11,12] Many cases document the imminent and long-term danger to man or his environment from improper disposal of such hazardous wastes. For example:

- Several people in Minnesota were hospitalized in 1972 after drinking well water contaminated by an arsenic waste buried 30 years ago on nearby agricultural land.
- Since 1953 an Iowa company has dumped several thousand cubic yards of arsenic-bearing wastes on a site located above an aquifer supplying a city's water. Arsenic content in nearby monitoring well samples has been measured as high as 175 ppm; the U.S. Public Health Service drinking water standards recommend an arsenic content less than 0.05 ppm.
- In Colorado a number of farm cattle recently died of cyanide poisoning caused by indiscriminate disposal of cyanide-bearing wastes at a dump site upstream.

Additional case studies citing the effects of hazardous waste mismanagement are given in Appendix A.

Discussed in this section are: the types, forms, sources, and quantities of hazardous waste; the current status of treatment and disposal technology; and the economic incentives bearing on hazardous waste treatment and disposal.

The Nature of Hazardous Wastes

The term "hazardous waste" means any waste or combination of wastes which pose a substantial present or potential hazard to human health or living organisms because such wastes are lethal, nondegradable, persistent in nature, biologically magnified, or otherwise cause or tend to cause detrimental cumulative effects.[13] General categories of hazardous waste are toxic chemical, flammable, radioactive, explosive and biological. These wastes can take the form of solids, sludges, liquids, or gases.

The sources of hazardous wastes are numerous and widely scattered throughout the nation. Sources consist of industry, the

Federal Government (mainly the AEC and DOD), agriculture, and various institutions such as hospitals and laboratories.

During this study waste streams containing hazardous compounds were identified and quantified by industrial source (see Appendix B). These waste streams were selected by utilizing a decision model (see Appendix C)[14] which is relatively unsophisticated compared to that required for standard setting purposes. Therefore, the hazardous compounds and waste streams cited in this report should be considered as illustrative and not necessarily those that should be regulated. From these data, the total quantity of non-radioactive hazardous waste streams generated by industrial sources in 1970 was estimated to be 10 million tons (9 million metric tons), or approximately 10 percent of the 110 million tons (100 million metric tons) of all wastes generated by industry annually.[15] This quantity includes most industrial wastes generated from contractor operated government facilities.

Approximately 70 percent of industrial hazardous wastes are generated in the mid Atlantic, Great Lakes, and Gulf Coast areas of the United States (see Table 2.1). About 90 percent by weight of industrial hazardous wastes are generated in the form of liquid streams of which approximately 40 percent are inorganic, and 60 percent are organic materials. Representative hazardous waste substances have been cross-indexed by industrial sources in Figure 2.1. It is important to recognize that these hazardous substances are constituents of waste streams, and it is these waste streams which require treatment, storage, and disposal.

Sources of radioactive wastes are: nuclear power generation and fuel reprocessing facilities; private sources, such as medical, R&D, and industrial laboratories; and government sources (AEC and DOD). Quantities of radioactive wastes generated in 1970 from the first two sources have been identified in Table 2.2. Only a limited amount of information is available on source material, special nuclear material or by-product materials from government operations. Such information is related to weapons production and is therefore classified.

Disposal of uranium mill tailings represents a unique problem similar in magnitude to the disposal of all industrial hazardous wastes. Several Federal agencies are working on the problem at present; a satisfactory disposal or recovery method has not yet been defined. Aside from uranium mill tailings, the quantity of radioactive wastes associated with the commercial nuclear electric power industry and other private sources is estimated to be approximately 24,000 tons (22,000 metric tons) per year at present, or less than one percent of the total hazardous wastes from all industry.

Toxic Wastes. Practically all of the estimated 10 million tons (9 million metric tons) of non-radioactive hazardous waste generated annually in the United States falls into the toxic category. In the context of this report toxicity is defined as the ability of a waste to produce injury upon contact with or accumulation in a susceptible site in or on the body of a living organism. Most toxic wastes belong to one or more of four categories: (1) inorganic toxic metals, salts, acids, or bases, (2) synthetic organics, (3) flammables, (4) explosives. There is considerable overlap within these waste categories. For example, a synthetic organic waste may be flammable and explosive, and it may also contain toxic metals. Flammable and explosive wastes are often categorized as separate hazardous waste entities; however, they are generally toxic and will be discussed here. Many radioactive and some biological wastes are also toxic, but they will be discussed separately.

Toxic Metals. Approximately 25 percent of the metals in common usage today are toxic metals.[16] The concentration and chemical form of toxic metals determine their potential health and environmental hazards. Some metals are essential to life at low concentrations but are toxic at higher concentrations.[17,18] Also, a pure metal is usually not as dangerous as a metallic compound (salt).[19] The largest quantities of toxic metal waste streams are produced by the mining and metallurgy and the electroplating and metal finishing industries. For example, arsenic-containing flue dusts collected from the smelting of copper, lead, zinc and other arsenic-bearing ores amount to 40,000 tons (36,200 metric tons) per year. Approximately 30,000 tons (27,200 metric tons) of chromium-bearing waste is discharged from the metal finishing industry annually.

Synthetic Organics. Hazardous synthetic organic compounds include halogenated hydrocarbon pesticides (such as endrin), polychlorinated biphenyls (PCB), phenols, etc. An estimated 5,000 tons (4,540 metric tons) of synthetic organic pesticide wastes were produced in 1970.[20] The Department of Defense (DOD) currently has 850 tons (770 metric tons) of dry pesticides and 15,000 tons (13,600 metric tons) in liquid form requiring disposal. Most of the liquid form consists of agent orange herbicide (a mixture of 2,4–D and 2,4,5–T) banned from use in South Vietnam.[21] These stocks contain significant quantities of a teratogenic dioxin. There are disposal requirements caused by the increasing numbers of waste pesticide containers as well. Over 250 million pesticide containers of all types will be used this year alone.[22]

TABLE 2.1

ESTIMATED INDUSTRIAL HAZARDOUS WASTE GENERATION BY REGION*

(Tons/Year)

Region	Inorganic in aqueous		Organics in aqueous		Organics		Sludges,† slurries, solids		Total		Percent of total
	tons	metric tons	tons	metric tons	tons	metric tons	tons	metric tons	tons	metric tons	
New England	95,000	(86,000)	170,000	(154,000)	33,000	(30,000)	6,000	(5,450)	304,000	(275,450)	3.1
Mid Atlantic	1,000,000	(907,200)	1,100,000	(1,000,000)	105,000	(90,600)	55,000	(50,000)	2,260,000	(2,047,800)	22.9
East North Central	1,300,000	(1,180,000)	850,000	(770,000)	145,000	(132,000)	90,000	(81,600)	2,385,000	(2,163,600)	24.2
West North Central	65,000	(59,000)	260,000	(236,000)	49,500	(45,000)	18,500	(16,800)	393,000	(350,800)	4.0
South Atlantic	230,000	(208,500)	600,000	(545,000)	75,000	(68,000)	80,000	(72,600)	985,000	(894,100)	10.0
East South Central	90,000	(81,700)	385,000	(350,000)	44,000	(40,000)	9,500	(8,600)	528,000	(480,300)	5.4
West South Central	320,000	(290,000)	1,450,000	(1,315,000)	180,000	(163,000)	39,000	(35,400)	1,989,000	(1,803,400)	20.2
West (Pacific)	120,000	(109,000)	550,000	(500,000)	113,000	(103,000)	30,500	(27,770)	813,500	(739,770)	8.3
Mountain	125,000	(113,500)	5,000	(4,540)	50,000	(45,400)	11,500	(10,400)	191,500	(173,840)	1.9
TOTALS	3,345,000	(3,034,900)	5,370,000	(4,874,540)	794,500	(717,000)	340,000	(308,620)	9,849,500	(8,929,060)	100.0

* Refers to Bureau of Census regions, as defined in Appendix B.

† Predominantly inorganic.

Note: Data for 1970

Source: EPA Contract No. 68–01–0762

FIGURE 2.1
REPRESENTATIVE HAZARDOUS SUBSTANCES WITHIN INDUSTRIAL WASTE STREAMS

HAZARDOUS SUBSTANCES

INDUSTRY	Arsenic	Cadmium	Chlorinated Hydrocarbons*	Chromium	Copper	Cyanides	Lead	Mercury	Miscellaneous Organics†	Selenium	Zinc
Mining & Metallurgy	X	X		X	X	X	X	X		X	X
Paint & Dye		X		X	X	X	X	X	X	X	
Pesticide	X		X			X	X	X	X		X
Electrical & Electronic			X		X	X	X	X		X	
Printing & Duplicating	X			X	X		X		X	X	
Electroplating & Metal Finishing		X		X	X	X					X
Chemical Manufacturing			X	X	X			X	X		
Explosives	X				X		X	X	X		
Rubber & Plastics			X			X		X	X		X
Battery		X					X	X			X
Pharmaceutical	X							X	X		
Textile				X	X				X		
Petroleum & Coal	X		X				X				
Pulp & Paper								X	X		
Leather				X					X		

* Including polychlorinated biphenyls
† E.g.: acrolein, chloropicrin, dimethyl sulfate, dinitrobenzene, dinitrophenol, nitroaniline, and pentachlorophenol.

TABLE 2.2
ESTIMATE OF RADIOACTIVE WASTE GENERATED IN 1970

Waste stream source	Form	Total annual curies	Tons/year	Metric tons/year	Major radioactive elements
Mineral extraction* (Uranium)	Sludge	9.0×10^3	4,400,000	4,000,000	Ra, Th, Pb, & Po
Commercial nuclear electric power	Solid or liquid	4.0×10^7	2,240	2,000	U,Th, Ra, Pu, Ag Fe, H, Mn, Ni, Co, Ru, Cs, Ce, Sr, Sb, Pm, Eu, Am & Cm
Miscellaneous private sources	Solid or liquid	2.0×10^5	11,000–22,000	10,000–20,000	Co, Sr, Pm, Cs, Pu, Am, & Cm
Government sources	Solid or liquid	Not available	Not available	Not available	Pu, Am & Cm
All known sources	Sludges, solids or liquids	$>4.0 \times 10^7$	>4,413,240	>4,012,000	

*Uranium mill tailings from extraction of uranium ores.

Source: EPA Contract No. 68–01–0762

Flammables. Flammable wastes consists mainly of contaminated organic solvents, but may include oils, pesticides, plasticizers, complex organic sludges, and off-specification chemicals. Highly flammable wastes can pose acute handling and chronic disposal hazards. Hazards related to disposal may exceed those of transportation and handling if sufficient waste volumes are involved. The nationwide quantities of flammable wastes have not been assessed as a separate category, but are included in the totals given previously.

Explosives. Explosive wastes are mainly obsolete ordance, manufacturing wastes from the explosives industry, and contaminated industrial gases. The largest amount of explosive waste is generated by the Department of Defense (DOD). An inventory by the DOD Joint Commanders Panel on Disposal Ashore indicates that the military has accumulated about 150,000 tons (136,080 metric tons) of obsolete conventional ammunition.[23] The former practice of loading obsolete munitions on ships and sinking them in the ocean has been discontinued. Final disposal is being delayed until a more suitable disposal method is available. A Joint Army, Navy, NASA and Air Force (JANNAF) group is working to resolve this impasse. Most waste materials generated by the commercial explosives industry consist of chemical wastes that are not clearly separable from wastes produced by large industrial chemical firms (e.g., ammonia, nitric acid, sulfuric acid, some common organic chemicals, etc.). These wastes represent a greater problem than military wastes because of uncontrolled disposal practices. Open burning of explosives, which is widely practiced, can result in the emission of harmful nitrogen oxides and other pollutants.

Radioactive Wastes.[24] Most radioactive wastes consist of conventional non-radioactive materials contaminated with radionuclides. The concentration of the latter can range from a few parts per billion to as high as 50 percent of the total waste. Frequently, many radionuclides are involved in any given waste. Radioactive wastes are customarily categorized as low- or high-level wastes, depending upon the concentrations of radionuclides. However, the long term hazard associated with each waste is not necessarily proportional to the nominal "level" of radioactivity, but rather to the specific toxicity and decay rate of each radionuclide. The most significant radionuclides, from the standpoint of waste management, decay with half-lives of months to hundreds of thousands of years. For the purposes of this study, the term high level wastes refers to those requiring special provisions for dissipation of heat produced by radioactive decay. Low level waste refers to all others.

The biological hazard from radioactive wastes is primarily due to the effects of penetrating and ionizing radiation rather than to chemical toxicity. On a weight basis, the hazard from certain radionuclides is more acute than the most toxic chemicals by about six orders of magnitude. The hazard from radionuclides cannot be neutralized by chemical reaction or by any currently practicable scheme. Thus, the only currently practical way to "neutralize" a radionuclide is to allow its decay. Storage of wastes containing radionuclides under carefully controlled conditions to assure their containment and isolation is necessary during this decay period. The time period necessary for decay of radionuclides to levels acceptable for release to the environment varies with each waste.

Radionuclides may be present in gaseous, liquid, or solid form. Solid wastes *per se* are not normally important as potential contaminants in the biosphere until they become airborne (usually as particulates) or water-borne (by leaching). Consequently, environmental effects and existing regulatory limits are based primarily on concentrations in air and water.

Biological Wastes. Biological wastes were divided into two categories for this study: pathological hospital wastes and warfare agents. Pathological wastes from hospitals are usually less infectious than biological warfare agents. Both types of wastes may also be toxic. For example, toxins produced by various strains of microorganisms may be just as hazardous as the associated infectivity of the organism.

Approximately 170,000 tons (154,000 metric tons) of pathological wastes are generated by hospitals annually, which is approximately 4 percent of the total 4.2 million tons (3.7 million metric tons) of all hospital wastes generated per year.[25,26] These wastes include malignant or benign tissues taken during autopsies, biopsies, or surgical procedures, animal carcasses and wastes, hypodermic needles, off-specification or outdated drugs, microbiological wastes, and bandaging materials.

Biological Warfare (BW) Agents. These are selected primarily because of their ability: (1) to penetrate outer epithelial tissues of plants or animals and (2) to spread rapidly. Antipersonnel agents like Bacillus anthrax are cultured to affect a specific animal, whereas anticrop agents like Puccinia graminis (Lx) (Rice blast) are used to inhibit growth of specific plants. DOD representatives have advised EPA that all stockpiles of biological warfare agents, including antipersonnel and anticrop agents, have been destroyed.[27] Due to the Administration's policy of restricting production of BW agents, the total quantity to be disposed of should be small in the future.

Chemical Warfare Agents. Production of chemical warfare agents such as HD (mustard), GB, and VX has been discontinued, but significant stockpiles of these agents must be treated and disposed of in an environmentally acceptable manner. The Department of the Army is in the process of demilitarizing HD (mustard) at Rocky Mountain Arsenal in Colorado, and is presently studying the feasibility of demilitarizing GB and VX by means of incineration. The exact quantity of chemical agents to be incinerated is classified, but it has been estimated that after the treatment process there will be approximately 70,000 tons (63,600 metric tons) or residual salts that will require proper disposal.

Factors Influencing the Growth of Harzardous Wastes.

A number of factors will increase the quantities of hazardous wastes generated in the future and will affect their disposal requirements. Some of these factors are production and consumption rates, legislative and regulatory actions, energy requirements, and recycling incentives.

National production and consumption rates are increasing 4 to 6 percent each year, while resource recovery from wastes is declining. During the period 1948 to 1968, U.S. consumption of selected toxic metals increased 43 percent.[28] Since 1954, production of synthetic organic chemicals has increased to an average rate of 10.5 percent per year.[29] Included in the latter category are such materials as dyes, pigments, and pesticides. Some of these products contain heavy metals in addition to organic constituents. Similar data indicating production growth can be cited for most industries which generate hazardous waste. There is a correlation between the amount of production and waste generated. Therefore, it can be concluded that hazardous waste generation rates will generally parallel industrial production rates.

Changing product material content also has an impact. For example, increasing polyvinylchloride (PVC) plastics usage in more mercury-bearing wastes from the chlorine production industry; in the computer industry, changeover from vacuum tube technology to integrated circuit board technology has resulted in increased generation of acid etchant wastes containing heavy metals.

The Nation's projected energy requirements are driving utilities towards construction of nuclear powered facilities. As of September 1972, there were 28 nuclear power plants in operation, 52 were being built, and 70 more were being planned. Operation of the additional 122 nuclear power plants will definitely increase the quantities of radioactive wastes.[30] Shortages of clean burning high grade coal have initiated a trend to utilize lower grades of coal, which contain larger amounts of arsenic and mercury; therefore, aqueous wastes from the scrubbers and ashes from coal burning furnaces will contain increased quantities of toxic wastes.

Enforcement of new consumer and occupational safety legislation could result in product bans with attendant disposal requirements. More stringent air and water effluent controls, new pesticide controls, and the new restrictions on ocean dumping of wastes will result in larger quantities of hazardous wastes in more concentrated form requiring disposal. As air, water and ocean disposal options are closed off, there will be increased pressure for improvement in production efficiency, for recovery and recycling of hazardous substances, and for disposal of hazardous wastes on or under the land.

Public Health and Environmental Effects

In order for an organic or inorganic hazardous compound within a waste to affect public health and the environment it must be present in a certain concentration and form.

Public health and environmental effects are directly correlated with the concentration and duration of exposure.[31,32] This has been better documented for acute effects resulting from high concentrations over a short period of time than for chronic effects resulting from low concentrations over a long period of time.[33] Most of the work to establish chronic effects has been done on lower animals, and extrapolating the evidence directly to man becomes difficult because of species variations.[34]

Synergistic or antagonistic interactions between hazardous compounds and other constituents within the waste can enhance or modify the overall effects of the particular hazardous compound. As an example, the effects of mercury salts with trace amounts of copper will be considerably accentuated in a suitable environment.

The form of a hazardous waste is also very critical because it determines if a toxic substance is releasable to the ambient environment. As an example, an insoluble salt of a toxic metal bound up within a sludge mass that is to be disposed of at a landfill does not present the same degree of immediate threat to public health and the environment as a soluble salt of the same metal that is unbound going to the same landfill. The interaction between biological systems and hazardous wastes is unpredictable, and in many cases the end product is more lethal than the original waste. An example is the conversion of inorganic mercury by anaerobic bacteria into methyl mercury. Furthermore, persistent toxic substances can accumulate within tissues of mammals as do certain radioisotopes. Under these circumstances, substances that are persistent in the ambient environment even though in low concentrations will be magnified in the living system. As a result, critical concentrations may accumulate in tissues and cause detectable physiological effects.

Cancers and birth defects are only a few of the recorded physiological effects that have been correlated with the presence of hazardous compounds in man. Other milder effects have also been recorded like headaches, nausea, and indigestion. In the environment, the effects of hazardous wastes are manifested by such events as fish kills, reduced shellfish production, or improper egg shell synthesis.[35]

This evidence points to the fact that hazardous wastes are detrimental to public health and the environment. Therefore, the real issue is to document the fact that present management practices for treating, storing, or disposing of hazardous wastes do not provide the necessary reassurances that man or the environment are being adequately protected.

Present Treatment and Disposal Technology

Treatment processes for hazardous waste streams should perform the following functions: (1) volume reduction where required, (2) component separation, (3) detoxification, and (4) material recovery. No single process can perform all these functions; several different processes linked in series are required for adequate treatment. Residues from these processes, or all hazardous wastes if treatment is bypassed, require ultimate disposal.

Treatment and disposal technology is available to process most hazardous waste streams. Table 2.3 lists the hazardous waste treatment and disposal processes examined during the course of

TABLE 2.3
CURRENTLY AVAILABLE HAZARDOUS WASTE TREATMENT AND DISPOSAL PROCESSES

Process	Functions performed	Applicable to waste											Resource recovery capability
		Types								Forms			
		1	2	3	4	5	6	7	8	S	L	G	
A. Physical Treatment													
Carbon sorption	Vol. reduc./separ.	X		X	X	X					X	X	Yes
Dialysis	Vol. reduc./separ.	X	X	X	X						X		Yes
Electro dialysis	Vol. reduc./separ.	X	X	X	X		X				X		Yes
Evaporation	Vol. reduc./separ.	X	X			X					X		Yes
Filtration	Vol. reduc /separ.	X	X	X	X	X					X	X	Yes
Flocculation-Settling	Vol. reduc./separ.	X	X	X	X	X					X		Yes
Reverse osmosis	Vol. reduc./separ.	X	X		X		X				X		Yes
Stripping-Ammonia	Vol. reduc./separ.	X	X	X	X						X		Yes
B. Chemical Treatment													
Calcination	Vol. reduction	X	X			X					X		
Ion exchange	Vol. reduc./separ. detoxification	X	X	X	X	X					X		Yes
Neutralization	Detoxification	X	X	X	X						X		Yes
Oxidation	Detoxification	X	X	X	X						X		
Precipitation	Vol. reduc./separ.	X	X	X	X	X					X		Yes
Reduction	Detoxification	X	X								X		
C. Thermal Treatment													
Pyrolysis	Vol. reduc./detox.			X	X		X			X	X	X	Yes
Incineration	Detox./disposal			X		X	X	X	X	X	X	X	Yes
D. Biological Treatment													
Activated sludges	Detoxification			X							X		No
Aerated lagoons	Detoxification			X							X		No
Waste stabilization ponds	Detoxification			X							X		No
Trickling filters	Detoxification			X							X		No
E. Disposal/Storage													
Deep well injection	Disposal	X	X	X	X		X	X			X		No
Detonation	Disposal						X		X	X	X	X	No
Engineered storage	Storage	X	X	X	X	X	X	X	X	X	X	X	Yes
Land burial	Disposal	X	X	X	X	X	X	X	X	X	X		No
Ocean dumping	Disposal	X	X	X	X			X	X	X	X	X	No

Waste type:
1. Inorganic chemical w/o heavy metals
2. Inorganic chemical w/heavy metals
3. Organic chemical w/o heavy metals
4. Organic chemical w/heavy metals
5. Radiological
6. Biological
7. Flammable
8. Explosive

Waste form:
S—Solid
L—Liquid
G—Gas

Source: EPA Contract Nos. 68-03-0089, 68-01-0762 and 68-01-0556.

this study. General applicability of these processes to types and forms of hazardous wastes is indicated. Many of these processes have been utilized previously for managing hazardous wastes in industry and government. Several processes have capabilities for resource recovery. Selection of appropriate methods depends on the type, form and volume of waste, the type of process required to achieve adequate control, and relative economics of processes.

Several treatment processes perform more than one function, or are applicable to more than one type or form of waste. For example, evaporation provides both volume reduction and component separation for inorganic liquids. Carbon sorption and filtration provide component separation for both liquids and gases, and are applicable to a wide range of heterogeneous waste streams. Both carbon sorption and evaporation are capable of large throughput rates. Neutralization, reduction and precipitation are effective for separation of most heavy metals.[36,37]

Certain weaknesses are inherent in some treatment processes. For example, the five biological treatment processes are inefficient when waste streams are highly variable in composition and concentration, or when solutions contain more than 1–5 percent salts.[38] Furthermore, biological treatment processes require larger land areas for facilities than the other physical or chemical processes. The efficiency of removal or hazardous liquids and gases from waste streams by carbon sorption is strongly dependent on pH. Similarly, the four dissolved solids removal processes (ion exchange, reverse osmosis, dialysis, and electrodialysis) are all subject to operational problems when utilized for treating heterogeneous brines.[39]

Radioactive emissions and effluents from production or reprocessing facilities are routinely controlled by a variety of treatment methods. High efficiency filters are used to remove radioactive particulates from gaseous effluents; caustic scrubbers of charcoal absorbers are used to remove radioactive gases. Liquid effluents containing small quantities of soluble or insoluble radioactive constituents are usually treated with conventional water treatment techniques such as ion exchange, settling, precipitation, filtration, and evaporation.[40]

Commonly used disposal processes for hazardous wastes include land burial, deep well injection, and ocean dumping. Detonation and open burning are sometimes used for disposal of explosives. Incineration is used for disposal of some organic chemicals, biologicals, and flammables.

All disposal processes have potential for adverse public health and environmental effects if used unwisely or without appropriate controls.

Land disposal sometimes consists of indiscriminate dumping on the land with attendant public health problems from animal vectors, water pollution from surface water runoff and leaching to ground waters, and air pollution from open burning, wind blown particulates and gas venting.

Sanitary landfills are much preferable to dumps in that daily earth cover minimizes vector problems, open burning and particulate transport. Unless specially designed, however, sanitary landfills still have potential for surface and ground water pollution and air pollution from gas venting.

Deep well injection of liquid and semi-liquid wastes can pollute ground waters unless great care is taken in site selection and construction and operation of such wells. EPA policy opposes deep well injection unless all other alternatives have been found to be less satisfactory in terms of environmental protection, and unless extensive hydraulic and geologic studies are made to ensure that ground water pollution will be minimized.

Environmental problems associated with ocean dumping have long been recognized. The Congress recently passed legislation to control ocean dumping of wastes (see Section 3).

Incineration, open burning, and detonation all can result in air pollution unless adequate controls are employed. The residues from incineration, and from associated pollution control devices, may require special care in disposal.

Selection of appropriate treatment and disposal methods for a given waste is a complex process. It is simplistic to assume that a treatment and disposal process is applicable to all wastes of a given category. For example, available treatment and disposal processes for three types of heavy metal hazardous wastes are illustrated in Figure 2.2. It can be seen that significant differences exist.

Transfer and adaptation of existing technology to hazardous waste management may be necessary in some cases. Some hazardous waste streams (e.g., those containing arsenites and arsenates of lead, sodium, zinc and potassium, and arsenic trioxide) cannot be treated or disposed of adequately with existing technology.[41] Secured storage is available until the appropriate treatment/disposal technology is developed.

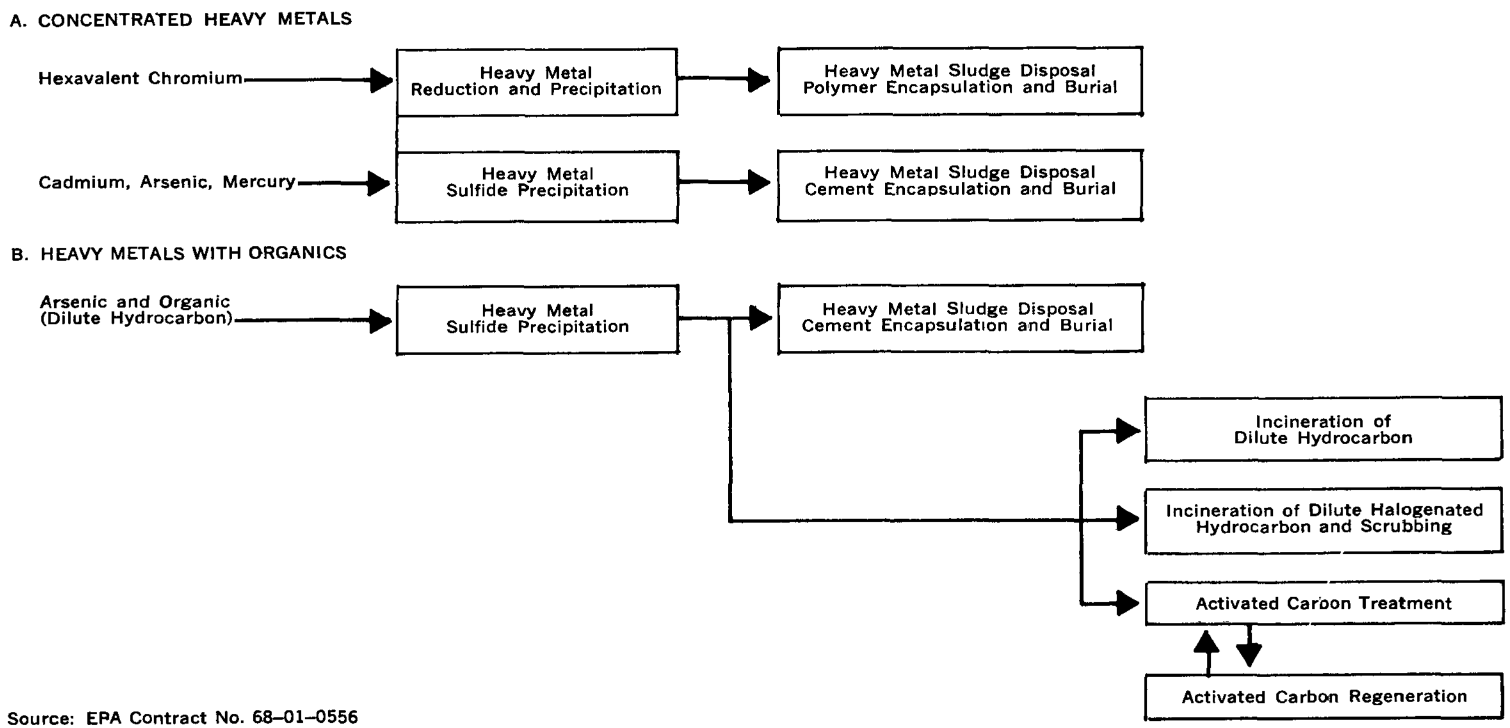
Synopses of treatment and disposal processes are given in Appendix D.

Public Use of Existing Technology. The Atomic Energy Commission and the Department of Defense presently utilize almost all the processes identified in Table 2.3 for management of hazardous wastes. High level radioactive treatment and storage sites operated by AEC are located at Hanford, Washington; Savannah River, South Carolina; and the National Reactor Testing Station in Idaho. Similar DOD operated non-radioactive hazardous waste treatment, storage and disposal sites are located at a great number of arsenals, depots, and ammunition plants throughout the country.

Private Use of Existing Technology. Some large manufacturers, notably in the chemical industry, have established in-house hazardous waste processing facilities which utilize some of the treatment and disposal processes listed in Table 2.3. EPA-held data on such

FIGURE 2.2

EXAMPLES OF INTERRELATIONSHIP BETWEEN HAZARDOUS WASTES AND TREATMENT/DISPOSAL PROCESSES



Source: EPA Contract No. 68–01–0556

in-house operations are sparse. Based on available ocean and land disposal data it is estimated, however, that only a small percentage of the hazardous wastes generated by industry receive treatment and are disposed of at in-house facilities.

The Hazardous Waste Processing Industry. In recognition of this situation several private companies have built facilities to treat, dispose, and recycle many hazardous wastes. These companies sell waste processing services to industries in their area, generally within a 500 mile (805 kilometer) radius. However, largely because of lack of demand for services, these regional waste processing plants still are few in number (about ten nationwide) and operate at about 25 percent of available capacity.

The total processing capacity of all facilities is approximately 2.5 million tons (2.3 million metric tons) per year. Operating at full capacity, these private processing firms presently could handle about 25 percent of the total nationwide non-radioactive hazardous wastes. None of these facilities provide a complete range of treatment and disposal processes capable of handling all types of hazardous wastes. Table 2.4 presents a summary of information available on these firms.

As stated earlier, nuclear weapons production facilities, commercial nuclear power reactors and private sources generate a substantial quantity of high- and low-level radioactive wastes. High-level wastes are controlled by the AEC. Management of low-level wastes by private companies at AEC or cooperative State sites is a highly specialized business with limited markets. As a result there are only two companies engaged in handling and disposing of low-level radioactive wastes. The quantities of radioactive wastes are expected to increase exponentially starting around 1980, and as a result the number of nuclear waste disposal companies should also increase.

Economic Incentives

The costs associated with proper hazardous waste treatment and disposal are fixed capital-intensive and vary widely, depending on the particular treatment process that is required. Table 2.5 presents typical capital and operating costs for a number of selected processes that are applicable to medium-size regional industrial waste treatment and disposal facilities. These examples illustrate that environmentally adequate technology is expensive. Moreover, to arrive at the actual costs associated with proper treatment of hazardous wastes, a combination of several treatment processes is usually required.

TABLE 2.4
SUMMARY OF INFORMATION
On Privately Owned Regional Hazardous Waste Processing Plants*

Number of regional plants	Approximately 10
Estimated available capacity	2,500,000 tons/year (2,272,000 metric tons/year)
Estimated utilization of available capacity	25 percent
Available capacity as percent of required nationwide capacity	*25 percent*
Regional distribution	Mostly in North Central, Mid-Atlantic and Gulf Coast regions
Total capital investment	$25 million
Resource recovery	Limited at present mostly to solvents and metallic salts

**This table does not consider very small firms with limited facilities (e.g., those plants that consist solely of an incinerator).*

TABLE 2.5
COSTS OF REPRESENTATIVE HAZARDOUS WASTE TREATMENT PROCESSES

Process	Capacity		Capital Costs	Operating costs	
	(1,000 gal./day)	(1,000 liters/day)	($1,000)	($/1,000 gal.)	($/1,000 liters)
1. Chemical oxidation of cyanide wastes	25	94.8	400	68	18
2. Chemical reduction of chromium wastes	42	159	340	29	7.65
3. Neutralization-Precipitation	120	452	3,000	50	13.20
4. Liquid-Solids separation	120	452	9,000	40	10.60
5. Carbon sorption	120	452	910	7	1.85
6. Evaporation	120	452	510	10	2.64
7. Incineration	74 tons/day	67 metric tons/day	4,900	95($/ton)	105($/metric ton)

NOTE:
1. Capital costs include land, buildings, and complete processing and auxiliary facilities.
2. Operating costs include neutralization chemicals, labor, utilities, maintenance, amortization charges (7 percent interest), insurance, taxes, and administrative expenses
3. Data corresponds to a typical medium size treatment and disposal facility capable of processing approximately 150 thousand tons (136 thousand metric tons) per year or 600 tons (545 metric tons) per day.

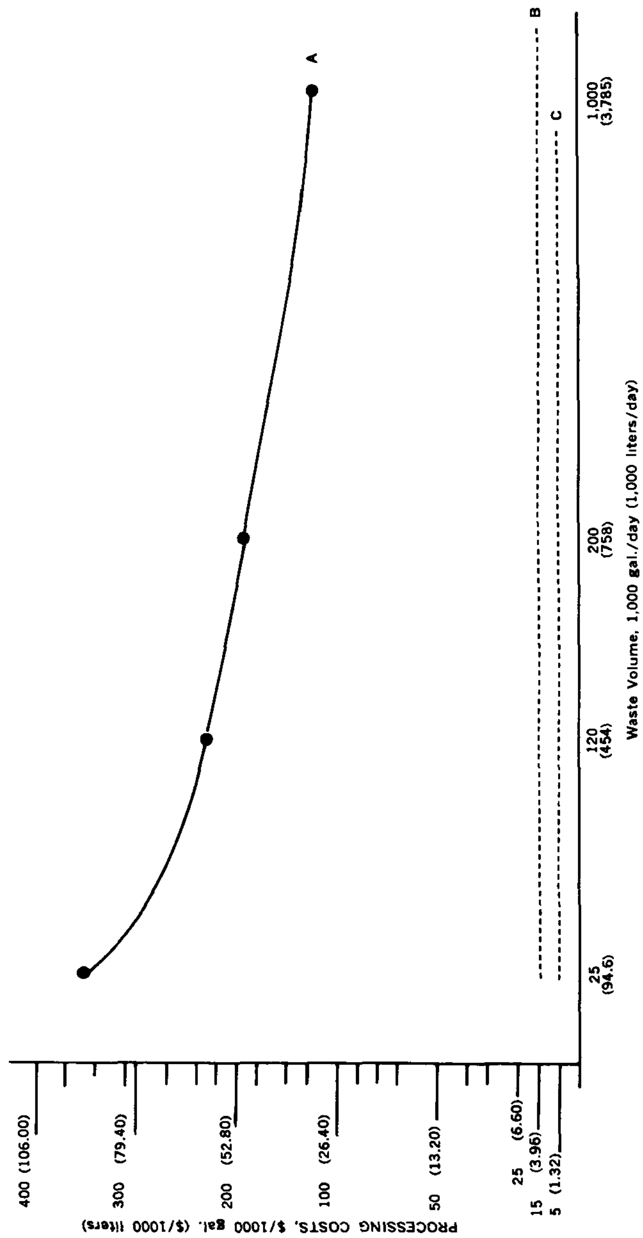
Source: EPA Contract No. 68–01–0762

The comparative economics of proper hazardous waste management versus presently used environmentally inadequate practices, such as disposal in dumps or in the ocean, are illustrated in Figure 2.3. This figure also depicts the economies of scale that can be attained by use of large waste processing facilities. The cost data used in support of this figure were based on typical treatment and disposal facilities capable of handling aqueous toxic wastes.

Figure 2.3 indicates that adequate treatment and disposal of hazardous wastes costs 10 to 40 times more than the environmentally offensive alternatives. With these kinds of economic differen-

FIGURE 2.3

COST COMPARISON OF PROPER VS. IMPROPER HAZARDOUS WASTE MANAGEMENT PRACTICES



A = Environmentally adequate treatment and disposal
B = Land disposal
C = Ocean disposal

Note: For aqueous wastes.
Includes capital write-off but not transportation costs from the generator to nearest treatment or disposal facility.

Source: EPA Contract No. 68–01–0762 & 68–03–0089.

tials, and in the general absence of pressures to do otherwise, one realizes why the more environmentally acceptable methods are seldom utilized. Available technology cannot compete economically with the cheaper disposal alternatives. Clearly, there are substantial economic incentives for industry not to use adequate hazardous waste treatment and disposal methods.

Should a generator elect to process his hazardous wastes in an environmentally acceptable manner, a basic decision must be made whether the particular waste stream should be processed on-site or off-site at some regional treatment facility, such as existing commercial waste processing plants. The cost analysis of this problem, as it applies to a number of commonly occurring industrial waste streams, was conducted by means of a mathematical model that produced "economic decision maps." [42] Typical examples are attached in Appendix E. An analysis of the decision maps indicates that cost factors generally favor off-site treatment and disposal of industrial hazardous wastes with the exception of dilute aqueous toxic metal streams. Other factors, such as the impact of pending water effluent standards and transportation problems, may alter this judgment.

Summary

EPA's findings relative to the current handling of hazardous wastes can be summed up as follows:

1. Current treatment and disposal practices are inadequate and cause unnecessary hazards to all life forms.
2. Techniques for safe and environmentally sound treatment and disposal of most hazardous wastes have been developed. Adaptation and transfer of existing technology, and development of new methods, is required in some cases. It is possible to retain hazardous wastes for which treatment/disposal methods are unavailable in long-term storage until their chemical conversion to harmless compounds or their reuse in industrial practice becomes feasible.
3. There are substantial economic incentives for industry not to use environmentally adequate treatment and disposal methods. Such methods are substantially more expensive than current inadequate practices, and in a climate of permissive legislation or total absence of legislation, competitive economic forces result in least-cost disposal regardless of the environmental consequences.
4. A small industry has emerged to treat and dispose of hazardous and other industrial wastes. This industry is not currently

operating at capacity because its services are being utilized only by a few clients that are concerned about the environment, or have no cheaper disposal alternatives, or sometimes find themselves forced to use such services because of environmental regulations. This industry, however, has the capability to expand to meet demands engendered by future Federal or State actions.

It is evident that a need exists for bringing about environmentally acceptable and safe treatment and disposal of hazardous wastes. The next section will discuss the need for a regulatory program in order to achieve this goal.

Section 3

THE CASE FOR HAZARDOUS WASTE REGULATIONS

The previous section has shown the potential for public health and environmental damages from mismanagement of hazardous wastes and the lack of economic incentives for proper management. There is a strong precedent for Federal regulation when health damage is at issue. Regulation is used because the other conceptual alternative, massive economic incentives, does not ensure compliance. Some forms of regulation, however, may embody certain types of economic incentives.

Federal and State statutes have attempted to regulate and control various parts of the problem, but there has never been an attempt to regulate hazardous waste management in a comprehensive manner.

The following discusses legislative precedents regarding hazardous wastes and illustrates a legislative gap in the regulation of land disposal of hazardous wastes.

Existing Authorities for Hazardous Waste Management

A large body of Federal and State law exists today which exerts a significant but peripheral impact on the land disposal of hazardous waste. The following discussion reviews existing laws and assesses their impact on the treatment, storage, transportation, handling, and disposal of hazardous wastes.

Federal Control Statutes. Thirteen Federal statutes have varying degrees of direct impact on the management of hazardous wastes. Four additional Federal statutes are either indirectly or potentially applicable to hazardous wastes. The Clean Air Act, as amended, and the new Federal Water Pollution Control Act will be discussed in some detail later in this section. The other statutes and their impact on the treatment, storage, transportation, and handling of hazardous wastes may be summarized as follows:

1. *The Resource Recovery Act of 1970.*[43] Section 212 of the Resource Recovery Act directs the Administrator of EPA to study the feasibility of a system of national disposal sites for hazardous wastes. The Act authorizes no regulatory activities, however.
2. *The Atomic Energy Act of 1954, as amended.*[44] This statute authorizes the Atomic Energy Commission to manage radioactive wastes generated in fission reactions both by the AEC and private industry. High-level radioactive wastes from weapons and reactor programs are controlled directly by the AEC at its facilities; commercially generated low-level radioactive wastes are generally disposed of at facilities licensed and controlled by the States. Naturally occurring materials, such as uranium mill tailings and radium, and radioisotopes produced by cyclotrons are not subject to regulation under the Act. There is room for improvement at the radioactive waste storage and disposal facilities, but by comparison with other hazardous wastes, high-level radioactive waste management is well regulated.

3–7. The Department of Transportation is responsible for administering five statutes which affect the transport of hazardous wastes. The oldest of these, the *Transportation of Explosives Act*[45] prohibits the knowing unregulated transport of explosives, radioactive materials, etiologic (disease-causing) agents and other dangerous articles in interstate commerce unless the public interest requires expedited movement or such transport involves "no appreciable danger to persons or property." Supplementing this law is the *Hazardous Materials Transportation Act of 1970,*[46] a non-regulatory statute which authorizes the Secretary of DOT to evaluate hazards associated with hazardous materials transport, establish a central accident reporting system, and recommend improved hazardous materials transport controls. *The Safety Regulation of Civil Aeronautics Act*[47] authorizes the Federal Aviation Administration to establish air transportation standards "necessary to provide adequately for national security and safety in air commerce." The *Hazardous Cargo Act*[48] places regulatory controls on the water transport of explosives or dangerous substances, authorizing the U.S. Coast Guard to publish regulations on packing, marking, labeling, containerization, and certification of such substances, *The Federal Hazardous Sub-*

stances Labeling Act[49] authorizes the DOT Secretary to identify hazardous substance and prohibits the transport of such substances if their containers have been misbranded or the labels removed. The Act authorizes the seizure of misbranded hazardous substances and requires the courts to direct the ultimate disposition of such seized substances.

8. *The Federal Environmental Pesticide Control Act of 1972*[50] requires the Administrator of EPA to establish procedures and regulations for the disposal or storage of packages, containers, and excess amounts of pesticides. EPA is also required to "accept at convenient locations for safe disposal" those pesticides whose registration is suspended to prevent an imminent hazard and later canceled, if the pesticide owner so requests.[51]
9. *The Marine Protection, Research and Sanctuaries Act of 1972*[52] prohibits the transport from the United States for the purpose of ocean dumping any radiological, chemical or biological warfare agents, high-level radioactive wastes, or (except as authorized by Federal permit) any other material. In granting permits for ocean dumping, the EPA Administrator must consider "appropriate locations and methods of disposal or recycling, including landbased alternatives, and the probable impact of [such use] upon considerations affecting the public interest."[53]

10–11. *The Clean Air Act*[54] and the *Federal Water Pollution Control Act,*[55] examined in detail later in this section, provide extensive control authority over the incineration and water disposal of certain hazardous wastes.

12. *The Poison Packaging Prevention Act*[56] authorizes the Secretary of HEW to establish special packaging standards for hazardous household substances whenever it can be shown that serious personal injury or illness to children can result from handling, using or ingesting such substances. Hazardous household substances already identified in regulations include oven cleaners, cigarette and charcoal lighter fluids, liquids containing turpentine and methyl alcohol, and economic poisons (pesticides).
13. *The Food, Drug and Cosmetic Act*[57] prohibits the adulteration and misbranding of certain consumer items and requires the disposal by destruction or sale of any items seized under the Act.
14. The first of the Federal statutes which have a general, nonregulatory impact on the management of hazardous wastes is the *National Environmental Policy Act of 1969* (NEPA).[58]

Sec. 101(b) of NEPA requires the Federal Government to "use all practicable means" to attain the widest range of beneficial uses without degrading the environment or risking health or safety. In order to ensure that the environmental policies expressed in Sec. 101 are effectively carried out, Sec. 102(2)(C) requires all agencies of the Federal Government to prepare detailed environmental impact statements for all "major Federal actions significantly affecting the quality of the human environment." All Federal hazardous waste management activities thus clearly fall within NEPA's ambit.

15. *The Armed Forces Appropriation Authorization Acts of 1969 and 1970* [59] prohibit the use of Federal funds for the transportation, open air testing, or disposal of any lethal chemical or biological warfare agent in the United States except under certain conditions requiring prior determination of the effect on national security, hazards to public health and safety, and practicability of detoxification prior to disposal.
16. *The Coastal Zone Management Act of 1972*,[60] in declaring it a national policy to preserve and protect the resources of the Nation's coastal zone, recognizes waste disposal as a "competing demand" on coastal zone lands which has caused "serious environmental losses." Because applicants for Federal coastal zone management grants must define "permissible land and water uses within the coastal zone," an applicant's failure to regulate hazardous waste disposal within such area so that it qualifies as a "permissible use" can serve as a basis for denying program funds under the Act.
17. *The Occupational Safety and Health Act of 1970* [61] authorizes the Secretary of Labor to set mandatory standards to protect the occupational safety and health of all employers and employees of businesses engaged in interstate commerce. Sec. 6(b)(5) deals specifically with toxic materials and other harmful agents, requiring the Secretary to "set the standard which most adequately assures . . . that no employee will suffer material impairment of health or financial capacity" from regular exposure to such hazards. Employees of hazardous waste generators, and treatment and/or disposal facilities, engaged in interstate commerce thus are clearly entitled to the Act's protection. It should be noted that standards issued under the Act can directly impact some phases of hazardous waste management. For example, the OSHA-enforced asbestos regulation requires that certain wastes be packaged for disposal.

State Control Statutes. At least 25 jurisdictions have enacted legislation or published regulations which control hazardous waste management activities to some degree. The most effective of these regulatory controls are currently placed on low-level radioactive wastes, the Atomic Energy Commission having contracted with a growing number of States for low-level radioactive waste disposal. Non-radioactive hazardous wastes, however, are essentially unregulated in practice, for none of the 25 jurisdictions has fully implemented its control legislation. The major reason for this failure is the negative approach—broadly-worded blanket prohibitions—utilized by virtually all of the States.

Legislative strategies which rely on blanket prohibitions rather than comprehensive management controls are difficult or impossible to administer in any meaningful, systematic fashion. In addition, many of these States enact control statutes without providing for acceptable treatment or disposal facilities. A recent survey [62] of 16 of the 25 "control" States reveals for example, that less than half of them have treatment/disposal facilities located within their boundaries (see Figure 3.1). By failing to specify acceptable alternatives to prohibited activities, such States encourage hazardous waste generators to ignore the law altogether or to select and employ divergent disposal alternatives unknown to the State control authorities which may be more environmentally harmful than the prohibited activity.

Summary: With the exception of radioactive waste disposal, which appears to be the subject of adequate Federal and State regulation, land-based hazardous waste treatment, storage and disposal activities are essentially unregulated by Federal and State laws. Because this legislative gap allows uncontrolled use of the land for hazardous waste disposal, there has been little incentive for the use of proper hazardous waste treatment and disposal technology to date. Until nationwide controls are established, the pressure on the land as a receptor for hazardous wastes can be expected to increase as the major hazardous waste disposal controls of the Clean Air Act, the Federal Water Pollution Control Act and the new Federal ocean dumping statute are tightened. The latter statute's mandate to the EPA Administrator to consider land-based disposal alternatives when granting ocean dumping permits seems certain to provide opponents of the practice of dumping toxic wastes into the ocean with a new and powerful legal tool. Depending on the courts' interpretation of this statute, the Marine Protection, Research and Sanctuaries Act of 1972 could add significantly to the pressure on the land as the last disposal medium for hazardous wastes.

The first two of these three statutes are analyzed in the discussion which follows.

Precedents for Hazardous Waste Regulation: The Clean Air Act and the Federal Water Pollution Control Act

Both the Clean Air Act [63] and the Federal Water Pollution Control Act [64] include provisions which address the problem of hazardous waste management directly. The former statute authorizes the control of hazardous air pollutants and the latter controls the discharge of hazardous pollutants into the Nation's waters.

Control Philosophy. The Clean Air Act best exemplifies a control strategy designed to protect the public health and welfare by placing the burden of standards compliance on the air polluter. As with most environmental control statutes, the costs of compliance are internalized by the polluter and ultimately passed on to the consumer, indirectly in the form of tax benefits to the polluting industries,[65] or directly in the form of higher prices for goods and services. In the past, Clean Air Act standards have been based almost exclusively on health effects. As a result of adverse court decisions on ambient air quality standards, however, EPA has expanded its efforts to consider, in addition to health and welfare factors (1) beneficial and adverse environmental effects, (2) social, economic, and other pertinent factors, and (3) the rationale for selecting the standard from the available options.[66,67,68]

The Federal Pollution Control Act Amendments of 1972 generally exemplify a control strategy based on factors in addition to human health and welfare. Typical of the FWPCA's new regulatory provisions are those keyed to "best practicable" control technology and "best available technology economically achievable," determinations which are to be made by EPA from studies of the age, size and unit processes of the point sources involved and the cost of applying effluent controls.

The Clean Air Act. Sec. 112 of the Clean Air Act authorizes the Administrator of EPA to set standards for hazardous air pollutants at any level "which in his judgment provides an ample margin of safety to protect the public health." [69] Hazardous air pollutants are defined as those which "may cause, or contribute to an increase in mortality, or an increase in serious irreversible or incapacitating reversible, illness" (Sec. 112(a) (1)). Asbestos, beryllium and mercury are three hazardous pollutants for which emission limits under Sec. 112 have been promulgated.

The Federal Water Pollution Control Act. The FWPCA contains a number of provisions which impact directly on hazardous pollutant-bearing wastes. Section 502(13) defines "toxic pollutant" as "those pollutants . . . which . . . after discharge and upon exposure, ingestion, inhalation or assimilation into any organism . . . will

FIGURE 3.1
SUMMARY OF STATE LEGISLATION SURVEY

	Solid waste		Radioactive material				Pesticides			
			Regulations on				Regulations on			
	Disposal regulations	Licensing of disposal sites	Disposal	Transportation	Processing	Storage	Disposal	Transportation	Processing	Storage
Alabama	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
California	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Colorado	Yes	Yes	Yes	No	No	No	No	No	No	No
Illinois	Dev	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kansas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maine	Dev	No	Yes	Yes	Yes	Yes	Yes	No	No	No
Michigan	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nevada	No	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes
New Jersey	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
New York	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Oregon	Yes	Yes	Yes	No	No	No	Yes	Yes	No	Yes
South Carolina	Yes	Yes	Yes	No	No	Yes	No	No	No	No
Texas	Yes	Yes	Yes	Yes	Yes	Yes	No	—	Yes	Yes
Vermont	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No
Virginia	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No
Washington	Yes	Yes	Yes	No	No	No	Yes	No	No	No

	Explosives				Transportation		Industrial Safety	Presence of existing facilities	
		Regulations on					Regulations for handling hazardous materials		
	Disposal	Transportation	Processing	Storage	DOT Regulations	Other [a]		Radioactive	Hazardous [b]
Alabama	—	—	—	—	Yes	—	Yes	Yes	No
California	No	Yes	No	Yes	Yes	Yes	Yes	—	Yes
Colorado	No	No	No	No	Yes	No	No	No	No
Illinois	—	Yes	—	—	Yes	Yes	—	Yes	No
Kansas	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes	—
Maine	Yes	Yes	—	—	Yes	—	Yes	No	No
Michigan	Yes	Yes	—	—	No	Yes	Yes	No	Yes
Nevada	Yes	No	No	Yes	Yes	No	No	No	No
New Jersey	Yes	Yes	Yes	Yes	Yes	—	Dev	Yes	Yes
New York	Yes	Yes	Yes	Yes	Yes	—	Yes	Yes	Yes
Oregon	Yes	Yes	No	Yes	Yes	No	No	No	No
South Carolina	No	Yes	No	No	Yes	Yes	—	Yes	Dev
Texas	—	—	—	—	Yes	Yes	—	Yes	Yes
Vermont	Yes	Yes	Yes	Yes	Yes	—	Dev	No	No
Virginia	Yes	Yes	Yes	Yes	Yes	—	Dev	No	Dev
Washington	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes

[a] Includes Hauling Permits, Vehicle Registrations, Material Registrations, Bills of Lading, Placard Attachment, and Vehicle Standards.
[b] Includes Pesticides, Toxic Substances, and other Chemicals.

Source: EPA Contract No. 68–01–0762

cause death, disease, behavorial abnormalities, cancer, genetic mutations, physiological malfunction . . . or physical deformations on such organisms or their offspring." Section 115 directs EPA to locate and contract for "the removal and appropriate disposal of [in-place toxic pollutant] materials from critical port and harbor areas." The potential for increased pressure for land disposal of such toxic pollutants is evident.

Title III of the FWPCA contains four provisions authorizing control over toxic pollutants discharged into water *from point sources*. The importance of the FWPCA's distinction between point and nonpoint sources cannot be overemphasized from a hazardous waste management viewpoint, for discharges from point sources *only* are subject to the Act's regulatory controls.* Because the Act defines "point source" as "any discernible, confined and discrete conveyance," and offers as examples such things as pipes, ditches, tunnels, etc.,[70] Congress seems *not* to have intended that land disposal facilities are to be included within the point source definition. In fact the opposite appears to be true, for Sec. 304(e) of the Act requires EPA to publish nonregulatory "processes, procedures, and methods to control pollution resulting from . . . *the disposal of pollutants in wells or in subsurface excavations*" [71] (emphasis supplied).

Since the types of pollutant discharges normally associated with improperly managed hazardous waste disposal facilities are runoff into navigable waters and migration into ground water supplies, it seems safe to conclude that, unless a disposal facility discharges toxic pollutants into a waterway through a "discernible, discrete conveyance" such as an outfall pipe, it will be exempt from the Act's proscriptions.

Hazardous waste *treatment* facilities, however, should not escape the Act's reach. Any toxic wastes produced by such facilities and not treated on-site must be stored and/or eventually transported in some manner, and any container or confined means of conveyance for such waste, by definition in Sec. 502(13) of the Act, qualifies as a potential "point source" of water pollution discharge.

The first of Title III's proscriptions against toxic pollutant discharges may be found in Sec. 301(f), which prohibits the "discharge of any radiological, chemical, or biological warfare agent, or high level radioactive waste into the navigable waters." The other statutory authorities which impact on the disposal of these wastes were discussed above.

* Sec. 301(a) established FWPCA's board prohibitions against the "discharge of any pollutant." Sec. 502(12) defines "discharge of pollutants" as ". . . any addition of any pollutant to navigable waters *from any point source* . . ." (emphasis supplied).

Sec. 306 is the second reference to hazardous wastes. It requires EPA to publish national standards of performance for new point source categories reflecting "the greatest degree of effluent reduction achievable . . . , including where practicable, a standard permitting no discharge of pollutants." [72] The Act singles out such new source categories as the organic and inorganic chemicals industries, well known generators of toxic wastes. These standards, which must take into account the cost of standards' achievement and "any non-water quality environmental impact and energy requirements,"* must be published not later than January, 1974. Hazardous waste generators and treatment facilities which otherwise qualify as "new" clearly are comprehended in Sec. 306(a)(3), which defines new sources as "any building, structure, facility, or installation from which there is or may be the discharge of pollutants." This adds to the general qualification of such facilities as point sources, discussed above.

The third FWPCA provision affecting toxic pollutants is *Sec. 307* which requires EPA to identify and publish effluent standards for a list of toxic pollutants or combinations of such pollutants. Standards are to be set "at that level which the Administrator determines provides an ample margin of safety," and are to take effect not later than one year after promulgation.[73] Even though Congress' standard-setting process mandate to EPA under this section was limited to consideration of toxicity data alone,** as previously discussed other factors likely will be considered to produce judicially enforceable standards, given recent air pollution-related court decisions.†

Sec. 311 is designed to protect the navigable waters and adjoining shorelines of the United States and the waters of the contiguous zone from "hazardous substance" discharges. EPA must designate as hazardous substances those elements and compounds "which,

* Sec. 306(b)(1)(B). The FWPCA's legislative history, however, makes it clear that individual new sources, rather than EPA, will determine which technologies will be used to achieve Sec. 306(b)'s performance standards. Conference Report No. 92-1465, FWPCA Amendments of 1972, 92nd Congress Sess. (Sept. 28, 1972, at p. 128).

** Sec. 307 (a) (2) requires the Administrator of EPA to publish proposed toxic effluent standards (or prohibitions) which shall take into account (1) the toxicity of the pollutant, (2) its persistence, (3) degradability, (4) the usual or potential presence of the affected organism in any waters, (5) the importance of the affected organisms, and (6) the nature and extent of the effect of the toxic pollutant on such organisms . . ." No other considerations are mentioned in Sec. 307 or its legislative history.

† *See e.g., Kennecott Copper v. EPA*, U.S. App. D.C. ___F. 2d___, 3 ERC 1682 (Feb. 8, 1972) (EPA must explain in detail the basis for sulfur oxide standards promulgated under informal rulemaking); *Annaconda Company v. Ruckelshaus*, D.C. Colorado, ___F, Suppl.___, 4 ERC 1817 (Dec. 19, 1972) (EPA must hold adjudicatory [formal rulemaking] hearing before promulgating State sulfur oxide emission standard that applies to a single company); *International Harvester Co. v. Ruckelshaus*, U.S. App. D.C., ___F. 2d___, 4 ERC 2041 (Feb. 10, 1973) (failure to support auto emission standard with "reasoned presentation" requires EPA to reconsider automakers' showing that technology is not available to achieve 1975 standards).

when discharged in any quantity, . . . present an imminent and substantial danger to the public health and substantial danger to the public welfare, including but not limited to fish, shellfish, wildlife, shorelines, and beaches." Designed primarily to control spills from vessels and onshore or offshore facilities, Sec. 311 requires violators to pay a fixed cost for each hazardous substance unit unlawfully discharged,* with the President alone authorized to permit certain of these discharges when he has determined them "not to be harmful." [75] Coastal zone-area hazardous waste generation and treatment facilities thus would clearly be subject to Sec. 311 controls and penalties.

Closing the Circle on Hazardous Wastes

The foregoing discussed the many Federal and State statutes which have impact on hazardous waste management activities. The more detailed analyses of the Clean Air Act and the Federal Water Pollution Act illustrate that, while the toxic effluents of hazardous waste generation and treatment facilities will probably come under control, land-based facilities for open storage or disposal of such hazardous wastes remain essentially unregulated. As standards and regulations published under recent environmental legislation begin to close off water as a disposal medium, and as enforcement of air pollution standards take shape, hazardous waste generators can be expected to turn increasingly to land disposal as a means of solving their hazardous waste problems. The need for regulations for land disposal will become more acute.

The concluding part of this section discusses the persons and activities which would be subject to control under a comprehensive hazardous waste regulatory program; reviews in some detail the type of hazardous waste standards considered to be appropriate under such a program; and identifies and evaluates the strengths and weaknesses of three alternative regulatory program enforcement strategies.

Persons/Activities Subject to Regulatory Controls. In order to forestall the type of environmental degradation likely to occur from the uncontrolled use of the land as an ultimate sink for the Nation's ever-increasing supply of hazardous wastes, the focus of any hazardous waste regulatory program must first be on land *disposal* activities and those who provide and utilize land disposal services. Persons subject to disposal controls should include all generators of hazardous waste who opt for on-site disposal, as well as those

* Sec. 311 (b) (2) (B) (IV) requires EPA to establish units of measurement based on usual trade practices, with penalties for each unlawful unit discharged ranging from $100 to $1000 per unit.

persons who receive wastes off-site for disposal. Long-term sealed *storage* should be considered "disposal" for the enforcement purposes of such regulation. The location of disposal sites should be permanently recorded in the appropriate office of legal jurisdiction.

The next priority activity for regulation is *treatment,* since utilization of the appropriate hazardous waste treatment processes can often detoxify such wastes and render them safe for unregulated disposal in sanitary landfill facilities or at a minimum reduce the need for long-term "perpetual care" and environmental risks inherent therein. EPA has proposed a regulatory program for hazardous waste streams which incorporates treatment in order to lessen the demand on land disposal alternatives. All persons who treat the same hazardous wastes, either on-site (generators) or off-site (by contract service organizations), should be subject to the same treatment standards. Processes for recovery of recyclable constituents from hazardous wastes should be controlled adequately by treatment regulations, for the technologies employed are often the same.

Other hazardous waste management activities which should be subjected to improved controls are hazardous waste *transport* and *handling.* As indicated earlier, the Department of Transportation administers a number of Federal statutes designed to control the transportation of hazardous materials in interstate commerce. These statutes should be amended by DOT where necessary to ensure that hazardous wastes are properly marked, containerized and transported (to authorized disposal sites). The packaging and labeling provisions of all other Federal statutes which have a potential impact on hazardous wastes should be reviewed by EPA and amended where necessary to ensure their applicability to such wastes.

It should be noted that control of toxic *materials* before they become toxic *wastes* could greatly reduce the size of the overall hazardous waste management problem. The proposed Toxic Substances Control Act, now pending before Congress, would provide for regulatory controls over toxic substances before they become wastes. The proposed legislation authorizes (1) testing of chemical substances to determine their effects on health or the environment, and (2) restrictions on use or distribution of such chemicals when warranted. Such restrictions may include labeling of toxic substances as to appropriate use, distribution, handling, or disposal, and limitations on particular uses, including a total ban. This "front end" approach to toxic substances problems should dovetail neatly with a hazardous waste regulatory program.

Types of Hazardous Waste Standards. The foundation of any regulatory program, of course, is the body of standards the program establishes and enforces. The Clean Air Act and FWPCA regulatory programs progressed from ambient air and water quality standards to specific pollutant emission and discharge standards, as practical experience with each statute's enforcement revealed the necessity for such an evolution.[76]

Because of the nature of the discharges associated with improperly managed hazardous waste, *two* types of standards are likely to be necessary in order to satisfactorily regulate hazardous waste treatment and disposal:

Type of Standard	*Treatment*	*Disposal*
1. Performance	Restrictions on quantity and quality of waste discharged from the treatment process.	Restrictions on performance of disposal site — e.g., amount, quality of leachate allowed.
2. Process	Specification of treatment procedures or process conditions to be followed—e.g., incineration of certain wastes.	Minimum site design and operating conditions—e.g., hydraulic connections are not allowed.

The *performance standards* correspond directly to the emission/discharge standards of the Clean Air Act and the FWPCA and would be designed to prevent hazardous pollutant discharges from treatment and disposal facilities from reaching air and surface waters in excess of acceptable air and water limits. A major advantage of this type of standard is the ability to use health and environmental effects data and criteria already developed by EPA's Office of Air and Water Programs and Office of Research and Monitoring.

Process standards would be designed to ensure that certain treatment technologies and minimum design and operating conditions are employed. These standards assume double importance because of the uncertainty surrounding the FWPCA's standard-setting authority regarding discharges into ambient groundwaters,* and the Act's clear lack of authority to regulate diffuse discharges from nonpoint sources such as land disposal sites.

* Although the broad definition given to "navigable waters" in Sec. 502(7) of FWPCA arguably includes groundwaters, the restriction of the Act's regulatory provisions to discharges of pollutants from point sources virtually eliminates the most common source of groundwater pollution, i.e., runoff or leachate from nonpoint sources. See text accompanying footnote on p.152.

Process (design and operating) standards, therefore, which are intended to establish controls at the hazardous waste sources, would be an important part of any regulatory program.

Strategies for Hazardous Waste Regulation. Hazardous wastes can be regulated by three distinct control strategies: (1) Federal only, (2) State only, and (3) Federal-State partnership. Each of these alternatives is examined below.

1. *Federal only.* This type of control strategy requires the exclusive jurisdiction of the Federal Government (Federal preemption) over all management activities for hazardous waste. The most obvious advantages include national uniformity of standards; elimination of State pollution havens for industries controlling a significant portion of such a State's economy; and uniform administration and enforcement. The major disadvantages of this control strategy are the difficulty in proving conclusively that the hazards of human health and the environment justify total Federal involvement; the prohibitive costs and administrative burdens involved in maintaining a nationwide Federal monitoring and enforcement program; and the total disincentive for State involvement in what is essentially a State problem. The only comparable Federal program is that involving the exclusive disposal of high-level radioactive wastes by the Atomic Energy Commission.

2. *State only.* Under this control strategy, the Federal Government would establish "recommended guidelines" for hazardous waste treatment and disposal which the States could adopt as a minimum, modify in either direction (more or less stringent) in response to local needs and pressure groups, or ignore altogether. These Federal guidelines could be used to recommend what would otherwise be process and performance standards under a Federal regulatory program, as well as the minimum efforts the Federal Government believes are necessary to administer and enforce an effective State control program. States could finance activities themselves; alternatively the Federal Government could offer technical and financial support to assist States in program development and enforcement.

The major advantage of this approach is in its low level of Federal involvement and correspondingly low Federal budget requirements. Another advantage includes enhanced ability to tailor solutions to particular problems which may be essentially local in character.

The disadvantages of the State-only approach to hazardous waste control include its total dependence on the States for voluntary guidelines adoption and enforcement; nonavailability of Federal "back-up" enforcement authority; its potential for extreme nonuniformity between the individual States adopting control programs; and the much greater period of time needed to enact and fully implement such a control system nationwide.

3. *Federal-State Partnership.* This is the control strategy which had been adopted by the Nation's major environmental pollution control statutes. The Federal Government would establish minimum Federal hazardous waste treatment and disposal standards; all States would be required to adopt these as minimum State standards within a specified time period. The States would bear the responsibility for establishing and administering EPA-approved State control programs. Functions could include operating a Statewide hazardous waste facility permit program; maintaining an inspection and monitoring force; enforcing statutory sanctions against violators; and filing program progress reports with EPA. As in the Federal air and water pollution control programs, States with approved implementation programs would be eligible for Federal financial assistance. For those States which fail to submit approved programs, or which do not enforce the Federal-State standards, back-up Federal enforcement powers could be exercised to ensure uniform compliance, or Federal program grant funds could be withheld. Provision could also be made for a Federally-administered control and enforcement program for certain hazardous wastes determined to pose extremely severe hazards, an approach already utilized by the TEC for high-level radioactive wastes.

The major advantage of this control strategy stems from the well-established legislative precedents discussed earlier; land pollution control regulations employing this strategy would be capable of being fully integrated with existing controls over air and water pollution. Other advantages include utilizing the Federal Government's superior resources to set standards and design programs, while retaining the concept of State responsibility for what are traditionally recognized as State problems; minimal Federal involvement once the States' implementation programs are fully underway; uniform *minimum* national hazardous waste standards, with States retaining the power to set more stringent standards if local conditions so dictate; and reasonable assurance that the standards will be enforced ultimately by someone.

The disadvantages of the combined Federal-State hazardous waste control strategy involve its potential for delay in final implementation, since States can be expected to demonstrate varying degrees of readiness and interest in gearing up State machinery to run their respective control programs. The major drawback to this approach, however, involves its potential for large expenditures of Federal manpower and funds, should the States choose to sit back and "let the Feds do it"; even worse is the possibility that Federal standards for hazardous waste control will be completely unenforced in laggard States simply because of the lack of adequate funds to exercise the "reserve" powers mentioned above. This problem seems capable of resolution, however, if adequate incentives for State action are made available (Federal grants or technical assistance) and if significant disincentives are applied (withholding air and water program grant funds; characterizing the State as "irresponsible", etc.).

Summary

The earlier parts of this section described the gap in Federal and State hazardous waste management legislation, a gap in which if not filled soon by Congress' adoption of a comprehensive hazardous waste control strategy could well result in irreparable damage to the health and environment of the Nation's citizens. The most viable hazardous waste control strategy would consist of a Federal-State regulatory partnership, in which the Federal Government would bear the responsibility for setting process and performance standards applicable to all hazardous waste treatment and disposal activities, while qualified State governments would be responsible for administering federally-approved control programs and enforcing the Federal standards.

Section 4

ISSUES OF IMPLEMENTATION

The previous section has spelled out the need for a regulatory program. A hazardous waste regulatory program does not directly create a national disposal site "system" as envisioned in Section 212 of the Resource Recovery Act of 1970. However, such a system would be ineffective unless its use is mandated via regulations. Even with total governmental subsidy of its construction and operation, such a system would not be assured of receiving all hazardous wastes. Therefore, a regulatory program is needed in any case.

EPA believes that private industry will respond to a regulatory program, but there are a number of questions relating to that response. Furthermore, several options are available to the Government to modify a purely private sector system to circumvent these questions if need be.

In this section, estimates are developed of a hazardous waste management system required to implement a hazardous waste regulatory program, the cost of such a system, and possible variations of the system. Issues related to cost distribution, private sector response and the role of Government are discussed thereafter.

Hazardous Waste Management System

A hazardous waste management program should result in creation of a "system" with certain characteristics:

- Adequate treatment and disposal capacity nationwide,
- Lowest cost to society consistent with public health and environmental protection,
- Equitable and efficient distribution of cost to those responsible for waste generation, and
- Conservation of natural resources achieved by recovery and recycling of wastes instead of their destruction.

This system should combine on-site (point of generation) treatment of some wastes, off-site (central facility) treatment for hazard elimination and recovery, and secure land disposal of residues which remain hazardous after treatment.

Scenario. Estimates of total required treatment and disposal capacity, and the mix of on-site and off-site capacity, are keyed to hazardous waste source quantities, types, and geographical distribution; the degree of regulation and enforcement; and the timing of regulatory and enforcement implementation. The hazardous waste management scenario developed below represents, in EPA's judgment, a system with the aforementioned characteristics. It is based on the best available source data and technology assessments,[6,7,9,10] discussions with major waste generators and disposal firms, and consideration of the following criteria: earth sciences (geology, hydrology, soils, climatology), transportation economics and risk, ecology, human environment, demography, resources utilization, and public acceptance. The scenario assumes complete regulation, treatment and disposal of all non-radioactive hazardous wastes (as defined in Appendix B), and anticipates issuance of regulations and vigorous enforcement of them at the earliest practicable time period.

The scenario which follows and the cost estimates derived from the scenario should be viewed with caution. Given any reasonable degree of dependence on private market choices on the part of waste generators and waste treatment/disposal firms, the actual implementation of a hazardous waste management program in the United States is not likely to follow predictable, orderly lines. Numerous interactive factors are likely to influence the shape and the cost of the system as it evolves—including such factors as the impact of air and water effluent regulations on waste stream volume and composition, the impact of uneven response to regulatory pressures from region to region, changes in technology, shifting locational patterns, and the like. What follows, therefore, should be considered as one of many possible permutations of the system. Nonetheless, the scenario does represent EPA's current best judgment of a reasonable, environmentally adequate hazardous waste management system.

As noted previously, approximately 10 million tons (9 million metric tons) of non-radioactive hazardous wastes are generated per year. Of these, about 60 percent by weight are organics, 40 percent are inorganics; about 90 percent of wastes are aqueous in form.

Economic analyses indicate that on-site treatment is generally justified only for dilute aqueous toxic metal wastes and only where the generation rate is high (see Appendix E). Based on analyses of source data, it is estimated that about 15 percent of the total wastes (1.5 million tons or 1.36 million metric tons) are in the dilute aqueous toxic metal category and would be pre-treated by generators on-site. Since on-site facilities are anticipated to be small in scale compared to off-site facilities, about 50 on-site facilities each capable of handling approximately 30,000 tons (27,000 metric tons) per year would be economically justified. About one-third (0.5 million tons or 0.45 million metric tons) of pre-treated wastes would require further processing at off-site facilities.

In this postulated scenario, therefore, most of the wastes (8.5 million tons or 7.7 million metric tons plus pre-treatment residues) would be transported to off-site facilities for treatment/disposal. The size and location of treatment plants is likely to correspond to patterns of waste generation: larger facilities would be located in major industrial regions, smaller facilities elsewhere. Background studies have identified the location of industrial waste production centers and designs and unit costs of small, medium and large size processing facilities (see Appendix F).

A reasonable prediction is that five large facilities, each capable of handling approximately 1.3 million tons (1.2 million metric tons) per year, would be created to serve five major industrial regions in the U.S. and 15 medium size treatment plants each processing approximately 160,000 tons (145 metric tons) would be built elsewhere to provide reasonable access from other waste generation points. Such an array of treatment plants, taken in conjunction with existing privately owned facilities, is capable of processing all the non-radioactive hazardous waste generated in the U.S. at present with a 25 percent margin for future growth in waste volume.

Processing reduces aqueous waste volume by about 50 percent and usually results in the elimination of hazard (detoxification, neutralization, decontamination, etc.). If the appropriate treatment processes are used, most processing residues will be harmless and disposal in ordinary municipal landfills will be possible. A small portion (5 percent—225,000 tons or 204,000 metric tons) of residues containing toxic metals would require disposal in special, secure landfills.

Under the assumption that maximum treatment for hazard elimination and volume reduction of extremely hazardous waste is carried out, no more than five (and possibly fewer) large scale secure landfills would be required. Facilities would transport their toxic metal residues to such land disposal sites rather than operating secure landfills of their own given the scarcity of naturally secure sites, the difficulty in gaining public acceptance of such sites, the additional expense of artificially securing sites, and the relatively low costs of long-haul transport.

Costs. Based on the above scenario, cost estimates have been prepared for on- and off-site treatment facilities, secure disposal, and waste transportation. The actual values used for estimation purposes are shown in Table 4.1; more detail is presented in Appendix F. Estimates are based on comprehensive engineering cost studies. Each regional processing facility was assumed to provide a complete range of treatment processes capable of handling all types of hazardous wastes, and therefore, each is much more costly than existing private facilities which are more specialized.

Based on these estimates, the development of this version of a national hazardous waste management system would require investments in new facilities of approximately $940 million. Average annual operating expenditures (including capital recovery, operating costs, and interest) of about $620 million would be required to sustain the program. In addition, administrative expenses of about $20 million annually for Federal and State regulatory programs would be necessary.

For this scenario, system costs fall into five broad categories: (1) on-site treatment (about 6 percent of total costs on an annualized basis), (2) transportation of wastes to off-site treatment facilities (16 percent), (3) off-site treatment (74 percent), (4)

TABLE 4.1
COST ASPECTS OF EPA SCENARIO OF A NATIONAL HAZARDOUS WASTE MANAGEMENT SYSTEM
(Million $)

	Cost per unit				
	Capital needed	Annual operating*	Number needed	Total capital required	Total annual cost *
On-site facilities	1.4	.73	51	71	37
Off-site					
Treatment (large)	86.0	57.1	5	430	286
Treatment (medium)	24.1	12.5	15	362	188
Secure disposal	2.5	1.2	5	13	6
Transport	63.0 †	$11/ton	‡	63	99
				939**	616

* Includes capital recovery in 10 years and interest at 7 percent.
† Capital required based on new rail rolling stock.
‡ Transport required for 9.0 million tons (8.25 million metric tons) of waste; average distance from generator to treatment facility is 150 miles.
**Approximately $25 million has already been invested in current private sector off-site treatment facilities.

secure disposal (1 percent), and (5) program administration (3 percent). The largest element of cost is off-site treatment. Treatment followed by land disposal of residues is not necessarily more expensive than direct disposal of untreated wastes in secure landfills (see below). Treatment before disposal would buy greater long-range protection of public health and the environment.

Variations. While the above scenario is reasonable and would satisfy requirements for environmentally adequate hazardous waste management, it is not presented as a hard-and-fast specification of what a national system should look like. There is no single "optimum" system given uncertainties of hazardous waste generator response to air, water and hazardous waste regulations, of future directions in production and waste processing technology, of timing and level of enforcement, of public reaction to site selection decisions, etc. However, some comments can be made about variations in the system scenario presented above.

It is unlikely that more large scale and fewer medium scale processing facilities would be constructed unless specifically mandated. The higher initial capital investment of large scale processing facilities is warranted only where large market potential exists, i.e., in the major industrial regions. Furthermore, at present, addition of only two more large scale facilities (over the five in the scenario) would provide sufficient capacity to treat all nonradioactive hazardous wastes. Stated another way, two more large scale facilities could handle all the wastes for which 15 medium sized facilities were postulated in the scenario. Resulting increased costs of transportation from generators to these larger treatment facilities (because average transport distances would increase) would offset cost reductions due to better economies of scale (see Figures 4.1 and 4.2). The net result would be a significant loss in convenience and increase in transportation risks for a fairly insignificant saving in capital cost and a higher operating cost.

Construction of a larger number of medium or small scale plants (and consequently fewer large scale plants) tends to drive capital costs up sharply (see Figure 4.1). Total system operating costs also rise because transportation cost savings are not sufficient to offset lost economies of scale (see Figure 4.2). Transportation risk would decline due to shorter haul distances, but inspection and enforcement costs would increase due to the larger number of plants requiring surveillance. As discussed below, however, a private sector system may consist of more smaller plants and thus may result in higher total costs.

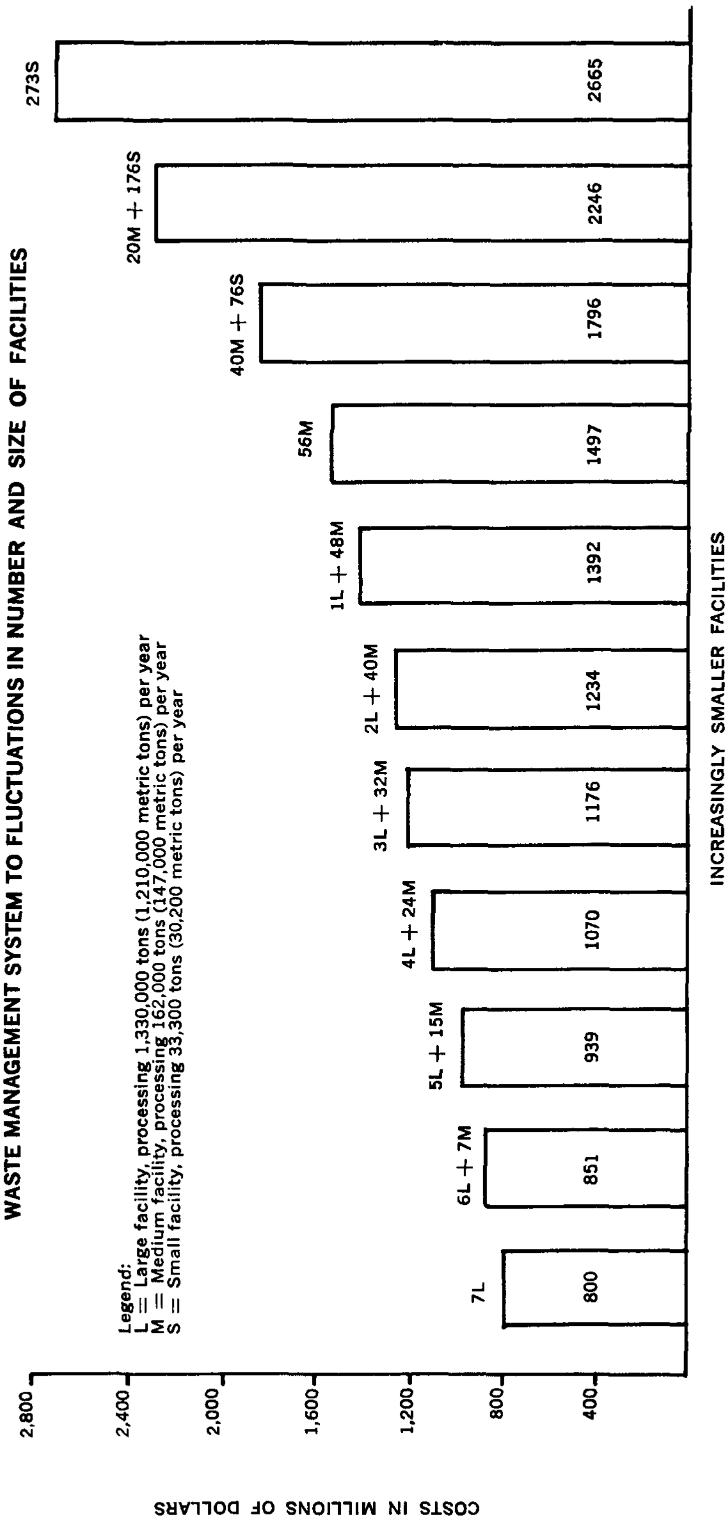
There could be fewer disposal sites than assumed in the scenario if land availability/suitability and public acceptance problems arise. This outcome is likely if, for instance, only arid lands with no hydrologic connection to surface and ground waters are deemed acceptable as disposal sites, i.e., if disposal siting standards are extremely strict. Transportation costs would increase somewhat, but not linearly with distance. For example, rail transport costs are estimated at $35 per ton for 1,000 miles and $49 per ton for 2,000 miles distance. Transport risks would be greater, but disposal risks and enforcement costs would decline because fewer sites would be easier to monitor.

On the other hand, as a policy decision, the Government could allow significantly more disposal relative to processing. Many more, or at least much larger, disposal sites would be required in this case since, for instance, approximately a forty-fold increase in tonnage going to secure disposal sites would result if processing were by-passed altogether. The total system capital cost would be reduced since treatment represents a large capital expense (see Table 4.2). If disposal siting standards were very strict such that arid lands in the western States were the only acceptable sites, transportation costs would increase substantially because of the large increase in tonnage transported over longer distances. In fact, in this case, annual operating costs for this "disposal only" option exceed annual costs for the treatment/disposal system scenario discussed above.

Aside from economic considerations, what is more important in EPA's judgment is that the "disposal only" option could significantly increase public health and environmental risk, perhaps to an unacceptable level, given the long-term hazard of many toxic

FIGURE 4.1

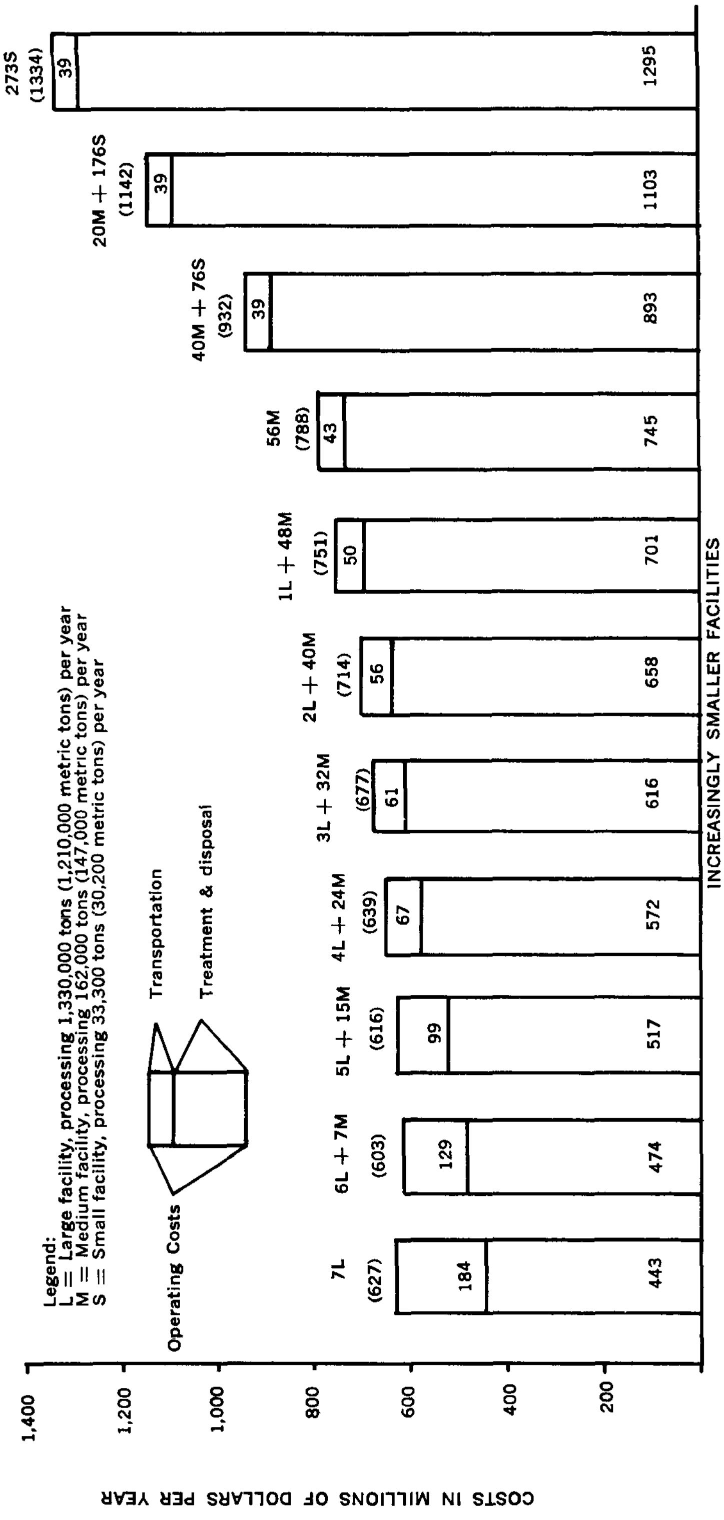
FIXED CAPITAL COST SENSITIVITY OF A NATIONAL HAZARDOUS WASTE MANAGEMENT SYSTEM TO FLUCTUATIONS IN NUMBER AND SIZE OF FACILITIES



Note: Each configuration includes $71 million for on-site facilities; $13 million for secure land disposal; and from $41 to $114 million for new transportation equipment (based on average distance and estimated turn-around time).

FIGURE 4.2

OPERATING COST SENSITIVITY OF A NATIONAL HAZARDOUS WASTE MANAGEMENT SYSTEM TO FLUCTUATIONS IN NUMBER AND SIZE OF FACILITIES



Note: Each configuration includes $37 million in annual costs for on-site facilities and $6 million for secure land disposal.

TABLE 4.2
COMPARATIVE COSTS OF REGIONAL HAZARDOUS WASTE TREATMENT VS. DISPOSAL ONLY

	Regional treatment*	Disposal only †
(A) TREATMENT		
Hazardous waste treatment on-site, million tons	1.0	0
Hazardous waste treatment off-site, million tons	9.0	0
Treatment cost, fixed capital	$863 million	$ 0
Treatment cost, annual operating	$511 million/yr	$ 0 /yr
(B) DISPOSAL		
Secured land disposal, million tons	.225	10.0
Disposal cost, fixed capital	$13 million	$386 million
Disposal cost, annual operating	$6 million/yr	$257 million/yr
(C) TRANSPORTATION		
Transportation cost, fixed capital	$63 million	$252 million
Transportation cost, annual freight charge	$99 million/yr	$490 million/yr
Total fixed capital	$939 million	$638 million
Total annual costs	$616 million/yr	$747 million/yr

*As described on p. 39.

† Cost data for this option are based on two large secure land disposal sites—both in the western States. 10×10^6 tons per year of untreated hazardous waste is shipped directly to these sites.

The average distance between waste generators and secure land disposal sites is 2,000 miles.

NOTE: Secure land disposal costs are based on preliminary OSWMP estimates

The indicated transportation costs represent a minimum, because bulk shipment via railroad in 10,000 gal. tank cars was assumed for all cases.

substances, particularly if such substances are not converted to relatively insoluble forms prior to disposal. Moreover, transport risks would undoubtedly increase.

Cost Distribution to Users

Given a hazardous waste regulatory program, and the need for a hazardous waste management system to implement such a program, the fundamental issue is who should pay for creation and operation of the system. The two basic options are:

- Hazardous waste generators pay, or
- Society pays.

This issue hinges on the principle of equity of cost distribution, and on an assessment of ability to pay.

Equity of Cost Distribution. The usual aim in environmental legislation is to cause costs to be *internalized.* Costs are internalized when the generator pays the full costs of actions for which he is responsible. In turn, he can either absorb the costs ("taxing" his stockholders) or pass on the costs in the price of his products/ services ("taxing" those who benefit from the use of his products/

services). Only those who have a direct relationship to the generator are required to pay for the generator's actions.

A publicly funded incentive distributes the costs inequitably by assigning costs incurred by a special group to the population at large—not in proportion to the use of waste-related products by that public but in proportion to income levels.

The regulatory approach internalizes the costs of hazardous waste management. It forces generators to pay for such management while it ensures that the practices are environmentally acceptable. The only portion of the program's cost that must be borne by the public as a whole is the small portion devoted to the actual preparation of the regulations and their enforcement, and the management of wastes generated by the Federal Government.

The regulatory strategy, therefore, results in equitable cost distribution. Only those institutions and individuals who benefit directly from the activities of hazardous materials production and consumption are required to bear the costs of waste disposal, and the costs borne are directly proportional to the amount and type of wastes generated.

Most hazardous wastes are generated by industry and the Federal Government rather than municipalities. The strategy adopted for dealing with air and water pollution from industrial sources has been the regulatory strategy. Thus, this approach is consistent with the total thrust of environmental control efforts. A subsidy strategy to industry would represent a new departure.

It could be argued that if some sector of the economy is unable to bear the costs of a regulatory program by nature of its institutional situation, fiscal support of that sector may be justified to enable it to meet the regulatory requirements without serious harm to the economy or interruption of vital services.

However, generators of most hazardous wastes are either private, profit-making industrial organizations or governmental entities. Private corporations are capable of accepting the additional costs of environmental control that may be imposed by a hazardous waste regulatory program. They have the option of passing on such costs to their customers or absorbing the costs by reducing the return on investment to their owners. Government agencies have the usual capabilities available to such entities to seek budgetary support for legally mandated activities. Neither sector would fall into the "hardship" category if it had to pay the full costs of its waste generation.

Analysis of Cost Impacts. No detailed study has yet been performed to determine the cost burden of specific hazardous waste regulations relative to the sales, costs, investment levels, and employment levels of the industrial sectors which would be affected. Rough aggregate calculations have been done for the following sectors: chemicals, chemical products, petroleum refining, rubber production, ordnance, primary metal industries, pulp and paper, and mining. These aggregate calculations indicate that the costs of hazardous waste management would be roughly equivalent to 1 percent of the value of product shipments. Of course, the corresponding percentage for some disaggregate categories may turn out to be much higher.

A general principle which recurs throughout this report is that the costs of hazardous waste management should be internalized in the prices of the commodities whose production has generated the hazardous waste. This principle is consistent with the President's environmental messages. The results of preliminary studies do not indicate that hazardous waste management costs would cause drastic industrial disruption. EPA is giving a high priority to detailed analysis of the costs and cost impacts of hazardous waste management.

Benefit-Cost Analysis. Given the cost and price impacts which hazardous waste regulations could impose, careful consideration is being given to benefit-cost analyses. Hazardous waste regulations may be said to be "benefit determined" in the sense that they cover situations in which the benefit to society in the form of a hazard reduction is shown to be large. Thus, the first type of benefit-cost comparison is that involved in placing a hazardous waste on the regulatory list, as a result of demonstrating that some regulatory option is preferable to the status quo. The second, and equally important, type of benefit-cost analysis is the comparison of all the options, each one involving different levels of benefit and cost. One may speak rhetorically about rendering a substance completely harmless, but in fact that is only one option. That option may have to be chosen in cases for which the associated benefits are large In other cases, cost-benefit comparisons may support a different process alternative. To the extent possible, EPA tends to use cost-benefit analyses to explore the full range of technological options for each hazardous waste.

Role of the Private Sector

As discussed earlier, processing economics appear to favor off-site treatment/disposal in most instances. A private hazardous waste services industry exists which already offers off-site treatment/disposal services, but currently available off-site capacity is clearly insufficient to handle the entire tonnage of hazardous waste materials that would ultimately be brought under control. In light of this, it is obvious that off-site capacity must be significantly expanded if environmentally adequate hazardous waste treatment and disposal is to take place.

EPA believes that private industry should and will respond to the proposed regulatory program, but there are a number of questions related to the nature of that response:

- Will adequate capacity be forthcoming?
- Can environmentally sound operations be assured?
- Can reasonable user charges be assured?
- Can the private sector provide long-term care of treatment, storage and disposal sites?

These questions are taken up in what follows. The general issue of the government's role is discussed separately.

Capacity Creation. The central question is whether or not a regulatory program will result in sufficient investment in new capacity by the private sector. Basic issues of capacity creation include the availability of investment capital and the willingness to invest capital in view of the risks involved, i.e., the factors influencing investment. Related to the broad question of private investment are other issues dealing with the availability of trained manpower and the availability of suitable land for facility siting. These issues are discussed below.

Private Investment Sources. Under a regulatory program capital is likely to be available from at least three private sources: hazardous waste service firms, generators, and solid waste management conglomerates.

In the initial stages of a regulatory program (e.g., the first year), no major new investments are likely to be required. Existing service firms will respond to new demand by increasing their throughput. Soon, however, demand is likely to outstrip supply of such services in a climate of vigorous enforcement, and new investments will be required.

The ability of present service firms to provide internal capital and to attract outside investments has been limited because of generally poor earning records in the past. This situation results from the absence of regulatory and economic incentives for generators to utilize their services. Increased regulatory activity, however, should improve the fiscal abilities of these companies over time by increasing their rate of facility utilization and (under conditions of strong demand) by increasing the prices they can command for services. In fact, the rates of utilization and earnings rates of most of these firms have been increasing as industries respond to water pollution control regulation. This will improve the ability of this industry to retain earnings for investment and also its ability to attract outside capital. This source of capital, however, is expected to be limited in the early years of a regulatory program.

Two other sectors of the economy, however, are expected to become more involved in capacity creation and to attract substantial investment capital to the field.

Major generators of hazardous wastes—e.g., the chemicals and metals industries—will have a strong interest in assuring that off-site facilities will be made available for their use because off-site handling will be more economical. These financially strong organizations—some of which already operate treatment/disposal systems for their own use—may enter the service field by acquisition or other routes or may underwrite the activities of others by provision of long-term contracts or use of other devices.

During the past five years large and financially strong private solid waste management "conglomerates" have emerged, offering management services for nonhazardous wastes. These organizations have established strong lines of credit at attractive interest rates. Although most of these firms lack the technical know-how to manage hazardous wastes today, they are likely to acquire know-how and to enter this field under the stimulus of a regulatory program in a logical extension of their current services to industry. Some have already established a position in this field by the acquisition of hazardous waste management subsidiaries.

From the above, it is concluded that sources of private capital to build new capacity potentially is available. This does not mean, however, that it will be forthcoming.

Factors Influencing Investment. Private sector investment in hazardous waste management facilities entails significant risks, and these risks generally increase as the size of the proposed facilities increase. There are uncertainties regarding waste generator response to air, water and hazardous waste regulations; generators may install new production processes which result in fewer wastes or wastes with different characteristics; generators may elect to treat wastes on-site; future breakthroughs in processing technology may prematurely obsolete the proposed plant; further environmental standards may impact on the proposed plant; economic forces may result in geographical shifts in waste generator plant locations; and there are uncertainties relating to the future activities of competitors.

These factors may (1) deter investment of any kind, (2) lead to investment in treatment processes only for wastes generated in high volume or for wastes which are relatively inexpensive to treat, (3) lead to investment in smaller, less risky facilities which are more expensive to operate on a unit cost basis, or (4) lead to processing plant siting only in locations where major industrial waste sources are assured.

In view of these uncertainties, the degree and timing of private capital investment in new capacity will depend heavily on the quantity of waste regulated and the level and timing of enforcement. Also, the ultimate private sector network which results may include many smaller facilities and therefore represent, in the aggregate, a more expensive system than the scenario depicted.

Quantity of Waste Regulated. Regulations which affect a significant tonnage of waste will spur investments more than regulatory activity aimed at a small proportion of the Nation's hazardous wastes.

A regulatory program is most likely to be aimed at the control of specific waste compounds rather than the waste streams in which the compounds occur. Justification of regulatory action must be tied to health and environmental effects, which can be established most conclusively by studying the effects associated with specific chemicals.

Unlike the regulator, the generator must dispose of and the service firm must manage waste streams which may contain a number of hazardous substances in mixture.

Background studies performed for EPA have provided useful data on the composition of waste streams. These data indicate that regulatory control of a limited number of the most hazardous substances could result in the treatment/disposal of a substantial proportion of the total waste stream. Several hazardous substances are usually present in chemical and metallurgical hazardous waste discharges, and selective treatment of one or two components of the waste does not appear to be economical. Not all hazardous substances must be regulated immediately, in other words, to cause most wastes to be treated/disposed of under controlled conditions.

This suggests that regulatory activity can move ahead based on regulation of groups of a few substances at a time—in a manner similar to that adopted to implement the hazardous effluent provisions of air and water mandates—while still ensuring that substantial quantities of hazardous wastes will be treated.

Level and Timing of Enforcement. The key to capacity creation appears to be vigorous enforcement of regulations to force the use of existing capacity by generators. Enforcement of regulations wherever possible will impose costs on generators which may exceed costs of treatment/disposal in new facilities more appropriately located relative to regions of waste generation and will build pressure for rapid investments. Such enforcement will also create incentives for new ventures by ensuring markets for services.

The regulatory approach most likely to result in private investment would be one which encouraged incremental additions to capacity by mandating their use as soon as they are created. The approach should be tied to a terminal date by which all regulated wastes must be managed as mandated.

The "incremental" approach has the drawback that it initially impacts more heavily on generators which are near existing treatment/disposal facilities. Thus, other generators which have no such services available to them have a potential advantage. However, the approach protects the public and the environment as soon as possible wherever it *is* possible.

The above approach is contrasted to a strategy where regulations are announced at one point in time but provide some "reasonable" time for creation of capacity nationwide by generators or their agents before any enforcement takes place. This latter approach would provide fewer incentives for investment in increments of capacity and, by "bunching" capital demand in the "reasonable" waiting period, would also tax the fiscal capacities of industry to respond. If no capacity is created by the deadline period, appeals to delay enforcement would be likely.

In summary, timely investment of private capital to create capacity is anticipated if the regulatory program affects a substantial portion of the Nation's hazardous wastes and if a vigorous but incremental enforcement approach over time is adopted. These conditions will assure an investor that the facilities he builds will be used, but will avoid excessive demands on available capital at the outset of the program.

Government activity in some fiscal role can potentially speed up timing of investments by private service firms where high investment risks must be overcome; this is discussed below in more detail. A governmental fiscal role, however, is also subject to a number of constraints.

Availability of Manpower. The technology of hazardous waste processing is capital intensive and a significant increase in capacity will require only a limited expansion of labor.

Much of the expertise required for the expansion of the hazardous waste management industry already exists in the metallurgical and petrochemical industries and the engineering and construction firms that service these.

Similarly, the skills required at local, State, and Federal levels of government are essentially the same as those necessary for the operation of air and water pollution control programs.

Capacity creation is not thought to be constrained by a shortage of manpower under any reasonable implementation time-frame, for example five years.

Availability of Land. Land suitable for the siting and operation of hazardous waste treatment facilities has been identified as part of EPA's background studies (Appendix F). There is no shortage of appropriate land for treatment facilities in the vicinity or immediately within the Nation's major hazardous waste generation regions.

Land used for disposal by burial should be "secure," i.e., it should be sealed off from underlying ground waters by impervious materials. Ideally, such sites should be located in areas where the cumulative precipitation is less than the evapotranspiration so that rain cannot accumulate in the "sealed" landfills. Such conditions prevail only in the western desert regions.

Ideal conditions for disposal sites need not be present if the secure landfill is located near hazardous waste treatment plants where water accumulations can be removed from the disposal site and treated in the plant. Sites with appropriate geological features are available in areas other than the western States.

Probably the most important potential problem associated with the land-use aspect of hazardous waste management is that of public resistance to the location of such facilities in their communities. Although EPA's public attitudes survey indicates public support of central treatment and disposal of hazardous wastes under controlled conditions, it is not at all certain that the public will express the same attitude when faced with an actual siting decision.

While siting problems are anticipated by EPA, there are indications that such constraints can be overcome. The private hazardous waste management industry and AEC contractors have been able to obtain sites in most cases. Treatment and ultimate disposal facilities will represent employment in areas which are of necessity low in population density (if sites are chosen to minimize safety hazard) and in need of industrial development.

Environmentally Sound Operation. The private sector, following a profit motive, has incentives to run only as good a hazardous waste management operation as it takes to obtain and keep business and to comply with governmental regulations. Customers may demand more stringent operations to benefit their image or for legal and other reasons, but the private sector hardly can be expected to go all out to maximize the environmental soundness of its operations.

It is anticipated, however, that environmentally acceptable operation of private facilities can be assured by appropriate governmental and citizen activities. The basic standards and regulations governing hazardous waste management operations must not only be environmentally adequate in themselves but also must provide for effective administrative and legal sanctions against potential offenders. Adoption of appropriate criteria for facility licensing can filter out candidates who do not possess resources sufficient to provide sound facility construction, operation, maintenance and surveillance. Vigorous inspection and enforcement by government, with the attendant threat of licensing suspension or revocation actions, can assure sound operations over time.

If the regulatory legislation contains provisions for citizen suits, which is likely given the trend of recent environmental legislation, citizens may bring legal pressure to bear on both the government and private industry to force compliance with existing Federal, State, and local regulations.

Reasonable User Charges. The issue of whether or not a private market situation will result in reasonable user charges is dependent upon quite complex interactions involving facility scale and location, risk, competition and transportation rates.

As has been discussed, significant economies of scale are possible in the processing of toxic waste. To the extent that such economies are realized and passed on to users of processing facilities, user charges will be "reasonable." To the extent economies of scale are not achieved or that economies are achieved but savings are absorbed as monopoly profits, charges for the use of processing facilities may be unreasonable.

Unfettered operation of the market system may not result in the construction of plants of optimal size initially. Due to a desire to minimize or avoid the risk factors discussed earlier, there may be a tendency to build a number of small, high unit cost plants where one large economical plant would suffice. On the other hand, although small plants may result in higher unit costs of operation, their lower investment requirements may spur competition and reduce opportunities for monopoly profits. Thus, in the scenario described earlier in which large plants with large investment costs and low operating costs predominate, there is potential for monopolistic behavior and, consequently, unreasonably high profits and user charges. The possibility of monopoly is increased by the relatively few companies nationally which have the resources and technical qualifications to enter this field.

Factors other than the risks associated with large investments tend to counter monopolistic behavior, however. Given the relatively low cost of transport in comparison to processing costs and the relative insensitivity of transport charges to increase in haul distances, trade-offs between transportation charges and at-the-plant user charges should result in some overlap among service regions and thus should stimulate competition. A second potential limitation on unreasonably high user charges is the ability of waste generators to operate their own waste processing plants if projected processing charges appear excessive. Also, the Federal Government could use the processing and disposal of its own wastes, which would be sent to the low bidder on a service contract, as leverage to keep charges reasonable. The revenue and cost information which the Federal Government typically requires as part of the procurement process should itself provide a means of tracking the reasonableness of processing charges on a continuing basis.

Although it is difficult to predict how these opposing forces will operate under a free market situation, there is no indication at this time of the need for additional government control (beyond that derived from Federal Government procurement) of hazardous waste service charges. Competition exists now in the general absence of specific hazardous waste regulations, and additional competition is anticipated if new regulatory legislation is passed. Overall system costs, even if many small plants are the rule (see Figure 4.2), should not be so unreasonably high that they merit Federal intervention.

Long Term Care. As indicated earlier, some non-radioactive hazardous wastes cannot be converted to an innocuous form with presently available technology, and some residues from waste/treatment processes may still be hazardous. Such materials require special storage or disposal and must be controlled for long periods of time.

In some respects such materials resemble long-lived radioactive wastes; both are toxic and retain essentially forever the potential for public health and environmental insult. There are differences, however: non-radioactive hazardous wastes normally do not generate heat nor do they require radiation shielding.

Until recently, essentially all radioactive wastes were generated by the Federal Government itself as a result of the nuclear weapon, naval propulsion and other programs. This established a precedent for Federal control of radioactive wastes which has carried over to the commercial nuclear power generation and fuel reprocessing industry. No such precedent exists for non-radioactive hazardous wastes from industrial sources.

The AEC has established the policy of "engineered storage" for long-lived radioactive wastes because of difficulties in assuring long-term control of these wastes if they are disposed of on or under the land or in the ocean. Designs of such storage facilities will vary with the nature of the wastes involved, but the general principle is to provide long-lived containerized or otherwise separated, easily retrievable storage units. These units generally will require heat removal, radiation shielding, surveillance, and security.

The storage/disposal facility requirements for non-radioactive hazardous wastes are anticipated to be less severe than for radioactive wastes since heat removal and shielding are not required, but many of the problems remain. Such facilities should be "secure" in the sense that there are no hydrologic connections to surface and ground waters. Long term physical security and surveillance of storage and land disposal sites are required. Also, there should be contingency plans for sealing off the facilities or removing the wastes if hydrologic connections are subsequently established by earthquakes or other phenomena.

From an institutional viewpoint, the private sector is not well suited for a role in which longevity is a major factor. Private enterprises may abandon storage and disposal sites due to changes in ownership, better investment opportunities, bankruptcy, or other factors. If sites are abandoned, serious questions of legal liability could arise. This issue led the State of Oregon, in its recently adopted hazardous waste disposal program, to require that all privately operated hazardous waste disposal sites must be deeded to the State and that a performance bond be posted as conditions for obtaining a license to operate such sites.

Traditionally, waste generators pay a one-time fee for waste disposal. If this concept were carried over to hazardous waste disposal, private operators of disposal sites would have to charge fees sufficient to cover expenses of site security and surveillance for a long, but indeterminant, time period. Another option would be to consider hazardous waste disposal as a form of long term storage. Generators would then pay "rent" in perpetuity. Given uncertainties of future market conditions, inflation, etc., neither of these options would have appeal to either the waste generator or disposer, nor would the options preclude legal problems if either party were to file for bankruptcy.

There are grounds, therefore, to consider the role of the private sector in hazardous waste storage and disposal as fundamentally different in character from its role in hazardous waste treatment. EPA believes that, given a regulatory stimulus, the private sector can and will provide necessary facilities for hazardous waste treatment which are operated in an environmentally sound manner with reasonable user charges. However, the issue of long term care of privately owned and operated hazardous waste storage and disposal sites poses significant problems not easily resolved. Some form of Federal or State intervention may be required. These options are discussed in what follows.

Role of Government

The implementation strategy described above assigns to government the limited role of promulgating and enforcing regulations. In view of the potential problems discussed above, however, a more extensive government role may be justified under certain circumstances. Options for more extensive government intervention which might be determined to be required include:

- Performance bonding
- Financial Assistance
- Economic Regulation
- Use of Government land
- Government ownership and operation of facilities

These options are discussed below.

Performance Bonding. The government could require a performance bond of private firms as a condition of issuing a license/permit for operation of hazardous waste treatment or disposal facilities. The bond would help to ensure environmentally sound operation of processing facilities and long term care of disposal sites. This system is used, for example, by the State of Oregon for all hazardous waste disposal sites and by the State of Kentucky for radioactive waste disposal sites.

Performance bonding presents a paradox, however. The bond must be large to be effective, but the larger the bond, the more likely it is to inhibit investment. Used unwisely, the performance bond concept could result in no private sector facilities, or in a monopolistic situation with a very limited number of large firms in the business.

EPA believes that a performance bonding system, wisely applied, could be beneficial in establishing the fiscal soundness of applicant firms (if fiscally weak, the firm could not be bonded). The bonding system could be adopted within a regulatory program in the licensing procedures with very little, if any, cost to government.

Financial Assistance. Some form of fiscal support of capacity creation may be justified if the private sector fails to invest the capital needed for new facilities. If that happens, environmental damage will continue and the potential hazard to public health and safety will increase.

Current indications are that private capital will begin to flow under a regulatory approach. It may be argued, however, that capital flow may be slow and uneven on a national basis. In some areas capacity may be created, in others not. Investors might play a wait-and-see game because of potential risks, etc. In such a situation governmental fiscal support might speed up implementation or ensure that all generators have facilities available for use.

A governmental fiscal role in capacity creation is not warranted —on equity and other grounds discussed earlier—unless capital flow is actually very slow and adverse environmental effects are resulting from the investment rate. If support is warranted, various types of support are likely to have different effects.

Indirect Support. A loan guarantee program, probably the most indirect form of fiscal support available, may be more effective in speeding up implementation than direct, massive support of construction. If capital is available (in the absolute sense), but is not obtainable practically because of risks associated with investment in such ventures, a loan guarantee program can induce investments by removing or cushioning the risk. At the same time, such a program would be less vulnerable to budgetary constraints and less likely to lead to a slowdown in private investments than direct support.

A loan program, while preferable to direct support on equity grounds, would depend on budget availability and would act to slow down implementation.

Other indirect approaches, such as investment incentives based on investment credits or rapid write-off provisions, are comparable to a loan program in that they have a budgetary impact (by affecting government tax income) but would be less likely to slow down implementation because no *positive* budgetary action would be required to implement such support.

These approaches, much like direct support, would be difficult to justify for a part of the nation only—that is, to support building of capacity only in areas where private action is not resulting in construction.

Direct Fiscal Support. Such support might conceivably take the form of construction grants or direct government construction of facilities. Such action can ensure capacity creation. Programs of this type, even in the environmental area, have often failed to meet originally established timing goals because of budgetary constraints and other factors. To the extent that local government involvement is sought in a Federal program, a further potential for delay is introduced. The availability of public funding also has a stifling effect on private initiative. It is economically unwise to invest private money if public funds are available.

This approach, while it can guarantee that ultimately capacity will be built, does not promise to be effective in speeding up the implementation rate. Where the objective is to provide capacities in regions where investments are lagging, direct fiscal support is extremely difficult to justify for only one area to the exclusion of others.

The advisability of government construction support may also be viewed in the content of government competition with private industry. A fledgling service industry exists. These firms would object to the entrance of the government into the field as a competitor (direct government construction) or government action to set up competition (grant programs). To the extent that private resources have already been committed to this field, great care would have to be exercised to avoid driving existing firms out of the market with the resultant economic loss to the Nation. It may be necessary on equity grounds to compensate existing companies for their investments—by outright purchase or post-factum grant support. Determining the value of these companies' investments may be difficult in the face of probably increasing demand for their services.

Economic Regulation. The Congress could mandate a hazardous waste management system patterned after the public utility concept. In this type of system, government could set up franchises with territorial limits and regulate user charge rates.

The hazardous waste management field shares many characteristics of currently regulated industries in any case. There are public service aspects, relatively few plants are required per region, and these facilities are capital-intensive. Further, there is potential for natural geographic monopolies because barriers to a second entrant in a given region are high.

Government control of plant siting, scale and rates could lessen the potential for environmental impacts and provide greater incentive for private sector investment since there would be no threat of competition and consequently less risk of failure. On the other hand, some companies may not enter the field on a utility basis because of potentially lower rate of return on investment. Further, lack of competition could inhibit new technology development.

Economic restrictions can be applied directly via a governmental franchise board or commission or indirectly via administrative actions such as licensing and permitting. Government control of franchising shifts the burden of market determination and related business decisions into the public sector, which is not inherently better equipped to make such decisions than private industry.

Licensing and permitting of treatment/disposal facilities appears to be a better approach for the exercise of economic control since they can be used to influence (rather than dictate) plant locations, sizes and rates. Some form of government control over such facilities is desirable in any case to ensure their proper operation.

Administrative rather than direct regulatory actions would be less costly to government. New legislation would be required to authorize either direct or indirect economic sanctions.

Use of Federal/State Land. Although suitable sites for hazardous waste processing facilities are generally available to the private sector, adverse public reaction to such sites may preclude their use. If this occurs, it may be necessary to make public land available to private firms. These lands could be leased or made available free of charge depending on circumstances. As noted earlier, the State of Oregon requires that hazardous waste facilities be located on State-owned land; other States may elect to follow this precedent.

There are compelling reasons for the use of public lands for hazardous waste disposal sites. The need for long term care of disposal sites and the potential problems associated with private sector ownership of such sites have been discussed previously. Publicly owned disposal sites could be leased to private operating firms, but legal title would remain with the governmental body.

Use of Federal or State lands for privately operated hazardous waste processing or disposal sites is one means of reducing the capital cost and risk of private sector investment while reducing environmental risk as well. Conceivably, some form of government influence over user charges could be a condition of the lease, in order to avoid potential monopolistic behavior on the part of the lessee. The initial cost to government of these measures would be minimal; however, government maintenance of disposal sites may be necessary if the lessee defaults.

Government Ownership and Operation of Facilities. This option provides maximum control over the economic and environmental aspects of hazardous waste management. The issues of potential monopolistic behavior (and consequent unreasonably high user charges) and long term care of hazardous waste disposal sites could be circumvented. Environmentally sound construction and operation of processing and disposal facilities could be assured, but would be dependent on public budgets for implementation. Resource recovery could be mandated.

Public land suitable for hazardous waste processing and disposal sites exists in the western States but may not be available in the eastern States. If government ownership and operation of facilities is mandated by Congress, the government may have to purchase private lands for this purpose. The potential for adverse public reaction would be present.

The government does operate some hazardous waste treatment, storage, and disposal facilities now, but these are generally limited to handling wastes generated by government agencies. There is no obvious advantage of government operation of facilities intended to treat and dispose of hazardous waste originating in the private sector. In fact, under government operation, there could be a tendency for selection of more expensive technology than is actually required and less incentive for efficient, low cost operation.

This option represents, of course, the maximum cost to government of those considered here. If use of government owned and operated facilities is mandated, capital and operating costs of processing plants can be recovered through user charges. Some subsidy of disposal operations is likely, however, since security and surveillance of disposal sites is required in perpetuity.

Summary

Given a hazardous waste regulatory program, issues of implementation of a non-radioactive hazardous waste management system hinge on the incentives for and inherent problems of private sector response, and the appropriate role of government. Past experience with air and water environmental regulation over industrial processes indicates that the private sector will invest in pollution control facilities if regulations are vigorously enforced. EPA anticipates that similar private sector investment in hazardous waste processing facilities will be forthcoming if a regulatory program is legislated and enforced. There is no real need for massive government intervention or investment in such facilities. The makeup of a hazardous waste processing system fully prescribed by free market forces is difficult to predict, however.

The storage and ultimate disposal of hazardous residues presents a significant problem of basically different character since the private sector is not well suited to a role of long term care of disposal sites.

Options for government action to mitigate this problem include (1) making new or existing Federal- and State-owned and operated disposal sites available to private industry, (2) leasing Federal or State lands to the private sector, subject to a performance bonding system, and (3) private ownership and operation of storage and disposal sites subject to strict Federal or State controls.

The optimum control scheme will depend upon the nature of the regulatory program, but Federal or State control of storage and land disposal sites is clearly implied in any case.

On balance, EPA believes that, with the possible exception noted above, the preferred approach to system implementation is to allow the private sector system to evolve under appropriate regulatory controls, to monitor closely this evolution, and to take remedial governmental action if necessary in the future.

Section 5

FINDINGS AND RECOMMENDATIONS

Findings

Under the authority of Section 212 of the Solid Waste Disposal Act (as amended), the Environmental Protection Agency has carried out a study of the hazardous waste management practices of industrial, government, and other institutions in the United States. The key findings of this study are presented in this section.

... *Current management practices have adverse effects.* Hazardous waste management practices in the United States are generally inadequate. With some exceptions, wastes are disposed of on the land without adequate controls and safeguards. This situation results in actual and potential damage to the environment and endangers public health and safety.

... *Causes are economics and absence of legislative control.* The causes of inadequate hazardous waste management are two-fold. First, costs of treating such wastes for hazard elimination and of disposing of them in a controlled manner are high. Second, legislation which mandates adequate treatment and disposal of such wastes is absent or limited in scope. The consequence is that generators of hazardous wastes can use low-cost but environmentally unacceptable methods of handling these residues.

... *Authorities for radioactive wastes are adequate.* Under the authority of The Atomic Energy Act of 1954, as amended, the management of radioactive wastes is placed under control. While the actual implementation of the act may be improved, the legislative tools for accomplishing such an end exist.

... *Air and water pollution control authorities are adequate.* The Clean Air Act of 1970 and The Federal Water Pollution Control Act of 1972 provide the necessary authorities for the regulation of the emission of hazardous compounds and materials to the air and to surface waters from point sources.

. . . *Legislative controls over hazardous waste land disposal are inadequate.* The legislative authorities available for the control of hazardous waste deposition on land—and the consequent migration of such wastes into the air and water media from land—are not sufficient to result in properly controlled disposal. This legislative gap literally invites the use of land as the ultimate sink for materials removed from air and water.

. . . *Land protection regulation is needed.* In order to close the last available uncontrolled sink for the dumping of hazardous waste materials and thus to safeguard the public and the environment, it is necessary to place legislative control over the disposal of hazardous wastes. In the absence of such control, cost considerations and the competitive posture of most generators of waste will continue to result in dangerous and harmful practices with both short range and long term adverse consequences.

. . . *The technology for hazardous waste management generally is adequate.* A wide array of treatment and disposal options is available for management of most hazardous wastes. The technology is in use today, but the use is not widespread because of economic barriers in the absence of legislation. Transfer and adaptation of existing technology to hazardous waste management may be necessary in some cases. Treatment technology for some hazardous wastes is not available (e.g., arsenic trioxide, arsenities and arsenates of copper, lead, sodium, zinc, and potassium). Additional research and development is required as the national program evolves. However, safe and controlled storage of such wastes is possible now until treatment and disposal technology is developed.

. . . *A private hazardous waste management industry exists.* A small service industry has emerged in the last decade offering waste treatment services to industry and other institutions. This industry is operating below capacity because its services are high in cost relative to other disposal options open to generators. The industry is judged capable of expanding over time to accept most of the Nation's hazardous wastes.

. . . *Hazardous waste management system costs are significant.* Estimates made by EPA indicate that investments of about $940 million and operating costs (including capital recovery) of about $620 million per year will be required to implement a nationwide hazardous waste management system which combines on-site (point of generation) treatment of some wastes, off-site (central facility) treatment for hazard elimination and recovery, and secure land disposal of residues which remain hazardous after treatment.

... *The private sector appears capable of responding to a regulatory program.* Indications are that private capital will be available for the creation of capacity and that generators of waste will be able to bear the costs of management under new and more exacting rules. Private sector response to a demand created by a regulatory program cannot be well defined, however, and the characteristics of the resulting hazardous waste management system cannot be definitely prescribed. Uncertainties inherent in a private sector system include

- availability of capital for facility construction and operation in a timely manner for all regions of the Nation,
- adequacy of facility locations relative to waste generators such as to minimize environmental hazard and maximize use,
- reasonableness of facility use charges in relation to cost of services,
- long term care of hazardous waste storage and disposal facilities, i.e., that such facilities will be adequately secured for the life of the waste, irrespective of economic pressures on private site operators.

... *Several alternatives for government action are available if such actions are subsequently determined to be required.* If capital flow were very slow and adverse environmental effects were resulting from the investment rate, financial assistance would be possible in indirect forms such as loans, loan guarantees or investment credits, or direct forms such as construction grants. If facility location or user charge problems arose, the Government could impose a franchise system with territorial limits and user charge rate controls. Long term care of hazardous waste storage and disposal facilities could be assured by mandating use of Federal or State land for such facilities.

Recommendations

Based on the above, it is recommended that . . .

Congress enact National legislation mandating safe and environmentally sound hazardous waste management.

The Environmental Protection Agency has proposed such legislation to Congress, embodying the conclusions of studies carried out under Section 212 of the Solid Waste Disposal Act.

The proposed Hazardous Waste Management Act of 1973 calls for authority to regulate the treatment and disposal of hazardous wastes. A copy of the proposed Act is presented in Appendix G. The key provisions of the proposed legislation are the following:

(1) Authority to designate hazardous wastes by EPA.
(2) Authority to regulate treatment/disposal of selected waste categories by the Federal Government at the discretion of the Administrator of the Environmental Protection Agency.
(3) Authority for the setting of Federal treatment/disposal standards for designated waste categories.
(4) State implementation of the regulatory program subject to Federal standards in most cases.
(5) Authority for coordination and conduct of research, surveys, development and public education.

EPA believes that no further Government intervention is appropriate at this time. It is EPA's intention to carry on its studies and analyses; and EPA may make further recommendations based on these continuing analyses.

REFERENCES

1. Swift, W. H., Feasibility study for development of a system of hazardous waste national disposal sites. v. 1. U.S. Environmental Protection Agency Contract No. 68-06-0762. [Richland, Wash.], Battelle Memorial Institute, Mar. 1, 1973. p. III-63. (Unpublished data.)
2. U.S. Congress. Marine Protection, Research, and Sanctuaries Act of 1972. Public Law 92-532, 92d Cong., H.R. 9727. Washington, Oct. 23, 1972. 12 p.
3. Smith, D. D., and R. P. Brown. Ocean disposal of barge-delivered liquid and solid wastes from U.S. coastal cities. Washington, U.S. Government Printing Office, 1971, p. 10.
4. Swift, Feasibility study for development of a system of hazardous waste national disposal sites, v. 2, p. IV-D-1 to IV-D-42.
5. Ottinger, R. S. Recommended methods of reduction, neutralization, recovery, or disposal of hazardous waste. v. 1. U.S. Environmental Protection Agency Contract No. 68-03-0089. [Redondo Beach, Calif.], TRW Systems Group, Inc., June 1973. (Unpublished data.)
6. Booz, Allen Applied Research, Inc. A study of hazardous waste materials, hazardous effects and disposal methods. U.S. Environmental Protection Agency Contract No. 68-03-0032. [Bethesda, Md.], June 30, 1972. 3 v.
7. Ottinger, Recommended methods of reduction, neutralization, recovery, or disposal of hazardous waste, 15 v.
8. Lackey, L. L., S. R. Steward, and T. O. Jacobs. Public attitudes toward hazardous waste disposal facilities. U.S. Environmental Protection Agency Contract No. 68-03-0156. [Columbus, Ga.], Human Resources Research Organization, Feb. 1973. (Unpublished data.)
9. Funkhouser, J. T. Alternatives to the management of hazardous wastes at national disposal sites. U.S. Environmental Protection Agency Contract No. 68-01-0556. [Cambridge, Mass.], Arthur D. Little, Inc., May 1973. 2 v. (Unpublished data.)
10. Swift, Feasibility study for development of a system of hazardous waste national disposal sites, 2 v.

11. Christensen, H. E., *ed.* Toxic substances annual list, 1971. National Institute for Occupational Safety and Health Publication DHEW (HSM) 72-10260. Washington, U.S. Government Printing Office, 1971. 512 p.
12. Council on Environmental Quality. Toxic substances. Washington, U.S. Government Printing Office, Apr. 1971. p. 2.
13. U.S. Congress. Proposed Hazardous Waste Management Act of 1973. 93d Cong., 1st sess., U.S. Senate, S.1086, introduced Mar. 6, 1973, U.S. House of Representatives, H.R.4873, introduced Feb. 27, 1973. Washington, U.S. Environmental Protection Agency, Aug. 1970, p. 107.
14. Swift, Feasibility study for the development of a system of hazardous waste national disposal sites, v. 1, p. III-2.
15. Environmental quality; the first annual report of the Council on Environmental Quality together with the President's message to Congress. Washington, U.S. Government Printing Office, Aug. 1970. p. 107.
16. Council on Environmental Quality, Toxic substances, p. 2.
17. Council on Environmental Quality, Toxic substances, p. 2.
18. Mahler, H. R., and E. H. Cordes. Biological chemistry. New York, Harper & Row, 1966. 872 p.
19. Council on Environmental Quality, Toxic substances, p. 2.
20. Johnson, O., Pesticides '72, *Chemical Week*, 110(25):33-48, 53-66, June 21, 1972; 111(4):17-46, July 26, 1972.
21. Jansen, L. L., Estimate of container number by size, type, and formulations involved. *In* Proceedings; National Working Conference on Pesticides, U.S. Department of Agriculture, Beltsville, Md., June 30-July 1, 1970. p. 27-30. [Distributed by National Technical Information Service, Springfield, Va. as PB 197 145.]
22. Jansen, Estimate of container number by size, type, and formulations, involved, p. 27-28.
23. Ottinger, Recommended methods of reduction, neutralization, recovery, or disposal of hazardous wastes, v. 14, p. 199.
24. Swift, Feasibility study for development of a system of hazardous waste national disposal sites, v. 1, p. V-1 to V-218.
25. Booz, Allen Applied Research, Inc., A study of hazardous waste materials, hazardous effects and disposal methods, v. 1, p. A-II-1 to A-II-22.
26. Proceedings; American Hospital Association [Institute on Hospital Solid Waste Management], Chicago, May 18-20, 1972. v. 3.
27. Personal communication. Chemical Biological Warfare Office, U.S. Army Material Command, Washington.
28. Council on Environmental Quality, Toxic substances, p. 8.
29. U.S. Tariff Commission. Synthetic organic chemicals; United States production and sales, [1954-1970]. Washington, U.S. Government Printing Office. [15 v.]
30. Commissioner Ray stresses positive understanding. *Hanford News (Hanford, Wash.)*, p. 5, Oct. 27, 1972.
31. Ottinger, Recommended methods of reduction, neutralization, recovery, or disposal of hazardous waste, v. 2, p. 5.
32. Council on Environmental Quality, Toxic substances, p. 2.
33. Council on Environmental Quality, Toxic substances, p. 9.
34. Council on Environmental Quality, Toxic substances, p. 9.
35. Committee on Toxicology. Toxicological reports. Washington, National Academy of Sciences-National Research Council, 1971. 219 p.

36. Funkhouser, Alternatives to the management of hazardous wastes at national disposal sites, v. 1, p. 3.5.1.
37. Swift, Feasibility study for a system of hazardous waste national disposal sites, v. 1, p. IV–11.
38. Swift, Feasibility study for a system of hazardous waste national disposal sites, v. 1, p. IV–12.
39. Swift, Feasibility study for a system of hazardous waste national disposal sites, v. 1, p. IV–12.
40. Swift, Feasibility study for a system of hazardous waste national disposal sites, v. 1, p. I–41–42.
41. Ottinger, Recommended methods of reduction, neutralization, recovery or disposal of hazardous waste, v. 1. p. 135–298.
42. Funkhouser, Alternatives to the management of hazardous wastes at national disposal sites, v. 1. p. 3.24–3.33.
43. U.S. Congress. Resource Recovery Act of 1970. Public Law 91–512, 91st Cong., H.R. 11833. Washington, Oct. 26, 1970. [9 p.]
44. U.S. Congress. Atomic Energy Act of 1954. Public Law 703, 83d Cong., H.R. 9757. Washington, Aug. 30, 1954. [41 p.]
45. United States Code, Title 18, chap. 39. Explosives and other dangerous articles. sec. 831–5. Washington, U.S. Government Printing Office, 1971.
46. U.S. Congress. [Federal Railroad Safety and Hazardous Materials Control Act]. Title III—Hazardous materials control. sec. 302. Public Law 91–458, 91st Cong., S. 1933. Washington, Oct. 16, 1970. [p. 7.] (United States Code, Title 46, sec. 1761–2.)
47. U.S. Congress. Federal Aviation Act of 1958. Title VI—Safety regulations of civil aeronautics. sec. 601. Public Law 85–726, 85th Cong., S. 3880. Washington, Aug. 23, 1958. [p. 45–46.] (United States Code, Title 49, sec. 1421.)
48. United States Code, Title 46, chap. 7. Carriage of explosives or dangerous substances. sec. 170. Washington, U.S. Government Printing Office, 1971.
49. U.S. Congress. Federal Hazardous Substances Labeling Act. sec. 17. Public Law 86–613, 86th Cong., S. 1283. Washington, July 12, 1960. [p. 9.]. (United States Code, Title 15, sec. 1261 et seq.)
50. U.S. Congress. Federal Environmental Pesticide Control Act of 1972. sec. 19. Disposal and transportation. Public Law 92–516, 92d Cong., H.R. 10729. Washington, Oct. 21, 1972. p. 23–24.
51. Federal Environmental Pesticide Control Act, sec. 19(a), p. 23–24.
52. U.S. Congress. Marine Protection, Research, and Sanctuaries Act of 1972. Title I—Ocean dumping. sec. 101. Public Law 92–532, 92d Cong., H.R. 9727. Washington, Oct. 23, 1972. p. 2.
53. Marine Protection, Research, and Sanctuaries Act. Title I—Ocean dumping, sec. 102(a), p. 3.
54. U.S. Congress. Clean Air Amendments of 1970. Public Law 91–604, 91st Cong., H.R. 17255. Washington, Dec. 31, 1970. [32 p.] (United States Code, Title 42, sec. 1857 et seq.)
55. U.S. Congress. Federal Water Pollution Control Act Amendments of 1972. Public Law 92–500, 92d Cong., S. 2770. Washington, Oct. 18, 1972. 89 p.
56. U.S. Congress. Poison Prevention Packaging Act of 1970. sec. 3. Public Law 91–601, 91st Cong., S. 2162. Washington, Dec. 30, 1970. [p. 1–2.]
57. U.S. Congress. [Crab Orchard National Wildlife Refuge, Ill. Legislative

Jurisdiction by U.S. Adjustment Act.] Public Law 90-339, 90th Cong., S.2452. Washington, June 15, 1968. [p. 1.] (United States Code, Title 21, sec. 1857 et seq.)

58. U.S. Congress. National Environmental Policy Act of 1969. Public Law 91-190, 91st Cong., S.1075. Washington, Jan. 1, 1970. [5 p.] (United States Code, Title 42, sec. 4321 et seq.)

59. U.S. Congress. [Armed Forces Appropriation Authorization, 1970 Act.] Public Law 91-121, 91st Cong., 2546. Washington, Nov. 19, 1969. [10 p.]; [Armed Forces Appropriation Authorization, 1971.] Public Law 91-441, 91st Cong., H.R.17123. Washington, Oct. 7, 1970. [10 p.] (United States Code, Title 50, sec. 1511-18.)

60. U.S. Congress. Coastal Zone Management Act of 1972. Public Law 92-583, 92d Cong., S. 3507. Washington, Oct. 27, 1972. 10 p.

61. U.S. Congress. Occupational Safety and Health Act of 1970. sec. 6(b) (5). Public Law 91-596, 91st Cong., S. 2193. Washington, Dec. 29, 1970. [p. 16.]

62. Swift, Feasibility study for a system of hazardous waste national disposal sites, v. 1, p. IX32-IX33.

63. U.S. Congress. Clean Air Amendments of 1970. Public Law 91-604, 91st Cong., H.R. 17255. Washington, Dec. 31, 1970 [32 p.] (United States Code, Title 42, sec. 1857 et seq.)

64. U.S. Congress. Federal Water Pollution Control Act Amendments of 1972. Public Law 92-500, 92d Cong., S. 2770. Washington, Oct. 18, 1972. 89 p.

65. Reitze, A. W., Jr. Tax incentives don't stop pollution. *In Environmental Law.* Spring of 1972 ed. Washington, North American International.

66. Kennecott Copper v. EPA, U.S. App. D.C., ___F. 2nd ___, 3 ERC 1682, (Feb. 18, 1972).

67. Anaconda Company v. Ruckelshaus, D.C. Colorado, ___ F. Supp. ___, 4 ERC 1817, (Dec. 19, 1972).

68. International Harvester Company v. Ruckelshaus, U.S. App. D.C., ___ F. 2nd ___, 4 ERC 2041, (Feb. 10, 1973).

69. U.S. Congress. Poison Prevention Packaging Act of 1970. sec. 112(b) (1)(B). Public Law 91-601, 91st Cong., S. 2162. Washington, Dec. 30, 1970. [p. 16.]

70. U.S. Congress. Federal Water Pollution Control Act Amendments of 1972. Title V—General provisions. sec. 502(14). Public Law 92-500, 91st Cong., S. 2770. Washington, Oct. 18, 1972. p. 72.

71. Federal Water Pollution Control Act, Title III—Standards and Enforcement, sec. 304(c) (2) (D), Public Law 92-500, p. 36-37.

72. Federal Water Pollution Control Act, Title III, sec. 306(a) (1), p. 39-40.

73. Federal Water Pollution Control Act, Title III, sec. 307(a) (4) (6), p. 42.

74. Federal Water Pollution Control Act. Title III, sec. 311(b) (2) (A), p. 48.

75. Federal Water Pollution Control Act, Title III, sec. 311(b) (3), p. 49.

76. Reitze, Tax incentives don't stop pollution, *Environmental Law,* chap. 3d and 4g.

Appendix A

IMPACT OF IMPROPER HAZARDOUS WASTE MANAGEMENT ON THE ENVIRONMENT

Improper management of hazardous materials or wastes is manifested in numerous ways. Waste discharges into surface waters can decimate aquatic plant and animal life. Contamination of land and/or ground waters can result from improper storage and handling techniques, accidents in transport, or indiscriminate disposal acts.

A few of the many cases documented by EPA which illustrate hazardous waste mismanagement are listed categorically in the following compilation. Most of these examples are water pollution related because there have been more monitoring and enforcement actions in this area.

Category I—Waste Discharge Hazards

(1) *Improper Arsenic Disposal.* Because of the lack of treatment and recovery facilities, arsenic waste materials generally are disposed of by burial. This practice presents future hazards since the material is not rendered harmless.

As a result of arsenic burial 30 years ago on agricultural land in Perham, Minnesota, several people who recently consumed water contaminated by the deposit were hospitalized. The water came from a well that was drilled near this 30 year old deposit of arsenic material. Attempts to correct this contamination problem are now being studied. Proposed methods of approach include (1) excavating the deposit and contaminated soil and diluting it by spreading it on adjacent unused farm land, (2) covering the deposit site with a bituminous or concrete apron to prevent ground water leaching, (3) covering the deposit temporarily and excavating the soil for use as ballast in future highway construction in the area, and (4) excavating the material and placing it in a registered landfill. None of these methods is particularly acceptable since the hazardous property of the material is not permanently eradicated, but they at least protect the public health and safety in the short run.

(2) *Lead Waste Hazard.* Annual production of organic lead waste from manufacturing processes for alkyl lead in the San Francisco Bay area amounts to 50 (45.4 metric) tons. This waste was previously disposed of in ponds at one industrial waste disposal site. Attempts to process this waste for recovery resulted in alkyl lead intoxication of plant employees, in one instance, and in another instance not only were plant employees affected, but also

employees of firms in the surrounding area were exposed to an airborne alkyl lead vapor hazard. Toll collectors on a bridge along the truck route to the plant became ill from escaping vapors from transport trucks. Currently, the manufacturers which generate organic lead waste are storing this material in holding basins at the plants pending development of an acceptable recovery process.

(3) *Cyanide, Phenol Disposal.* A firm in Houston, Texas, as early as 1968 was made aware that its practice of discharging such hazardous waste as cyanides (25.40 lbs./day, or 11.5 kilograms/day), phenols (2.1 lbs./day, or 0.954 kilograms/day), sulfides, and ammonia into the Houston ship channel was creating severe environmental debilitation. The toxic wastes in question are derived from the cleaning of blast furnace gas from coke plants. Based on expert testimony, levels as low as 0.05 mg/1 of cyanide effluent are known to be lethal to shrimp and small fish of the species found in the Galveston Bay area.

Alternative disposal methods involving deep well injection were recommended by the firm and the Texas Water Quality Board. EPA rejected this proposal and the firm in question was enjoined by the courts to cease and desist discharging these wastes into the ship channel. Subsequently, the courts have ruled in favor of EPA that deep well injection of these wastes is not an environmentally acceptable disposal method at this site.

(4) *Arsenic Contamination.* A chemical company in Harris County, Texas, that produces insecticides, weed killers, and similar products containing arsenic has been involved in litigation over the discharge of arsenic waste onto the land and adjacent waters. Charges indicate that waste containing excessive arsenic was discharged into, or adjacent to, Vince Bayou causing arsenic-laden water drainage into public waters. This company and its predecessor have a long history of plant operation at this site. Earlier, waste disposal was accomplished by dumping the waste solids in open pits and ditches on the company's property. This practice was abandoned in 1967 in favor of a proposed recycling process. However, as of August 1971, actions were taken on behalf of the county to enjoin manufacturing operations at the plant because of alleged excessive arsenic discharge into the public waters. No other information is available regarding the current status of court actions or disposal practices.

(5) *Insecticide Dumping.*

(a) In mid-1970, an applicator rinsed and cleaned a truck rig after dumping unused Endrin into the Cuivre River at Mosco Mills, Missouri. This act resulted in the killing of an estimated 100,000 fish and the river was closed to fishing for one year by the Missouri Game and Fish Commission.

(b) In mid-1972, a chemical manufacturing company in Waterloo, Iowa, burned technical mevinphos (phosdrin), resulting in gross contamination to the plant area. Approximately 2,000 pounds (908 kilograms) of previously packaged material were dumped and left for disposal. After discussion with EPA Region VII office personnel and appropriate Iowa agencies, the area was neutralized with alkali and certain of the materials were repackaged for disposal by a private hazardous waste disposal firm in Sheffield, Illinois.

(6) *Trace Phenol Discharge.* During 1970, the Kansas City, Missouri, water supply contained objectionable tastes and odors due to a phenolic content. It was alleged, and subsequent investigation indicated, that fiberglass wastes dumped along the river bank upstream was the source of the tastes and odors. The waste was coated with phenol and was possibly being washed into the river. Action was taken to have the dump closed and sealed.

(7) *Fatality Caused by Discharge of Hydrocarbon Gases Into River.* In July 1969, an Assistant Dean at the University of Southern Mississippi died of asphyxiation while fishing in a boat in the Leaf River near Hattiesburg, Mississippi. The victim's boat drifted into a pocket of propane gas that reputedly had been discharged into the river through a gasoline terminal "wash pipe" from a petroleum refinery.

(8) *Cyanide Discharge.* Part of the Lowry AFB Bombing Range, located 15 miles (24.1 kilometers) east of Denver was surplused and given to Denver as a landfill site. As of July 1972, the Lowry site was accepting, with the exception of highly radioactive wastes, any wastes delivered without inquiry into the contents and without keeping anything more than informal records of quantities delivered.

Laboratory tests of surface drainage have indicated the presence of cyanide in ponded water downstream from the site. Significant amounts of cyanide are discharged in pits at the disposal site, according to the site operator. Short-lived radioactive wastes from a nearby medical school and a hospital also are accepted at this site. These wastes are apparently well protected, but are dumped directly into the disposal ponds rather than being buried separately.

The Denver County Commissioners received a complaint that some cattle had died as the result of ingesting material washed downstream from this site. Authorities feel this occurred because of runoff caused by an overflow of the disposal ponds into nearby Murphy Creek after a heavy rainstorm.

(9) *Arsenic Dump—Groundwater Contamination.* A laboratory company in the north central United States has been utilizing the same dump site since 1953 for solid waste disposal. Of the total amount (500,000 cubic feet or 14,150 cubic meters) dumped as of 1972, more than half is waste arsenic. There are several superficial monitoring wells (10–20 feet deep or 3.05–6.10 meters) located around the dump site. Analyses of water samples have produced an arsenic content greater than 175 ppm. The dump site is located above a limestone bedrock aquifer, from which 70 percent of the nearby city's residents obtain their drinking and crop irrigation water. There are some indications that this water is being contaminated by arsenic seepage through the bedrock.

(10) *Poisoning of Local Water Supply.* Until approximately two years prior to June 1972, Beech Creek, Waynesboro, Tennessee, was considered pure enough to be a source of drinking water. At that time, waste polychlorinated biphenyls (PCB) from a nearby plant began to be deposited in the Waynesboro city dump site. Dumping continued until April 1972. Apparently, the waste, upon being offloaded at the dump, was pushed into a spring branch that rises under the dump and then empties into Beech Creek. Shortly after depositing of such wastes began, an oily substance appeared in the Beech Creek waters. Dead fish, crawfish, and waterdogs were found and supported wildlife also was being affected (e.g., two raccoons were found dead). Beech Creek had been used for watering stock, fishing, drinking water, and recreation for decades. Presently, the creek seems to be affected for at least 10 miles (16.09 kilometers) from its source and the pollution is moving steadily downstream to the Tennessee River. Health officials have advised that the Creek should be fenced off to prevent cattle from drinking the water.

Category II—Mismanagement of Waste Materials

In the presence of locally imposed air and water effluent restrictions/prohibitions, industrial concerns attempt to manage disposal problems by storage, stockpiling, and/or lagooning. In many instances, the waste quantities become excessive and environmental perils evolve as a result of leaching during flooding or rupturing of storage lagoons. Instances of this type of waste management problem which have been reported are shown in the following:

(1) *Fish Kills (one of many examples).* On June 10, 1967, a dike containing an alkaline waste lagoon for a steam generating plant at Carbo, Virginia, collapsed and released approximately 400 acre-

feet (493,400 cubic meters) of fly ash waste into the Clinch River. The resulting contaminant slug moved at a rate of one mile/hr. (1.6 kilometers/hour) for several days until it reached Norris Lake in Tennessee; whereupon, it is estimated to have killed 216,200 fish. All food organisms in the 4 mile (6.43 kilometers) stretch of river immediately below Carbo were completely eliminated. The practice of waste disposal by lagooning is a notoriously inadequate method which lends itself to negligence and subsequent mishaps.

(2) *Phosphate Slime Spill.* On December 7, 1971, at a chemical plant site in Fort Meade, Florida, a portion of a dike forming a waste pond ruptured releasing an estimated two billion gallons (7.58 billion liters) of slime composed of phosphatic clays and insoluble halides into Whidden Creek. Flow patterns of the creek led to subsequent contamination of Peace River and the estuarine area of Charlotte Harbor. The water of Charlotte Harbor took on a thick milky white appearance. Along the river, signs of life were diminished, dead fish were sighted and normal surface fish activity was absent. No living organisms were found in Whidden Creek downstream of the spill or in Peace River at a point eight miles downstream of Whidden Creek. Clam and crab gills were coated with the milky substance and in general all benthic aquatic life was affected in some way.

(3) *Mismanagement of Heterogeneous Hazardous Waste.* A firm engaged in the disposal of spent chemicals generated in the Beaumont-Houston area ran into considerable opposition in Texas and subsequently transferred its disposal operations to Louisiana. In October, 1972, this firm was storing and disposing toxic chemicals at two Louisiana locations: De Ridder and De Quincy. At the De Ridder site, several thousand drums of waste (both metal- and cardboard-type, some with lids and some without) were piled up at the end of an airport runway apron within a pine tree seed orchard. Many of the drums were popping their lids and leaking, and visible vapors were emanating from the area. The pine trees beside the storage area had died. At the same time, the firm was preparing to bury hundreds of drums of hazardous wastes at the De Quincy location, which is considered by EPA to be hydrogeologically unsuitable for such land disposal. Finally, court action enjoined this firm from using the De Ridder and De Quincy sites; however, the company has just moved its disposal operations near Villa Platte in Evangeline Parish, where the same problems exist.

(4) *Arsenic Waste Mishap.* Since August 1968, a commercial laboratory in Myerstown, Pennsylvania, has disposed of its arsenic waste by surface storage within the plant area. (Form of waste materials not known.) This practice apparently has led to contam-

ination of the ground and subsequent migrations into groundwaters via leaching, ionic migration actions, etc., abetted by the geologic and edaphic character of the plant site. In order to meet discharge requirements and/or eliminate the waste hazard, the company has had to design and construct a system of recovery wells to collect the arsenic effluent from ground waters in the area. Recovered arsenic and current arsenic waste (previously stored on the land) are now retained in storage lagoons. Presumably, the sludge from these lagoons is periodically reclaimed in some way. Lagoons of this type are generally not well attended and frequently result in environmental catastrophes. (As evidenced under case 1 above.)

(5) *Contaminated Grain.*

(a) *Grant County, Washington.* In 1972, mercury-treated grain was found at the Wilson Creek Dump by an unsuspecting farmer. He hauled it to his farm for livestock feed. The episode was discovered just before the farmer planned to utilize the grain.

(b) *Albuquerque, New Mexico.* Three children in a family became seriously ill, in 1970, after eating a pig which had been fed corn treated with a mercury compound. Local health officials found several bags of similarly treated corn in the community dump.

(6) *Radioactive Waste; Steven County, Washington.* Low level radioactive waste is lying exposed on about 10 acres (4.05 hectares) of ground and is subject to wind erosion. The waste comes from an old uranium processing mill. County and State officials are concerned because, although it is of low radioactivity level, it is the same type that caused the public controversy at Grand Junction, Colorado.

(7) *Waste Stockpiling Hazard; King County, Washington.*

(a) All types of waste chemicals have been dumped into the old Dodgers Number Five Coal Mine shaft for years. Much of this practice has stopped but sneak violations still occur.

(b) Expended pesticides have been stored in old wooden buildings in the area that are very susceptible to fire. Several fires have occurred. In addition, large numbers of pesticide containers have been stacked at open dumps.

(8) *Chlorine Holding Pond Breach.* A holding pond and tank at a chemical manufacturing plant in Saltville, Virginia failed, spilling chlorine, hypochlorites and ammonia into the North Fork Holston River. River water samples showed concentration levels at 0.5 ppm hypochlorite, and 17.0 ppm of fixed ammonia. Dead fish were sighted along the path of the flow of the river.

(9) *Malpractice Hazard; Bingham County, Idaho.* Several drums

of a 15 year old chemical used for soil sterilization were discovered in the warehouse of the weed control agency. It was taken to a remote area where it was exploded with a rifle blast. Had it been disturbed only slightly while in storage, several people would have been killed.

(10) *Explosive Waste; Kitsap County, Washington.* Operations at a Naval Ammunition Depot involved washing RDX (a high explosive) out of shells from 1955–1968, and the resulting wash water went into a dump. In routine monitoring of wells in the area, the RDX was found in the groundwater and in several cases the concentrations exceed the health tolerance level of 1 ppm.

(11) *Unidentified Toxic Wastes.* A disposal company undertook to dispose some drums containing unidentified toxic residues. Instead of properly disposing of this material, the disposal company dropped these drums off at a dump located in Cabayon, Riverside County, California. Later, during a heavy flood, the drums were unearthed, gave off poisonous gases, and contaminated the water. Steps were taken to properly dispose of the unearthed drums.

(12) *Container Reclamation.* At a drum reclaiming plant in northern California, 15 men were poisoned by gases given off from the drums. It is presumed that this incident occurred because of inadequate storage procedures by the company involved.

(13) *Stockpiling of Hazardous Waste (Great Britain).** Several sheep and cattle and a foxhound died, and many cattle became seriously affected, on two farms close to a factory producing rodenticides and pesticides. The drainage from the factory led into a succession of ponds to which the animals had unrestricted access, and from which they are therefore likely to have drunk. Investigations showed that a field on the site was a dumping ground for large metal drums and canisters, many of which had rusted away their contents seeping into the ground. Residues from the manufacture of fluoroacetamide were dumped on the site, and percolated into the drainage ditches leading to the farm ponds. Veterinary evidence indicated the assimilation of fluoroacetamide compatible with the animals, having drunk contaminated water. Ditches and ponds were dredged and the sludge deposited on a site behind the factory. All sludges and contaminated soil were subsequently excavated, mixed with cement, put into steel drums capped with bitumen, and dumped at sea. The presence of fluoroacetamide in the soil and associated water samples persisted at very low, but significant levels, and thus delayed the resumption of normal farming for nearly two years.

* Case illustrates the similarity of problems that exist in highly industrialized nations.

(14) *Pesticides in Abandoned Factory.* In the summer of 1972, approximately 1,000 pounds (454 kilograms) of arsenic-containing pesticide were discovered in an abandoned factory building in Camden County, New Jersey. The building used to belong to a leather tannery that had discontinued its operations.

(15) *Ground Water Contamination by Chromium- and Zinc-containing Sludge.* An automobile manufacturing company in the New York area is regularly disposing of tank truck quantities of chromium- and zinc-containing sludge through a contract with a trucking firm, that in turn has a subcontract with the owner of a private dump. The sludge is dumped in a swampy area, resulting in contamination of the ground water. The sludge constitutes a waste residue of the automobile manufacturer's paint priming operations.

(16) *Disposal of Chromium Ore Residues.* A major chemical company is currently depositing large quantities of chromium ore residues on its own property in a major city on the East Coast. These chromium ore residues are piled up in the open, causing probable contamination of the ground water by leaching into the soil.

(17) *Dumping of Cadmium-containing Effluents into the Hudson River.* A battery plant in New York State for years was dumping large amounts of cadium-containing effluents into the Hudson River. The sediment resulting from the plant's effluents contained about 100,000 ppm of cadmium. The firm now has agreed to deposit these toxic sediments in a specially insulated lagoon.

(18) *Pesticide Poisoning.* On July 3, 1972, a 2½ year old child in Hughes, Arkansas, became ill after playing among a pile of fifty-five gallon (208 liter) drums. He was admitted to the hospital suffering from symptoms of organophosphate poisoning. The drums were located approximately fifty feet (15 meters) from the parents' front door on city property. The city had procured the drums from an aerial applicator to be used as trash containers. The residents were urged to pick up a drum in order to expedite trash collection. It has been determined that these drums contained various pesticides, including methyl parathion, ethyl parathion, toxaphene, DDT, and others. The containers were in various states of deterioration, and enough concentrate was in evidence to intoxicate a child or anyone else who was unaware of the danger.

(19) *Improper Disposal of Aldrin-treated Seed and Containers.* On July 9, 1969, in Patterson, Louisiana, the owner of a farm noticed several pigs running out of a cane field; some of the animals appeared to be undergoing convulsions. It appears that aldrin-

treated seed and containers had been dumped on the land in a field and that the pigs, running loose had encountered this material. Eleven of the pigs died. Analysis of rumen contents showed 230.7 ppm aldrin and 1.13 ppm dieldrin.

(20) *Improper Pesticide Container Disposal.* In May 1969, in Jerome, Idaho, Di-Syston was incorporated into the soil in a potato field. The "empty" paper bags were left in the field, and the wind blew them into the adjacent pasture. Fourteen head of cattle died, some with convulsions, after licking the bags. Blood samples showed .0246 ppm Di-Syston.

(21) *Ocean Dumping of Chemical Waste.* The *Houston Post* reported in December 1971 that large quantities of barrels containing chemical wastes had turned up in shrimpers' nets in the Gulf of Mexico approximately 40 miles (64.3 kilometers) off the Texas coastline. Aside from physical damages to nets and equipment, the chemical wastes caused skin burning and eye irritation among exposed shrimper crewmen. Recovered barrels reportedly bore the names of two Houston-area plants—both of whom apparently had used a disposal contractor specializing in deep sea disposal operations.

Category III—Radioactive Waste Disposal

(1) *National Reactor Testing Station.* In October 1968, the Idaho Department of Health and the former Federal Water Quality Administration made an examination of the waste treatment and disposal practices at the AEC National Reactor Testing Station (NRTS) near Idaho Falls, Idaho. There were three types of plant wastes being generated: radioactive wastes, chemical or industrial wastes, and sanitary wastes. It was found that there were no observation wells to monitor the effects of the burial ground on water quality, that low-level radioactive wastes were being discharged into the ground water, that chemical and radioactive wastes had degraded the ground water beneath the NRTS, and that some sanitary wastes were being discharged into the ground water supply by disposal wells.

In a report issued in April 1970, authorities recommended that the AEC abandon the practice of burying radioactive waste above the Snake Plain aquifer, remove the existing buried wastes to a new site remote to the NRTS and hydrologically isolated from groundwater supplies, and construct observation wells that are needed to monitor the behavior and fate of the wastes.

(2) *De-Commissioning of AEC Plant.* The Enrico Fermi nuclear reactor just outside of Detroit is closing. However, there still re-

mains a substantial waste management problem. The owner of the plant has set aside $4 million for de-commissioning the plant. A preliminary de-commissioning plan and cost estimate have been submitted to the AEC. However, the AEC acknowledges that costs and procedures for de-commissioning are still unknown, since few nuclear plants (and never one such as Fermi) have been de-commissioned. As of this date, an answer is still being sought to this waste disposal problem.

(3) *Nuclear Waste Disposal.* After a fire on May 11, 1969 at the Rocky Flats plutonium production plant near Denver, Colorado, it was discovered that since 1958 the company that operated the plant had been storing outside on pallets fifty-five gallon drums of laden oil contaminated with plutonium.* The drums corroded and the plutonium-contaminated oils leaked onto the soil in the surrounding area. Soil sample radioactivity measurements made in 1970–71 at various locations on the Rocky Flats site indicated that the surrounding area was contaminated 100 times greater than that due to world-wide fallout. The increase in radioactivity as defined by the health and safety laboratory of AEC was attributed to the plutonium leakage from the stored fifty-five gallon drums rather than any plutonium that might have been dispersed as a result of the 1969 fire. Later the area where the plutonium contaminated laden oil was spilled was covered with a four inch slab of asphalt and isolated by means of a fence. The fifty-five gallon drums were moved to a nearby building and the plutonium was salvaged from the oil. The oil was dewatered and solidified into a grease-like consistency. Then the drums and the solidified oil were sent to and buried at the National Reactor Testing Station at Idaho Falls, Idaho.

* Containing measurable quantities of plutonium.

Appendix B

HAZARDOUS WASTE STREAM DATA

Identifying and quantifying the Nation's hazardous waste streams proved to be especially formidable, because historically there has been little interest in quantifying specific amounts of waste materials with the exception of radioactive wastes.

Distribution and volume data by Bureau of Census regions were compiled on those non-radioactive waste streams designated as hazardous (see Table B–1). Table B–2 identifies those states geographically distributed within the nine Bureau of Census regions. The approach used is predicated on the assumption that the hazardous properties of a waste stream will be those of the most hazardous pure compound within that waste stream. Using threshold levels established for the various hazardous properties, wastes containing compounds with values more than or equal to these thresholds are classified as hazardous. This approach takes advantage of the available hazard data on pure chemicals and avoids speculation on potential compound interactions within a waste stream. Table B–3 serves to illustrate what types of chemical compounds in the Nation's waste streams could be regarded as hazards to public health and the environment. It should be noted that Table B–3 is not an authoritative enumeration of hazardous compounds but a sample list which will be modified on the basis of further studies.* Table B–4 identifies those radioactive isotopes that are considered hazardous.† Detailed data sheets describing the volumes, constituents, concentrations, hazards, disposal techniques, and data sources for each waste stream are available in EPA Contract No. 68–01–0762.

It is important to emphasize that while Table B–1 is sufficiently accurate for planning purposes, the indicated total national non-radioactive hazardous waste volume of 10 million tons (9 million metric tons) per year is not a firm number but an estimate based on currently available information. A more accurate indication of actual waste volumes will become available only after a comprehensive national waste inventory has been accomplished for specific waste streams.

* Compounds on the list should not be construed as those to be regulated under the proposed Hazardous Waste Management Act.

† From a disposal standpoint.

TABLE B–1

SUMMARY DATA FOR NONRADIOACTIVE WASTE STREAMS

SIC #	Waste Stream Title	Geographic Distribution—Fraction NE	MA	ENC	WNC	SA	ESC	WSC	W	M	Volume (lbs/yr)
1031	Zinc ore roasting acid wash										
333	Brass mill wastes	.04	.29	.01	.25	.01	.04	.04	.19	.13	5×10^7
1099	Cadmium ore extraction										2×10^8
3312	Coke plant raw waste	.02	.33	.41	.01	.07	.02	.06	.02	.06	8×10^7
331	Consolidated steel plant wastes	.02	.33	.42	.02	.09	.02	.03	.02	.05	5×10^8
331	Iron manufacturing waste sludge	.05	.05	.56	.02	.12	.03	.09	.03	.05	6×10^6
1021	Recovered arsenic from refinery flues (stored)	—	—	—	—	—	—	—	1.00	—	4×10^7 (Tacoma, Wa.)
1092	Mercury ore extraction wastes	—	—	—	—	—	—	—	.72	.28	
3312	Stainless steel pickeling liquor	.050	.259	.404	.026	.068	.055	.044	.067	.028	5×10^7
333	Arsenic trioxide from smelting industry	—	.03	.015	.07	.005	.01	.10	.07	.70	2×10^7
291	Copper and lead bearing petroleum refinery wastes	.001	.102	.175	.056	.019	.031	.417	.160	.039	8×10^8
3691	Battery manufacturing wastes	.030	.236	.289	.111	.103	.029	.056	.134	.012	
3691	Battery manufacturing waste sludge	.117	.043	—	.118	.117	—	—	—	.118	5×10^7
3692	Mercury cell battery wastes	.060	.138	.556	.049	.074	.019	.017	.087*	—	*M&W combined
3585	Refrigeration equipment manufacturing wastes	.013	.232	.408	.096	.040	.069	.086	.045	.011	2×10^8
3555	Duplicating equipment manufacturing wastes		1.00								7×10^5 (Upstate, New York)
3555	Graphic arts photography wastes (leather press plates)	.06	.19	.20	.08	.15	.06	.09	.04	.13	4×10^3
3555	Rotogravure printing plate wastes	.105	.446	.320	.051	.019	—	.028	.031	—	
3231	Mirror production wastes	.09	.25	.23	.01	.28	.10	.04	—	—	9×10^6
372	Aircraft plating wastes	.123	.158	.117	.093	.057	.013	.095	.325	.019	4×10^7
40	Arsenic wastes from transportation industry										
40	Railroad engine cleaning										
2879	Benzoic herbicide contaminated containers	—	—	.655	.154	.006	.017	—	.160	.009	2×10^4 User
2879	Calcium arsenate contaminated containers	.03	.02	.08	.07	.16	.16	.35	.03	.09	6×10^8 SIC #s
2879	Carbamate pesticide contaminated containers	.0008	.016	.382	.070	.022	.108	.321	.060	.020	5×10^4 AG–01,02,07

*Classified by Bureau of Census regions.

NE = New England
MA = Mid Atlantic
ENC = East North Central
WNC = West North Central
SA = South Atlantic
ESC = East South Central
WSC = West South Central
W = West
M = Mountain

TABLE B-1—Continued

SIC #	Waste Stream Title	Geographic Distribution—Fraction NE	MA	ENC	WNC	SA	ESC	WSC	W	M	Volume (lbs/yr)
2879	Chlorinated aliphatic pesticide contaminated containers	.381	—	.076	.418	—	.105	.010	.010	—	1×10^4 Forestry −08
2879	Dinitro pesticide contaminated containers	.496	.168	.023	.017	.228	—	.003	.165	.006	2×10^4 Trans. −40, 41,42,44,45
2879	Lead arsenate contaminated containers	.03	.02	.08	.07	.17	.17	.35	.08	.03	1×10^4
2879	Mercury fungicide contaminated containers	.02	.03	.04	.03	.28	.32	.05	.22	.01	5×10^2
2879	Miscellaneous organic pesticide contaminated containers	.014	.162	.385	.068	.162	.123	.041	.034	.014	1×10^4
2879	Miscellaneous organic insecticide contaminated containers	.148	.084	.054	.039	.197	.143	.148	.170	.017	4×10^4
2879	Organic arsenical contaminated containers	—	.007	—	—	.011	.764	.218	—	—	5×10^3
2879	Organic fungicide contaminated containers	.048	.125	.047	.028	.441	.001	.036	.266	.007	8×10^4
2879	Organophosphorous contaminated containers	.043	.050	.018	.125	.139	.192	.175	.208	.049	1×10^5
2879	Phenoxy contaminated containers	.035	.033	.196	.321	.031	.030	.067	.146	.141	2×10^5
2879	Phenyl-urea contaminated containers	.106	.085	.106	.033	.106	.424	.042	.095	.003	9×10^3
2879	Polychlorinated hydrocarbon contaminated containers	.017	.107	.019	.138	.306	.211	.133	.044	.024	2×10^5
2879	Triazine contaminated containers	.147	.121	.320	.372	.013	.003	.011	.011	.002	6×10^4
2879	Wastes from pesticide-herbicide manufacture (arsenites)	.005	.075	.145	.074	.299	.207	.090	.058	.046	
2879	Benzoic herbicide wastes (DOD)	.168	.130	.009	—	.447	—	—	.246	—	3×10^3
2879	Chlorinated aliphatic herbicide wastes (DOD)	.196	.062	.027	—	.649	—	.010	—	.057	5×10^3
2879	Organic arsenicals from production of cacodylates	—	.200	.800	—	—	—	—	—	—	
2879	Phenyl-urea herbicide wastes (DOD)	.539	.059	—	—	.343	.059	—	—	—	2×10^3
2879	Phenoxy herbicide wastes (DOD)	.0002	.0001	.0007	—	.0008	.849	.149	.0004	.0002	8×10^6
2879	Halogenated aliphatic hydrocarbon fumigant wastes (DOD)	1.0	—	—	—	—	—	—	—	—	2×10^2
2879	Mercuric fungicide production wastes	.005	.075	.145	.074	.299	.207	.090	.058	.046	
2816	Chromate wastes from pigments and dyes	.015	.170	.156	.047	.156	.111	.265	.060	.020	
22	Chromate wastes from textile dying	.101	.178	.034	.005	.568	.034	.014	.060	.006	2×10^7 maximum
2865	Dye manufacturing wastes	.015	.170	.156	.047	.156	.111	.265	.060	.020	
283	Drug manufacturing wastes	.056	.348	.183	.089	.100	.033	.060	.115	.011	5×10^9
2892	Nitrocellulose propellant contaminated wastes	—	.041	—	.457	.492	—	—	—	.009	9×10^6
2892	High explosive contaminated wastes	—	.005	.094	.394	.397	.027	.004	.012	.023	1×10^7
2892	Waste incindiaries	—	.014	.002	.002	—	—	.718	.255	.009	8×10^5
2892	Incindiary contaminated wastes	—	—	—	—	—	—	1.0	—	—	6×10^5
2892	Wastes from production of nitrocellulose propellants and smokeless powder	—	.060	.046	.387	.477	—	.006	—	.025	6×10^6
2892	Production of nitroglycerin	—	—	—	—	.42	.19	—	.39	—	7×10^5
2892	Solid waste from old primers and detonators	—	.005	.430	.454	.001	.006	—	.014	.084	3×10^5

TABLE B-1—*Continued*

SIC #	Waste Stream Title	Geographic Distribution—Fraction									Volume (lbs/yr)
		NE	MA	ENC	WNC	SA	ESC	WSC	W	M	
2892	Contaminates and wastes from primary explosives production	—	.096	.001	.898	—	.001	—	.001	.003	4×10^6
2879	Miscellaneous organic herbicide production wastes	.076	.135	.124	.080	.156	.062	.108	.200	.059	4×10^8
2879	Phenoxy herbicide production wastes	.076	.135	.124	.080	.156	.062	.108	.200	.059	4×10^7
2892	Waste high explosives	.002	.006	.346	.174	.218	.104	.127	001	.010	1×10^7
2892	Waste nitrocellulose and smokeless powder	—					—		.594	.406	2×10^6
2892	Waste nitroglycerin	—	—	.01	—	.50	.22	—	.266	.004	5×10^5
2892	Contaminated and waste industrial propellants and explosives	—			—	—		—	.655	.344	3×10^6
0175	Contaminated orchard soil	.05	—	.15	—	.33	—	.35	.09	.03	Unknown
011 072	Wastes from seed industry	.017	.088	.371	.213	.053	.060	.081	.094	.023	
9711	Highly contaminated soil (stored)	—	—	—	—	—	—	—	—	1.0	3×10^9 (*Rocky Mountain* Arsenal)
2879	Organic pesticide production wastes	.115	.148	.136	.073	.141	.057	.093	.183	.054	3×10^8
2879	Organic fungicide production wastes	.076	.135	.124	086	.156	.062	.107	.202	.058	2×10^8
9711	Solid military arsenical wastes										
9711 9221	Contaminated or outdated tear gas	—	.002	.001	—	.015	.031	.001	.926	.024	3×10^6
9711	Military ordnance (munitions & explosives)	—	138	.189	—	.022	.044	.252	.209	.144	3×10^8
9711	Military cadmium plating wastes (USAF)	—	—	—	—	—	—	—	—	—	2×10^6
9711	Spent filter media from military operations										
9711	Off Spec "Agent Orange" defoliant										
9711	Paint stripping wastes, Vance Air Force Base, OK	—	—	—	—	—	—	1.0	—	—	(Vance Air Force Base, OK)
9711	Stored military mercury compounds	.47	—	—	.51	—	—	—	.02	—	215
31	Chrome tanning liquor	.22	.29	.29	.03	.086	.05	.004	.03	—	2×10^7
2822	Nitrobenzene from rubber industry wastes	—	.07	.14	—	.11	.11	.50	.07	—	5×10^9 (probaly too dilute to be of concern)
2822	Rubber manufacturing wastes	—	.07	.14	—	.11	.11	.50	.07	—	1×10^6
2824	*Synthetic fiber production* wastes	.046	.121	.101	.018	.404	.182	.101	.027	—	
281	Acetaldehyde via ethylene oxidation	.015	.170	.156	.047	.156	.111	.265	.060	.020	8×10^7
28211	Cellulose ester production wastes	.10	.21	.21	.16	.14	07	.10	.02	—	5×10^7
9711	Wastes from production of chloropicrin	—	x	—	—	—	—	x	xx	—	Neg.

TABLE B-1—Continued

SIC #	Waste Stream Title	Geographic Distribution—Fraction NE	MA	ENC	WNC	SA	ESC	WSC	W	M	Volume (lbs/yr)
2899	Nonutility PCB wastes	.037	.221	.372	.153	.040	.041	.057	.072	.009	8×10^{8}
2818	∞ synthesis methanol production wastes	—	—	.05	—	.05	—	.90	—	—	1×10^{8} Sludge
2611	Dimethyl sulfate production wastes	—	x	—	—	x	—	—	—	—	2×15^{5} Still bottoms
2818	Formaldehyde production wastes	—	—	.02	—	.05	—	.93	—	—	8×10^{5} Sludge
2818	N-butane dehydrogenation butadiene production wastes	—	—	.03	—	—	—	.92	.05	—	3×10^{5} Sludge
2821	Wastes from polycarbonate polymer production	.046	.121	.101	.018	.404	.182	.101	.027	—	
2821	Residue from manufacture of ethylene dichloride/vinyl chloride	—	.021	.015	—	.163	.171	.533	.117	—	2×10^{7}
2821	Urethane manufacturing wastes	.046	.121	.101	.018	.404	.182	.101	.027	—	
2491 2865	Wood preservative wastes	.007	.029	.117	.060	.267	.141	.174	.162	.042	4×10^{2}
2491	Spent wood preserving liquors	.007	.029	.117	.060	.267	.141	.174	.162	.042	
287	Agricultural chemical manufacturing wastes	.005	.075	.145	.074	.299	.207	.090	.058	.046	
2819	Arsenic wastes from purification of phosphoric acid	.015	.170	.156	.047	.156	.111	.265	.060	.020	Neg.
3339	Beryllium salt production wastes	—	1.0	—	—	—	—	—	—	—	Neg.
2813	Borane production wastes	—	1.0	—	—	—	—	—	—	—	Neg.
2812	Chlorine production brine sludges	.02	.11	.10	—	.19	.22	.24	.12	—	1×10^{8}
2869	Contaminated antimony pentafluoride	—	x	x	—	—	—	x	—	—	Neg.
2869	Contaminated antimony trifluoride	—	x	x	—	—	—	x	—	—	Neg.
2819	Contaminated fluorine	.007	.101	.166	.075	.147	.207	.147	.096	.054	Neg.
2813	Nickel carbonyl production wastes	—	1.0	—	—	—	—	—	—	—	Neg.
2819	Cyanide production wastes	.007	.101	.166	.075	.147	.207	.147	.096	.054	
2869	Hydrazine production wastes	x	x	—	—	x	—	x	—	—	
287	Intermediate agricultural product wastes—Nitric acid	.005	.075	.145	.074	.299	.207	.090	.058	.046	2×10^{5}
2819	Potassium chromate production wastes	.19	.06	.015	.005	.60	.10	.01	.01	.01	1×10^{8}
2873	Production wastes for ammonium sulfate	—	—	.04	—	—	—	—	—	.96	1×10^{3} (dry basis chromate)
3339	Selenium production wastes	—	.75	—	—	—	—	—	—	.25	2×10^{4} (particulates)
2819	Sodium dichromate production wastes		.150	.243	—	.437	—	.170			3×10^{8}
2869	Tetraethyl and tetramethyl lead production wastes	—	—	—	—	—	—	.63	.37	—	3×10^{6}
2873	Urea production wastes	—	.05	.09	.18	.09	.15	.29	.14	—	2×10^{5} (dry basis)
2813	Waste bromine pentafluoride	—	—	—	—	—	—	1.0	—	—	Neg.
2813	Waste chlorine pentafluoride	—	—	x	—	—	—	x	—	—	Neg.
2813	Waste chlorine trifluoride	—	—	x	—	—	—	x	—	—	Neg.

TABLE B-1—Continued

SIC #	Waste Stream Title	Geographic Distribution—Fraction NE	MA	ENC	WNC	SA	ESC	WSC	W	M	Volume (lbs/yr)
2819	Waste from production of barium salts	.007	.101	.166	.075	.147	.207	.147	.096	.054	Neg.
2879	Organo-phosphate pesticide production wastes	.115	.148	.136	.073	.141	.057	.093	.183	.054	6×10^7
2879	Chlorinated hydrocarbon pesticide production wastes	.115	.148	.136	.073	.141	.057	.093	.183	.054	2×10^8
2819	Waste from manufacture of mercuric cyanide	—	1.0	—	—	—	—	—	—	—	Neg.
3339	Thallium production wastes	—	—	—	—	—	—	1.0	—	—	Neg. (small amount in Colorado)
2813	Arsine production wastes	x	x	x	—	—	x	x	x	—	1×10^4
33 34	Metal finishing wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	4×10^7 Cyanide solution 8×10^6 Metal sludges
	Aluminum anodizing bath with drag out	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Brass plating wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Cadmium plating wastes	.131	.285	.321	.045	.049	.023	.036	.103	.007	1×10^6
	Chrome plating wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Cyanide copper plating wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Finishing effluents	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Metal cleaning wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Plating preparation wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Silver plating wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	
	Zinc plating wastes	.115	.179	.379	.046	.050	.015	.036	.169	.011	
33	Metal finishing chromic acid	.244	.198	.149	.095	.081	.032	.031	.031	.041	
331	Cold finishing wastes	.03	.34	.43	.01	.07	.02	.05	.01	.04	5×10^9
9711	Waste chemicals from military										3×10^5
	Etiological materials from commercial production										3×10
	Cooling tower blowdown	.005	.150	.170	.060	—	.58	—	—	.035	2×10^7 (as Chromate)
2816	Cadmium-selenium pigment wastes										
22	Mercury bearing textile cleaning wastes	.101	.178	.034	.005	.568	.034	.014	.060	.006	
283	Pharmaceutical arsenic wastes	.056	.348	.183	.089	.100	.033	.060	.115	.011	Neg.
283	Pharmaceutical mercurial wastes	.056	.348	.183	.089	.100	.033	.060	.115	.011	Neg.
285	Water-based paint sludge	.044	.243	.269	.072	.103	.041	.069	.147	.012	3×10^7
285	Solvent-based paint sludge	.044	.243	.269	.072	.103	.041	.069	.147	.012	4×10^7
28	Waste or contaminated perchloric acid										Neg.
9711	Military sodium chromate (stored)	—	—	—	—	—	—	—	—	—	2,765 (Okinawa)

TOTAL approximately 2×10^{10} lb/yr. or 9×10^9 kilograms/yr. (10 million T/yr or approx. 9 million metric tons).

TABLE B–2
STATES WITHIN BUREAU OF CENSUS REGIONS

New England	Mid Atlantic	East North Central	West North Central	South Atlantic
Maine	New York	Wisconsin	North Dakota	West Virginia
Vermont	Pennsylvania	Michigan	South Dakota	Delaware
New Hampshire	New Jersey	Illinois	Minnesota	Maryland
Massachusetts		Indiana	Nebraska	Virginia
Rhode Island		Ohio	Iowa	North Carolina
Connecticut			Kansas	South Carolina
			Missouri	Georgia
				Florida
				District of Columbia

East South Central	West South Central	Mountain	Pacific (West)
Kentucky	Oklahoma	Montana	Washington
Tennessee	Arkansas	Idaho	Oregon
Mississippi	Texas	Wyoming	California
Alabama	Louisiana	Arizona	Hawaii
		New Mexico	Alaska
		Utah	
		Nevada	
		Colorado	

TABLE B–3
A SAMPLE LIST OF NONRADIOACTIVE HAZARDOUS COMPOUNDS

MISCELLANEOUS INORGANICS

Ammonium Chromate
Ammonium Dichromate
Antimony Pentafluoride
Antimony Trifluoride
Arsenic Trichloride
Arsenic Trioxide
Cadmium (Alloys)
Cadmium Chloride
Cadmium Cyanide
Cadmium Nitrate
Cadmium Oxide
Cadmium Phosphate
Cadmium Potassium Cyanide
Cadmium (Powdered)
Cadmium Sulfate
Calcium Arsenate
Calcium Arsenite
Calcium Cyanides
Chromic Acid
Copper Arsenate
Copper Cyanides
Cyanide (Ion)
Decaborane
Diborane
Hexaborane
Hydrazine
Hydrazine Azide
Lead Arsenate
Lead Arsenite
Lead Azide
Lead Cyanide
Magnesium Arsenite
Manganese Arsenate
Mercuric Chloride
Mercuric Cyanide
Mercuric Diammonium Chloride
Mercuric Nitrate
Mercuric Sulfate
Mercury
Nickel Carbonyl
Nickel Cyanide
Pentaborane -9
Pentaborane -11
Perchloric Acid (to 72%)
Phosgene (Carbonyl Chloride)
Potassium Arsenite
Potassium Chromate
Potassium Cyanide
Potassium Dichromate
Selenium
Silver Azide
Silver Cyanide
Sodium Arsenate
Sodium Arsenite
Sodium Bichromate
Sodium Chromate
Sodium Cyanide
Sodium Monofluoroacetate
Tetraborane
Thallium Compounds
Zinc Arsenate
Zinc Arsenite
Zinc Cyanide

HALOGENS & INTERHALOGENS

Bromine Pentafluoride
Chlorine
Chlorine Pentafluoride
Chlorine Trifluoride
Fluorine
Perchloryl Fluoride

MISCELLANEOUS ORGANICS

Acrolein
Alkyl Leads
Carcinogens (In General)
Chloropicrin
Copper Acetylide
Copper Chlorotetrazole
Cyanuric Triazide
Diazodinitrophenol (DDNP)
Dimethyl Sulfate
Dinitrobenzene
Dinitro Cresols
Dinitrophenol
Dinitrotoluene
Dipentaerythritol Hexanitrate (DPEHN)
GB (Propoxy(2)-methylphosphoryl fluoride)
Gelatinized Nitrocellulose (PNC)
Glycol Dinitrate
Gold Fulminate
Lead 2,4–Dinitroresorcinate (LDNR)
Lead Styphnate
Lewisite (2–Chloroethenyl Dichloroarsine)
Mannitol Hexanitrate
Nitroaniline
Nitrocellulose
Nitrogen Mustards (2,2′,2″ Trichlorotri-ethylamine)
Nitroglycerin
Organic Mercury Compounds
Pentachlorophenol
Picric Acid
Potassium Dinitrobenzfuroxan (KDNBF)
Silver Acetylide
Silver Tetrazene
Tear Gas (CN) (Chloroacetophenone)
Tear Gas (CS) (2–Chlorobenzylidene Malononitrile)
Tetrazene
VX (Ethoxy-methyl phosphoryl N,N dipropoxy-(2–2), thiocholine)

ORGANIC HALOGEN COMPOUNDS

Aldrin
Chlorinated Aromatics
Chlordane
Copper Acetoarsenite
2,4–D (2,4–Dichlorophenoxyacetic Acid)
DDD
DDT
Demeton
Dieldrin
Endrin
Ethylene Bromide
Fluorides (Organic)
Guthion
Heptachlor
Lindane
Methyl Bromide
Methyl Chloride
Methyl Parathion
Parathion
Polychlorinated Biphenyls (PCB)

TABLE B–4

POTENTIALLY HAZARDOUS RADIONUCLIDES*

Nuclide	Half-Life, Years	Source †	Nuclide	Half-Life, Years	Source †
H–3	12.33	1,2,3	Sm–151	93.	1
Be–10	1,600,000.	2	Eu–152	13.	1
C–14	5730.	2	Eu–154	8.6	1
Na–22	2.601	2	Eu–155	4.8	1
Ci–36	301,000.	2	Gd–153	0.662	1
Ar–39	269.	2	Ho–166m	1200.	1
Ca–41	130,000.	2	Tm–170	0.353	3
Ca–45	0.447	2	Ta–182	0.315	3
V–49	0.907	2	W–181	0.333	2
Mn–54	0.856	2	Ir–192m	241.	3
Fe–55	2.7	2	Pb–210**	22.3	1,2
Co–60	5.27	2,3	Bi–210	3,500,000.	1
Ni–59	80,000.	2	Po–210	0.379	2,3
Ni–63	100.	2	Ra–226**	1,600.	1,2
Se–79	65,000.	1	Ra–228**	5.75	1
Kr–85	10.73	1	Ac–227**	21.77	1
Sr–90**	29.	1,3	Th–228**	1.913	1
Zr–93**	950,000.	1	Th–229**	7,340.	1
Nb–93m	12.	1,2	Th–230**	77,000.	1,2
Nb–94	20,000.	2	Pa–231**	32,500.	1
Mo–93	3,000.	2	U–232**	72.	1
Tc–99	213,000.	1	U–233**	158,000.	1
Ru–106**	1.011	1,3	U–234**	244,000.	1
Rh–102m	0.567	1	U–236	23,420,000.	1
Pd–107	6,500,000.	1	Np–237	2,140,000.	1
Ag–110m	0.690	1	Pu–236**	2.85	1
Cd–109	1.241	1	Pu–238**	87.8	1,3,2
Cd–113m	14.6	1	Pu–239	24,390.	1,2
Sn–121m	50.	1	Pu–240**	6,540.	1,2
Sn–123	0.353	1	Pu–241**	15.	1,2
Sn–126	100,000.	1	Pu–242**	387,000.	1
Sb–125	2.73	1,2	Am–241**	433.	1,3
Te–127m	0.299	1	Am–242m**	152.	1
I–129	15,900,000.	1	Am–243**	7,370.	1
Cs–134	2.06	1	Cm–242**	0.446	1,3
Cs–135	2,300,000.	1	Cm–243**	28.	1
Cs–137**	30.1	1,3	Cm–244**	17.9	1,3
Ce–144**	0.779	1,3	Cm–245**	8,500.	1
Pm–146	5.53	1	Cm–246**	4,760.	1
Pm-147	2.5234	1,3	Cm–247**	15,400,000.	1

*Criteria for inclusion of nuclides are:

(a) That they have half-lives greater than 100 days. Nuclides with half-lives less than 100 days are assumed to decay to insignificance before disposal or are included in their long half-life parents. Note that this excludes *nuclides such as I–131 with an 8.065–day half-life.*

(b) That they shall not be naturally occurring because of their own long half-lives. This table excludes such nuclides as K–40, Rb–87, Th–232, U–235, and U–238 with half-lives greater than 10^8 years. There are also 75 potentially hazardous radionuclides that occur in research quantities that have not been included in this table.

† Source terms:

(1) Found in high-level radioactive wastes from fuel reprocessing plants, both government and industry.

(2) Found in other nuclear power wastes such as spent fuel cladding wastes, reactor emissions and mine and mill tailings.

(3) Found in wastes of nonnuclear power origin such as nuclear heat sources, irradiation sources, and biomedical applications.

**Indicates hazardous daughter radionuclides are present with the parent.

Appendix C

DECISION MODEL FOR SCREENING, SELECTING, AND RANKING HAZARDOUS WASTES

This preliminary decision model was developed for interim use* in order to screen and select hazardous compounds and rank hazardous wastes. This appendix provides an explanation of the terminology and definitions utilized, and the exact mechanism for screening, selecting, and ranking.

It is essential to make a clear distinction between development and application of criteria for purposes of designating hazardous wastes and development and application of a priority ranking system for hazardous wastes despite the fact that similar or related data must be manipulated. The distinction is that the hazardous waste criteria relate solely to the intrinsic hazard of the waste on uncontrolled release to the environment regardless of quantity, pathways to man or other critical organisms. Therefore criteria such as toxicity, phytotoxicity, genetic activity, and bioconcentration were utilized.

In contrast, in the development of a priority ranking system, it is obvious that the threat to public health and environment from a given hazardous waste is strongly dependent upon the quantity of the waste involved, the extent to which present treatment technology and regulatory activities mitigate against the threat, and the pathways to man or other critical organisms.

Criteria for Screening and Selection

The screening criteria are based purely on the inherent or intrinsic characteristics of the waste as derived from its constituent hazardous compounds. The problem in seeking a set of criteria becomes one of establishing for public health and the environment some acceptable level of tolerance. Wastes displaying characteristics outside of these predetermined tolerance levels are designated as hazardous. This approach requires that defensible thresholds be selected for each tolerance level. For example, if the toxicity threshold is defined as an LD_{50} of 5,000 mg/Kg of body weight or less, all wastes displaying equal or lower mean lethal dose levels would be designated hazardous. Similar numeric threshold values were developed for other basic physical, chemical or biological criteria utilized in the screening phase of the decision

* The decision model used for purposes of this study is not nearly as sophisticated as that required for standard setting purposes.

model. Ideally then, the decision criteria for designating hazardous wastes could be based upon numeric evaluations of intrinsic toxicological, physical, and chemical data.

In addition, a criteria system for screening hazardous wastes must retain a degree of flexibility. This is self-evident because all potential wastes cannot now be identified, let alone their composition. Consequently, it appears that a technically sound and administratively workable criteria system must have levels of tolerance against which any waste stream can be compared.

As a result a preliminary screening model was developed as illustrated in Figure C–1. Each stage of the screening mechanism compares the characteristics of a waste stream to some preset standard. Qualification due to any one or more screens automatically designates a waste as hazardous. Explanations of those terms that have been utilized in the screening model in Figure C–1 are enclosed at the end of this appendix.

Priority Ranking of Wastes

There is little doubt that, on the basis of intrinsic properties alone, many wastes will qualify as hazardous wastes. Therefore it was necessary to rank these wastes in priority fashion so that those presenting the most imminent threats to public health and the environment receive the greatest attention.

To assess the magnitude of the threat posed by hazardous wastes is difficult. Such a determination requires input concerning the inherent hazards of the wastes, the quantities of waste produced, and the ease with which those hazards can be eliminated or circumvented. These considerations were incorporated into numerical factors, which in turn were used to determine the priority-of-concern of a particular waste. The final numerical factor is designed to represent the volume of the environment potentially polluted to a critical level by a given waste. The assumption is made that all sectors of the environment are equally valuable so that a unit volume of soil is as important as a unit volume of water or air. This simplification does not reflect the fact that atmospheric and aquatic contaminants are more mobile than terrestrial ones, but does recognize the problem of environmental transfer from one phase to another.

The numerical factor is derived by dividing the volume of a waste by its lowest critical product. This may be expressed mathematically as

$$R = \frac{Q}{CP}$$

where R = ranking factor
Q = annual production quantity for the waste being ranked
CP = critical product for the waste being ranked

A critical product is the lowest concentration at which any of the hazards of concern become manifest in a given environment multiplied by an index representative of the waste's mobility into that environment. Hence, for a waste which will be discharged to water or to a landfill where leaching will occur, the product might be the 96 hour TLm to fish for that waste (e.g. 1 mg/l) multiplied by its solubility index. The solubility index is defined as a dimensionless number between 1 and infinity obtained by dividing 10^6 mg/l by the solubility of the waste in mg/l. A waste soluble in water to 500,000 mg/l has a solubility index of:

$$SI = 10^6/5 \times 10^5 = 2$$

This presumes that all wastes miscible in water or soluble to more than 1,000,000 mg/l will have similar mobility patterns and thus should receive a maximum index of 1. The critical product for the example waste would then be:

$$CP = 96 \text{ hr TLm} \times SI$$
$$CP = 1 \text{ mg/l} \times 2 = 2 \text{ mg/l}$$

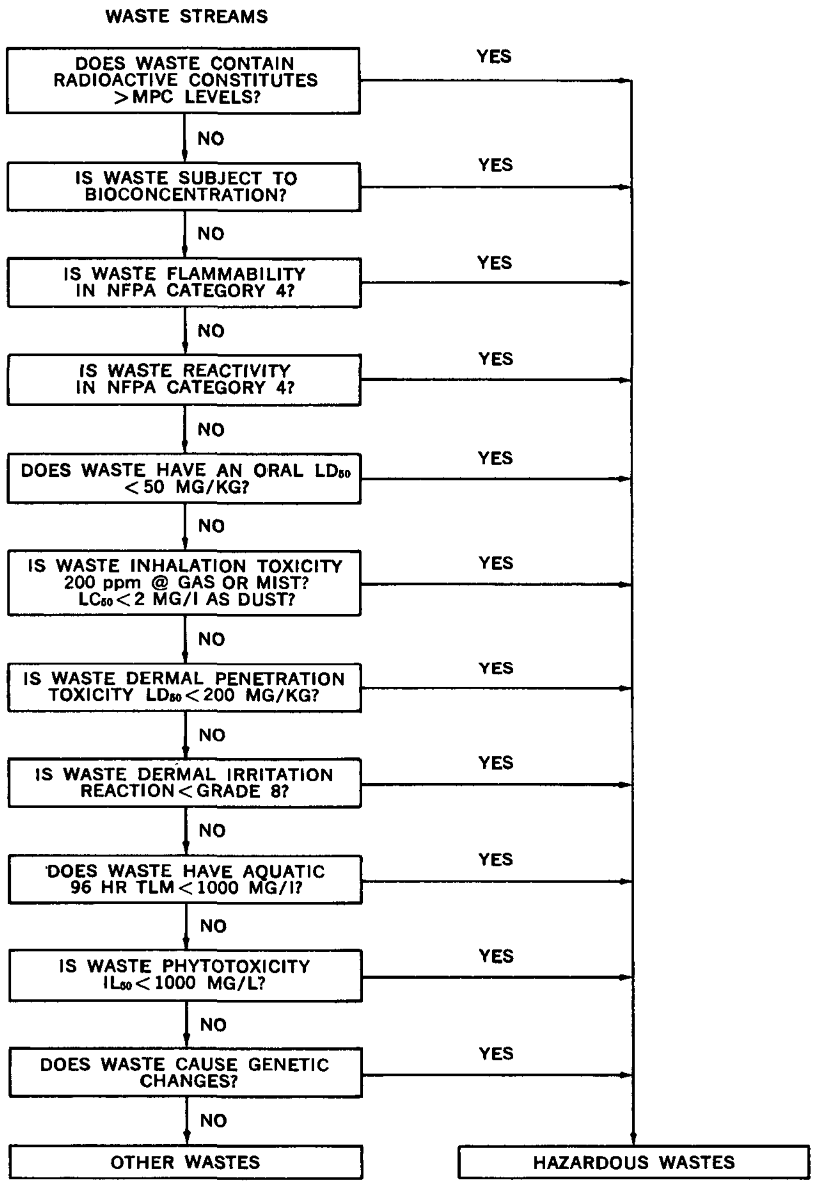
Similarly, for atmospheric pollutants the critical product might be the LC_{50} multiplied by the volatility index. This index would be derived by dividing atmospheric pressure under ambient conditions by the vapor pressure of the waste. Potential for suspension of dusts in air would be given a mobility index of 1.

The aqueous and atmospheric environments are of greatest concern since discharge to the land represents major hazards in the form of volatilization of wastes or leaching. Where data are available on phytotoxicity or other hazards related to direct contact with wastes in soil, the critical product for ranking would be derived from use of the critical concentration at which the hazard becomes apparent, and a mobility index of 1.

Actual waste stream data is most desirable for use in the priority ranking formulation. However, since such data are generally lacking, the additive estimations recommended for interim use can be employed for priority ranking until waste stream data become available.

FIGURE C-1

GRAPHIC REPRESENTATION
OF THE HAZARDOUS WASTE SCREENING MODEL*



*Definitions of terms are given on p. 213.

Definitions of Abbreviations Used in the Screening Model in Table C–1

Maximum Permissible Concentration (MPC) Levels. These are levels of radioisotopes in waste streams which if continuously maintained, would result in maximum permissible doses to occupationally-exposed workers, and may be regarded as indices of the radiotoxicity of the different radionuclides.

Bioconcentration (bioaccumulation, biomagnification). The process by which living organisms concentrate an element or compound to levels in excess of those in the surrounding environment.

National Fire Protection Association (NFPA).

Category 4 Flammable Materials. These materials include very flammable gases, very volatile flammable liquids, and materials that in the form of dusts or mists readily form explosive mixtures when dispersed in air.

NFPA Category 4 Reactive Materials. These are materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.

Lethal Dose Fifty (LD_{50}). A calculated dose of a chemical substance which is expected to kill 50 percent of a population of experimental animals exposed through a route other than respiration. Dose concentration is expressed in milligrams per kilogram of body weight.

Lethal Concentration Fifty (LC_{50}). A calculated concentration which when administered by the respiratory route would be expected to kill 50 percent of a population of experimental animals during an exposure of 4 hours. Ambient concentration is expressed in milligrams per liter.

Grade 8 Dermal Irritation. An indication of necrosis resulting from skin irritation caused by application of a 1 percent chemical solution.

96 Hour TLm (median threshold limit). That concentration of a material at which it is lethal to 50 percent of the test population over a 96 hour exposure period. Ambient concentration is expressed in milligrams per liter.

Phytotoxicity. Ability to cause poisonous or toxic reactions in plants.

Median Inhibitory Limit (ILm). That concentration at which a 50 percent reduction in the biomass, cell count, or photosynthetic activity of the test culture occurs when compared to a control culture over a 14 day period. Ambient concentration is expressed in milligram per liter.

Genetic Changes. Molecular alterations of the deoxyribonucleic or ribonucleic acids of mitotic or meiotic cells occurring from chemicals or electromagnetic or particulate radiation.

Appendix D

SUMMARY OF HAZARDOUS WASTE TREATMENT AND DISPOSAL PROCESSES

The objectives of hazardous waste treatment are the destruction or recovery for reuse of hazardous substances and/or conversion of these substances to innocuous forms which are acceptable for uncontrolled disposal. Several unit processes are usually required for complete treatment of a given waste stream. In some cases, hazardous residues result from treatment which cannot be destroyed, reused or converted to innocuous forms. These residues, therefore, require controlled storage or disposal.

This appendix presents a description of each of the treatment and disposal processes examined during this study. No claim is made that these hazardous waste treatment processes or combinations of processes and storage or disposal methods are environmentally acceptable. Treatment technology can be grouped into the following categories: physical, chemical, thermal, and biological. These processes are all utilized to some extent by both the public and private sectors. However, treatment processes have had only limited application in hazardous waste management because of economic constraints, and, in some cases, because of technological constraints.

The physical treatment processes are utilized to concentrate waste brines and remove soluble organics and ammonia from aqueous wastes. Processes such as flocculation, sedimentation, and filtration are widely used throughout industry, and their primary function is the separation of precipitated solids from the liquid phase. Ammonia stripping is utilized for removing ammonia from certain hazardous waste streams. Carbon sorption will remove many soluble organics from aqueous waste streams. Evaporation is utilized to concentrate brine wastes in order to minimize the cost of ultimate disposal.

The chemical treatment processes are also a vital part of proper hazardous waste management. Neutralization is carried out in part by reacting acid wastes with basic wastes. Sulfide precipitation is required in order to remove toxic metals like arsenic, cadmium, mercury, and antimony. Oxidation-reduction processes are utilized in treating cyanide and chromium-6 bearing wastes.

Thermal treatment methods are used for destroying or converting solid or liquid combustible hazardous wastes. Incineration is the standard process used throughout industry for destroying liquid and solid wastes. Pyrolysis is a relatively new thermal process that is used to convert hazardous wastes into more useful products, such as fuel gases and coke.

Biological treatment processes can also be used for biodegrading organic wastes; however, careful consideration needs to be given to the limitations of these processes. These systems can operate effectively only within narrow ranges of flow, composition, and concentration variations. Biological systems generally do not work on solutions containing more than 1–5 percent salts. Systems which provide the full range of biodegradation facilities usually require large land areas. Toxic substances present a constant threat to biological cultures. In summary biological treatment processes should be used only when the organic waste stream is diluted and fairly constant in its composition.

Disposal methods currently used vary depending upon the form of the waste stream (solid or liquid), transportation costs, local ordinances, etc. Dumps and landfills are utilized for all types of hazardous wastes; ocean disposal and deep well injection are used primarily for liquid hazardous wastes. Engineered storage or a secure landfill should be utilized for those hazardous wastes for which no adequate treatment processes exist.

In Table D–1, each of the processes evaluated by EPA is described in more detail. Also provided is an assessment of each process's waste handling capabilities. The most widely applicable processes are incineration, neutralization, and reduction.

TABLE D–1
SUMMARY OF HAZARDOUS WASTE
TREATMENT AND DISPOSAL PROCESSES

Physical Treatment Processes	Description	Waste Handling Capability
1. Reverse Osmosis	1. The physical transport of a solvent across a membrane boundary, where external pressure is applied to the side of less solvent concentration so that the solvent will flow in the opposite direction. This allows solvent to be extracted from a solution, so that the solution is concentrated and the extracted solvent is relatively pure.	1. Almost any dissolved solid can be treated by reverse osmosis, provided the concentrations are not too high and it is practical to adjust the pH to range 3–8.
2. Dialysis	2. A process by which various substances in solution having widely different molecular weights may be separated by solute diffusion through semi-permeable membranes. The driving force is the difference in chemical activity of the transferred species on the two sides of the membrane.	2. The oldest continuing commercial use of dialysis is in the textile industry. Dialysis is particularly applicable when concentrations are high and dialysis coefficients are disparate. It is a suitable means of separation for any materials on the hazardous materials list which form aqueous solutions.
3. Electrodialysis	3 Similar to dialysis in that dissolved solids are separated from their solvent by passage through a semi-permeable membrane. It differs from dialysis in its dependence on an electric field as the driving force for the separation.	3. Electrodialysis is applicable when it is desired to separate out a variety of ionized species from an unionized solvent such as water. Ionizable nitrates and phosphates (e.g. $Pb(NO_3)_2$, $Na_3 PO_4$) are removed with varying degrees of efficiency. With regard to NDS, electrodialysis *is applicable for the treatment of waste streams where it is* desirable to reduce the concentrations of ionizable species in the intermediate range (10,000 ppm to 500 ppm) over a broad range of pH (e.g , pH 1 to 14). If an effluent of concentration lower than 500 ppm is desired, the electrodialysis effluent could be fed into another treatment process.
4. Evaporation	4. The removal of solvent as vapor from a solution or slurry. This is normally accomplished by bringing the solvent to its boiling point to effect rapid vaporization. Heat energy is supplied to the solvent and the vapor evolved must be continuously removed from above the liquid phase to prevent its accumulation. The vapor may or may not be recovered depending on its value Thus, the principal function of evaporation is the transfer of heat to the liquid to be evaporated.	4. Evaporation processes are widely used throughout industry for the concentration of solutions and for the production of pure solvents. Evaporation represents the most versatile wastewater processing method available that is capable of producing a high quality effluent. It is, however, one of the most costly processes and is therefore generally limited to the treatment of wastewaters with high solids concentrations or to wastewater where very high decontamination is required (e.g., radioactive wastes).
5. Carbon Sorption	5. Sorption is said to occur when a substance is brought into contact *with a solid and is held at the surface or internally by physical and/or* chemical forces. The solid is called the sorbent and the sorbed substance is called the sorbate. The amount of sorbate held by a given quantity	5. Activated carbon sorption has been used to remove dissolved re*fractory organics from* municipal waste streams and to clean up industrial waste streams. It has been used to remove some heavy metals and other inorganics from water. Carbon sorption can remove most types of

TABLE D-1—Continued

Physical Treatment Processes	Description	Waste Handling Capability
	of sorbent depends upon several factors including the surface area per unit volume (or weight) of the sorbent and the intensity of the attractive forces. Activated carbon has been historically used to remove organic and other contaminants from water.	organic wastes from water. Those which have low removal by carbon include short carbon chain polar substances such as methanol, formic acid, and perhaps acetone. This process is being utilized to treat herbicide plant wastes. Also, full scale carbon sorption units have been successfully used for petroleum and petrochemical wastes.
6. Ammonia Stripping	6. Ammonia can be readily removed from alkaline aqueous wastes by stripping with steam at atmospheric pressure. The waste stream, at or near its boiling point, is introduced at the top of a packed or bubble cap tray type column and contacted concurrently with steam. Due to its *high partial pressure over alkaline solutions, ammonia is condensed* and reclaimed for sale, and liquid effluents from a properly designed steam stripping column will be essentially ammonia free.	6. This process is quite useful in the treatment of ammonia bearing wastes. However, it can also be used to remove various volatile and organic contaminants from waste streams.
7. Filtration	7. This process involves the physical removal of the solid constitutes from the aqueous waste stream. A slurry is forced against a filter medium. The pores of the medium are small enough to prevent the passage of some of the solid particles; others impinge on the fiber of the medium. Consequently, a cake builds up on the filter and after the initial deposition, the cake itself serves as the barrier. The capacity of this process is governed by the rate of the fluid filtrate through the bed formed by the solid particles.	7. Most of the aqueous hazardous waste streams which contain solid constituents will be treated by this process.
8 Sedimentation (Settling)	8. This process is used to separate aqueous waste streams from the particles suspended in them. The suspension is placed in a tank, and the particles are allowed to settle out; the fluid can then be removed from above the solid bed. The final state is that of a packed bed resembling a filter cake if the process is allowed to continue long enough.	8 Sedimentation is widely used throughout industry for treatment of waste streams for which there is a need for separation of precipitated solids from the liquid phase.
9. Flocculation	9 This process is used when fine particles in a waste stream are difficult to separate from the medium in which they are suspended. These waste constitutes are in the low and fractional micron-range of sizes; they settle too slowly for economic sedimentation and they are often difficult to filter. Thus, this process is applied to gather these particles together as flocculates which allows them to settle much faster and the resulting sediment is less dense and is often mobile. The particles also filter more readily into a cake which is permeable and does not clog.	9. Flocculation is also widely used throughout industry for treatment of waste streams for which there is a need for separation of precipitated solids from the liquid phase.

TABLE D-1—Continued

Chemical Treatment Processes	Description	Waste Handling Capability
1. Ion Exchange	1. The reversible interchange of ions between a solid and a liquid phase in which there is no permanent change in the structure of the solid. It is a method of collecting and concentrating undesirable materials from waste streams. The mechanism of ion exchange is chemical, utilizing resins that react with either cations or anions.	1. Ion exchange technology has been available and has been employed for many years for removing objectionable traces of metals and even cyanides from the various waste streams of the metal process industries. Objectionable levels of fluorides, nitrates, and manganese have also been removed from drinking water sources by means of ion exchange. Technology has been developed to the extent that the contaminants that are removed can either be recycled or readily transformed into a harmless state or safely disposed.
2. Neutralization	2. This method is utilized to prevent excessively acid or alkaline wastes from being discharged in plant effluents. Some of the methods utilized to neutralize such wastes are: (a) mixing wastes such that the net effect is a near-neutral pH; (b) passing acid wastes through beds of limestone; (c) mixing acid with lime slurries; (d) adding proper proportions of concentrated solutions of caustic soda (NaOH) or soda ash to acid waste waters; (e) blowing waste boiler-flue gas through alkaline wastes, (f) adding compressed CO_2 to alkaline waste; and (h) adding sulfuric acid to alkaline wastes.	2. Neutralization is utilized in the precipitation of heavy metal hydroxides or hydrous oxides and calcium sulfate.
3. Oxidation	3. This is a process by which waste streams containing reductants are converted to a less hazardous state. Oxidation may be achieved with chlorine, hypochlorites, ozone, peroxide, and other common oxidizing agents. The method most commonly applied on a large scale is oxidation by chlorine.	3. Ths process is used in the treating of cyanides and other reductants.
4. Reduction	4 This is a process whereby streams containing oxidants are treated with sulfur dioxide to reduce the oxidants to less noxious materials. Other reductants which can be used are sulfite salts and ferrous sulfate depending on the availability and cost of these materials.	4. This process is used to treat chromium–6 and other oxidants.
5. Precipitation	5. The process of separating solid constituents from an aqueous waste stream by chemical changes. In this process, the waste stream is converted from one with soluble constituents to one with insoluble constituents	5. This process is applicable to the treatment of waste streams containing heavy metals.
6. Calcination	6. The process of heating a waste material to a high temperature but without fusing in order to effect useful changes, such as oxidation or pulverization.	6 Calcination is commonly applied in the processing of high-level radioactive wastes.

TABLE D-1—Continued

Thermal Treatment Processes	Description	Waste Handling Capability
1. Incineration	1. A controlled process to convert a waste to a less bulky, less toxic, or less noxious material. Most incineration systems contain four basic components: namely, a waste storage facility, a burner and combustion chamber, an effluent purification device when warranted, and a vent or a stack. The (11) basic types of incineration units are: open pit, open burning, multiple hearth, rotary kiln, fluidized bed, liquid combustors, catalytic combustors, after burners, gas combustors, and stack flares.	1. The type of waste for which each of these incineration units is best suited is detailed diagrammatically in Figure D-1.
2. Pyrolysis	2 The thermal decomposition of a compound. Wastes are subjected to temperatures of about 1200°F, (648°C), plus or minus 300°F (148°C), depending upon the nature of the wastes, in an essentially oxygen-free atmosphere. Without oxygen, the wastes cannot burn and are broken down (pyrolyzed) into steam, carbon oxides, volatile vapors and charcoal.	2. Most municipal and industrial wastes which are basically organic in nature can be converted to coke or activated charcoal and gaseous mixtures which may approach natural gas in heating values through the utilization of pyrolysis.

FIGURE D–1

TYPES OF INCINERATORS AND THEIR APPLICATIONS

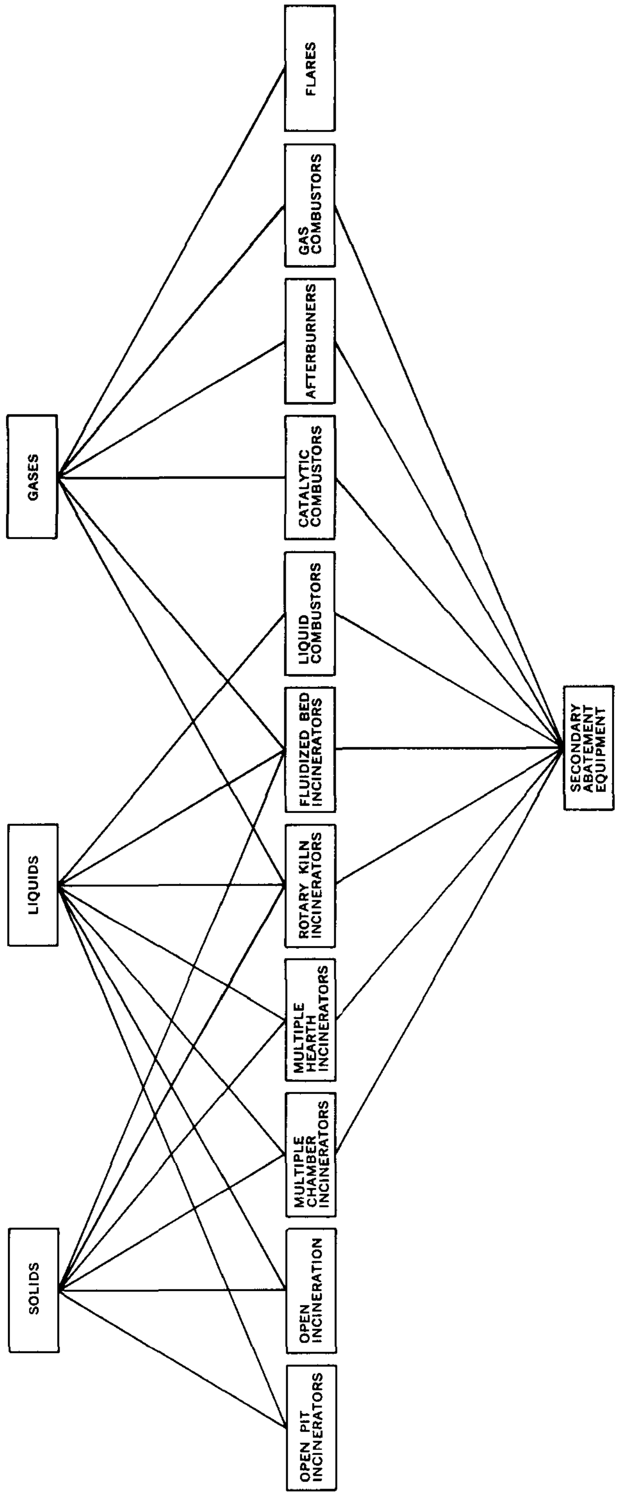


TABLE D-1—Continued

Biological Treatment Processes	Description	Waste Handling Capability
1. Activated Sludge Process	1. The activated sludge process may be defined as a system in which biologically active growths are continuously circulated and contacted with organic waste in the presence of oxygen. Normally, oxygen is supplied to the system in the form of fine air bubbles under turbulent conditions. The activated sludge is composed of the biologically active growths and contains microorganisms which feed on the organic waste. Oxygen is required to sustain the growth of the microorganisms. In the conventional activated sludge process incoming waste water is mixed with recycled activated sludge and the mixture is aerated for several hours in an aeration tank. During this period, adsorption, flocculation, and various oxidation reactions take place which are responsible for removing much of the organic matter from the waste water. The effluent from the aeration tank is passed to a sedimentation tank where the flocculated microorganisms or sludge settles out. A portion of this sludge is recycled as seed to the influent waste water.	1. The activated sludge process has been applied very extensively in the treatment of refinery, petrochemical, and biodegradable organic waste waters
2 Aerated Lagoon	2. A basin of significant depth (usually 6 to 17 feet or 1.83 to 5.19 meters), in which organic waste stabilization is accomplished by a dispersed biological growth system, and where oxygenation is provided by mechanical or diffused aeration equipment.	2. Aerated lagoons have been used successfully as an economical means to treat industrial wastes where high quality effluents are not required.
3. Trickling Filter	3. *Trickling filters are artificial beds of rocks or other porous media* through which the liquid from settled organic waste is percolated. In the process the waste is brought into contact with air and biological growths. Settled liquid is applied intermittently or continuously over the top surface of the filter by means of a distributor. The filtered liquid is collected and discharged at the bottom. The primary removal of organic material is not accomplished through filtering or straining action. Removal is the result of an adsorption process similar to activated sludge which occurs at the surfaces of the biological growths or slimes covering the filter media.	3. *Trickling filters* have been used extensively in the treatment of industrial wastes such as: acetaldehyde, acetic acid, acetone, acrolein, alcohols, benzene, butadiene, chlorinated hydrocarbons, cyanides, epichlorohydrin, formaldehyde, formic acid, ketones, monoethanolamines, phenolics, proplylenedichloride, terpenes, ammonia, ammonium nitrate, nylon and nylon chemical intermediates, resins, and rocket fuels.
4 Waste Stabilization Ponds	4. Waste Stabilization Ponds are large shallow basins (usually 2 to 4 feet or 0.61 to 1.22 meters deep) used for the purposes of purifying waste water by storage under climatic conditions that favor the growth of algae. The conversion of organics to inorganics or stabilization in such ponds results from the combined metabolic activity of bacteria by the algae and by surface aeration. Waste stabilization ponds have been widely used where land is plentiful and climatic conditions are favorable.	4. They have been used extensively in treating industrial wastewaters when a high degree of purification is not required. More recently, stabilization ponds have proven to be successful in treating steel mill wastes.

TABLE D-1—Continued

Ultimate Disposal Processes	Description	Waste Handling Capability
1. Landfill Disposal	1. A well controlled and sanitary method of disposal of wastes upon land. Common landfill disposal methods are: (a) miving with soil, (b) shallow burial, and (c) combinations of these.	1. The utilization of landfill procedures for the disposal of certain hazardous waste materials at a NDS, in an industrial environment, or in municipal applications will undoubtedly be required in the future.
2. Deep Well Disposal	2. A system of disposing of raw or treated, filtered hazardous wastes by pumping the waste into deep wells where they are contained in the pores of the permeable subsurface rock, separated from other ground-water supplies by impermeable layers of rock or clay.	2. Subsurface injection has been extensively used in the disposal of oil field brines (between 10,000 and 40,000 brine injection wells in U S.). The number of industrial waste injection wells in the U.S. has increased to more than 100. Injection wells can be used by virtually any type of industry which is located in the proper geologic environment and which has a waste product amenable to this method. Industries presently using this method are chemical and pharmaceutical plants, refineries, *steel and metal industries, paper mills, coke plants, etc*
3. Land Burial Disposal	3. Adaptable to those hazardous materials that require permanent disposal. Disposal is accomplished by either near-surface or deep burial. In near-surface burial, the material is deposited either directly into the ground or is deposited in stainless steel tanks or concrete lined pits beneath the ground. In land burial the waste is transported to the selected site, where it is prepared for final burial.	3. At the present time, near-surface burial of both radioactive and operated burial sites. Pilot plant studies have been conducted for deep chemical wastes is being conducted at several AEC and commercially burial in salt formations and hard bedrock. Land burial is a possible choice for the hazardous materials that require complete containment and permanent disposal. This includes radioactive wastes as well as highly toxic chemical wastes. At the present time only near-surface burial is used for the disposal of most wastes.
4. Ocean Dumping	4. The process of utilizing the ocean as the ultimate disposal sink for all types of waste materials (including hazardous wastes). There are three basic techniques for ocean disposal of hazardous wastes. One *technique is bulk disposal for liquid or slurry-type wastes. Another* technique is stripping obsolete or surplus World War II cargo ships, loading the ships with obsolete munitions, towing them out to sea, and scuttling them at some designated spot. The third technique is the sinking at sea of containerized hazardous toxic wastes.	4. The broad classes of hazardous wastes dumped at sea have been categorized as follows: industrial wastes; obsolete, surplus, and non-serviceable conventional explosive ordinance and chemical warfare and *miscellaneous hazardous wastes.*
5. Engineered Storage	5 This is a potential system to be utilized for those hazardous wastes (especially radioactive) for which no adequate disposal methods exist. Such a facility would have applicability until such time as a method for permanent disposal of these wastes is developed. Such a near-ground-surface engineered storage facility must provide for the following: (a) safe storage of the solidified hazardous wastes for long periods of time, and (b) retrievability of the wastes at any time during this storage. *The ultimate goal is to transfer these wastes to a permanent* disposal site when a suitable site is found.	5. This process is being proposed for the long-term storage of high level radioactive wastes. Also, some low level radioactive wastes will probably go to engineered storage facilities.

TABLE D-1—Continued

Ultimate Disposal Processes	Description	Waste Handling Capability
6. Detonation	6. This is the process of exploding a quantity of waste with sudden violence. Detonation can be performed by several means which include thermal shock, mechanical shock, electrostatic charge, or contact with incompatible materials. Detonation of a single waste may be followed by secondary explosions or fire.	6. This technique is most commonly applied to explosive waste materials. However, several flammable waste streams can also be detonated.

Appendix E

ON-SITE VERSUS OFF-SITE TREATMENT/DISPOSAL

Assuming that a hazardous waste generator elects to treat or dispose of his hazardous waste in an environmentally acceptable manner, an important economic decision that must be made by him is whether a particular waste stream should be processed on-site or off-site at some regional treatment facility. In order to make a sound business decision between these options an industrial manager must consider a number of variables such as the following: the chemical composition of the particular waste stream; the on-site availability and unit cost of a satisfactory treatment process; the quantity of the waste stream; and the distance to and user charge of the nearest off-site processing facility.

To gain a general insight into the economics of this problem, information was compiled on eight commonly occurring industrial hazardous waste stream types, and a mathematical model was formulated. The mathematical model resulted in economic decision maps for each of the eight industrial waste categories. (Nine decision maps are attached, because two maps are included for heavy metal sludges.)

As a result of this analysis, it was concluded that economic considerations favor the off-site treatment and disposal of seven out of the eight waste stream types examined. Only in the case of dilute aqueous heavy metals (Figure E–9) is the strategy of on-site treatment more economical.

The decision map for concentrated heavy metals (Figure E–1) is typical. The following discussion will identify and interpret, point by point, those aspects of the map that are considered significant.

Point A on the map represents data collected for a sample of actual waste sources. This point is defined by the mean separation between sources* and the mean source size (size as measured by waste stream volume). The position of point A on the map shows whether the on-site or off-site processing alternative is economically preferable. Here Point A lies comfortably within the OFF-SITE region of the map, and off-site processing of wastes collected from multiple sources is the most logical choice.

The vertical lines corresponding to the smallest and largest sources in the sample are also shown for perspective. For each of

* By "mean separation between sources" is meant the average distance between some waste sources actually found within a particular region.

the stream types an attempt was made to include the largest single producer of the waste in the country.

Two other points on the map are of interest. Point B defines the separation between sources that would be required if on-site processing is to be feasible, assuming no change in the sample mean. For concentrated heavy metals, this change-of-strategy separation distance is 360 miles (580 kilometers) compared to the mean value of 81 miles (131 kilometers).

Point C defines the source size at which on-site processing becomes feasible for sources separated by the sample mean separation. For concentrated heavy metals, this size is 16 million gallons per year (gpy) (61 million liters), compared to the sample mean of 325,000 gpy (1.2 million liters) and a sample maximum of 950,000 gpy (3.6 million liters). Clearly, off-site processing is preferable for concentrated heavy metal wastes. A mean volume concentrated heavy metals waste producer would have to be nearly 400 miles (640 kilometers) from any other similar waste producer before on-site treatment becomes attractive.

Examining the succeeding eight decision maps (Figures E–2 through E–9), it becomes apparent that each is different because each particular waste stream has its own cost characteristics as a result of different treatment and/or disposal requirements. Only in the case of dilute heavy metals (Figure E–9) is the above-defined Point A within the ON-SITE region of the map. Accordingly, the average generator of dilute heavy metal wastes would logically choose on-site treatment.

Development of the model on which the decision maps are based may be found in Reference thirty-six. Included among other important results of that particular study are discussions of location and spacing of regional treatment facilities.

FIGURE E-1
DECISION MAP CONCENTRATED HEAVY METALS

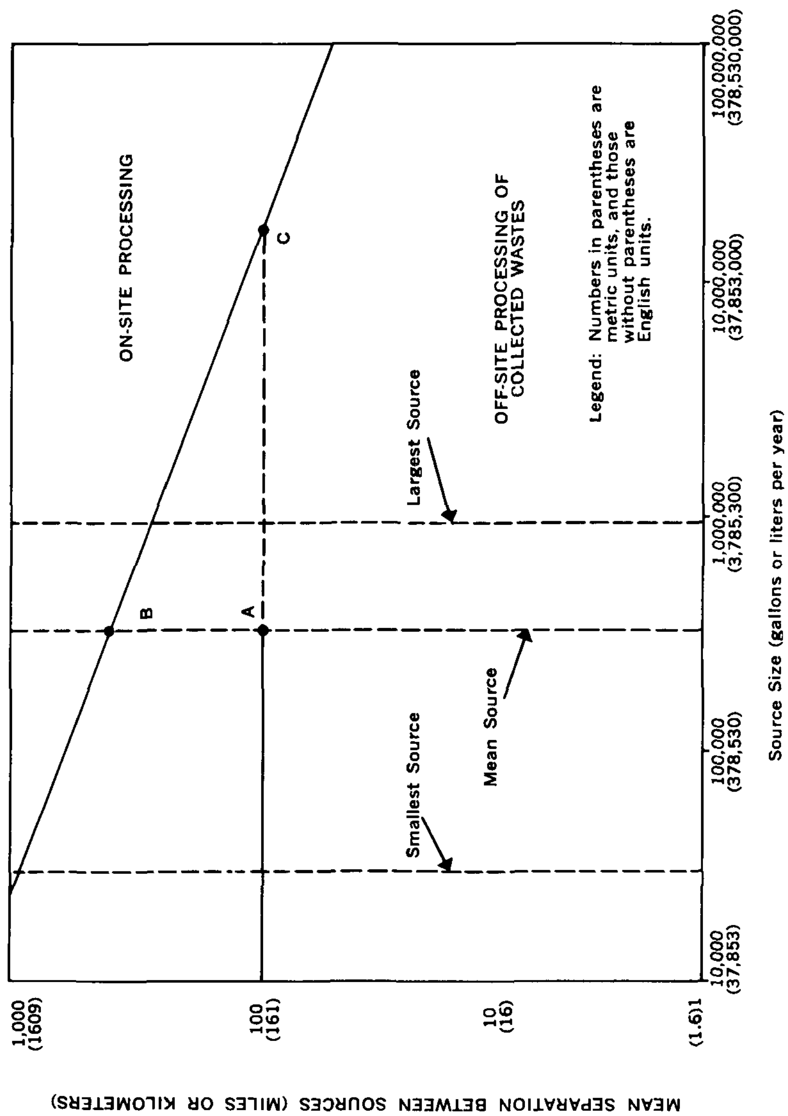


FIGURE E–2
DILUTE METALS WITH ORGANIC CONTAMINATION

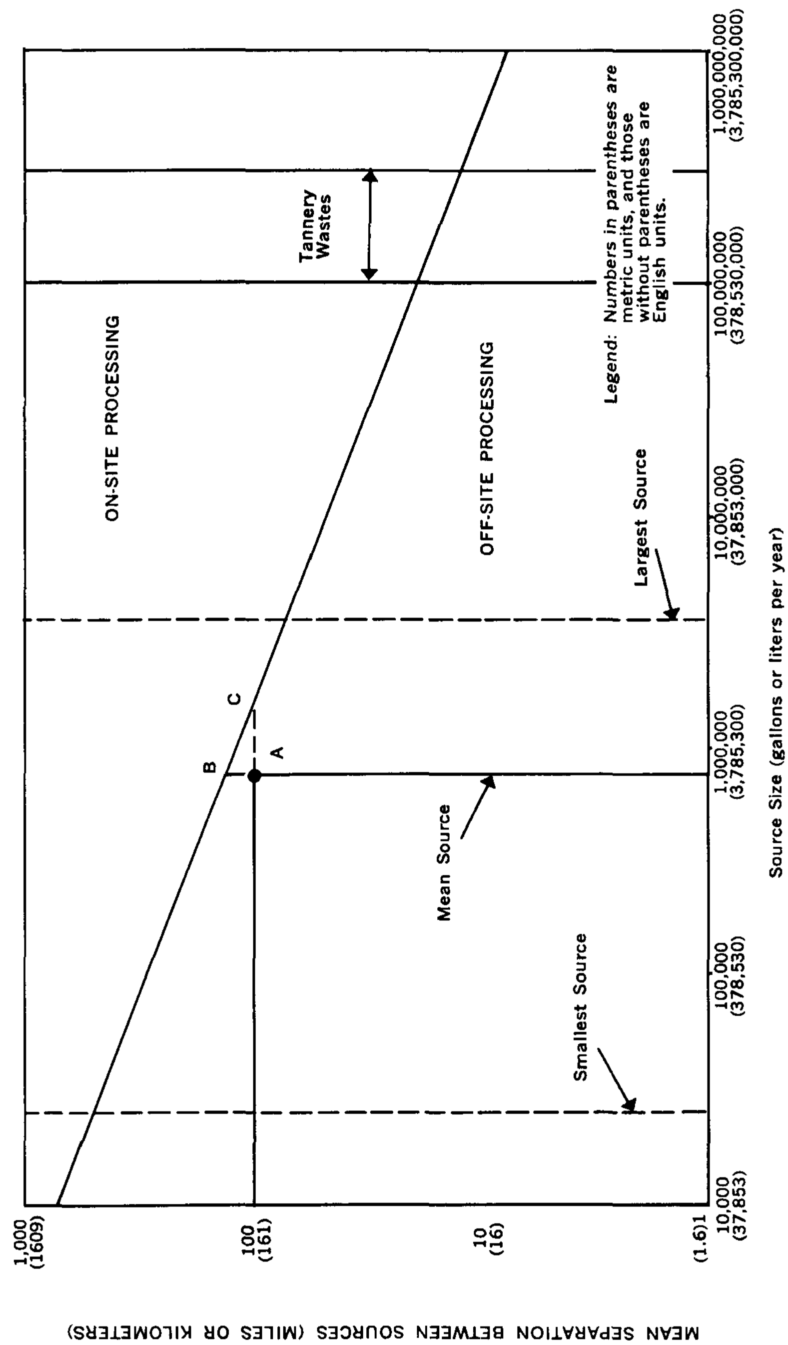


FIGURE E-3

ASPHALT ENCAPSULATION OF HEAVY METAL SLUDGES

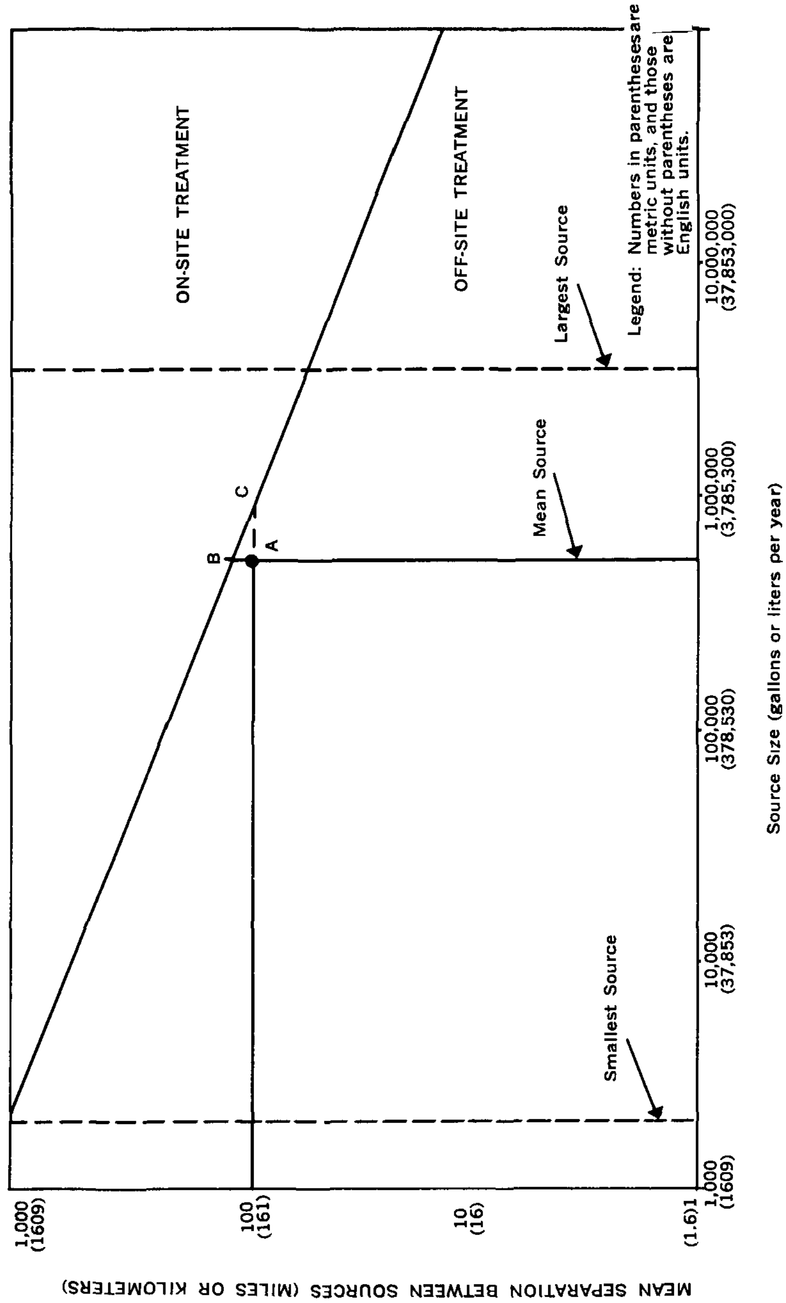


FIGURE E-4

CEMENT ENCAPSULATION OF HEAVY METAL SLUDGES

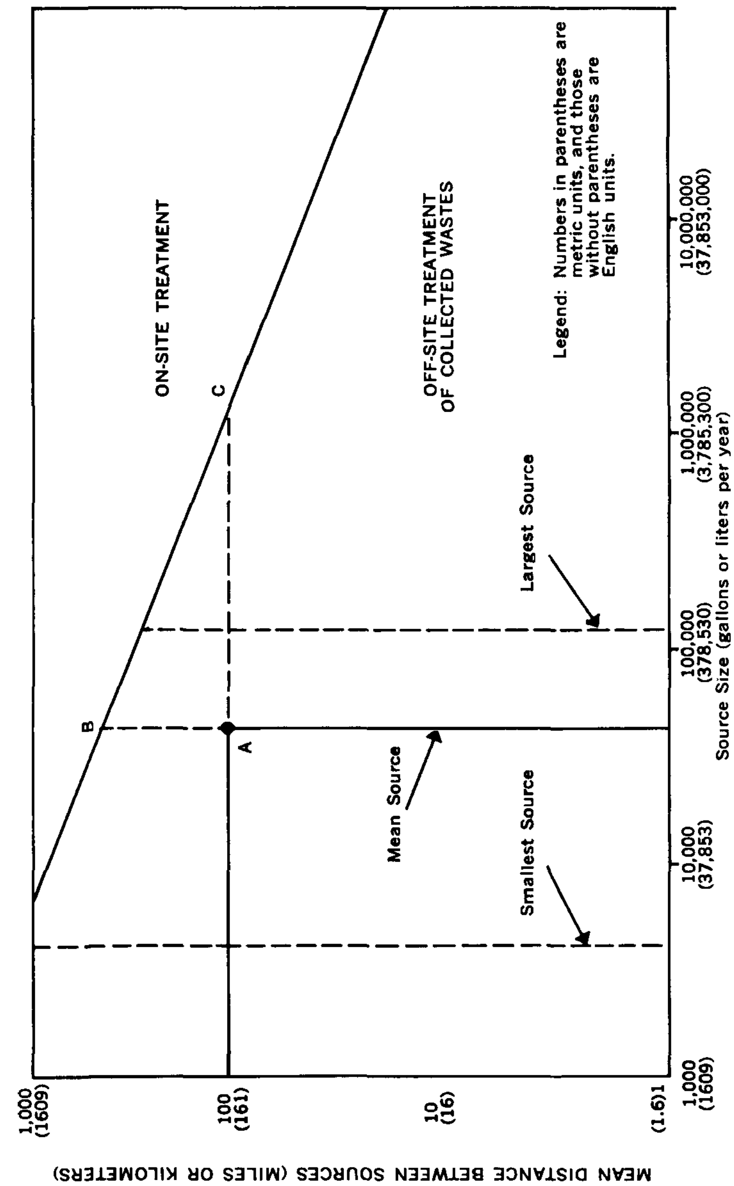


FIGURE E-5

CONCENTRATED CYANIDES

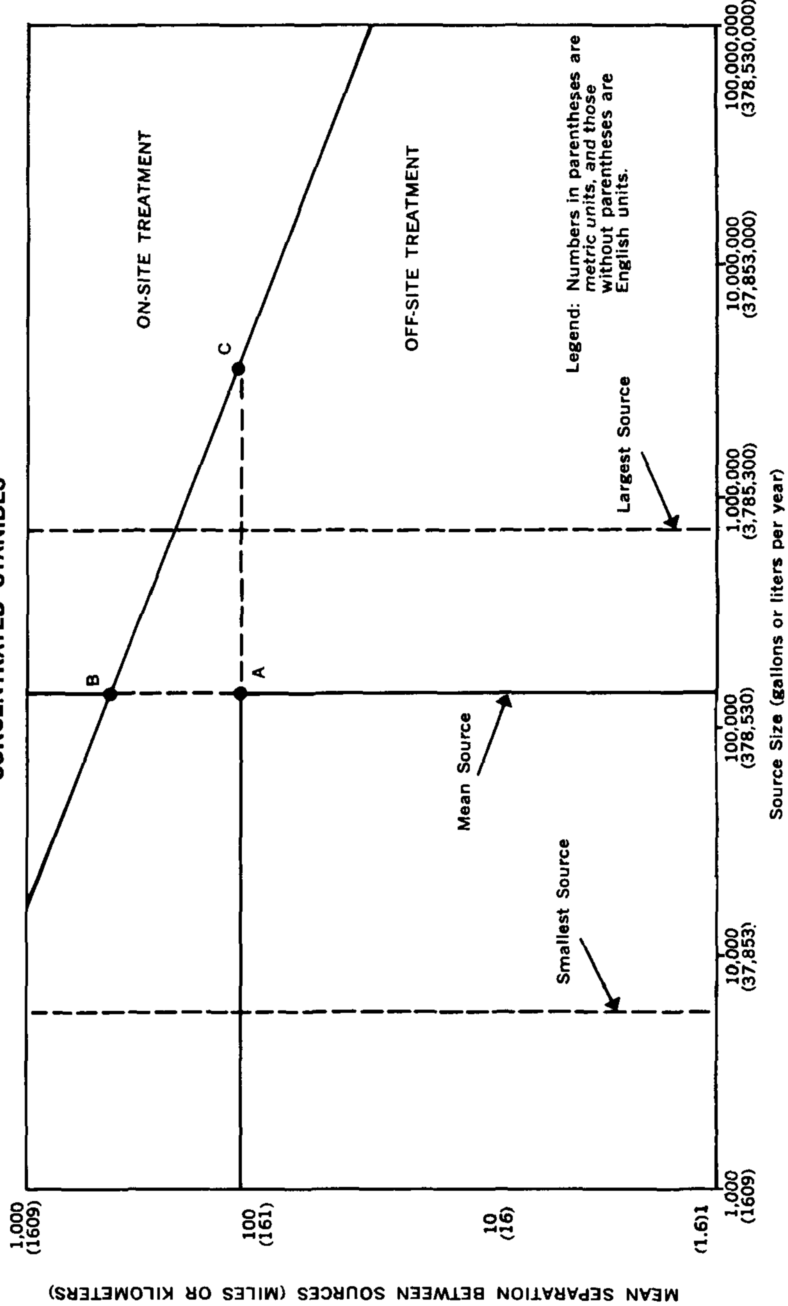


FIGURE E-6

LIQUID CHLORINATED HYDROCARBONS

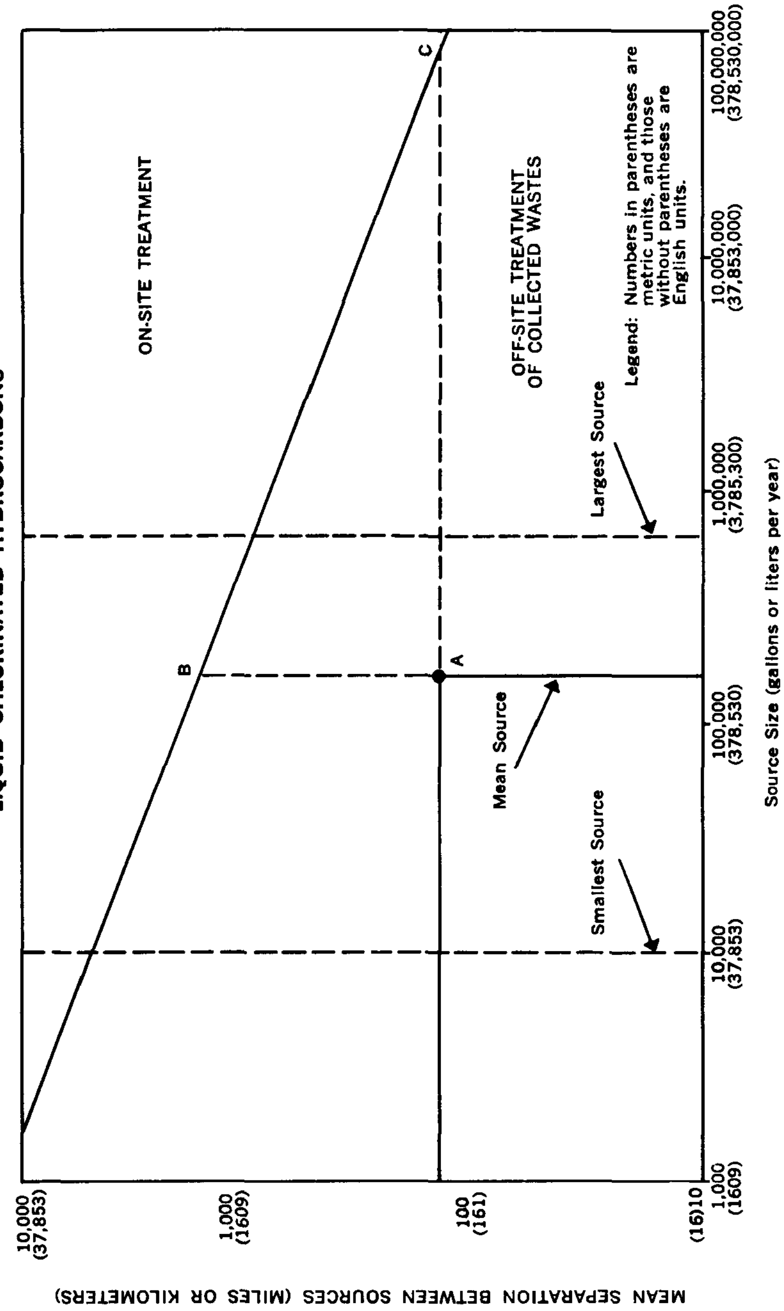


FIGURE E-7
DILUTE CYANIDES

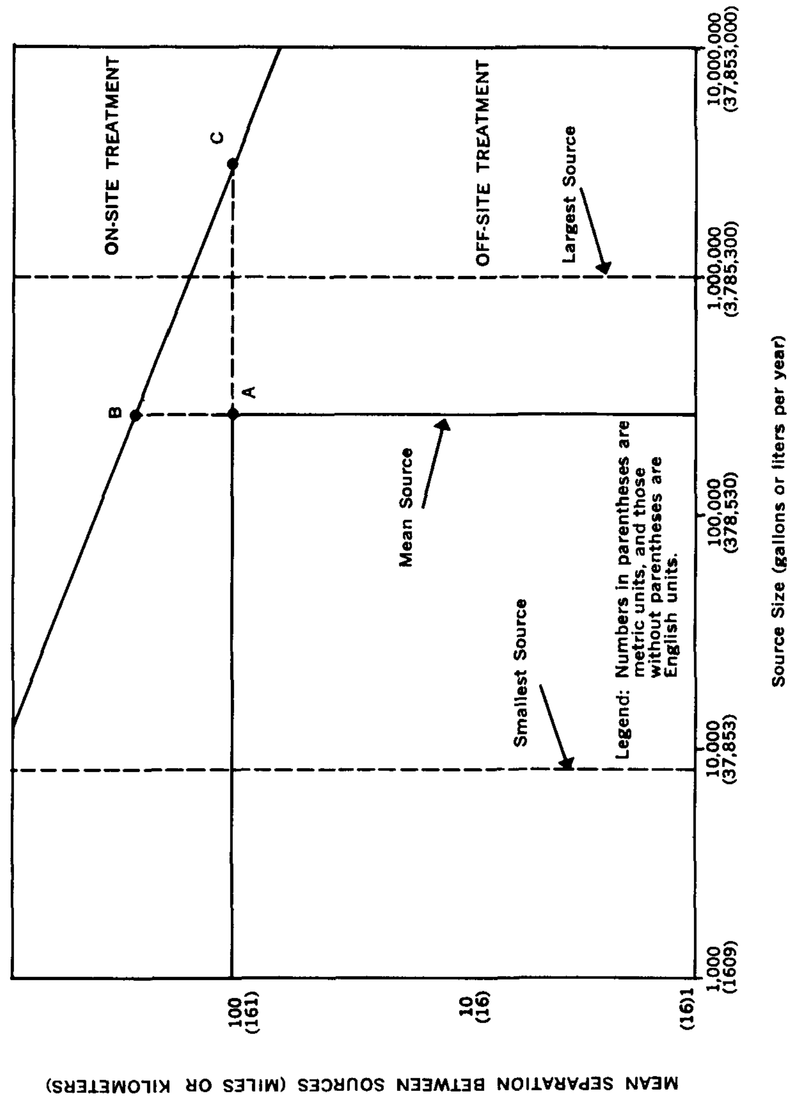
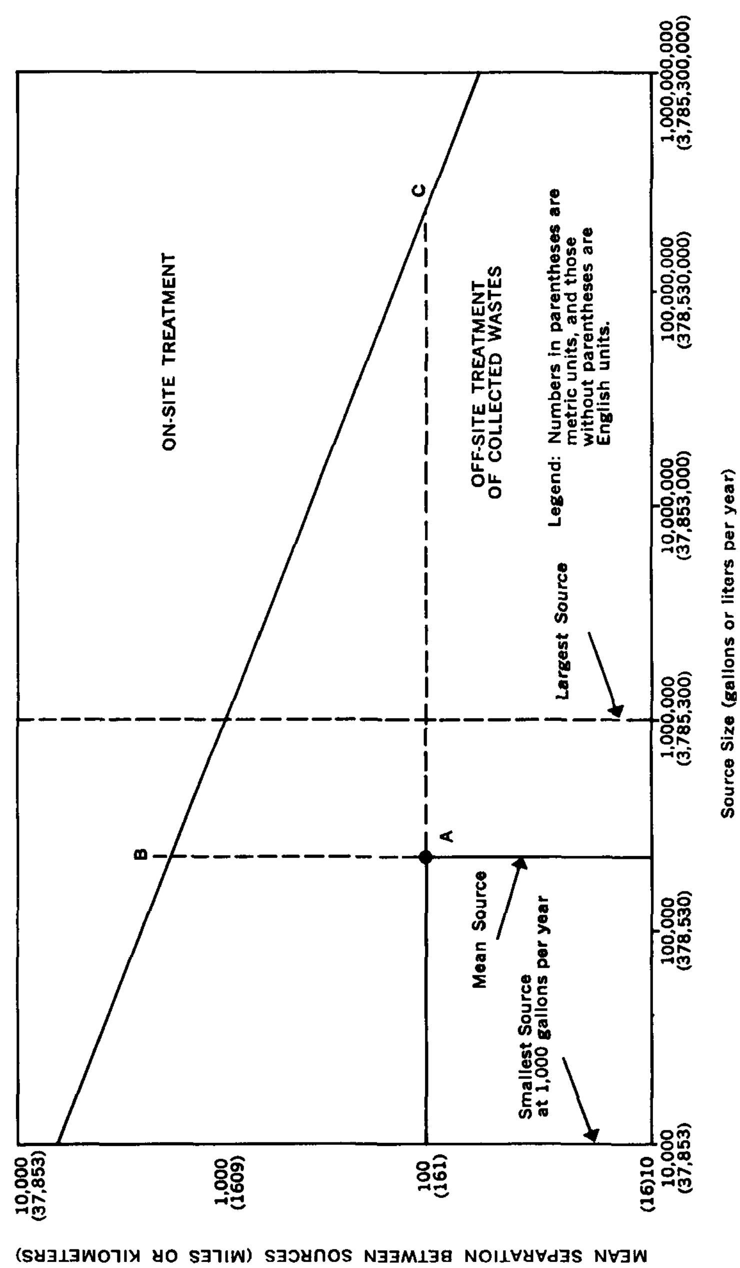


FIGURE E-8

CHLORINATED HYDROCARBON AND HEAVY METAL SLURRIES



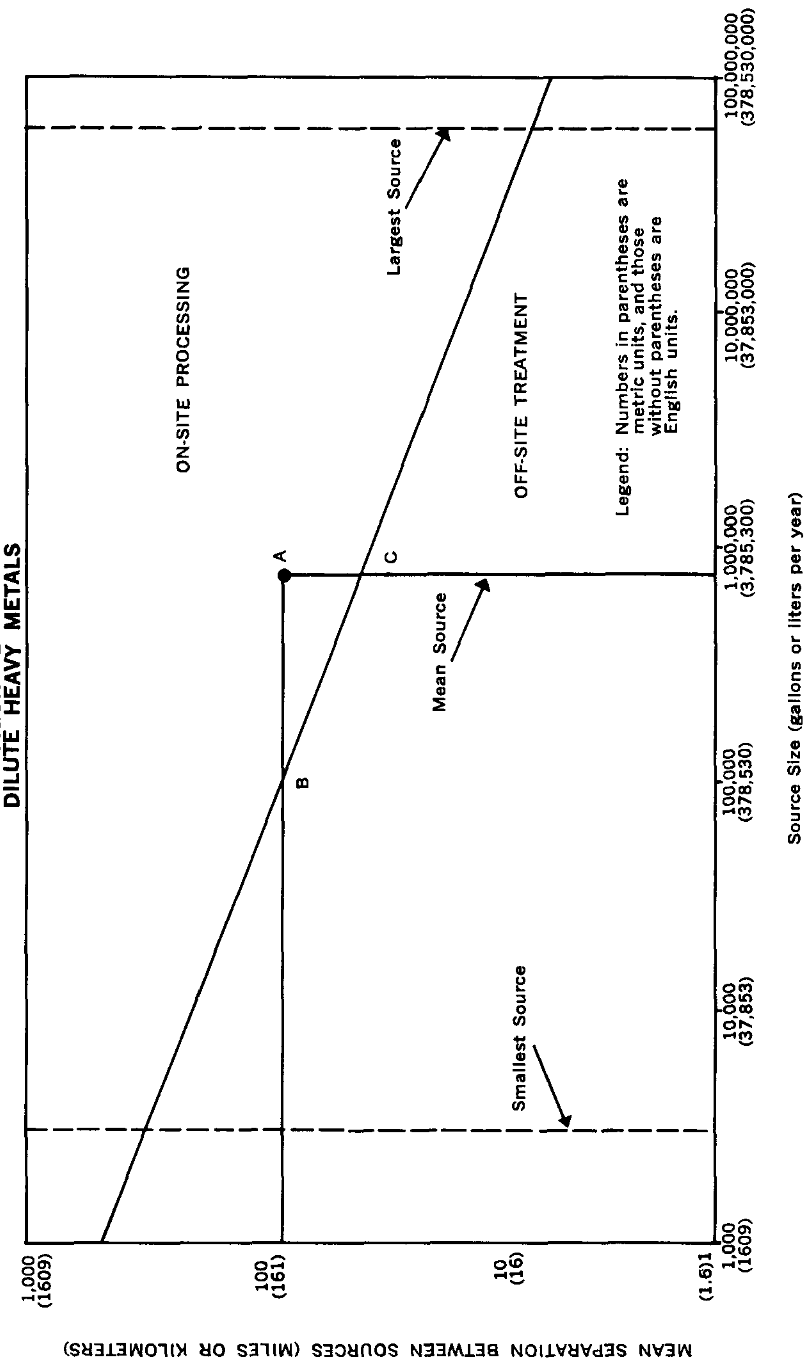


FIGURE E-9
DILUTE HEAVY METALS

Appendix F

SUMMARY OF THE HAZARDOUS WASTE NATIONAL DISPOSAL SITE CONCEPT

In the course of investigating the concept of "National Disposal Sites" for hazardous wastes as mandated by Section 212 of the Solid Waste Disposal Act (P.L. 89–272 amended by P.L. 91–512), important and relevant information was developed. Appendices B and D, respectively, provide a list of hazardous wastes subject to treatment at such sites, and summaries of current methods of treatment and disposal. This Appendix summarizes the findings related to: site selection, methods and processes that are likely to be used at a typical site, and the costs for developing and maintaining such sites. Reference one contains the detailed analyses performed and the rationale for this information.

Siting of Hazardous Waste Treatment and Disposal Facilities

The general approach to the site selection process was to first regionalize the coterminous United States into 41 multi-county regions. Spheres of influence for major industrial waste production areas, which are closely related to hazardous waste production areas, served as the basis for regional delineation (see Table F–1). Thirty-six waste treatment regions were identified, based upon the distance from the 41 major industrial waste production centers, and are shown on Figure F–1. A distance of about 200 miles (322 kilometers) in the East and 250 miles (402 kilometers) in the West was selected as the maximum distance any treatment site should be from the industrial waste production centers in a given subregion. Some of the regions do not contain an industrial waste production center; however, their boundaries are defined by surrounding regions containing waste production centers. No region was generally permitted to cross any major physiographic barrier. Notably, the regions are smaller in the East than in the West.

Criteria for site selection were defined with the major emphasis placed on health and safety, and environmental considerations. It was recognized early that two general types of sites would need to be identified: waste processing plant sites, and long-term hazardous waste disposal/storage sites. Site selection criteria and numerical weightings are presented in Table F–2.

Based on the site selection criteria, a ranking, screening, and weighting procedure was developed and applied to all counties located in the 36 regions which cover the country. The county-size areal unit (3,050 counties in the coterminous U.S.) appeared to be one of manageable size for the survey. The output listing of all 3,050 counties, grouped by regional ratings is contained in Reference one and is too voluminous for inclusion here. This listing allows for the orderly and rational selection of counties within each region, for site-specific reconnaissance, and for later detailed field studies that would be required in order to prove out the feasibility of a candidate site. From the total list that rates and ranks all counties, 74 appear to be potentially the best areas for locating hazardous waste treatment/disposal sites. These are presented in Table F–3. In addition, existing or potential Federal and State hazardous waste treatment and disposal sites were identified. Selected examples of these are presented in Table F–4. It should be noted that these are candidate sites; the suitability of a particular site can only be determined by additional field studies, field testing, and technical analyses of the data.

Hazardous Waste Management Methods and Costs

The approach used in this phase of the study involved development of a "model" facility capable of processing a wide variety of hazardous wastes (excluding radioactive wastes or chemical warfare agents generated or stored at AEC or DOD installations). Conceptual design and cost estimates were prepared for a complete waste management system to process and dispose of the wastes. In addition to treatment and disposal, peripheral functions such as transportation, storage, and environmental monitoring were also considered.

The basic objective of waste treatment at a hazardous wastes processing facility is the conversion of hazardous substances to forms which are acceptable for disposal or reuse. Since the majority of hazardous waste streams are complex mixtures containing several chemical species, treatment for removal and/or conversion of certain nonhazardous substances from the waste stream will also be required in order to comply with pollution control regulations. In a number of instances, treatment for the nonhazardous substances will dictate the type of process used and will entail the most significant operational costs (e.g., acid neutralization).

Broad treatment capability in a central processing facility will permit the processing of many nonhazardous wastes which could give the facility the advantage of economy of scale. In order to maintain a competitive position in the waste processing field in the case of a privately operated facility, it is anticipated that all wastes which can be processed with some return on investment will be accepted. It is possible that the volume of nonhazardous wastes will exceed the volume of hazardous wastes, perhaps by wide margins, in many areas. Inclusion of nonhazardous wastes processing also increases the opportunities for resource recovery (e.g., recovery of metals, oils, and solvents).

It must be emphasized that the model facility developed in this study was primarily designed for processing hazardous wastes. Therefore, processing facilities designed for both hazardous wastes and nonhazardous wastes may be different in many respects. A number of factors will dictate individual design variations for a given facility. Foremost will be the volumes and types of wastes, both hazardous and nonhazardous, that will be received for processing. One facility may require many different processes whereas another may require only one. Furthermore, processes selected for the model facility are not intended to be all-inclusive. A wide variety of processes, in addition to those selected for the model facility, is available to meet the needs of a particular location.

Description of Model Facilities

Hazardous Wastes Processing Facility. The model hazardous wastes processing facility incorporates the various functions related to waste treatment and disposal at one central location. The facility is basically a chemical processing plant which has design features for safe operation in a normal industrial area. Effluents discharged from the facility will be limited to those which meet applicable water and air standards. Local solid waste disposal will be limited to nonhazardous wastes which are acceptable for burial at a conventional landfill. The conventional landfill may be located adjacent to the processing facility or a short distance away. In general, nonhazardous waste brines resulting from hazardous waste treatment will be disposed by ocean dumping where appropriate to avoid potential quality impairment of fresh water sources. Land disposal of these brines is a potential alternative method which is less desirable and which will be used only in arid regions and even there infrequently. All such disposal operations will be in accordance with applicable local, State, and Federal standards.

In order to accomplish treatment and disposal objectives, the facility will also contain equipment and structures necessary for transporting, receiving, and storing both wastes and raw material. Another important feature will be a laboratory which provides: (1) analytical services for process control and monitoring of effluent and environmental samples; and (2) pilot scale testing services to assure satisfactory operation of the processing plant. The latter normally is not required in a conventional chemical processing plant, but due to the highly variable nature of the waste feed in this case, pilot scale testing is considered essential.

Hazardous Wastes Disposal Facility. For purposes of the model the hazardous wastes disposal facility will consist of a "secure" landfill and the appropriate equipment and structures necessary to carry out burial and surveillance of the hazardous solid wastes. Special measures are to be taken during backfilling to minimize water infiltration. It is possible that low level radioactive burial sites currently used in arid regions of the western United States could also be used with appropriate segregation, for disposal of the hazardous solid wastes.

Process Selection. Conceptual design objectives for the model facility included broad treatment capability to permit processing of all hazardous wastes of significant volume generated across the country. Important process selection criteria include demonstrated applicability to the treatment and disposal of existing hazardous wastes and flexibility to handle a wide variety of different waste streams.

The objectives of waste processing at the model facility are the removal of hazardous and polluting substances and/or conversion of these substances to forms which are acceptable for disposal or reuse. Based upon the hazardous wastes identification portion of this study described in Section 2 and in Appendix B, it was determined that in order to accomplish these objectives the model facility should include treatment processes for:

1. Neutralization of acids and bases
2. Oxidation of cyanides and other reductants
3. Reduction of chromium-6 and other oxidants
4. Removal of heavy metals
5. Separation of solids from liquids
6. Removal of organics
7. Incineration of combustible wastes
8. Removal of ammonia
9. Concentration of waste brines

Processes selected for inclusion in the model facility are presented in Table F–5. Also, Appendix D describes the major characteristics of these processes. A conceptual flow diagram, which integrates the various treatment steps in modular form (illustrated in Figure F–2), was developed for the model hazardous waste facility. The flow pattern represents that normally expected, and provides for additional piping to permit alterations when necessary.

Cost Estimates. Design capacities, capital, and operating costs for typical small, medium, and large size processing facilities are summarized in Tables F–6, F–7, and F–8, respectively. The costs include estimates for land, buildings, laboratory offices, and auxiliary equipment. It should be noted that these cost data are based on preliminary estimates which have been developed from a number of basic assumptions, and are only intended to indicate the norm of a range of costs. Table F–9 identifies in sequence those basic assumptions that have been utilized to arrive at the number, fixed capital and operating costs of large, medium, and small hazardous waste treatment/disposal facilities. This information was then utilized to develop the configuration for the scenario of a hazardous waste management system cited in Section 4.

A more detailed comparative cost analysis that identifies and summarizes capacities, fixed capital, and operating costs associated specifically with treatment facilities has been developed in Table F–10. These data were utilized in developing the cost aspects of the system scenario.

TABLE F–1

INDUSTRIAL WASTE PRODUCTION CENTERS

1. Seattle, Tacoma, Everett, Bellingham, WA
2. Portland, OR; Vancouver, Longview, WA
3. San Francisco Bay Area, CA
4. Ventura, Los Angeles, Long Beach, CA
5. San Diego, CA
6. Phoenix, AZ
7. Salt Lake, Ogden, UT
8. Idaho Falls, Pocatello, ID
9. Denver, CO
10. Sante Fe, Aubuquerque, NM
11. El Paso, TX
12. Fort Worth, Dallas, Waco, TX
13. Austin, San Antonio, Corpus Christi, TX
14. Houston, Beaumont, Port Arthur, Texas City, Galveston, TX
15. Oklahoma City, Tulsa, Bartlesville, OK
16. Wichita, Topeka, Kansas City, KS
17. Omaha, Lincoln, NB; Des Moines, IA
18. Minneapolis, St. Paul, Duluth, MN
19. Cedar Rapids, IA; Burlington, Dubuque, IA; Peoria, IL.
20. St. Louis, MO; Springfield, IL
21. Memphis, TN
22. Shreveport, Baton Rouge, New Orleans, LA; Jackson, MS
23. Mobile, Montgomery, AL; Tallahassee, FL; Biloxi, Gulfport, MS; Columbus, GA
24. Huntsville, Birmingham, AL; Atlanta, Macon, GA; Chattanooga, Nashville, TN
25. Louisville, Frankfort, Lexington, KY; Evansville, IN
26. Albany, Troy, Schenectady, NY
27. Indianapolis, IN; Cincinnati, Dayton, OH
28. Chicago, Kankakee, IL; Gary, South Bend, Hammond, Fort Wayne, IN
29. Midland, Saginaw, Grand Rapids, Detroit, Dearborn, Flint, MI; Toledo, OH
30. Columbus, Cleveland, Youngstown, Akron, OH
31. Pittsburgh, Johnstown, Erie, PA
32. Charleston, WV; Portsmouth, Norfolk, VA
33. Charleston, SC; Savannah, Augusta, GA
34. Winston-Salem, Raleigh, Greensboro, Charlotte, NC
35. Baltimore, MD
36. Philadelphia, Allentown, Harrisburg, PA; Camden, Elizabeth, NJ; Wilmington, DE
37. New York, NY; Newark, Paterson, NJ
38. Buffalo, Rochester, Syracuse, Watertown, NY
39. Boston, MA
40. Orlando, Tampa, Miami, FL
41. Little Rock, Pine Bluff, Hot Springs, AR

FIGURE F-1
SITE SELECTION REGIONS

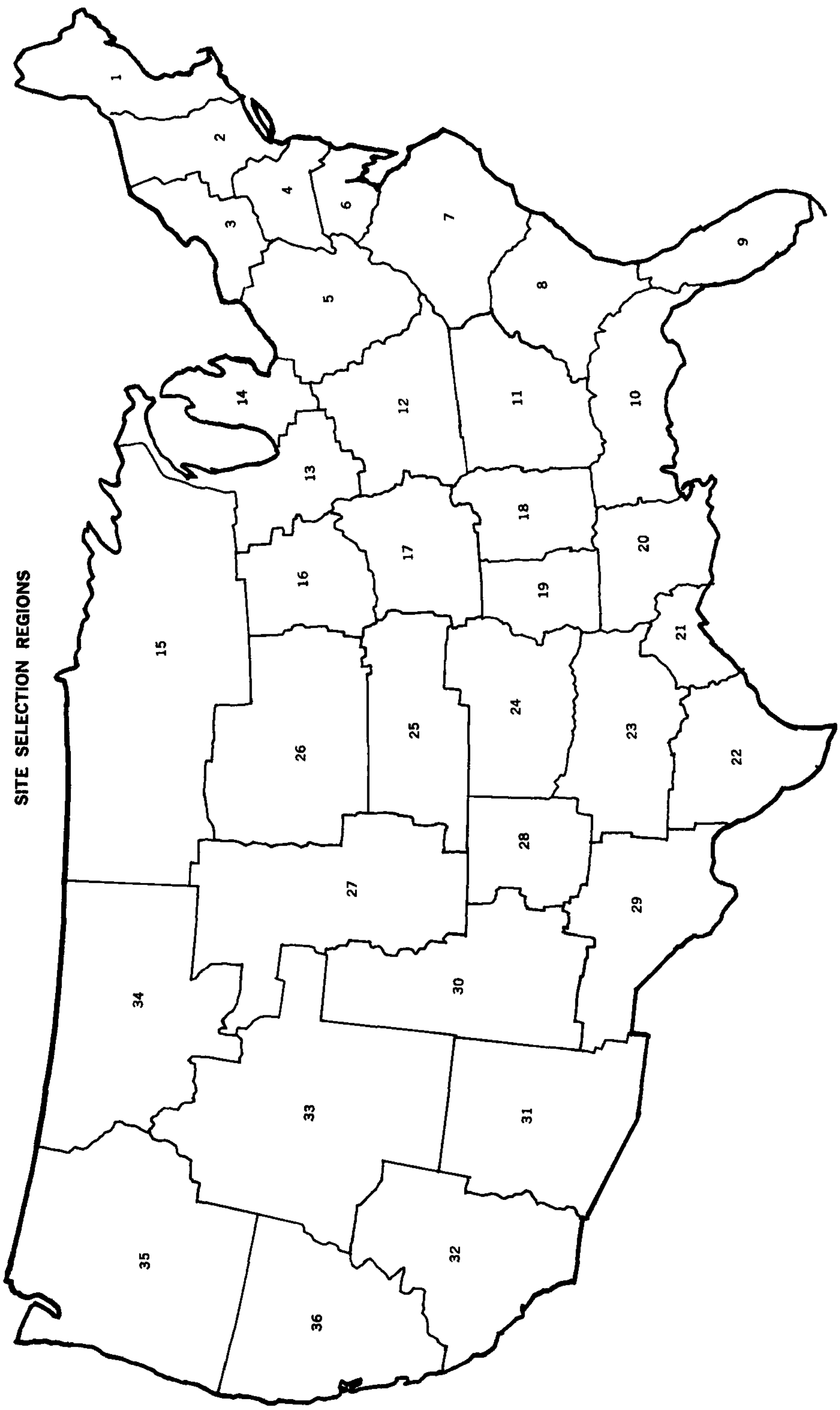


TABLE F-2
SITE SELECTION CRITERIA

General Criteria	Weighting
o Earth Sciences o Geology o Hydrology o Soils o Climatology	31
o Transportation o Risk o Economics	28
o Ecology o Terrestrial Life o Aquatic Life o Birds and Wildfowl	18
o Human Environment and Resources Utilization o Demography o Resources Utilization o Public Acceptance	23

TABLE F-3
POTENTIAL WASTE TREATMENT AND DISPOSAL SITES

State	County	State	County	State	County
Alabama	Sumter*	Missouri	Audrain	South Carolina	Barnwell
Arizona	Yuma	Montana	Custer		Greenwood
	Dallas	Nebraska	Kearney	Tennessee	Gibson
California	Fresno	Nevada	Nye*		Montgomery
	Inyo		Pershing	Texas	Bell
	Kern*		Washoe		Erath*
	Ventura	New Jersey	Sussex		Gillespie
Colorado	Weld	New Mexico	Eddy		Grimes
Connecticut	Hartford		Quay		Harris*
Florida	Alachua		San Juan		Haskell
Georgia	Dooley*	New York	Albany		Kendall
Iowa	Howard		Onondaga		Polk
Illinois	Jasper		Otsego		Sutton
	Vermillion		Steuben	Utah	Tooele
	Livingston*		Wyoming	Virginia	Brunswick
	Ogle	North Dakota	Grand Forks		Caroline
Indiana	Jackson	Oklahoma	Atoka		Fluvana
Kansas	Ellsworth		Custer		Pittsylvania
Kentucky	Franklin		Kay	Washington	Benton
Maryland	Carroll	Ohio	Darke		Lincoln
Massachusetts	Franklin*		Carroll	West Virginia	Doddridge
	Worcester		Wayne	Wyoming	Campbell
Mississippi	Lincoln	Oregon	Deschutes		Laramie
Michigan	Isabella*	Pennsylvania	Clinton		
	Shiawassee		Montgomery		
			York*		

*Denotes potential for large size processing facilities.

TABLE F-4

EXISTING AND POTENTIAL HAZARDOUS WASTE TREATMENT AND DISPOSAL SITES
(FEDERAL AND STATE)

Existing Sites Operated by Federal Agencies

USAEC

- Hanford Works, Benton County, Washington
- Savannah River Plant, Aiken County, South Carolina
- National Reactor Testing Station, Bingham County, Idaho
- Nevada Test Site, Nye County, Nevada
- Oak Ridge, Anderson County, Tennessee
- Los Alamos Scientific Laboratory, Los Alamos County, New Mexico
- Pantex Plant, Randall County, Texas
- Rocky Flats Plant, Jefferson County, Colorado
- Fernald, Butler/Hamilton Counties, Ohio

DOD

- Edgewood Arsenal, Maryland
- Pine Bluff Arsenal, Arkansas
- Rocky Mountain Arsenal, Colorado
- Tooele Army Depot, Utah
- Umatilla Army Depot, Oregon
- Anniston Army Depot, Alabama
- Pueblo Army Depot, Colorado
- Newport Army Ammunition Plant, Indiana
- Lexington Bluegrass Army Depot, Kentucky

State Licensed Radioactive Waste Sites*

- Morehead, Kentucky
- Beatty, Nevada
- Hanford Works, Washington
- West Valley, New York
- Barnwell, South Carolina

Representative Commercial Radioactive Waste Burial Site Characteristics

a. Beatty, Nevada Site

Background

Ownership of site	State of Nevada, leased to NECO
Population—density in area	Desert, virtually uninhabited
Location re towns and cities	About 12 mi (19.3 kilometers) southeast of Beatty
Area of (1) site; (2) controlled acres	(1) 80; (2) desert, not controlled
Communications	Good; hwy U.S 95
Precipitation (in.) (centimeters)	2.5–5.0(6.35–12 7 cm)/yr

Site Characteristics

Drainage	Adequate
Bedrock depth and materials (est)	575 +ft (175 meters); various sedimentary and metamorphic
Surficial material—depth; types	∾575 ft (175 meters) alluvial clay, sand, etc.
Groundwater—depth; slope	275–300 ft (84–91.5 meters); SE∾30 ft/mi (5.67 meters/kilometers)
Land and water use downstream	Very little, desert conditions
General soil characteristics	Semi-arid desert; deep soil

*Denotes potential for large size processing facility.

TABLE F-4—(Continued)

Operation—Equipment and Methods

Monitoring instruments and devices	14 survey instrs; film, air monitors; etc.
Waste handling machinery	Tank truck; trailer trucks; dozer; 35-T crane
Trenches—(1) dimensions; (2) design; (3) water pumped?	(1) 650 (198m) × 50 (15.2m) × depth 20 (6.1m) ft; (2) usual design, i.e., drain to sump, 4 ft (1.2m) backfill; (3) no water collected
Waste handling—(1) transport by company; (2) processing; (3) burial procedures.	(1) yes; (2) liquids solidified; (3) sp. nu. mat. spaced at bottom, slit trench for high-activity materials

b. Morehead, Kentucky Site

Background

Ownership of site	State of Kentucky, leased to NECO
Population—density in area	Rural, sparse (Maxey Flats)
Location re towns and cities	10 mi (16 hectares) northwest of Morehead
Area of: (1) site; (2) controlled acres (hectares)	(1) 200 (81 hectares); (2) 1000 (405 hectares)
Communications	Fair; state hwy N and S
Precipitation (in.) (centimeters)	46 (117 cm)/yr (heavy storms)

Site Characteristics

Drainage	Well drained
Bedrock depth and materials (est)	50–75 ft (15.25–22.8 meters) (?); shale, sandstone, siltstone
Surficial material—depth; types	50–75 ft (15.25–22.8 meters) (?); shale, clay, siltstone
Groundwater—depth; slope	35–50 ft (10.7–15.25 meters) ("perched" 2–6 ft [0.61–1.83 meters]); erratic
Land and water use downstream	Very little nearby, distant (no data)
General soil characteristics	Very impermeable; good soil sorption

Operation—Equipment and Methods

Monitoring instruments and devices	Essentially same as at Beatty
Waste handling machinery	Usual—crane; dozer; forklifts; etc.
Trenches—(1) dimensions; (2) design; (3) water pumped?	(1) 300 (9.15m) × 50 (15.25m) × depth 20 (6.1m) ft; (2) usual design, sump; (3) yes
Waste handling—(1) transport by company; (2) processing; (3) burial procedures.	(1) and (2) same as Beatty (both NECO); (3) per "Radiation Safety Plan" (NECO)

c. Hanford, Washington Site

Background

Ownership of site	State of Washington, leased to NECO
Population—density in area	No resident, inside AEC plant
Location re towns and cities	25 mi (40 2m) north of Richland
Area of (1) site; (2) controlled acres	(1) 100 (40 hectares); (2) 1000 (400 hectares) state owned
Communications	Good, AEC Hanford reservation
Precipitation (in.) (centimeters)	6–8 (15–20 cm)/yr.

Site Characteristics

Drainage	Well drained
Bedrock depth and materials (est)	250–450 ft (76–137m); basalt
Surficial material—depth; types	150–350 ft (47–10.7m); silty sand, gravel, clay
Groundwater—depth; slope	240 ft (73m); N and E ∾ 15–35 ft/mi (2.8–6.6 meters/kilometers)
Land and water use downstream	Columbia River—all uses
General soil characteristics	Little precipitation; deep dry soil

TABLE F-4—(Continued)

Operation—Equipment and Methods	
Monitoring instruments and devices	As licensed—survey instrs, film, counters
Waste handling machinery	Usual—crane, shovel, dozer, lifts, etc.
Trenches—(1) dimensions; (2) design; (3) water pumped?	(1) 300 (92m) × 60 (18m) × depth 25 ft (7.6m); (2) usual design; (3) no water collects in sump
Waste handling—(1) transport by company; (2) processing; (3) burial procedures.	(1) yes, 95%; (2) liquids solidified; (3) sp. nu. mat. spaced, separate trench for ion-exchange resins

TABLE F-5
PROCESS SELECTED FOR INCLUSION IN
MODEL HAZARDOUS WASTES PROCESSING/DISPOSAL FACILITY

Treatment Processes	Disposal Processes
Neutralization	Ocean dumping
Precipitation	Landfill
Oxidation-Reduction	
Flocculation-Sedimentation	
Filtration	
Ammonia Stripping	
Carbon Sorption	
Incineration	
Evaporation	

FIGURE F–2

CONCEPTUAL MODULAR FLOW DIAGRAM

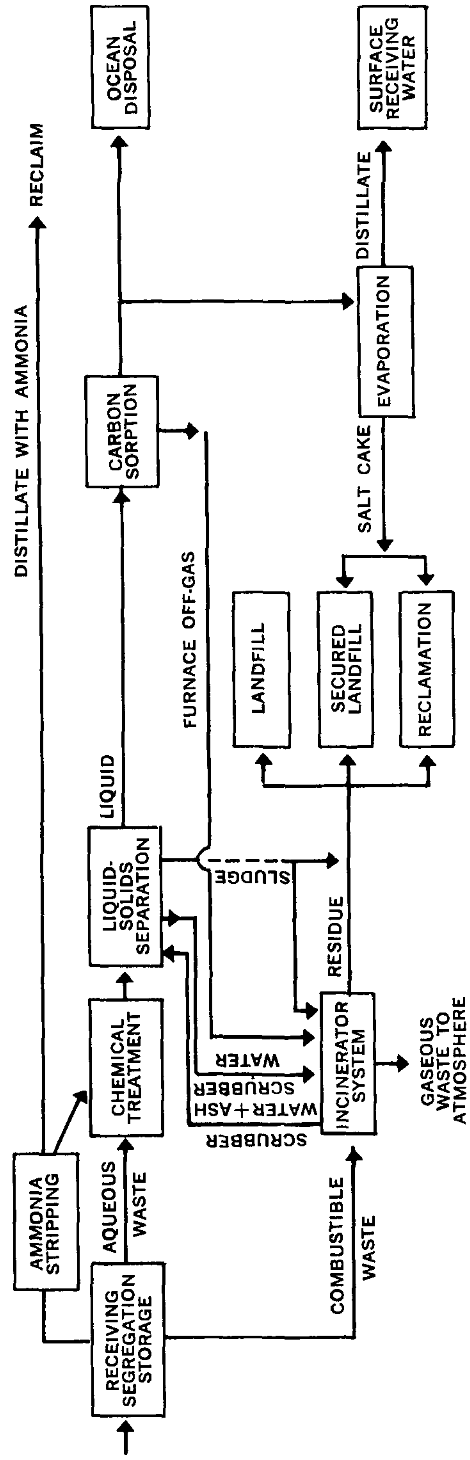


TABLE F-6

PRELIMINARY COST ESTIMATE SUMMARY FOR SMALL SIZE PROCESSING FACILITY

CAPACITY: 25,000 gpd (94,600 liters) Aqueous waste treatment
15 tons (13.6 metric tons)/day Incineration
260 day/year Operation

TOTAL FIXED CAPITAL COST: $9,300,000

MODULAR CAPITAL AND OPERATING COST: AQUEOUS WASTE TREATMENT

Module	Fixed capital cost, $	Daily operating cost, $	Ave. cost per 1000 gal (3,785 liters), $
Receiving & storage	1,262,000	1,881	66.20
Ammonia stripping	298,700	461	18.40
Chemical treatment	1,827,300	3,298*	150.50
Liquid-solids separation	3,460,000	3,888*	80 10**
Carbon sorption	363,000	758*	17.50
Evaporation	198,000	635*	14.60
Rounded totals	7,410,000	10,900	347.00

MODULAR CAPITAL AND OPERATING COST: INCINERATION

Module	Fixed capital cost, $	Daily operating cost, $	Ave. cost per ton, $
Incinerator	1,880,000	3,200	213.00
	Scrubber waste-water treatment	(18,450 gpd) (70,000 liters)	185.000
		Total	398.00

* Includes processing cost for incinerator scrubber wastewater.

** Excludes processing cost for clarifying incinerator scrubber wastewater.

TABLE F-7

PRELIMINARY COST ESTIMATE SUMMARY FOR MEDIUM SIZE PROCESSING FACILITY

CAPACITY:	122,000 gpd (462,000 liters)	Aqueous waste treatment
	74 tons (67 metric tons)/day	Incineration
	260 day/year	Operation

TOTAL FIXED CAPITAL COST: $24,070,000

MODULAR CAPITAL AND OPERATING COSTS: AQUEOUS WASTE TREATMENT

Module	Fixed capital cost, $	Daily operating cost, $	Ave. cost per 1000 gal (3,785 liters), $
Receiving & storage	3,270,000	6,424	46.40
Ammonia stripping	773,800	952	7.80
Chemical treatment	4,734,000	11,307*	84.70
Liquid-solids separation	8,963,700	9,516*	39.60**
Carbon sorption	941,000	1,578*	7.40
Evaporation	514,000	2,173*	10.20
Rounded totals	19,200,000	32,000	196.00

MODULAR CAPITAL AND OPERATING COSTS: INCINERATION

Module	Fixed capital cost, $	Daily operating cost, $	Ave. cost per ton, $
Incinerator	4,873,000	7,000	94.60
	Scrubber waste-water treatment	(90,000 gpd) (341,000 liters)	80.60
		Total	175.00

* Includes processing cost for incinerator scrubber wastewater.

** Excludes processing cost for clarifying incinerator scrubber wastewater.

TABLE F-8

PRELIMINARY COST ESTIMATE SUMMARY FOR LARGE SIZE PROCESSING FACILITY

CAPACITY: 1,000,000 gpd (3,785,300 liters) Aqueous waste treatment
607 tons (550 metric tons)/day Incineration
260 day/year Operation

TOTAL FIXED CAPITAL COST: $86,000,000

MODULAR CAPITAL AND OPERATING COSTS: AQUEOUS WASTE TREATMENT

Module	Fixed capital cost, $	Daily operating cost, $	Ave. cost per 1000 gal (3,785 liters), $
Receiving & storage	11,543,000	38,150	33.60
Ammonia stripping	2,731,500	3,180	3.18
Chemical treatment	16,710,600	60,630*	53.83
Liquid-solids separation	30,915,700	34,687*	17.18
Carbon sorption	3,322,000	6,290*	3.62
Evaporation	3,413,000	15,947*	9.16
Rounded totals	68,600,000	159,000	121.00

MODULAR CAPITAL AND OPERATING COSTS: INCINERATION

Module	Fixed capital cost, $	Daily operating cost, $	Ave. cost per ton, $
Incinerator	17,201,700	27,374	45.10
	Scrubber waste-water treatment	(738,000 gpd) (2,800,000 liters)	55.70
		Total	101.00

* Includes processing cost for incinerator scrubber wastewater.

** Excludes processing cost for clarifying incinerator scrubber wastewater.

TABLE F–9

BASIC ASSUMPTIONS UTILIZED FOR DEVELOPING THE HAZARDOUS WASTE MANAGEMENT SYSTEM SCENARIO

Number	Basic Assumptions
1	All hazardous waste will be treated and disposed of in an environmentally acceptable manner.
2	All hazardous wastes will be treated prior to being disposed of at designated sites to minimize hazard and volume of wastes deposited on land.
3	Treatment and disposal facilities will be dedicated to hazardous wastes. Treatment facilities should have those capabilities indicated in Tables F–6, F–7, and F–8.
4	*Certain types and quantities of hazardous wastes will be treated on-site (at the source) and others at off-site facilities.* ° The estimated total amount of hazardous wastes to be treated/disposed of is 1.0×10^7 tons (9×10^6 metric tons) per year. Approximately 4.0×10^6 tons (3.6×10^6 metric tons) are inorganic and 6.0×10^6 tons (5.4×10^6 metric tons) are organic.*
5	*EPA economic studies indicate that on-site treatment facilities will be small plants treating primarily* dilute aqueous acidic toxic metal wastes which constitute approximately 15 percent by weight of all hazardous wastes. Small on-site facilities will be capable of neutralizing wastes and precipitating toxic metals from the wastes, but will produce a toxic residue which will require further treatment at off-site facilities. ° Small facilities will have a capacity of 2.94×10^4 tons (2.6×10^4 metric tons) per year Approximately 51 small on-site facilities will be required to treat the estimated 1.5×10^6 tons (1.36×10^6 metric tons) per year. Approximately one third of wastes treated on-site [5×10^5 tons (4.5×10^5 metric tons) per year] will be shipped to off-site facilities for further treatment.
6	To achieve economics of scale, off-site treatment facilities will be large or medium-size treatment plants. ° Approximately 9.0×10^6 tons (8.2×10^6 metric tons) per year will be processed at off-site facilities. ° Large facilities will have a capacity of 1.33×10^6 tons (1.2×10^6 metric tons) per year, and medium facilities a capacity of 1.62×10^5 tons (1.47×10^5 metric tons) per year. ° System variation studies indicate that the configuration combining least cost and adequate geographical distribution consists of 5 large and 15 medium size facilities. Therefore, large off-site treatment facilities will process approximately 6.5×10^6 tons (6.0×10^6 metric tons) per year and medium facilities will process approximately 2.5×10^6 tons (2.27×10^6 metric tons) per year.
7	Current treatment technology does not allow complete neutralization/detoxification of all hazardous wastes. It is estimated that treatment residues constituting 2.5 percent of the incoming waste [225,000 tons (200,000 metric tons) per year] will still be hazardous.* ° Hazardous residues resulting from treatment facilities will be disposed of in secure land disposal sites. ° The most convenient location for secure land disposal sites is in association with the large treatment facilities. Therefore, five large secure disposal sites would initially be required. ° Hazardous wastes generated at other off-site treatment facilities would also be disposed of at the five large secure disposal sites

*EPA Contract No. 68–01–0762.

TABLE F-10

CAPACITIES AND COSTS OF HAZARDOUS WASTE TREATMENT FACILITIES ASSUMED IN HAZARDOUS WASTE MANAGEMENT SYSTEM SCENARIO

	OFF-SITE			ON-SITE	
	Large facility	Medium facility	Small facility	Small facility	Total costs
Capacity					
(1) Processing capacity, gal/day (liters/day) aqueous wastes	1,000,000 (3,800,000)	122,000 (462,000)	25,000 (95,000)	25,000 (95,000)	
(2) @ 9lb/gal, (1) expressed as tons/day (metric tons/day)	4,500 (4,080)	550 (498)	113 (102)	113 (102)	
(3) Processing capacity, tons/day (metric tons/day) combustible wastes	607 (550)	74 (67)	15 (14)	— —	
(4) Total processing capacity, tons/day (metric tons/day)	5,107 (4,627)	624 (565)	128 (116)	113 (102)	
(5) Total processing capacity, tons/year (metric tons/year) [1]	1,330,000 (1,210,000)	162,000 (147,000)	33,300 (30,200)	29,400 (26,600)	
Cost					
(6) Fixed capital, $	86,000,000	24,100,000	9,300,000	1,400,000	
(7) Operating cost, $/day	186,400	39,000	14,100	2,265	
(8) Operating cost, $/yr. [2]	48,500,000	10,130,000	3,660,000	589,000	
(9) Operating cost, $/yr., with capital write-off [3]	57,100,000	12,540,000	4,590,000	729,000	
Total Cost					
(10) Approximate no. of facilities required [4]	5	15	—	51	
(11) Fixed capital, $ million	430	362	—	71	863
(12) Operating cost, $ million/yr., basis (9)	286	188	—	37	511

Notes: [1] Assuming actual plant operation of 260 days/year.
[2] Includes neutralization chemicals, labor, utilities, maintenance, amortization charges (@ 7% interest), insurance, taxes, and administrative expenses.
[3] 10-year straight line depreciation.
[4] Based on data from EPA Contract No. 68-01-0762 and EPA system variation analysis.

Appendix G

PROPOSED

HAZARDOUS WASTE MANAGEMENT

ACT OF 1973

93D CONGRESS, 1ST SESSION

IN THE U.S. SENATE

Bill S. 1086

Introduced by Senator Baker

March 6, 1973

Referred to Committee on Public Works

IN THE U.S. HOUSE OF REPRESENTATIVES

Bill H.R. 4873

Introduced by Representative Staggers

for himself

and Representative Devine

February 27, 1973

Referred to Committee

on Interstate and Foreign Commerce

U.S. Environmental Protection Agency

A BILL

To assure protection of public health and other living organisms from the adverse impact of the disposal of hazardous wastes, to authorize a research program with respect to hazardous waste disposal, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. This Act may be cited as the "Hazardous Waste Management Act of 1973".

FINDINGS AND PURPOSE

SEC. 2. (a) The Congress finds—

(1) that continuing technological progress, improvement in the methods of manufacture, and abatement of air and water pollution has resulted in an ever-mounting increase of hazardous wastes;

(2) that improper land disposal and other management practices of solid, liquid, and semisolid hazardous wastes which are a part of interstate commerce are resulting in adverse impact on health and other living organisms;

(3) that the knowledge and technology necessary for alleviating adverse health, environmental, and esthetic impacts associated with current waste management and disposal practices are generally available at costs within the financial capacity of those who generate such wastes, even though this knowledge and technology are not widely utilized;

(4) that private industry has demonstrated its capacity and willingness to develop, finance, construct, and operate facilities and to perform other activities for the adequate disposal of hazardous and other waste materials;

(5) that while the collection and disposal of wastes should continue to be a responsibility of private individuals and organizations and the concern of State, regional, and local agencies, the problems of hazardous waste disposal as set forth above and as an intrinsic part of interstate commerce have become a matter national in scope and in concern, and necessitate Federal action through regulation of the treatment and the disposal of the most hazardous of these wastes, and through technical and other assistance in the application of new and improved methods and processes to provide for

proper waste disposal practices and reduction in the amount of waste and unsalvageable materials.

(b) The purposes of this Act therefore are—

(1) to protect public health and other living organisms through Federal regulation in the treatment and disposal of certain hazardous wastes;

(2) to provide for the promulgation of Federal guidelines for State regulation of the treatment and disposal of hazardous wastes not subject to Federal regulation;

(3) to provide technical and other assistance to public and private institutions in the application of efficient and effective waste management systems;

(4) to promote a national research program relating to the health and other effects of hazardous wastes and the prevention of adverse impacts relating to health and other living organisms.

DEFINITIONS

SEC. 3. When used in this Act:

(1) The term "Administrator" means the Administrator of the Environmental Protection Agency.

(2) The term "State" means a State, the District of Columbia, and the Commonwealth of Puerto Rico.

(3) The term "waste" means useless, unwanted, or discarded solid, semisolid or liquid materials.

(4) The term "hazardous waste" means any waste or combination of wastes which pose a substantial present or potential hazard to human health or living organisms because such wastes are nondegradable or persistent in nature or because they can be biologically magnified, or because they can be lethal, or because they may otherwise cause or tend to cause detrimental cumulative effects.

(5) The term "secondary material" means a material that is or can be utilized in place of a primary or raw material in manufacturing a product.

(6) The term "generation" means the act or process of producing waste materials.

(7) The term "storage" means the interim containment of waste after generation and prior to ultimate disposal. Containment for more than two years shall be considered disposal.

(8) The term "transport" means the movement of wastes

from the point of generation to any intermediate transfer points, and finally to the point of ultimate disposal.

(9) The term "treatment" means any activity or processing designed to change the physical form or chemical composition of waste so as to render such materials nonhazardous.

(10) The term "disposal of waste" means the discharge, deposit, or injection into subsurface strata or excavations or the ultimate disposition onto the land of any waste.

(11) The term "disposal site" means the location where any final deposition of waste materials occurs.

(12) The term "treatment facility" means a location at which waste is subjected to treatment and may include a facility where waste has been generated.

(13) The term "person" means any individual, partnership, copartnership, firm, company, corporation, association, joint stock company, trust, State, municipality, or any legal representative agent or assigns.

(14) The term "municipality" means a city, town, borough, county, parish, district, or other public body created by or pursuant to State law with responsibility for the planning or administration of waste management, or an Indian tribe or an authorized Indian tribal organization.

(15) The term "waste management" means the systematic control of the generation, storage, transport, treatment, recycling, recovery, or disposal of waste materials.

STANDARDS AND GUIDELINES FOR STATE REGULATION

SEC. 4. (a) Within eighteen months after the date of enactment of this Act, and from time to time thereafter, the Administrator pursuant to this section and after consultation with representatives of appropriate Federal agencies shall by regulation—

(1) identify hazardous wastes;

(2) establish standards for treatment and disposal of such wastes; and

(3) establish guidelines for State programs for implementing such standards.

(b) In identifying a waste as hazardous, pursuant to this section, the Administrator shall specify quantity, concentration, and the physical, chemical, or biological properties of such waste, taking into account means of disposal, disposal sites, and available disposal practices.

(c) The standards established under this section shall include minimum standards of performance required to protect human health and other living organisms and minimum acceptable criteria as to characteristics and conditions of disposal sites and operating methods, techniques, and practices of hazardous wastes disposal taking into account the nature of the hazardous waste to be disposed. Such standards shall include but not be limited to requirements that any person generating waste must (1) appropriately label all containers used for onsite storage or for transport of hazardous waste; (2) follow appropriate procedures for treating hazardous waste onsite; (3) transport all hazardous waste intended for offsite disposal to a hazardous waste disposal facility for which a permit has been issued. In establishing such standards the Administrator shall take into account the economic and social costs and benefits of achieving such standards.

(d) The guidelines established under paragraph (a)(3) of this section shall provide that—

(1) with respect to disposal sites for hazardous wastes, the State program requires that any person obtain from the State a permit to operate such site;

(2) such permits require compliance with the minimum standards of performance acceptable site criteria set by the guidelines;

(3) the State have such regulatory and other authorities as may be necessary to carry out the purpose of this Act, including, but not limited to, the authority to inspect disposal sites and records, and to judicially enforce compliance with the requirements of an approved program against any person.

(e) Within eighteen months of the promulgation of final regulations under this Act, each State shall submit to the Administrator evidence, in such form as he shall require, that the State has established a State program which meets the requirements of the guidelines of paragraph (a)(3) of this section. If a State fails to submit such evidence, in whole or in part, the Administrator shall publish notice of such failure in the Federal Register and provide such further notification, in such form as he considers appropriate, to inform the public in such State of such failure.

FEDERAL REGULATION

SEC. 5. (a) Within eighteen months after the date of enactment of this Act and from time to time thereafter, the Administrator after consultation with representatives of appropriate Federal agencies may with respect to those hazardous wastes identified pursuant to subsection (a) (1) of section 4 determine in regulations those of such wastes which because of their quantity or concentration, or because of their chemical characteristics, could if allowed to be dispersed into the environment result in, or contribute to, the loss of human life or substantial damage to human health or to other living organisms.

(b) The Administrator may promulgate regulations establishing Federal standards and procedures for the treatment and disposal of such wastes. Such Federal standards and procedures shall be designed to prevent damage of human health or living organisms from exposure to such wastes identified pursuant to subsection (a) and may include—

(1) with respect to hazardous waste disposal sites—

(A) minimum requirements as to the characteristics and conditions of such sites,

(B) minimum standards of performance for the operation and maintenance of such sites, and

(C) recommendations as to specific design and construction criteria for such sites; and

(2) with respect to hazardous waste treatment facilities—

(A) minimum standards of performance for the operation and maintenance, and

(B) recommendations based on available technology as to appropriate methods, techniques, or practices for the treatment of specific wastes.

(c) The Administrator may issue a permit for the operation of a hazardous waste disposal site or treatment facility if, after a review of the design, construction, and proposed operation of such site or facility, he determines that such operation will meet the requirements and standards promulgated pursuant to subsection (b).

(d) Within eighteen months after the date of enactment of this Act, the Administrator shall promulgate regulations establishing requirements for generators of hazardous wastes subject to regulation under this section to—

(1) maintain records indicating the quantities of hazardous waste generated and the disposition thereof;

(2) package hazardous waste in such a manner so as to protect human health and other living organisms, and label such packaging so as to identify accurately such wastes;

(3) treat or dispose of all hazardous waste at a hazardous

waste disposal site or treatment facility for which a permit has been issued under this Act;

(4) handle and store all hazardous waste in such a manner so as not to pose a threat to human health or other living organisms;

(5) submit reports to the Administrator, at such times as the Administrator deems necessary, setting out—

(A) the quantities of hazardous waste subject to Federal regulation under this subsection that he has generated;

(B) the nature and quantity of any other waste which he has generated which he has reason to believe may have a substantial adverse effect on human health and other living organisms; and

(C) the disposition of all waste included in categories (A) and (B).

(e) The Administrator may prescribe regulations requiring any person who stores, treats, disposes of, or otherwise handles hazardous wastes subject to regulation under this section to maintain such records with respect to their operations as the Administrator determines are necessary for the effective enforcement of this Act.

(f) The Administrator is authorized to enter into cooperative agreements with States to delegate to any State which meets such minimum requirements as the Administrator may establish by regulation the authority to enforce this section against any person.

FEDERAL ENFORCEMENT

SEC. 6. (a) Whenever on the basis of any information the Administrator determines that any person is in violation of requirements under section 5 or of any standard under section 4(a) (2) under this Act, the Administrator may give notice to the violator of his failure to comply with such requirements or may request the Attorney General to commence a civil action in the appropriate United States district court for appropriate relief, including temporary or permanent injunctive relief. If such violation extends beyond the thirtieth day after the Administrator's notification, the Administrator may issue an order requiring compliance within a specified time period or the Administrator may request the Attorney General to commence a civil action in the United States district court in the district in which the violation occurred for appropriate relief, including a temporary or permanent injunction: *Provided,* That, in the case of a violation of any standard under section 4(a) (2) where such violation occurs in a State which has submitted the evidence required under section 4(e), the Administrator shall give notice to the State in which such violation has occurred thirty days prior to issuing an order or requesting the Attorney General to commence a civil action. If such violator fails to take corrective action within the time specified in the order, he shall be liable for a civil penalty of not more than $25,000 for each day of continued noncompliance. The Administrator may suspend or revoke any permit issued to the violator.

(b) Any order or any suspension or revocation of a permit shall become final unless, no later than 30 days after the order or notice of the suspension or revocation is served, the person or persons named therein request a public hearing. Upon such request the Administrator shall promptly conduct a public hearing. In connection with any proceeding under this section the Administrator may issue subpenas for the attendance and testimony of witnesses and the production of relevant papers, books, and documents, and may promulgate rules for discovery procedures.

(c) Any order issued under this section shall state with reasonable specificity the nature of the violation and specify a time for compliance and assess a penalty, if any, which the Administrator determines is a reasonable period and penalty taking into account the seriousness of the violation and any good faith efforts to comply with the applicable requirements.

(d) Any person who knowingly violates any requirement of this Act or commits any prohibited act shall, upon conviction, be subject to a fine of not more than $25,000 for each day of violation, or to imprisonment not to exceed one year, or both.

RESEARCH, DEVELOPMENT, INVESTIGATIONS, TECHNICAL ASSISTANCE AND OTHER ACTIVITIES

SEC. 7. (a) The Administrator shall conduct, encourage, cooperate with, and render financial and other assistance to appropriate public (whether Federal, State, interstate, or local) authorities, agencies, and institutions, private agencies and institutions, and individuals in the conduct of, and promote the coordination of, research, development, investigations, experiments, surveys, and studies relating to—

(1) any adverse health and welfare effects on the release into the environment of material present in waste, and methods to eliminate such effects;

(2) the operation or financing of waste management programs;

(3) the development and application of new and improved methods of collecting and disposing of waste and processing and recovering materials and energy from wastes; and

(4) the reduction of waste generation and the recovery of secondary materials and energy from solid, liquid, and semisolid wastes.

(b) In carrying out the provisions of the preceding subsection, the Administrator is authorized to—

(1) collect and make available, through publication and other appropriate means, the results of, and other information pertaining to, such research and other activities, including appropriate recommendations in connection therewith;

(2) cooperate with public and private agencies, institutions, and organizations, and with any industries involved, in the preparation and the conduct of such research and other activities; and

(3) make grants-in-aid to and contract with public or private agencies and institutions and individuals for research, surveys, development, and public education. Contracts may be entered into without regard to sections 3648 and 3709 of the Revised Statutes (31 U.S.C. 529; 41 U.S.C. 5).

(c) The Interstate Commerce Commission, the Federal Maritime Commission, and the Office of Oil and Gas in the Department of the Interior, in consultation with the Environmental Protection Agency and with other Federal agencies as appropriate, shall conduct within twelve months of the date of enactment of this Act and submit to Congress, a thorough and complete study of rate setting practices with regard to the carriage of secondary materials by rail and ocean carriers. Such study shall include a comparison of such practices with rate setting practices with regard to other materials and shall examine the extent to which, if at all, there is discrimination against secondary materials.

INSPECTIONS

SEC. 8. (a) For the purpose of developing or assisting in the development of any regulation or enforcing the provisions of this Act, any person who stores, treats, transports, disposes of, or otherwise handles hazardous wastes shall, upon request of any officer or employee of the Environmental Protection Agency or of any State or political subdivision, duly designated by the

Administrator, furnish or permit such person at all reasonable times to have access to, and to copy all records relating to such wastes.

(b) For the purposes of developing or assisting in the development of any regulation or enforcing the provisions of this Act, officers or employees duly designated by the Administrator are authorized—

(1) to enter at reasonable times any establishment or other place maintained by any person where hazardous wastes are stored, treated, or disposed of;

(2) to inspect and obtain samples from any person of any such wastes and samples of any containers or labeling for such wastes. Before undertaking such inspection, the officers or employees must present to the owner, operator, or agent in charge of the establishment or other place where hazardous wastes are stored, treated, or disposed of appropriate credentials and a written statement as to the reason for the inspection. Each such inspection shall be commenced and completed with reasonable promptness. If the officer or employee obtains any samples, prior to leaving the premises, he shall give to the owner, operator, or agent in charge a receipt describing the sample obtained and if requested a portion of each such sample equal in volume or weight to the portion retained. If an analysis is made of such samples, a copy of the results of such analysis shall be furnished promptly to the owner, operator, or agent in charge.

(c) Any records, reports, or information obtained from any person under this subsection shall be available to the public, except that upon a showing satisfactory to the Administrator by any person that records, reports, or information, or particular part thereof, to which the Administrator has access under this section if made public, would divulge information entitled to protection under section 1905 of title 18 of the United States Code, the Administrator shall consider such information or particular portion thereof confidential in accordance within the purposes of that section.

ENCOURAGEMENT OF INTERSTATE AND INTERLOCAL COOPERATION

SEC. 9. The Administrator shall encourage cooperative activities by the States and local governments in connection with waste disposal programs, encourage, where practicable, interstate, interlocal, and regional planning for, and the conduct of, interstate, interlocal, and regional hazardous waste disposal programs; and encourage the enactment of improved and, so far as practicable, uniform State and local laws governing waste disposal.

IMMINENT HAZARD

SEC. 10. (a) An imminent hazard shall be considered to exist when the Administrator has reason to believe that handling or storage of a hazardous waste presents an imminent and substantial danger to human health or other living organisms the continued operation of a disposal site will result in such danger when a State or local authority has not acted to eliminate such risk.

(b) If an imminent hazard exists, the Administrator may request the Attorney General to petition the district court of the United States in the district where such hazard exists, to order any disposal site operator or other person having custody of such waste to take such action as is necessary to eliminate the imminent hazard, including, but not limited to, permanent or temporary cessation of operation of a disposal site, or such other remedial measures as the court deems appropriate.

PROHIBITED ACTS

SEC. 11. The following acts and the causing thereof are prohibited and shall be subject to enforcement in accordance with the provisions of subsection 6(d) of this Act:

(a) Operating any disposal site for hazardous waste identified pursuant to section 5 without having obtained an operating permit pursuant to such section.

(b) Disposing of hazardous waste identified pursuant to section 5 in a manner not in compliance with requirements under section 5.

(c) Failure to comply with the requirements of section 5 in labeling containers used for the storage, transport, or disposal of hazardous waste.

(d) Failure to comply with (1) the conditions of any Federal permit issued under this Act, (2) any regulation promulgated by the Administrator pursuant to section 4(a)(2) or section 5 of this Act, or (3) any order issued by the Administrator pursuant to this Act.

APPLICATION OF STANDARDS TO FEDERAL AGENCIES

SEC. 12. (a) Each department, agency, and instrumentality of the executive, legislative, and judicial branches of the Federal Government having jurisdiction over any property or facility, or engaged in any activity which generates, or which may generate, wastes shall insure compliance with such standards pursuant to subsections 4(a)(2), 5(a), and 5(c) as may be established by the Administrator for the treatment and disposal of such wastes.

(b) The President or his designee may exempt any facility or activity of any department, agency, or instrumentality in the executive branch from compliance with guidelines established under section 4 if he determines it to be in the paramount interest of the United States to do so. Any exemption shall be for a period not in excess of one year, but additional exemptions may be granted for periods of not to exceed one year upon the President's or his designee's making of a new determination. The Administrator shall ascertain the exemptions granted under this subsection and shall report each January to the Congress all exemptions from the requirements of this section granted during the preceding calendar year.

(c) Within eighteen months after enactment of this Act and from time to time thereafter, the Administrator, in consultation with other appropriate Federal agencies, shall identify products which can utilize significant quantities of secondary materials and shall issue guidelines with respect to the inclusion of such secondary materials to the maximum extent practicable in products procured by the Federal Government.

(d) In any proceeding initiated before the Interstate Commerce Commission or the Federal Maritime Commission after the enactment of this Act where a determination is made by such Commission as to any individual or joint rate, fare, or charge whatsoever demanded, charged, or collected by any common carrier or carriers, a specific finding by the Commission will be required that such rate, fare, or charge does not or will not cause discrimination against secondary materials.

CITIZEN SUITS

SEC. 13. (a) Except as provided in subsection (b) any person may commence a civil action for injunctive relief on his own behalf—

(1) against any person who is alleged to be in violation of

any regulation promulgated or order issued under this Act;

(2) against the Administrator where there is alleged a failure of the Administrator to perform any act or duty under this Act which is not discretionary with the Administrator.

Any action under paragraph (a) (1) of this subsection shall be brought in the district court for the district in which the alleged violation occurred and any action brought under paragraph (a) (2) of this subsection shall be brought in the District Court of the District of Columbia. The district courts shall have jurisdiction, without regard to the amount in controversy or the citizenship of the parties, to enforce such regulation or order, or to order the Administrator to perform such act or duty as the case may be.

(b) No action may be commenced—

(1) under subsection (a) (1) of this section—

(A) prior to sixty days after the plaintiff has given notice of the violation (i) to the Administrator, (ii) to the State in which the alleged violation occurs, and (iii) to any alleged violator of the standard, limitation, or order, or

(B) if the Administrator or State has caused to be commenced and is diligently prosecuting a civil or criminal action in a court of the United States or a State to require compliance with requirements of this Act or order issued hereunder;

(2) under subsection (a) (2) prior to sixty days after plaintiff has given notice of such action to the Administrator.

Notice under this subsection shall be given in such manner as the Administrator shall prescribe by regulation.

(3) in such action under this section, if the United States is not a party, the Attorney General may intervene as a matter of right.

(c) The court, in issuing any final order in any action brought pursuant to this section, may award costs of litigation (including reasonable attorney and expert witness fees) to any party, whenever the court determines such award is appropriate.

(e) Nothing in this section shall restrict any right which any person (or class of persons) may have under any statute or common law to seek enforcement of any regulation or to seek any other relief (including relief against the Administrator or a State agency).

STATE AUTHORITY

SEC. 14. (a) If the Administrator has promulgated regulations under section 5 no State or municipality may without the approval of the Administrator impose more stringent requirements than those imposed under the provisions of section 5 on the transport, treatment, or disposal of hazardous wastes.

(b) No State or municipality shall impose, on wastes originating in other States or municipalities, requirements respecting the transport of such wastes into or disposal within its jurisdiction which are more stringent than those requirements applicable to wastes originating within such receiving States and municipalities.

AUTHORIZATION AND APPROPRIATION

SEC. 15. There is hereby authorized to be appropriated to the Environmental Protection Agency such sums as may be necessary for the purposes and administration of this Act.

JUDICIAL REVIEW

SEC. 16. (a) A petition for review of action of the Administrator in promulgating any regulation pursuant to sections 4 or 5 shall be filed in the United States Court of Appeals for the District of Columbia. Any person who will be adversely affected by a final order or other final determination issued under section 6 may file a petition with the United States Court of Appeals for the circuit wherein such person resides or has his principal place of business, for a judicial review of such order or determination. Any such petition shall be filed within thirty days from the date of such action or order, or after such date if such petition is based solely on grounds arising after such thirtieth day.

(b) Action of the Administrator with respect to which review could have been obtained under subsection (a) shall not be subject to judicial review in civil or criminal proceedings for enforcement.

(c) In any judicial proceeding in which review is sought of an action under this Act required to be made on the record after notice and opportunity for hearing, if any party applies to the court for leave to adduce additional evidence, and shows to the satisfaction of the court that such additional evidence is material and that there were reasonable grounds for the failure to adduce such evidence in the proceedings before the Administrator, the court may order such additional evidence (and evidence in rebuttal thereof) to be taken before the Administrator, in such manner and upon such terms and conditions as the court may deem proper. The Administrator may modify his findings as to the facts, or make new findings, by reason of the additional evidence so taken and he shall file such modified or new findings, and his recommendation, if any, for the modification or setting aside of his original determination, with the return of such additional evidence.

RELATIONSHIP TO OTHER LAWS

SEC. 17. (a) This Act shall not apply to—

(1) any source material, special nuclear material, or byproduct material subject to regulation or control pursuant to the Atomic Energy Act of 1954, as amended;

(2) lethal chemicals subject to regulation pursuant to title 50, United States Code, section 1511, and the following, as amended.

(b) This Act shall not be construed to relieve any person from any present or future requirement arising from any other Federal law.

☆ U S GOVERNMENT PRINTING OFFICE 1974 O—548-497