To the Graduate Council:

I am submitting herewith a thesis written by Carol Whitt Tevepaugh entitled "Impact of the Interaction of the Resource Conservation and Recovery Act Hazardous Waste Regulations with Energy Supply Facility Siting on Land Use Issues." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning.

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IMPACT OF THE INTERACTION OF THE RESOURCE CONSERVATION AND RECOVERY ACT HAZARDOUS WASTE REGULATIONS WITH ENERGY SUPPLY FACILITY SITING ON LAND USE ISSUES

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ABSTRACT

The Resource Conservation and Recovery Act (RCRA) of 1976 is a multifaceted approach to the management of both solid and hazardous waste. The focus of this research is on the RCRA mandated proposed regulations for the siting of hazardous waste disposal facilities. This research is an analysis of the interactions among hazardous waste disposal facilities, energy supply technologies and land use issues.

This study addresses the impact of RCRA hazardous waste regulations in a descriptive and exploratory manner. A literature and legislative review, interviews and letters of inquiry were synthesized to identify the relationship between RCRA hazardous waste regulations and the siting of selected energy supply technologies. The results of this synthesis were used to determine if and how RCRA influences national land use issues.

It was found that the interaction between RCRA and the siting of hazardous waste disposal facilities required by energy supply technologies will impact national land use issues. All energy supply technologies reviewed generate hazardous waste. The siting of industrial functions such as energy supply facilities and hazardous waste disposal facilities will influence future development patterns. The micro-level impacts from the siting of hazardous waste disposal facilities will produce a ripple effect on land use with successive buffer zones developing around the facilities due to the interactive growth of the land use sectors.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

". . . matter can neither be created nor destroyed"[1]

According to the Law of Conservation of Mass, matter cannot be created or destroyed, only transformed into other forms of matter or energy. Solid waste is a form of matter, which, contrary to popular belief, does not "go away" when it is taken from the site of generation. It must go somewhere and that somewhere is usually on land. Of the six billion tons of solid waste generated each year in the United States, more than 90 percent is disposed of upon land. Of this six billion tons, recent estimates by the Environmental Protection Agency (EPA) indicate that more than thirty-five million tons are hazardous. The consequences of hazardous waste disposal are examined in this research, specifically, the impacts on land use issues which stem from the interaction of the Resource Conservation and Recovery Act of 1976 Hazardous Waste Regulations with energy supply facility siting.

History and Background

The disposal of solid waste has been a problem for society since its beginnings. Most of man's activities consume resources and/or contaminate the environment. For the early cave man, it was simply a matter of moving when his cave or den became too cluttered with debris. The situation is

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[1]Douglas M. Considine, ed., *Van Nostrand's Scientific Encyclopedia* (New York: Van Nostrand Reinhold Co., 1976), p. 655.

different now. People have run out of places to clutter and can no longer simply move to a new site.[2]

Our society must come to grips with the waste disposal problem. Damage caused by the disposal of chemical wastes at the Love Canal Chemical Waste Landfill in Niagara Falls, New York, requiring the relocation of more than one hundred families, is just one example of inadequate disposal of hazardous waste.[3] An Assistant Dean at the University of Southern Mississippi died of asphyxiation while fishing when his boat drifted into a pocket of propane gas in 1969. The gas had been discharged from a petroleum refinery. More than 200,000 fish were killed at Norris Lake in 1967 when a dike containing an alkaline waste lagoon for a steam plant in Virginia collapsed and released approximately 400 acre feet of fly ash into the Clinch River.[4] The disposal of hazardous waste without careful planning and management presents an immediate danger to human health and the environment.

The solutions to pollution problems often increase or create other pollution problems. As awareness of environmental protection evolved in the United States, air and water pollution were the first problems identified. Seen as common resources shared by all the people, air and

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[2]Environmental Quality Forum, East Tennessee State University, *The Nation's Environmental – Problems and Action* (Johnson City, TN: East Tennessee State University, 1970), p. 71.

[3]United States Comptroller General, *Report to the Congress: How to Dispose of Hazardous Waste,* CED-79-13, December 1978, p. 2.

[4]*International Conference on Hazardous Materials Management: Proceedings* (Detroit, MI: n.p., 1978), p. 2.

water pollution were recognized as harmful to the general public. While legislation has been enacted and implemented for the control of air and water pollution, this same legislation tends to increase pressures on land. Hazardous materials which were once dumped in our water or emitted into the air have ended up on land.

Land has traditionally been viewed as "private property," which owners could use as they pleased, provided that they did not injure others. Citizen awareness of the serious harms to public health and the environment, as a result of what private property owners do with their land, has led to the realization that more effective land use regulation is essential.[5] The tenet that each individual should determine what is best for him or her — within the laws of society — is deeply imbedded in the Western culture. But in the realm of pollution, often the individual either lacks or refuses to utilize the information necessary for the protection of human health and the environment.

Regardless of land ownership, the occupants of the land are merely its custodians, obligated to hold it in trust and preserve it for future generations. Since individuals cannot be relied upon to provide adequate protection of the environment, an elaborate system of laws and regulations has been developed.[6]

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[5]Elaine Moss, ed., *Land Use Control in the United States* (New York: The Dial Press, 1977), pp. 1-2.

[6]William E. Small, *Third Pollution: The National Problem of Solid Waste Disposal* (New York: Praeger Publishers, 1971), p. 45.

Current Status

The legal system in this country seeks to achieve goals by securing compliance to a formal system of regulation. It is a method of social control. Members of society accept regulations to insure the protection of their welfare. The support of the community is necessary for the political system to survive. It is society's support of the political system that enables the federal government to regulate the disposal of solid and hazardous wastes.

In the past, regulations for the disposal of wastes were primarily administered at the local level. Some of the more specific local hazardous wastes statutes that exist today were enacted in response to previous potential public health or environmental incidents resulting from improper management and disposal of hazardous waste substances.[7] With the advent of increased awareness of the possible impact on human health and the environment of hazardous waste disposal, other levels of government have also become involved in the regulation of waste disposal.

With the Solid Waste Disposal Act of 1965 and the Resource Recovery Act of 1970, the federal government maintained a policy of recognizing solid waste disposal as primarily a state or local problem. The Resource Conservation and Recovery Act of 1976 (RCRA)[8] is a multifaceted approach

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[7]Battelle, Columbus Laboratory, *Final Report on State of Ohio Hazardous Waste Management Plan: Hazardous Waste Management Program, Part II* (Columbus, OH: Battelle National Laboratory, 1978), p. 38.

[8]Resource Conservation and Recovery Act, 42 U.S.C. 3251 et seq., PL 94-580.

to solving the problems associated with the disposal of solid wastes.[9] RCRA signifies the federal government's recognition of the growing problem of solid waste management and disposal. It greatly expands the role of the federal government in the realm of solid waste disposal and management with particular emphasis on the regulation of hazardous waste.[10] RCRA establishes the principle of systematic control of hazardous waste.[11] With RCRA, for the first time the federal government became directly involved in solid waste control.

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[9]Section 1004 of RCRA gives the following definition of solid waste:

> The term "solid waste" means any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act. as amended (86 Stat. 880). or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended. (68 Stat. 923)

[10]Thomas F. P. Sullivan, *Resource Conservation and Recovery Act: A Compliance Analysis* (Washington, DC: Government Institutes, Inc., 1979), p. 5.

[11]Section 1004 of RCRA gives the following definition of hazardous waste:

> The term "hazardous waste" means a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may —
>
> "(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or"

Statement of the Problem

Hazardous waste disposal is an extremely complicated issue. It is complex in that it involves not only air, surface and groundwater, and land, but also the entire spectrum of waste types from gases to liquids to semisolids and solids. It involves diverse methods for treatment and disposal such as landfills, incineration, processing or recycling, and deep well injection. These restrictions are further complicated by the fact that earlier environmental regulations prevent its introduction into the air or water.[12] RCRA addresses where and how to dispose of solid and hazardous waste.

One of the objectives of RCRA is "to promote the protection of health and the environment . . . by regulating the treatment, storage, transportation, and disposal of hazardous wastes which have adverse effects on health and the environment."[13] The implementation of this objective will impact national land use issues. Regulations dealing with hazardous waste management will serve as a limiting factor in the siting of a number of economic activities, including energy supply facilities. This study focuses on hazardous waste streams[14] from current and proposed

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"(B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed."

[12]Sullivan, pp. 45-91.

[13]RCRA, Section 1003.

[14]For this report the term "waste stream" refers to mass flow in the engineering process sense and not necessarily to a liquid stream. The waste stream for energy supply technologies is composed of residuals

energy supply technologies which could limit the locational siting of energy facilities proposed or anticipated by the private sector (e.g., utilities) and the public sector (e.g., the Department of Energy). The siting of these facilities will in turn impact national land use patterns.

In this research analysis it is important to understand the interconnections of hazardous waste disposal facilities, energy supply technologies and land use issues. The energy supply technologies reviewed generate hazardous waste which must be disposed of in permitted hazardous waste disposal facilities. Both energy supply facilities and hazardous waste disposal facilities have siting constraints. The locational siting of these facilities, because of the constraints, impact land use issues.

Control of land use and facility siting in the past was largely based on decisions by local officials and private sector interests (e.g., utilities). Decision making was focused almost entirely upon the maintenance of public health, and the preservation and enhancement of economic values.[15] Control of land was traditionally viewed as "private property" which owners could use as they pleased.[16] However, recent legislation (forced by public awareness and environmental concerns) is indirectly placing some aspects of land use control in the hands of the the federal government, e.g., the National Environmental Policy Act, the

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resulting from extraction and processing, manufacturing of system components, generation of energy, and decommissioning/disposal of the energy system.

[15]J. Gordon Arbuckle et al., *Environmental Law Handbook*, 4th ed. (Washington, DC: Government Institutes, Inc., 1976), p. 189.

[16]Moss, p. 1.

Clean Air Act, and the Federal Water Pollution Control Act. Federal agencies, including the Department of Energy (DOE), need to be aware of the consequences of legislative actions, for they ultimately influence, either directly or indirectly, the siting of energy supply facilities and the commercialization of emerging energy supply technologies.

Currently DOE is the federal agency responsible for overseeing energy technology research and development. Included in this responsibility is the task of reviewing site locations for proposed energy facilities. In order to facilitate this task, the criteria were examined which will influence the siting of energy supply facilities.

It is expected that the waste streams of some energy technologies will be included in the RCRA hazardous waste lists. Currently, some of the energy supply waste streams are classified as "special waste" by EPA (i.e., utility waste, mining waste, and gas and oil drilling muds and oil production brines). The Environmental Protection Agency (EPA) proposes to regulate these high volume low hazard wastes with special standards.[17] Depending on the method and site of disposal, RCRA will be *a* determining factor in energy supply facility siting. The process and final determination of site selection will have an impact on local, regional, state, and national land use issues.

Role of Energy Planning

In view of current energy supply problems in the United States, energy planning is a necessary and viable subject of study for planners

[17] *Federal Register,* 43: 58946-59028; December 18, 1978.

and decision makers. For the purpose of this research, energy planning is defined as the application of the planning process to energy policy formulation. "Planning is the process of preparing a set of decisions for action in the future, directed at achieving goals by preferable means."[18] For energy planning this includes (1) the identification and analysis of policy objectives, (2) the translation of objectives into needs and requirements, (3) the development of a set of alternative strategies and the selection of a desired strategy, and (4) implementation of the policy strategy chosen.

The planning process applied to energy planning enables federal decision makers to focus on various dimensions of the complex relationships influencing energy policy options. The government must do the planning, at least from the action standpoint. If they don't accept the responsibility and do the planning, no one else can.[19] This specific research effort provides information about legislative influences on land use issues necessary for the development of alternative energy strategies.

The amount of land allocated to energy production, conversion, and use is expected to rise markedly over current levels. This increase will be relatively insensitive to changes in the world price of crude oil and to the choice of strategies chosen. It will be felt in all regions of

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[18]Andreas Faludi, ed., *A Reader in Planning Theory* (New York: Pergamon Press, 1973), p. 330.

[19]Arnold W. Reitz, Jr., *Environmental Law*, 2nd ed. (Washington, DC: North American International, 1972), p. 25.

the country. Much of this increase is due to solid waste pollution (e.g., according to MITRE environmental data, 9.3 acre/10^{12} Btu will be required for solid waste disposal for fluidized-bed combustion of high sulfur coal). It is imperative that the relationship of waste disposal to energy supply facility siting be explored to indicate probable effects on national land use, because energy planning and land use planning are inevitably linked.[20]

Other Research

Considerable research has been conducted in the area of federal facility siting, primarily as a result of the National Environmental Policy Act's (NEPA) requirement for an environmental impact statement (EIS) on "major Federal actions significantly affecting the quality of the human environment."[21] There have also been research efforts exploring federal legislation and energy facility planning (Shreeve et al., 1978). In fact, there are previous studies on all the main variables covered in this research, i.e., federal legislative impact on facility siting and land use issues, energy supply technologies and facilities, and hazardous waste disposal. The unique feature of this research effort is that the interaction of these variables with each other is explored. What will be the impact of the interaction of RCRA hazardous waste regulations with energy supply facility siting on land use issues?

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[20]Thomas H. Tietenberg, *Energy Planning and Policy* (Lexington, MA: D. C. Heath and Co., 1976), p. 54.

[21]Moss, p. 18.

Justification

RCRA is not the latest, the last, nor the most important federal legislation which will affect land use. However, it is anticipated that its impact on national land use issues via exclusionary constraints will be significant. For example, in some states, hazardous waste facilities cannot be located within a certain distance of residential areas. If the energy supply facilities are in place before other kinds of development, this will result in a form of ex post facto land use regulation (i.e., after the fact because of the spatial location of the site itself). All land converted to hazardous waste management uses would either permanently or temporarily change existing land uses. Some agricultural, forest, grazing, recreational and other lands could be removed from their existing uses.[22]

RCRA provides for the enforcement of adequate hazardous waste disposal. Information concerning the impact of RCRA on national land use issues will be relevant to planning officials, energy policy analysts and federal decision makers. The decision model involved in the siting of major energy supply facilities begins with local property owners, goes through local government to state and regional bodies and then to the federal government.[23] The application and enforcement of criteria for nonhazardous waste is the responsibility of the states.[24]

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[22]U.S., Environmental Protection Agency, Office of Solid Waste, *Subtitle C, Resource Conservation and Recovery Act of 1976: Draft Environmental Impact Statement* (Washington, DC: Government Printing Office, 1979), p. 7:201.

[23]Arbuckle, pp. 221-214.

[24]Sullivan, pp. 9-10.

Though some states are adopting a "wait and see" attitude regarding future EPA RCRA regulations before drafting their own, other states are drafting regulations prior to the enactment of federal hazardous waste guidelines.[25] RCRA has directed that state plans be coordinated with planning for regional solid waste management services.[26] Therefore it is imperative that planning officials at all levels employ a common information base. Planning must be conducted and utilized in a logical manner by all actors who provide input to the decision making process. The purpose of this research is to identify issues which should be considered.

Approach

This study addresses the impact of RCRA hazardous waste regulations in a descriptive and exploratory manner. First, it is necessary to identify the relationship between RCRA hazardous waste regulations and the siting of facilities of various energy supply technologies. Secondly, an investigation is required of why RCRA hazardous waste regulations are associated with the siting of energy supply facilities. It is expected that land use issues will emerge as a major constraint in the siting of energy supply facilities, and in turn, that certain land use issues will develop as a consequence of this constraint. This research found that there is an independence of land use and energy. Hazardous waste disposal

[25]Battelle, Columbus Laboratory, *Part II,* p. 34.

[26]RCRA, Section 4002 (a).

facilities will impact land use issues depending upon their proximity to the facility.

Legislative Activities

RCRA essentially replaces the 1965 Solid Waste Disposal Act.[27] Prior to the enactment of RCRA, there was not direct federal regulation of the disposal of hazardous waste. Both the 1965 Act and 1976 RCRA legislation are reviewed as a means for determining what changes in exclusionary land use constraints have been made at the national level in hazardous waste management. At the state level, the review will focus on pre-RCRA legislation, and new or proposed post-RCRA legislation.

Based on the December 18, 1978, "Hazardous Waste: Proposed Guidelines and Regulations and Proposal on Identification and Listing,"[28] as a primary reference document, exclusionary constraints of RCRA are enumerated.[29] In order to facilitate a comparison of state programs, a matrix/table is used to compare pre-RCRA and post-RCRA legislation at the state level according to the presence or absence of hazardous waste management program elements. This matrix compares state legislation for California, Connecticut, Tennessee and Texas.

Investigation of the differences between state legislation permits an examination of approaches taken by states in the management of

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[27]Solid Waste Disposal Act, 42 U.S.C. 3251 et seq., PL 89-272.

[28]*Federal Register,* 43: 58946-59028.

[29]Final hazardous waste regulations have not and will not be forthcoming during the research effort.

hazardous waste. The state legislative review is not intended to be an all inclusive survey of state hazardous waste management programs but rather an abbreviated summary of state response to RCRA.

To better understand the present position of the states in hazardous waste management, letters of inquiry and interviews have been used. The letters of inquiry included questions directly relevant to state hazardous waste management (see Appendix A). However, it also had questions provided by other RCRA researchers.[30] Telephone interviews were administered with state hazardous waste management personnel and representatives of the National Governors Association and the National Conference of State Legislators who are involved in the review of RCRA legislation. The letters and interviews indicated state responsiveness to RCRA.

Additionally, the research includes a review of federal legislation which must be considered in the implementation of RCRA. Section 1006 directs EPA to integrate provisions of RCRA with appropriate provisions of other Acts of Congress, e.g., the Safe Drinking Water Act, the Clean Air Act and the Clean Water Act. Subtitle C of RCRA stipulates that RCRA regulations concerned with the transportation of hazardous waste shall be consistent with the Hazardous Materials Transportation Act. Other relevant federal legislation, mentioned specifically in RCRA, is examined to determine if through hazardous waste management and disposal they

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[30]This project was performed under contract for the Oak Ridge National Laboratory, Office of Integrated Assessment and Policy Analysis as part of a task to examine a variety of potential impacts of RCRA on energy technology.

influence the siting of energy supply facilities. This examination serves primarily as a guide to coordinate action in preliminary siting activities. The intent of Chapter 2 is to provide an overview of federal legislation with which RCRA is to be coordinated and not a detailed analysis of each act.

Energy Supply Technologies

Specific energy supply technologies inspected are oil shale, petroleum refineries, coal combustion, geothermal, biomass, solar collectors and photovoltaics. These technologies were examined to provide an indication of some of the different technology and siting characteristics: (1) whether the technology supplies energy directly or indirectly, (2) whether the technology's energy is generated in a centralized or decentralized fashion, and (3) whether the technology's fuel is renewable or nonrenewable. Data generated by the RCRA policy analysis project members were used to determine at what stage the energy supply technology waste stream is hazardous. If the waste stream does not include hazardous material, the wastes will be regulated under Subtitle D of RCRA (State or Regional Solid Waste Plans).[31] Section 4004, "Criteria for Sanitary Landfills," will determine disposal of nonhazardous solid waste. This information is the basis for evaluating the effect of hazardous waste siting limitations on energy supply options. The set of energy supply technologies examined in the development of an energy

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[31]Radioactive waste resulting from energy production are regulated by the Atomic Energy Act of 1954, as amended (PL 83-703).

policy must be compared on the basis of the cost of generated energy rather than solely on the basis of the cost of hardware production. This includes the cost of waste disposal.[32]

Methods of Hazardous Waste Disposal

Owners and operators of hazardous waste disposal facilities are regulated by Section 3004.

> Disposal of hazardous waste involves the discharge, deposit, injection, dumping, spilling, leaking, or placing of any of the waste into or on any land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.[33]

The generator of hazardous wastes can choose among several avenues for disposal of these wastes, including

- Incineration
- Landfills
- Surface impoundments
- Landfarming
- Underground injection
- Resource recovery

All of the above methods may be utilized either at the site of generation (on-site) or transported to a separate facility (off-site).

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[32]Neil L. Goldman, *Photovoltaic Decision Analysis* (Cambridge, MA: Massachusetts Institute of Technology, 1977), p. i.

[33]U.S., EPA, Office of Solid Waste, *Draft Environmental Impact*, pp. 5:35-5:36.

Incineration. Incinerators for hazardous wastes are defined as combustion devices. EPA believes that incineration of hazardous waste should be actively encouraged. This disposal method has been found to be technically feasible and environmentally sound, and it reduces or eliminates the volume and/or toxicity of waste to be disposed on the land.[34] By using incinerators to reduce the volume of waste, less land will be needed for final disposal, thereby decreasing the amounts of land preempted from other land use functions.

Landfills. EPA cannot predict how long hazardous waste in a landfill will remain hazardous. Therefore, to fulfill the mandate to protect human health and the environment the EPA is requiring that landfills be designed, constructed and operated so that discharges are minimized or do not occur. Leachate collection is required to monitor the landfill and prevent the possibility of ground water contamination. While the Agency does not categorically ban liquids from landfills, discouragement of the landfilling of liquids is another element of EPA's strategy for maximizing the containment of wastes. Liquids are required to be modified and/or treated to a nonflowing consistency prior to landfilling or in situ. EPA feels it is important to discourage the landfilling of liquid hazardous waste because such waste increases the likelihood that hazardous materials will enter the environment.[35]

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[34] *Federal Register*, 43: 58989.

[35] Ibid.

Surface impoundments. Basins and surface impoundments may be used to hold, treat or dispose of waste. A "basin" is an uncovered aboveground device constructed of artificial materials which is used to retain hazardous waste as part of a treatment process. Surface impoundments are any natural topographic depressions, artificial excavations, or dike arrangements which are used primarily for holding, treatment or disposal of waste, constructed above, below, or partially in the ground or in navigable waters. Surface impoundments are usually built by constructing earth dikes around the impoundment area. Most impoundments are lined either with soil or synthetic materials. RCRA regulation of surface impoundments serves primarily to ensure the impermeability, structural stability, and integrity of dikes, soil barriers, and synthetic liners.[36]

Landfarming. Provided certain operating and design parameters are used, landfarming is an environmentally acceptable method for hazardous waste disposal. RCRA regulations require that landfarms be located on areas of fine grained soil types (OH, CH, MH, CL and OH as defined by the Unified Soil Classification System). Soil monitoring determines the soil conditions at a landfarm. Certain types of hazardous waste should not be landfarmed (e.g., excessively volatile substances or environmentally persistent organics). One objective of RCRA regulations on landfarming is to prevent the conversion of large tracts of productive land to land with limited potential use. The proposed RCRA objective requires that the soil of the treated area of a landfarm be returned to

[36]Ibid., pp. 58989-58990.

its previously existing condition when landfarming operations cease. However the growth of food chain crops upon hazardous waste land farms is prohibited. EPA deems a general prohibition of the growth of food crops on such land warranted due to the possibility of high levels of toxic constituents in the hazardous waste which might be landfarmed, the absence of adequate information on crop uptake of contaminants in these wastes, and the lack of data on management control necessary to allow growth of food crops.[37]

Underground injection. Disposal of hazardous waste by underground injection is not covered by proposed RCRA rules where this activity is regulated by the Safe Drinking Water Act. Since most underground injection facilities involve aboveground storage of hazardous waste prior to injection, some of those facilities will have to comply with both RCRA standards and the Underground Injection Control (UIC) regulations to be promulgated under the Safe Drinking Water Act (including closure procedures).[38] However, EPA "Proposed Consolidated Permit Regulations" (for the RCRA, Safe Drinking Water Act, Clean Water Act and Clean Air Act) propose to regulate the activity of injecting hazardous waste into underground injection wells.[39]

Resource recovery. Resource recovery of any waste, including hazardous waste, is the most desirable method for treatment/disposal.

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[37]Ibid., pp. 58990-58991.

[38]Ibid., p. 58993.

[39]*Federal Register*, 44: 34255: June 14, 1979.

Conservation of resources through recovery and recycling technologies is encouraged and provided for in RCRA (Subtitle E — Duties of the Secretary of Commerce in Resource and Recovery). EPA believes it is necessary to regulate hazardous waste used to make commercial products, if necessary to protect human health and the environment. There are currently no standards covering products made from hazardous waste except for radioactive special waste. In the December 18, 1978, proposed regulations it was suggested, as an alternative, that products made from a hazardous waste which do not pose a threat greater than the threat posed by the virgin product it replaces would cease being hazardous waste for purposes of Subtitle C of RCRA and thus no longer subject to Subtitle C regulations. The classification and regulation of recovered material as hazardous will tend to discourage existing and future options for resource recovery. Removing a substance from compliance with hazardous waste management regulations will serve as an incentive for industries to explore and develop new recovery techniques and uses.

Limitations and Assumptions

There are several assumptions and limitations to be aware of in reviewing this study. To make the research project manageable, the topic was tightly defined. Although it was possible to accommodate a broader view, time and resource limitations dictated a product that would be an in-depth review of a narrow topic as opposed to a broad view of the "universe."

At various stages in the research process it is inevitable that assumptions are made. In any evaluation involving regulatory activities, the specific answers to some questions are not available. Therefore, one must assume an answer, state the assumption and proceed with the research. Because RCRA hazardous waste regulations are not yet finalized, assumptions have been made in order to complete this research effort. This research is an attempt to focus on a "moving target."

When in doubt, a conservative "worst case" condition is assumed. Specifically, if a stage of the waste stream of an energy supply technology is currently classified as "special waste," this research effort assumes that special wastes will not be managed and disposed in compliance with all RCRA hazardous waste regulations. Also, if there is a question of whether a particular stage of the hazardous waste stream is regulated by other federal legislation, the waste is assumed to be regulated by RCRA.

Organization of Thesis and Analysis

Based on the introductory and background information given in this chapter, the remainder of the thesis will give evidence to substantiate the proposition that the interaction of RCRA hazardous waste regulations with energy supply facility siting will impact land use issues. The results of the literature and legislative review was synthesized to determine if and how RCRA influences land use issues. The impact on land use is developed from an analysis of the literature reviewed and interviews.

In Chapters II and III a review of legislation and regulations indicates the current status of hazardous waste regulations and exclusionary siting constraints. In Chapter II a comparison of pre-RCRA legislation and RCRA, in addition to an overview of other federal legislation related to RCRA, is presented. Chapter III is a review and comparison of selected state legislative activities with each other, and with federal policy.

The chapter on energy supply technologies (IV) serves two purposes. A brief description of the technologies included in this research and their role in the energy supply network is presented. Secondly, the stage of each energy supply technology generating a hazardous waste stream is indicated.

Chapter V first identifies what is meant by the term "land use"; and second, what are some of the interrelationships between hazardous waste disposal facilities and land use issues. Included in this chapter is a proposed hierarchical model of land use functions surrounding hazardous waste disposal facilities.

Identification of the types of land use impacts caused by specific energy supply technologies which generate hazardous waste is given in Chapter VI. Depending upon the technology, energy waste may cause various land use impacts.

In the concluding chapter, major research findings are presented. Recommendations regarding RCRA, the siting of hazardous waste disposal facilities and energy supply facilities, and the planning for these facilities are made. Such recommendations will be useful to DOE and energy industries in preliminary planning for the siting of energy facilities. They will also be beneficial at the state, regional and local levels where it is necessary to assess the limitations (and the significance of the limitations) of RCRA in terms of local land use.

The importance of this research is not necessarily resolution of current hazardous waste disposal problems but identification of land use issues impacted by future energy supply facility siting. It is the awareness and intelligent use of information that will enable energy and land use planners and policy makers to provide adequately for protection of the public health and environment without jeopardizing the future energy needs of the country.

CHAPTER II

FEDERAL LEGISLATIVE ACTIVITY

The federal government plays a complex policy role by affecting the behavior of energy and waste disposal industries through legislative requirements. In recent years there has been an influx of environmental legislation from the federal government. The combination of these legislative requirements sometimes imposes conflicting demands on industry. These conflicts are also felt in the energy supply industry. For example, the energy industry, in an effort to comply with environmental regulations for new plants have (1) increased their project lead times, (2) elevated environmental factors in planning decisions, and (3) recognized a need for contingency plans in case their initial plans were unacceptable.[1] Although RCRA is just one of numerous legislative statutes that must be complied with in the siting of energy supply and hazardous waste disposal facilities, as a *new and developing* legislative requirement which is not well understood by the public and private sector, it may be quite important.

To better understand common operating constraints that affect the implementation of RCRA hazardous waste regulations, this chapter examines federal legislative activities. First is a summary review of other relevant federal legislation. Next, pre-RCRA and post-RCRA regulatory constraints are examined at the federal level.

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[1]John Quarles, "Federal Regulation of New Industrial Plants," *Environmental Reporter* (Monograph No. 28), 10 May 1979, p. 2.

Relevant Federal Legislation

Though the main purpose of the legislative review is to assess the impact of RCRA hazardous waste regulations on the siting of energy supply facilities, other relevant legislation must also be reviewed. Section 1006 requires the integration of RCRA with other federal legislation. Secondly, the requirements and definitions of terms in environmental legislation is often based on previous legislation. A review of other relevant environmental legislation facilitates a better understanding of the complexity of the institutional environment in which energy planners and decision makers must operate.

The legislative Acts reviewed in this report are those specifically mentioned in "Hazardous Waste: Proposed Guidelines and Regulations and Proposal on Identification and Listing" (*Federal Register*, 43: 58946-59028). In addition to legislative Acts, the proposed RCRA regulations must also conform with applicable Executive Orders. These statements are nonstatutory provisions used by the President to further the goals of their administration.

The proposed rules for hazardous waste management and disposal were developed in accordance with Executive Order (EO) 11821, as amended by Executive Order 11949, and Office of Management and Budget (OMB) Circular A-107, and Executive Order 12044. The executive directives require the review of economic, environmental and regulatory impacts of proposed rules, regulations and guidelines. These analyses have been completed in draft form.[2]

Executive Order 11821, signed by President Gerald Ford on November 27, 1974, is entitled "Inflation Impact Statements." It requires all major legislative proposals, regulations and rules issued by the executive branches of government to include a statement certifying that the inflationary impact of such actions on the Nation has been carefully considered. This order was to expire December 31, 1976. Executive Order 11949, also signed by Gerald Ford, amended EO 11821 to read "Economic Impact Statements" and extended its requirements to December 31, 1977.

On March 23, 1978, President Jimmy Carter signed Executive Order 12044, "Improving Government Regulations." This EO, effective until June 30, 1980, directs executive agencies to adopt procedures to improve existing and future regulations. It is intended to improve the quality of executive agency regulatory practices. OMB Circular A-107 was superseded by the Executive Orders as of October 31, 1977. This document, an EPA policy statement, was concerned with evaluation of the inflationary impact of major proposals, legislation, regulations and rules.

<u>National Environmental Policy Act (NEPA)</u>. This Act, signed into law on January 1, 1970, is the foundation of federal environmental legislation.

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[2]U.S., Environmental Protection Office, Office of Solid Waste, *Subtitle C, Resource Conservation and Recovery Act of 1976:* (1) *Draft Economic Impact Analysis,* (2) *Draft Environmental Impact Statement,* and (3) *Appendices* (Washington, DC: Government Printing Office, 1979).

NEPA establishes general federal environmental policy and contains action forcing provisions affecting federal agencies (e.g., Department of Energy). One of the most important provisions of this Act is the requirement that an environmental impact statement (EIS) for "major Federal actions significantly affecting the quality of the human environment" be prepared. Because of the EIS requirement, environmental consequences must be considered before action is taken.[3]

The initial impact of NEPA on energy facility siting is twofold. First, any project undertaken by DOE must be preceded by an EIS. Secondly, for those states where EPA retains the authority over hazardous waste management, the granting of a federal permit may necessitate an EIS. All DOE energy supply facilities, with or without on-site hazardous waste disposal, will require an EIS. In addition, all energy supply facilities with on-site disposal, in states without hazardous management authority, will require an EIS. EPA permits for hazardous waste disposal facilities are not subject to the formal requirements of NEPA, although future litigation may challenge this holding.[4]

Clean Air Act (CAA). EPA is authorized by the Clean Air Act to set standards for hazardous air pollutants. It is founded on the concept of achieving specified national ambient air quality standards (NAAQS). These standards define the quality of air which must be achieved to prevent adverse public health or environmental effects.[5]

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[3] Moss, pp. 18-19.

[4] *Federal Register*, 44: 34247.

[5] Quarles, p. 3.

The Clean Air Act may affect the siting of energy facilities in areas where any ambient air quality standard is being violated. In these areas, no major new source of potential pollution can be constructed without a permit. This permit imposes stringent control requirements and requires sufficient "offsets"[6] to assure progress toward compliance.[7] Hazardous waste management facilities must comply with the Clean Air Act requirements in addition to RCRA facility siting requirements. All facilities must be located, designed, constructed and operated so as to prevent air emissions from these facilities from causing a violation of regulations or standards promulgated as a result of the Clean Air Act.

Clean Water Act (CWA). Prior to the 1972 amendments to the Federal Water Pollution Control Act, federal legislation had endorsed the practice of allowing certain waters to remain severely degraded by permitting industrial and other uses. The 1972 amendments abandoned this interpretation and adopted the notion that "no one has the right to pollute — that pollution continues because of technological limits, not because of any inherent right to use the nation's waterways for the purpose of disposing of wastes."[8]

The FWPCA, further amended by the Clean Water Act of 1977, prohibits the discharge of any pollutants into public waterways unless authorized by a permit. Conditions are set forth in the permit which require adequate pollution control. The permit program, the National Pollutant

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[6]"Offsets" means the reduction in emissions from other existing sources.

[7]Quarles, p. 15.

[8]Moss, p. 68.

Discharge Elimination System (NPDES), was originally administered by EPA, but now thirty-two states have taken over and are conducting their own permit program.[9] This Acts' restrictions impacts the siting of hazardous waste disposal facilities because it: (1) prohibits discharge of hazardous materials into navigable waters, (2) requires the promulgation of EPA guidelines for the pretreatment of some pollutants; including plant site runoff, spillage or leaks, sludge or water disposal, and drainage from new material storage, (3) deals with new source performance standards, (4) protects navigable waters and shorelines from discharges, (5) requires a permit by EPA for the disposal or relocation of sewage sludge that could affect navigable waters, and (6) gives the EPA Administrator the authority to bring suit against any one who contributes to a pollution source which may cause eminent danger to public health or welfare.[10]

Safe Drinking Water Act (SDWA). This Act requires the EPA administrator to establish a permit program to regulate and control the contamination of public water systems which could have adverse effects on public health. The main significance of this Act in relation to hazardous waste disposal is its control of underground injections. EPA (or the State, where it has effective programs) regulates the underground sources of drinking water.[11] Additionally, a facility cannot be located

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[9]Quarles, pp. 22-23.

[10]U.S., EPA, Office of Solid Waste, *Draft Environmental Impact*, pp. 2:14-2:15.

[11]Ibid., p. 2:15.

in the recharge zone of a sole source aquifer as designated by the Safe Drinking Water Act.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA, as amended by the Federal Pesticide Control Act of 1972, requires labeling of pesticide containers, classification and registration of pesticides, and certification of applicators who use restricted pesticides.[12] It also requires the Administrator of EPA to establish procedures and regulations for the storage and disposal of pesticides and their containers. Farmers, as generators of hazardous waste from pesticides, are exempted from RCRA provisions. The FIFRA is used to control the disposal of excess pesticides and their containers.

Toxic Substances Control Act (TSCA). This 1976 legislation regulates hazardous substances before they become waste. TSCA requires testing and necessary use restrictions on specific chemical substances. The Administrator of EPA may prohibit or limit the manufacturing, processing, distribution or disposal of certain substances. The disposal of polychlorinated biphenyls (PCB's) (which constitute a hazardous waste product) are regulated by requirements promulgated pursuant to TSCA. EPA is considering the option of integrating RCRA disposal standards and TSCA rules for other special chemicals also.

Marine Protection, Research, and Sanctuaries Act (MPRSA). This Act regulates the transportation for dumping, and the dumping of materials

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[12]Ibid., p. 2:17.

into ocean waters. The Administrator of EPA is authorized to issue permits for ocean dumping, but must consider other alternatives to disposal including land based alternatives, and the impact on the public. RCRA does not regulate ocean disposal of hazardous waste.[13] That activity was preempted by the regulations of the Marine Protection, Research and Sanctuaries Act of 1972.

Endangered Species Act. The Endangered Species Act of 1973, as amended, provides a way to preserve ecosystems upon which endangered and threatened species depend. In concurrence with this Act, RCRA prohibits the location of hazardous waste facilities in areas which are likely to jeopardize the continued existence of endangered and threatened species or result in the destruction or adverse modification of their critical habitat, pursuant to the Endangered Species Act.

Hazardous Material Transportation Act (HMTA). By the authority granted in the 1974 Act, the Department of Transportation (DOT) promulgated regulations which list hazardous materials and specific procedures to be adhered to when transporting those materials. Any material which meets DOT criteria of hazardous material must be handled according to DOT regulations, including waste. Standards set forth under RCRA (subparts B and C) are consistent with HMTA standards.

> Depending on DOT's actions, EPA may jointly promulgate regulations with DOT, modify regulations previously proposed, or adopt forthcoming DOT regulations. EPA and DOT intend to

[13]Battelle, Columbus Laboratory, *Part II*, p. 31.

jointly enforce any DOT regulations governing transportation of hazardous waste.[14]

Atomic Energy Act (AEA). As amended, this Act authorizes the Atomic Energy Commission — now the Nuclear Regulatory Commission (NRC) — to manage radioactive waste generated in fission reactors by both the federal government and private industry. Uranium mill tailings, radium, radioisotopes, and other naturally occurring materials are not subject to regulation under this Act.[15] The requirements of proposed RCRA hazardous waste management regulations do not apply to "source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended."[16]

Federal Occupational Safety and Health Act (OSHA). The Secretary of Labor is authorized to set mandatory standards to protect workers from occupational hazards by this Act. This includes hazards associated with contact with hazardous materials. The specific relationship between OSHA and RCRA are standards for storage. Hazardous waste storage tanks and containers must meet OSHA regulations which provide for the occupational safety and health of all employers and employees of hazardous waste management operations.

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[14] *Federal Register*, 43: 58971.

[15] U.S., Environmental Protection Office, Office of Solid Waste Management Programs, *Report to Congress: Disposal of Hazardous Waste* (Washington, DC: Government Printing Office, 1974), p. 15.

[16] *Federal Register*, 43: 58996.

Freedom of Information Act (FOIA). The Freedom of Information Act provides standards for the dissemination of public and personal information. Title 5 of the Code of Laws of the United States of America applies to Executive Departments and Government Officers and employees. It regulates what information can be made public and under what constraints. As it applies to RCRA, Sec. 552 of FOIA stipulates agency (EPA) responsibility for making available to the public information concerning publication of proposed regulations and guidelines in the Federal Register, and makes available for public inspection other pertinent information. However, the legislation does consider proprietary information confidential.

Summary of relevant federal legislation. As can be seen in the review of legislative activities, other environmental Acts directly influence RCRA's authority in regulating hazardous waste. The Acts with major impact on hazardous waste management are: the Clean Air Act; Clean Water Act; Safe Drinking Water Act; Federal Insecticide, Fungicide, and Rodenticide Act; Toxic Substances Control Act; and Hazardous Materials Transportation Act. These Acts either preempt RCRA's authority over the management of certain substances, the methods of disposal, or regulation of transportation of hazardous materials.

Federal Waste Legislation

A comparison of pre-RCRA legislation — the Solid Waste Disposal Act of 1965 and its amendment, the Resource Recovery Act of 1970 — with RCRA legislation and post-RCRA administrative rules — "Hazardous Waste:

Proposed Guidelines and Regulations and Proposal on Identification and Listing" — reflects the magnitude of change in federal involvement with hazardous waste disposal. The sections of these legislative documents which deal with hazardous waste disposal (more specifically, facility siting) are reviewed and compared.

Pre-RCRA legislation. Primary responsibility for handling solid waste — collection, processing, and disposal — was traditionally in the hands of individuals or the local government. However, passage of the Solid Waste Disposal Act (SWDA) of 1965 authorized federal intervention in solid waste activities, but only to assist state and local governments.[17] This Act recognized the interrelationship between solid waste management and water pollution control. It established policies concerning regionalization and area wide approaches which are essential in developing adequate solid waste management and authorized assistance to states in organizing and installing solid waste management programs.[18]

In 1970 the Solid Waste Disposal Act of 1965 was amended by the Resource Recovery Act. This amendment further extended SWDA and redirected federal emphasis. It stressed the importance of resource recovery, and authorized assistance to the states in the area of resource recovery. The Solid Waste Disposal Act and its amendment, the Resource Recovery Act, were "to authorize a research and development program with

[17]Small, p. 31.

[18]Lynton K. Caldwell, *Man and His Environment: Policy and Administration* (New York: Harper and Row Publishers, 1975), p. 113.

respect to solid-waste disposal." In Sec. 202(a)(4), Congress found:

> that inefficient and improper methods of disposal of solid wastes result in scenic blights, create serious hazards to the public health, including pollution of air and water resources, accident hazards, and increase in rodent and insect vectors of disease, have an adverse effect on land values, create public nuisances, and otherwise interfere with community life and development.

Though SWDA recognized that improper methods of disposal of solid wastes could result in health and environmental hazards, it dealt primarily with nonhazardous wastes and resource recovery. This Act provides for (1) research, demonstration and training in solid waste activities and resource recovery (Sec. 204 and 205); (2) encouraged interstate and interlocal cooperation (Sec. 206); (3) recommended the promulgation of guidelines for waste management (Sec. 209); (4) provided grants for planning, resource recovery systems, improved disposal facilities and training projects (Sec. 207 and 208); and (5) required that a comprehensive report and plans for a system of national disposal sites for storage and disposal of hazardous wastes be submitted to Congress (Sec. 212). The Sec. 212 requirement of the national disposal sites study was due in 1972. However, EPA requested and received a time extension to June 30, 1973, for submission of that report.[19]

Section 212 of SWDA provided the initiative for EPA "Report to Congress: Disposal of Hazardous Waste." This 1973 report was the first major assessment of the seriousness of the Nation's hazardous waste problem. One of its major conclusions was that "hazardous waste

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[19] U.S., EPA, Office of Solid Waste Management Programs, *Disposal of Hazardous Waste*, p. 1.

legislation was a key to solution of the problem of mismanaged waste." It also concluded that "national disposal sites were not a viable waste disposal strategy."[20] It wasn't until passage of the Resource Conservation and Recovery Act of 1976 that hazardous waste management was specifically addressed as a national problem.

RCRA legislation. With RCRA, for the first time the federal government became directly involved in solid waste control.[21] By replacing the Solid Waste Disposal Act of 1965, RCRA was:

> To provide technical and financial assistance for the development of management plans and facilities for the recovery of energy and other resources from discarded materials and for the safe disposal of discarded materials, and to *regulate the management of hazardous waste.* (emphasis added)

The basic thrusts of this legislation are to promote the protection of health and the environment and to conserve valuable material and energy resources. According to Sec. 1003, these objectives are to be accomplished by:

> (1) providing technical and financial assistance to State and local governments and interstate agencies for the development of solid waste management plans (including resource recovery and resource conservation systems) which will promote improved solid waste management techniques (including more effective organizational arrangements), new and improved methods of collection, separation, and recovery of solid waste, and the environmentally safe disposal of nonrecoverable residues;

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[20]Wallace H. Fuller, ed., *Residual Management by Land Disposal: Proceedings of the Hazardous Waste Research Symposium* (Washington, DC: Government Printing Office, 1976), p. 32.

[21]Sullivan, p. 2.

(2) providing training grants in occupations involving the design, operation, and maintenance of solid waste disposal systems;

(3) prohibiting future open dumping on the land and requiring the conversion of existing open dumps to facilities which do not pose a danger to the environment or to health;

(4) regulating the treatment, storage, transportation, and disposal of hazardous wastes which have adverse effects on health and the environment;

(5) providing for the promulgation of guidelines for solid waste collection, transport, separation, recovery, and disposal practices and systems;

(6) promoting a national research and development program for improved solid waste management and resource conservation techniques, more effective organizational arrangements, and new and improved methods of collection, separation, and recovery, and recycling of solid wastes and environmentally safe disposal of nonrecoverable residues;

(7) promoting the demonstration, construction, and application of solid waste management, resource recovery, and resource conservation systems which preserve and enhance the quality of air, water, and land resources; and

(8) establishing a cooperative effort among the Federal, State, and local governments and private enterprise in order to recover valuable materials and energy from solid waste.

Subtitle C (Hazardous Waste Management) is the main regulatory program of RCRA. The initial thrust of the hazardous waste management program, contained in this Subtitle, is to identify and list which wastes are hazardous, in what quantities, qualities and concentrations, and the disposal methods which may make otherwise benign waste hazardous (i.e., the mixing of certain nonhazardous wastes may result in a hazardous waste). The EPA Administrator is required to promulgate regulations applicable to generators, transporters and disposers of hazardous waste.[22]

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[22]Arbuckle, p. 326.

The siting restrictions for disposal facilities, when examined more closely, indicate an interaction of hazardous waste regulations with the siting of energy supply facilities.

Comparison of SWDA and RCRA. A comparison of SWDA and RCRA regulations regarding hazardous waste management illustrates the substantial redirection of federal concern. A review of their waste definitions and regulations for the siting of disposal facilities is indicative of the magnitude of the change.

SWDA defines solid waste in Sec. 203(4) as:

> garbage, refuse, and other discarded solid materials, including solid-waste materials resulting from industrial, commercial, and agricultural operations, and from community activities, but does not include solids or dissolved material in domestic sewage or other significant pollutants in water resources, such as silt, dissolved or suspended solids in industrial waste water effluents, dissolved materials in irrigation return flows or other common water pollutants.

This Act gives no concise definition of hazardous waste. However, in the discussion of hazardous wastes in Sec. 212's requirement for the national disposal sites study, it included "radioactive, toxic chemical, biological, and other wastes which may endanger public health or welfare."

RCRA gives definitions for both solid and hazardous wastes (ref. Chapter 1 and Sec. 1004). The solid waste definition is expanded to include such wastes as sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility, and liquid, semisolid, or contained gaseous material. Hazardous wastes have an extended definition which includes wastes which may increase mortality, illness, or substantial or potential hazard to human health and the environment.

Proposed RCRA regulations also have a category of "special waste." These large volume wastes are hazardous within Subtitle A (General Provisions, i.e., definitions) standards and are therefore subject to Subtitle C (Hazardous Waste Management) regulations. EPA does not have adequate information on the composition, characteristics or degree of hazard posed by these wastes. However, the limited information available indicates that these special large volume wastes pose relatively low potential hazards. "For the time being, all facilities which handle special waste will be exempted from the storage standards and the treatment and disposal standards."[23]

Both special and hazardous wastes must be disposed of in permitted disposal facilities and be tracked by a "cradle-to-grave" manifest system. Special waste can be disposed of in RCRA regulated facilities which meet environmental and performance standards. Hazardous waste disposal facilities must meet operating and design standards in addition to environmental and performance standards. The primary difference in management of special waste as compared to hazardous waste is groundwater monitoring requirements. Though water coming into contact with the waste may leach soluble components which could alter water quality, groundwater monitoring is not required for special waste disposal facilities.

The siting of hazardous waste disposal sites is not regulated in the SWDA. A report on methods of disposal for hazardous materials was included in the Sec. 212 "Report to Congress: Disposal of Hazardous

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[23]*Federal Register*, 43: 58991-58992.

Wastes," but these were not requirements. It is important to note, however, that the SWDA, Sec. 207 provides grants for planning of waste disposal systems. While the resulting plans would not *require* particular site selection features, they could influence indirectly the actual siting of the disposal facilities — some of which may include hazardous waste.

Section 3004 of RCRA (Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities) requires that the EPA Administrator promulgate regulations which establish performance standards for treatment, storage, and disposal of hazardous waste. These standards are to include location, design, and construction of hazardous waste treatment, storage and disposal facilities.

The "Hazardous Waste: Proposed Guidelines and Regulations and Proposal on Identification and Listing" list general facility standards for the siting of hazardous waste disposal facilities. The guidelines include exclusionary constraints for the siting of these disposal facilities (operating and design standards), administrative or other legislative restrictions, and a mechanism in the permitting process to provide flexibility for facility siting (environmental and performance standards). Exclusionary constraints are those disposal facility site locations made unacceptable by RCRA. Only two of the constraints are totally exclusionary — active fault zones and regulatory floodways. Some of the constraints allow the EPA Regional Administrator to deviate from a specific standard if an equivalent degree of containment and environmental protection is achieved. Other siting limitations are the result of previous legislation (e.g., the Clean Air Act, Clean Water Act, and Safe Drinking Water Act) or an administrative requirement (e.g., public participation). As can be seen in Table 1, there are numerous potential siting constraints for hazardous waste facilities which may in turn limit energy facility siting.

RCRA also requires closure and postclosure standards. These standards specify what facility owners and operators must do after closeout (the time when wastes are no longer received). The potential land uses allowed after closure are affected by the closure and post-closure standards. Depending on the adequacy and enforcement of these standards, some land use options may be closed. Therefore, though closure and postclosure standards are not an "exclusionary constraint" of where a hazardous waste disposal facility can be located, they do influence the land use of the area because of limitations on what activities will be allowed in the future (e.g., residential use is not allowed but recreational is).

Summary of Federal Waste Legislation

Before RCRA was enacted in 1976, solid waste (including hazardous waste) was regulated by the SWDA. However, hazardous waste management was insufficient under the SWDA. An EPA initiated report to Congress in 1973 gave notice of the seriousness of the hazardous waste problem. With the passage of RCRA, the federal government became involved in the regulation of hazardous waste management. In order to protect public health and the environment, RCRA required the promulgation of regulations

Table 1. RCRA hazardous waste facilities siting constraints

Constraints	Exclusionary constraint	Variance mechanism (Notes[b])	Administrative or other legislative restrictions
Active fault zone	X		
Regulatory floodway	X		
Coastal high hazard area	X	X	
500 year flood plain	X	X	
Wetlands	X	X	
Endangered species/critical habitat	X	X	
Sole source aquifers	X	X	
Site buffer zone	X	X	
24-hour, 25-year storms	X	X	
Air quality	X		X
Groundwater	X		X
Surface water	X		X
Soil types[a]	X		
Public participation			X

[a]Soil types as an exclusionary constraint apply only to land farming techniques.

[b]The "Notes" mechanism authorizes the EPA Regional Administrator to allow deviation from a specific requirement if it can be demonstrated that an equivalent degree of protection is provided.

providing for comprehensive control of hazardous waste from its generation – through transportation, treatment and storage – to its final disposal. Chapter III is a sample indicator of state responsiveness to RCRA legislation. The focus of the remainder of this study is upon the impact RCRA regulations for hazardous waste disposal facilities will have on national land use issues.

CHAPTER III

STATE LEGISLATIVE REVIEW

At this point in the EPA process of formulating regulations it is important to know the kinds of state action to expect. California, Connecticut, Tennessee and Texas hazardous waste regulations and statutes were reviewed and compared with each other, and with federal policy. It is obvious that these states are not totally representative of regional characteristics found in the United States. However, this was not the purpose of reviewing state regulatory behavior. The *nature* of state response to RCRA, rather than the specific actions of each state, indicates the type of activities that planners and decision makers need to be aware of when attempting to site hazardous waste disposal facilities.

States were chosen not because of a particular characteristic, but rather to provide a general representation of different regions of the country. These states have unique as well as common approaches to the siting of hazardous waste disposal facilities. In each state, there have been actual or proposed legislative and administrative changes which reflect the influence of RCRA. The importance of this review of state legislation is not an all inclusive survey of state hazardous waste management programs. This descriptive research is an attempt to further explore the context of decisions made in state response to RCRA.

A state hazardous waste management program should include the following six elements in order to be substantially equivalent to RCRA:

(1) legislative authority, (2) adequate resources, (3) published criteria and standards, (4) established permit mechanisms, (5) surveillance and enforcement, and (6) a manifest system.[1] The presence of these elements establishes the state programs as equivalent to federal regulations and therefore establish grounds for EPA authorization of state control over hazardous waste management. The following review of state regulations, statutes, and programs helps determine if these elements were present.

Information utilized in this review was obtained by three methods: (1) review of literature, legislation, and regulations; (2) letters of inquiry (see Appendix A), and (3) telephone interviews. The literature review provides background information on the states. Both pre-RCRA and post-RCRA statutes and regulations were examined to determine the magnitude of change in state programs. Letters of inquiry were sent to hazardous waste officials in all four states to obtain additional information about how the state program was actually managed.[2] The telephone interviews provided by far the greatest insights into what the states are actually doing. State hazardous waste management officials were very helpful in providing information and insight about their programs. The information gathered did allow for an overview of state response to RCRA hazardous waste regulations in California, Connecticut, Tennessee, and Texas.

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[1]Battelle, Columbus Laboratory, *Final Report on State of Ohio Hazardous Waste Management Plan: Executive Summary, Part III* (Columbus, OH: Battelle National Laboratory, 1978), p. 12.

[2]However only three states responded and one of those was a letter explaining that until the federal government has its hazardous waste management program in order, the states find it difficult to complete their programs.

California

According to 1978 data California, with a population of 22,294,000 has the largest population of any state. It has a predominately urban settlement pattern and is the third largest state, encompassing 158,693 square miles.[3] This EPA Region IX state is noted for its innovative legislation. In fact, California was under contract to EPA for a pilot program in the treatment of waste, and RCRA was patterned to a considerable extent after California legislation.[4]

The principal regulatory agency for hazardous waste in California is the Department of Public Health. It will be responsible for an estimated 3,760,000 metric tons of hazardous waste by 1980. In fiscal year 1978 California had $1,489,000 available for the operation of its hazardous waste program. This included a staff of 29 persons. However, state officials said they needed funding in the amount of $2,220,000 and a staff of 46 to adequately manage their hazardous waste program. California is one of the few states which presently charge fees for hazardous waste disposal permits — $100 per ton (California and Maryland have model fee systems).[5]

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[3]American Institute of Planners, *State Land Use Activity* (Springfield, VA: Department of Commerce, 1976), p. 439.

[4]Phone interview with Wade Cornwell, California Department of Health Services, Sacramento, CA, 20 March 1979.

[5]"1979 Landfill Practices Survey," *Waste Age*, January 1970, p. 49.

In California, 97 sites accommodate some portion of the hazardous waste generated. Furthermore, California expects that all 97 of these sites will meet the anticipated requirements under RCRA.[6]

The California State Department of Health, Hazardous Waste Control Law was passed in 1972 and amended in 1977.[7] The 1972 legislation has a permit mechanism and manifest system, charges a fee for disposal, and has a means for enforcement. The Department of Health was given the authority to adopt regulations for hazardous waste management and to enforce them.[8]

The 1977, "Title 22: Environmental Health" state administrative regulations provides for a more comprehensive hazardous waste management program.[9] The published standards and management criteria are more clearly defined, thereby reinforcing other elements of the program. The 1977 regulations establish a permit mechanism, manifest system, enforcement and surveillance functions, and the disposal fee system which helps to offset some of the costs.

The current regulations insure more complete protection of public health, safety, and the environment. When compared with the 1972 regulations, the 1977 regulations establish more criteria to be evaluated in the approval process for the siting of a hazardous waste disposal

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[6]Ibid.

[7]California, *Hazardous Waste Control Law* (1977), Health and Safety Code, Division 20, Chapter 6.5.

[8]California, *Hazardous Waste Regulations* (1972), California Government Code, Title 22.

[9]California, *Hazardous Waste Regulations* (1977), California Government Code, Title 22.

facility. These include, but are not limited to, consideration of water quality, air quality, special environmental considerations, current land use and material features, and operation plans.

The actual process for selecting sites for hazardous waste disposal facilities is basically subjective. The Department of Health Services evaluates the permit application, meets with the operators, and utilizes the personal knowledge of their inspectors to make a decision on whether or not to grant a permit. The operators of the facility must obtain a local Land Use Permit from the County Board of Supervisors. The State Water Resources Control Board is responsible for granting a permit to dispose of waste on land. By looking at how the waste will be handled and the air quality of the area, the State Air Resources Control Board also has input into the permitting process. None of the above decisions are totally objective. Each is basically a subjective – though often conservative – decision.[10] Therefore, it is the judgement of these state and local decision makers which actually decide how stringent the California hazardous waste management program will be.

California has one of the more comprehensive state hazardous waste management programs. This state's political climate has allowed the development and passage of effective regulations. Even though many of the actual decisions are based on subjective judgement, this state seems to have adequate personnel to make these decisions. It is expected that the requirements for the siting of hazardous waste disposal facilities in California will closely parallel RCRA hazardous waste regulations.

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[10]Phone interview with Wade Cornwell, 15 June 1979.

Connecticut

Manufacturing is Connecticut's most important economic activity, providing 97 percent of the value of goods produced in the state. The 1978 population of the Region I state was 3,099,000, of which 77 percent live in urban areas.[11] In view of the potential impact of siting of hazardous waste facilities, it is important to note that this state has 618 miles of tidal shoreline, including bays and mouths of many rivers.[12]

Solid waste disposal is regulated by the Department of Environmental Protection in the state of Connecticut. This state has about 22 personnel in their solid waste program, however, only 3 of these work in the area of hazardous waste management. State officials say they need about 10 people in their hazardous waste program. Though operating with a budget of $50,000, hazardous waste officials feel that they need $240,000. Furthermore, Connecticut has indicated that it may not accept the responsibility for a state hazardous waste management program without adequate federal funding. If they do not have an adequate state program for hazardous waste management, EPA will be responsible for the 950,000 metric tons of hazardous waste expected to be generated in that state in 1980.[13]

Connecticut has ten sites which accommodate some portion of the hazardous waste generated. Connecticut officials do not know how many

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[11]"1979 Landfill Practices Survey," p. 46.

[12]American Institute of Planners, p. 1.

[13]United States Comptroller General, *Report to the Congress: Hazardous Waste Management Programs Will Not Be Effective*, CED-79-14, January 1979, pp. 23-26.

of these will meet anticipated RCRA criteria for hazardous waste facilities.[14] Current regulatory statutes do not provide hazardous waste regulations or guidelines.

The 1975 Department of Environmental Protection, "Solid Waste Management Regulations," and slightly amended 1978 Regulations, do not specifically address comprehensive hazardous waste management.[15] The regulations were developed for solid wastes in general. They will be reviewed together since they are so similar.

For solid waste management, both the 1975 and 1977 regulations require permits for the operation of solid waste facilities, certification for the operators, and establish requirements for the operation and management of solid waste, and the closing of solid waste facilities. Included in these requirements for permits, certification, operation and management are criteria which must be met. Some of the criteria which must be followed take into account:

- Water quality
- Engineering plans and specifications
- Operation and management plans
- Rainfall or surface runoff
- Flood plains
- Erosion control

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[14]"1979 Landfill Practices Survey," p. 49.

[15]Connecticut, *Solid Waste Management Regulations* (1975), Connecticut Department of Environmental Protection, Section 19-524-1 through 19-524-12; and Connecticut, *Solid Waste Management Regulations* (1978), Connecticut Department of Environmental Protection, Section 19-524-1 through 19-524-14.

- Access roads
- 20-year Solid Waste Management plan

These regulations give the following definition of hazardous wastes:

> Hazardous wastes mean solid and liquid wastes in the following classifications:
>
> (a) explosives
>
> (b) pathogenic wastes
>
> (c) radioactive wastes
>
> (d) Chemical wastes which either create an immediate safety hazard to persons disposing of the waste or which by virtue of their chemistry and/or the method of disposal present a threat, as determined by the Commissioner, to the quality of ground or surface waters.
>
> (e) hospital operating room wastes.[16]

With specific regard to hazardous wastes, those

> wastes which are toxic or hazardous to handle or may cause contamination of ground or surface waters shall be excluded from the solid waste disposal area or disposed of under the direction of the (Connecticut) Department of Environmental Protection and with written approval from the Commissioner.[17]

As can be seen in this review, Connecticut does not at this time have an adequate hazardous waste management program. Also, Connecticut legislation allows local governments to prohibit, through zoning, land used for hazardous waste disposal. Both the local planning and zoning board and the Connecticut Department of Environmental Protection must give approval before a disposal site can be built or altered. According

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[16]Ibid., Section 19-524-2(b)(12).

[17]Ibid., Section 19-524-6.

to the director of the State Department of Environmental Protection, that law reasonably guarantees that local governing bodies will not grant approval for sites to be used for regional disposal purposes. The advocates of this legislation maintain that smaller towns should not be forced to serve as dumping grounds for wastes from other communities.[18] If all states were to pass this type of legislation, it could severely limit the siting of hazardous waste facilities (and therefore some energy supply facilities).

Recently, the Connecticut legislature passed new legislation which gives the Department of Environmental Protection the authority to write regulations for the implementation of RCRA. At the time this report was written, state officials were waiting for the governor to sign it into law. Their hazardous waste personnel were unable to provide a copy of that legislation for review, but did indicate that the new regulations would substantially support RCRA provisions.[19]

Tennessee

Slightly more than half of Tennessee's population lives in urban areas. About 49 percent of the 4,357,000 residents live in the state's four SMSAs — Memphis, Nashville, Knoxville and Chattanooga. Tennessee's land area, 42,244 square miles, include 878 square miles of inland water.

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[18]Resource Conservation Committee, *Third Report to the President and Congress: Status Report on Solid Waste Disposal Change Analysis* (1978), p. 8.

[19]Phone interview with John Houseman, Connecticut Department of Environmental Protection, Hazardous Materials Management, Hartford, CT, 15 June 1979.

Since 1943, the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers have constructed many dams along the Tennessee and Cumberland rivers and their tributaries. The artificial lakes formed by these dams have more than doubled the inland water of the state.[20]

The Tennessee Department of Public Health is the regulatory agency for solid and hazardous waste management in this Region IV state. At present there are 33 professionals on their staff. It was estimated that 40 percent of these professionals were associated with the hazardous waste program. Tennessee officials anticipate an increase of five staff members per year over the next five years. Four out of every five new staff members to be added will be devoted to the hazardous waste program. These people will be necessary to manage the 3,580,000 metric tons of hazardous waste expected to be generated in Tennessee in 1980.[21] While the overall level of funding is adequate ($200,000[22]), the salaries for the professional personnel are so low that it is difficult to obtain the quality of professionals necessary for implementation of a hazardous waste program.[23]

In reviewing the funding and staff needs for the hazardous waste program it is also important to note that of the 120 sites which currently

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[20]American Institute of Planners, p. 217; and "1979 Landfill Practices Survey," p. 46.

[21]U.S. Comptroller General, *Hazardous Waste Management Programs*, p. 24.

[22]Ibid., p. 26.

[23]Interview with Mike Apple, Tennessee Department of Public Health, Division of Sanitation and Solid Waste Management, Nashville, TN, by J. Roth.

accommodate some portion of the hazardous waste generated, only 12 are expected to meet anticipated RCRA criteria.[24]

At the present time solid waste is regulated by the "Regulations Governing Solid Waste Processing and Disposal in Tennessee."[25] These regulations, developed to insure implementation of the Tennessee Waste Disposal Act, were designed primarily for the disposal and processing of solid waste in general, not hazardous waste per se.[26] According to Rule 1200-1-7-.01, "Hazardous Waste – Includes, but is not necessarily limited to, explosives, pathological wastes, radioactive materials, and certain chemicals which shall be determined by the Department" (of Health). Special wastes, i.e., hazardous, can be disposed of in a sanitary landfill only if special provisions approved by the Department of Public Health are made for their disposal.

The Tennessee solid waste regulations do not reflect the intent of RCRA hazardous waste management, though this state does have a relatively adequate *solid* waste program. All processing and disposal facilities, and potential sites must make application for and receive acknowledgement from the Commissioner of Public Health before operating or maintaining such facilities. These applications include a feasibility study, site evaluation, design and construction review, and operation requirements.

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[24]"1979 Landfill Practices Survey," p. 49.

[25]Tennessee, *Regulations Governing Solid Waste Processing and Disposal in Tennessee.*

[26]Tennessee, *Solid Waste Disposal Act, Code Annotated* (1969), Sections 53-4301, 53-4315 and 53-4321.

The review process for the siting of waste disposal facilities entails (1) a preliminary review by the Division of Solid Waste Management staff, (2) review by a geologist (for consideration of impact on water quality and geological features, and (3) review of engineering plans (to insure adequate access, fencing, drainage, etc.).[27]

The Tennessee Hazardous Waste Management Act was passed in 1977.[28] This Act declared it to be public policy of the State of Tennessee to regulate hazardous waste management in order to protect public health, safety and welfare, and to prevent degradation of the environment. According to this Act, hazardous waste is defined as:

> a waste or combination of waste, not generated within a residence or farm, which because of its quantity, concentration, or physical, chemical, or infectious characteristics will
>
> (A) cause or significantly contribute to an increase in mortality or an increase in serious, irreversible or incapacitating reversible, illness; or
> (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

With passage of the Hazardous Waste Management Act, the Tennessee Department of Public Health was given the authority to prepare hazardous waste management criteria and standards, establish permit and manifest systems, provide for surveillance and enforcement, and require the posting of bonds by hazardous waste facility owners and operators.

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[27]Phone interview with Mike Apple, 18 June 1979.

[28]Tennessee, *Hazardous Waste Management Act* (1977), Chapter 175.

The Tennessee Department of Public Health, Division of Solid Waste Management has developed Draft Hazardous Waste Management regulations.[29] The regulations have not been approved, but if they are, they will establish a state hazardous waste program substantially equivalent to RCRA.

If the draft regulations pass, they will provide for:

(1) a classification of hazardous waste in Tennessee;
(2) adequate storage, transportation, treatment, and disposal of hazardous waste;
(3) manifest and reporting requirements;
(4) a fee system for treatment and disposal of hazardous waste and the posting of a bond by an applicant for registration of hazardous waste facilities;
(5) registration of facilities and sites;
(6) procedures for administrative and judicial review.

It is anticipated that the proposed regulations will be approved in the fall of 1979. According to state guidelines, the criteria for the siting of a hazardous waste disposal would require (1) a preliminary review, (2) a geological review, and (3) an engineering review. Both the present 1977 regulations for siting a solid waste disposal facility and the proposed regulations for siting a hazardous waste facility necessitates a subjective judgement in the decision making process.[30] Because of this subjective nature, the quality of the disposal sites could vary depending on who made the decisions. Also important in the review of hazardous waste disposal sites is the provision for local input into the decision making process. There is no state legislation which gives local

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[29]Tennessee, *Hazardous Waste Management Regulations (Draft)* (1978).

[30]Phone interview with Mike Apple, 18 June 1979.

jurisdictions the authority to prohibit the siting of disposal facilities. However, land must have proper zoning to allow disposal sites before it will be passed by the State Department of Public Health.[31]

Texas

Texas is one of the world's great petroleum storehouses, with nearly 15 billion barrels of oil. It accounts for almost half of this country's known supply. This Region VI state, with a population of 13,014,000 ranks second only to California in electric power production. The availability of fresh groundwater has become a major determinant in finding suitable locations for urban expansion in Texas.[32]

In Texas, the State Solid Waste Agency is under the auspices of the Texas Board of Health Resources.[33] However, Industrial Solid Waste Management regulations, including hazardous waste, are the responsibility of the Texas Water Quality Board, Department of Water Resources.[34] It is expected that by 1980 this department will be responsible for 3,580,000 metric tons of hazardous solid waste to be generated in Texas.[35]

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[31]Phone interview with Mike Apple, 11 April 1979.

[32]American Institute of Planners, p. 325; and "1979 Landfill Practices Survey," p. 46.

[33]Texas, *Solid Waste Disposal Act* (1977), Article 4477-7 of Revised Civil Statutes.

[34]Texas, *Rules of the Texas Water Development Board Pertaining to Industrial Solid Waste Management* (1978), Sections 156.22.01.001-.014.

[35]U.S. Comptroller General, *Hazardous Waste Management Programs*, p. 24.

The current waste management program in Texas has a staff of 48.[36] Seventeen of the professional staff are devoted to hazardous waste management.[37] While Texas funding to manage hazardous waste is $482,122, officials feel they need $753,122.[38] This additional funding takes into account the 512 sites which currently accommodate some portion of the hazardous waste generated.[39] There are 25 permitted commercial industrial waste facilities in Texas. Eighteen of these are Class I (hazardous) waste management facilities.[40]

The 1975 "Industrial Solid Waste Management Regulations" identify hazardous waste as "any solid waste or combination of industrial solid wastes identified or listed as hazardous waste by the administrator of the United States Environmental Protection Agency pursuant to the Federal Solid Waste Disposal Act."[41] These regulations apply differently to on-site disposers as opposed to off site. The Texas Solid Waste Disposal Act allows the disposal of hazardous waste without a permit if it is on site (*defined* as within 50 miles of the generator's facility from

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[36]Letter from Jack Carmichael, Division of Solid Waste Management, Department of Health, Austin, TX, 13 July 1979.

[37]Letter from Jay Snow, Solid Waste Unit, Department of Water Resources, Austin, TX, 29 June 1979.

[38]U.S. Comptroller General, *Hazardous Waste Management Programs*, p. 46.

[39]Ibid.

[40]"1979 Landfill Practices Survey," pp. 49-50; and U.S. Comptroller General, *Hazardous Waste Management Programs*, p. 46.

[41]Texas, *Regulation of Industrial Solid Waste Management* (1975).

which the waste is produced). All other hazardous waste disposal sites require a permit. The 1975 regulations required notification of plans to dispose of hazardous and industrial wastes by all generators. Before a permit is issued, the permit applicant must submit to the Water Quality Board detailed plans and specifications for construction, operation and closing, and engineering plans and specifications to insure that the site and related facility would be in compliance with all pertinent state and local air, water and solid waste statutes and regulations. A public hearing is held on each permit application. After a permit is issued, the permitee is required to execute a bond or give other financial assurance to insure the satisfactory closing of the facility.

Current regulations, "Rules of the Texas Water Development Board pertaining to Industrial Solid Waste Management," were issued in 1977. The rules have many of the same requirements as the 1975 regulations including permits, application procedures, and notification requirements. These rules are enforced by the Texas State Department of Health and the Texas Water Quality Board. The actual permitting process involves (1) the submission of an application; (2) evaluation by the Department of Water Resources; (3) issuance of a draft permit, which may include specific requirements, by the Department of Water Resources; (4) a public hearing conducted by the Texas Water Commission; and (5) a decision by the Texas Water Commission as to whether or not to grant a permit. At several points in this process, the decisions made are subjective judgements, thereby making the quality of the decision dependent upon the competence of those individuals making the decisions. Texas officials feel that their decisions have basically been good.[42]

State hazardous waste personnel have indicated that when RCRA regulations are passed, the on-site disposal of hazardous waste without a permit will be prohibited. The Department of Water Resources periodically reviews all hazardous waste notifications to insure compliance with the regulations. Thus, when RCRA regulations are passed, the state of Texas will already have a record of where the wastes are located.[43]

There are several potential problem areas for Texas in the siting of hazardous waste disposal sites. There is no state legislation giving local jurisdictions the authority to preempt the siting of disposal facilities. However, the Department of Water Resources is reluctant to issue a permit to site a facility in a location which has been zoned to exclude such a use. If a municipality anticipated the request for a permit to construct a hazardous waste disposal site, they could zone the area to exclude such a use; or if it was close to the municipality but not actually within its boundaries, the municipality could annex the area and zone it to suit their purposes. Also, if local citizens object enough at the public hearing, this could influence whether or not a permit was actually issued.[44]

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[42]Phone interview with Greg Tipple, Texas Department of Water Resources, Austin, TX, 18 June 1979.

[43]Ibid.

[44]Ibid.

Summary of State Legislation

Table 2 is an abbreviated indication of state response to RCRA at the present time by California, Connecticut, Tennessee and Texas. Both California and Texas have passed regulations regarding the management of hazardous waste disposal. If the governor signs it, Connecticut will have the authority to promulgate regulations. Tennessee does not currently have hazardous waste regulations, but their Department of Public Health has prepared a draft version and are trying to get them approved. Table 2 data assumes that the Tennessee draft regulations will be passed. However, for Connecticut, it can only be surmised that their regulations will in fact conform to RCRA regulatory criteria.

If the Connecticut legislation is signed by the governor, then all four states will have the legislative authority to implement RCRA. As indicated earlier, the states reviewed all lack adequate resources (e.g., funding and staff) to implement RCRA (though they do have mechanisms which could be used to obtain additional resources). The states have, to varying degrees, published criteria and standards for implementation (again with the exception of Connecticut). However, they are not "hard and fast" rules; *they often utilize subjective judgement on the part of decision makers.* California, Tennessee and Texas all require some form of permitting and a manifest system. Again, because of lack of adequate resources there may be a problem with adequate surveillance and enforcement.

At the present time, some states are drafting regulations prior to final RCRA hazardous waste regulations. Others have been adopting a

Table 2. State response to RCRA hazardous waste regulations

Program elements	States			
	California	Connecticut[a]	Tennessee[b]	Texas
Legislative authority	X	X	X	X
Adequate resources	X		X	X
Published criteria and standards	X		X	X
Established permit mechanism	X		X	X
Surveillance and enforcement	X		X	X
Manifest system	X		X	X

[a]Current Connecticut legislation deals with solid waste in general. Legislative authority is assumed and the remaining elements will be met if their proposed legislation is signed by the governor.

[b]Tennessee response assumes that the draft regulations will be passed as written (phone interview with Mike Apple, Tennessee Division of Solid Waste Management, Nashville, TN, 18 June 1979).

"wait and see" attitude regarding future EPA regulations. It remains to be seen just how many states will have a hazardous waste program equivalent to RCRA, and how many will opt for federal control. Both federal and state level hazardous waste programs are characterized by a lack of funding and staff. It is estimated that about 20 states will have EPA operated programs because the states either did not apply for or are not eligible to operate their own programs. The problem is that even though the states do not have enough funding and staff, neither does EPA.[45]

All states have some sort of waste disposal law, and some incorporate proposed RCRA guidelines while others date back to the early 70's. Just as there is a wide variation in the states themselves, there is a wide range of approaches to managing hazardous waste. RCRA provides for state hazardous waste control programs if the state programs meet federal standards. For a state hazardous waste program to be authorized, it must be judged equivalent to the federal program. Though the state program can be more stringent than the federal program, it cannot be less stringent. States must also provide for adequate enforcement of their program. EPA promulgated guidelines are to assist states in the development of their own programs. The original intent of RCRA was that the states would manage their own programs and not operate under federal programs run by EPA.

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[45]U.S. Comptroller General, *Hazardous Waste Management Programs*, p. 14.

EPA officials in all ten regions say they do not have the staff to authorize, review, and monitor state hazardous waste programs. Nor can they provide technical assistance needed to initiate the state programs. In eight of the regions, they cannot supply adequate help for developing state regulations or provide assistance in orienting industry and the public on regulatory requirements. Six regions indicated that they do not have enough staff to provide assistance for reviewing disposal sites to determine if they are environmentally sound.[46]

EPA regional officials feel that most states do not have enough staff to operate substantially equivalent hazardous waste programs. However, the officials in two regions have stated that they intend to grant interim authorization to the states rather than try to operate the program themselves.[47] Evidently the philosophy is that some regulation is better than none at all.

From the brief analysis of selected state legislative activities regarding hazardous waste it is apparent that state level hazardous waste management is insufficient. The state legislative overview was intended to be a descriptive overview of the nature of state response to RCRA rather than an examination of precise activities in specific states. If hazardous waste management activities in states other than those reviewed are similar to the activities in California, Connecticut, Tennessee and Texas, the public health and environment may not be protected as a result of RCRA. California, Tennessee and Texas do

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[46]Ibid., p. 11.

[47]Ibid., pp. 11-12.

include necessary elements in their hazardous waste management programs for effectively equivalent state programs (and Connecticut probably will also). But, as it stands now there will not be adequate funding available to implement and enforce the hazardous waste programs.

Effective response to hazardous waste management does not end with state legislative activities; it is only one stage of the decision making process. At the federal level RCRA was enacted and regulations were proposed. Assuming that RCRA guidelines will provide adequate protection of the environment if state hazardous waste management programs are substantially equivalent, state level decision makers must also pass compatible legislation. But it doesn't stop there. Local decision makers must be adequately informed so as to understand, implement, and enforce those programs which are necessary for protection of public health and the environment. To use the term used so often by the Tennessee Valley Authority (TVA), "grass root" support is needed. The general public must be informed and educated about their rights and responsibilities in hazardous waste management. They have a *right* to a clean and healthy environment, but they also have the *responsibility* to support those activities necessary to achieve that goal. Although federal and state level response to hazardous waste management is important, local decision makers and the general public must also be involved.

CHAPTER IV

ENERGY SUPPLY TECHNOLOGIES

No existing or proposed energy supply technology is so free of environmental liabilities so as to resolve satisfactorily the dilemma between energy's role in creating and enhancing prosperity, and its role in undermining it through environmental (including social) impacts. No energy supply technology is completely benign.[1] Environmental control technologies and waste management systems have uncertain reliability. For the energy supply technologies under consideration the hazardous waste streams must be adequately managed to minimize public health and environmental risks.

This chapter provides a general description of each energy supply technology. Also indicated is the stage of each energy supply technology which produces a hazardous waste stream. As mentioned earlier, while EPA, at this point, considers some energy supply waste as "special waste" subject to a case-by-case review, this paper assumes that hazardous waste regulations will apply to the management and disposal process for each technology which does not "pass" the proposed Sec. 3001 regulations.

The energy supply technologies to be reviewed are oil shale, petroleum refineries, coal combustion, geothermal, biomass, solar collectors and photovoltaics. Although they represent a mixture of energy

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[1]Marc W. Goldsmith et al., *New Energy Sources: Dreams and Promises* (Framington, MA: Energy Research Group, Inc., 1979), p. 1.

sources, it is obvious that the total future energy supply for the United States will not be limited to these supply technologies. Review of the selected technologies provides a general indication of some of the energy supply technologies which produce hazardous waste.

Organizing Supply Principles of Energy Technologies

Energy is not a variable that can be evaluated in isolation from other influencing factors. It is a product generated and distributed by a centralized or decentralized system. As a product, the resources for the production of that product may or may not be renewable. The combination of factors influencing the supply of energy must be reviewed as a prerequisite to understanding the energy supply technology.

Centralized or decentralized. Whether an energy source is generated or distributed in a centralized or decentralized manner affects how it is used, its potential for commercialization, and the extent of governmental control and regulation that can be expected. For some of the energy supply technologies reviewed, generation and distribution are both centralized and decentralized. However, the expected predominant use is emphasized in this report.

A centralized energy supply concentrates its production and marketing capabilities by placing the generation plant itself in a centralized location. From there, energy is distributed to users. The decentralized energy supply technologies have dispersed facilities for the actual generation of energy (at the point of use, e.g., solar collector panels on residential units). Of the energy supply technologies reviewed in this report, oil shale, petroleum refineries, coal combustion, and geothermal are predominantly centralized sources of energy. The more recently developed technologies, solar collectors and photovoltaics, are primarily decentralized. The generation and distribution characteristics of energy from biomass depends on how the energy is produced. Biomass energy techniques such as wood burning stoves are decentralized, while the production of gaseous products from biomass necessitates centralized generation and distribution.

Centralized energy sources are more conducive to use in the commercial/industrial arena than decentralized energy (though this may change as new technological processes are developed). As centralized sources, an energy supply technology with a concentrated area of production also has a concentrated area from which to market that commodity. Centralized energy sources, often characterized by the support of large enterprises (because of the large amounts of capital initially needed), are more likely to be subject to governmental control and/or regulation. The fact that they are centralized, with concentrated production facilities, makes governmental regulation easier.

Governmental control and/or regulation is less plausible for decentralized energy sources. The logistics of keeping track of numerous small generators make it highly unlikely that the federal government will choose to regulate these energy supply technologies as closely as they do the centralized sources. The manufacturing of necessary components for decentralized systems, however, may well be centralized (e.g., copper or aluminum for solar collectors). A decentralized energy supply technology is more likely to be used by individual consumers, i.e., residential solar cooling and heating. The commercialization of decentralized energy supply technologies will occur at the marketing and merchandising stage rather than the source of energy generation.

Renewable or nonrenewable. Another influencing characteristic of an energy supply technology is whether or not the resource supplies for that energy source are renewable. For an overall view of the United States' energy options this variable must be seriously evaluated. Though there may be adequate resource supplies now, the country's planners and decision makers must start now to prepare for the future when some commonly used resources are no longer available. Some of the major energy supply technologies are dependent on nonrenewable resources. Researchers must continue to develop alternative energy sources. The full-scale development and commercialization of a technology requires a "lead-time," and an advance warning and preparation period to get the "bugs" worked out of the system. It is imperative that this country does not limit its future potential as a leader among the world's nations by lack of preparation — preparation for the transfer of energy dependence from nonrenewable to renewable energy sources.

Energy supply options considered in this report include both renewable and nonrenewable energy sources. Oil shale, petroleum refineries, coal combustion and geothermal energy supply technologies are based on nonrenewable resources, while the solar collector, photovoltaic and biomass supply technologies depend upon renewable energy resources. The energy production capabilities of some of the energy supply technologies are not very large at the present time. However, each of the energy supply options reviewed will supply energy for the United States for some time to come. Therefore, their impact on this country must be assessed.

Energy Supply Technology Description

Though the purpose of this report is to assess the impact on land use of the interaction of RCRA hazardous waste regulations with energy supply technologies, a brief description of each of the technologies is provided to familiarize the reader with the technology itself. Included in this summary information is a brief description of the energy supply technology, an account of stages of development leading to its use, how the technology supplies energy and its potential use as a future energy supply for the United States.

Oil shale. Oil shale is a fine sedimentary rock which, when crushed and heated, decomposes a solid, organic material called kerogen into a form of crude oil. This crude oil can be upgraded and refined. Oil shale is produced by strip mining or underground mining. After mining, it is crushed and then fed into a kiln where it is heated. This process (retorting) produces a thick crude oil, gas which can be used to fire the kiln, and waste shale. A synthetic crude oil is produced when the thick crude oil is "upgraded" to thin it, and to remove excess nitrogen and sulfur.[2]

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[2]Ibid., p. 4.

This report considers oil shale in its extraction (mining) and initial refining (retorting and upgrading) stages. This stage generates hazardous waste residuals.[3] About 3000 acres of land each year will be mined for a million-barrel-a-day oil shale industry. This scale of production would also necessitate the disposal of 700 million tons of waste shale each year.[4] Both of these major land uses have potential for significantly impacting the environment. However, one of the biggest constraints on oil shale development is the amount and availability of water needed, especially in shale-rich areas such as the Green River formation in the semiarid land of the western United States.

As an energy technology, oil shale supplies energy indirectly. It undergoes a conversion/transformation process before it can be used as an energy source. Oil shale produces fuel for energy generation but does not actually generate energy itself. The sequence of events, from extraction to actual consumption, also increases the potential for governmental intervention because of centralized distribution.[5] Oil shale is a nonrenewable resource.

Oil shale development is an expensive venture. But the increasingly higher prices of conventional fuels should make oil shale a commercially feasible endeavor. By 1985, projections indicate that 0.1 quads

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[3]Dennis W. Weeter and Hugh T. Carson, *The Impact of the Resource Conservation and Recovery Act upon Renewable and Oil Based Energy Technologies* (Oak Ridge National Laboratory, forthcoming), p. 40.

[4]Goldsmith, p. 4.

[5]David Howard Davis, *Energy Politics*, 2nd ed. (New York: St. Martin's Press, 1978), p. 48.

(10^{15} Btu's) of energy will be produced as a result of oil shale development.[6] Increased oil shale development will preempt the land mined and used for waste disposal from some other uses.

Petroleum refineries. Petroleum refineries are characterized by centralized energy generation and indirect energy conversion. The resource fuel for these facilities is nonrenewable. Refineries require advanced utilization technology and significant amounts of capital. Essentially, a petroleum refinery reduces the crude oil feedstock to usable products for petroleum based industries including, but not limited to, energy supply facilities. The actual process of a particular refinery depends upon the type of crude taken in (the feedstock) and the desired end products. There is considerable variation in the demand for various petroleum products as well as types and quantities of crude oil feedstocks.[7]

The stage of hazardous waste generation for petroleum refinery industries is extraction and refining. The petroleum crude is extracted from the ground and then processed (refined). Currently, pollution control equipment adds 10 to 15 percent to total investment costs of new refineries. Both air and water pollutants are discharged. However, there are several refinery and wastewater treatment solids classified as

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[6]This and subsequent energy supply projections are from DOE's PIES and SEAS models; Goldsmith et al.; and DOE's *Environmental Readiness Documents*.

[7]Weeter and Carson, p. 44.

hazardous waste (e.g., DAF sludge, kerosene filter cakes, lube oil filtration clays, slop oil emulsion solids and exchange bundle cleaning solvent).[8]

Petroleum refineries, as an energy supply technology, are an indirect source of energy. As with oil shale, petroleum refineries produce fuel which will be used for energy generation, but they do not generate energy. Crude oil is extracted, processed, sent to a centralized generation facility, and from there electricity is distributed. The needs for advanced technology and large amounts of capital favor petroleum-based advanced technology, and large amounts of capital favor petroleum resource development by large corporations. Government officials try to monitor the petroleum industries in order to prevent monopolistic practices. This is especially important in view of the fact that oil (a petroleum product) provided more than 40 percent of the energy consumed in this nation in 1977. Of that amount, 52 percent of U.S. petroleum consumption is by the transportation sector. This amounts to 25 percent of total U.S. energy consumption.[9] By 1985 petroleum refineries will account for an estimated 39.16 quads of energy.

Coal combustion. Coal combustion is literally the burning of coal to produce energy. Coal is extracted by surface or deep (underground) mining. It is then pulverized, chemically processed to remove some of

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[8]Weeter and Carson, p. 47.

[9]TRW, *Environmental Characterizations for Energy Technologies and End Uses: Energy End Use Sectors, Vol. V* (McLean, VA: TRW, 1978), p. I:1.

the pollutants if it is low quality, and transported to large fossil power plants. There, it is combusted (burned) to supply heat for a steam power cycle to produce electricity. The solid waste stream from coal combustion includes fly ash, bottom ash and scrubber sludge, all of which are considered as "special waste."[10]

At the scale evaluated in this report, coal combustion is an indirect energy source (i.e., from coal to steam to electricity for consumer use). Energy produced from coal is generated and distributed from centralized locations. Currently coal is responsible for about 19 percent of U.S. energy consumption. Even though coal is a nonrenewable resource, presidential policy is to encourage U.S. dependence on coal, because of its availability in this country and to lessen dependence on imported oil. By 1985 it is projected that coal combustion will account for 21 quads of electricity.

Geothermal. The earth contains vast amounts of heat which is constantly flowing toward the surface. This heat originates from decay of radioactive elements, chemical reactions, and areas of friction.[11] This report reviews the technology of using geothermal fluids for electric power generation.

If the outlets for geothermal resources are not already in existence (e.g., geysers at Yellowstone National Park), geothermal wells are drilled. The geothermal steam is used to turn turbines which in turn generate electricity. This process involves the conversion of geothermal

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[10] *Federal Register*, 43: 58992. [11] Goldsmith, p. 8.

steam into electrical power, an indirect energy source. (The use of waste process heat from a geothermal electric power plant in a co-generation facility would improve the overall efficiency of the technology but would generate no additional solid or hazardous waste.) Environmental impacts from geothermal power plants occur in four major areas: land use (the land area varies with reservoir type and land subsidence may occur due to the removal of fluids); air quality (such as hydrogen sulfide emissions); water quality (waste water); and noise (the steam venting process). Geothermal, like the fossil fuels, is a nonrenewable source of energy. There is a given amount of heat stored in the earth which can be utilized. Though it can be used as a direct source of energy (e.g., space heating), it is anticipated that the predominant use of geothermal energy in this country will be indirect centralized power facilities to produce electricity. For future U.S. energy supply, geothermal power is expected to provide about 1 percent of the country's energy by 1985.

Biomass. Biomass as an energy supply technology is considered in two forms. Wood can be used directly as a heating source, and organic plant matter can be converted into gas. Methane gas (similar to natural gas) is produced when plant material decays in the absence of air. Biomass fuel is a renewable resource.

As an energy source, gas and wood have different characteristics. Wood is used directly in a decentralized manner (although there are some experimental and planned centralized uses where large quantities of wood are burned to drive a turbine to produce electricity). Energy from biomass/gas is an indirect process. This energy is likely to be generated from a centralized location.

The use of wood and other organic plant matter as an energy source would compete with agriculture for available productive land and water. Since solar power plants only require about one-tenth of the land area used for biomass energy farms, they would probably be a better choice on marginal or submarginal land.[12] The 1985 projection of quads of energy produced by biomass is only 0.004.

Solar collectors. The ability to directly harness the sun's energy is one of the most often hypothesized solutions to current energy problems. Recent sharp rises in fuel prices have caused a resurgence of interest in solar heating and cooling of buildings. The center of the typical solar space heating system is the flat plate collector. A collector basically consists of an absorber surface attached to pipes. Liquid (e.g., water, ethylene glycol) or air circulates through these pipes to carry away heat. These collector panels are usually placed on a sloping roof facing the sun, absorb solar radiation and heat the transfer fluid in the pipes. The liquid (or air) is first pumped to a large storage tank (or bin of crushed rock if air is used), then circulated through the building as needed. Storage capacity is required because of the need to store heat for nights and cloudy days.[13]

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[12] Ibid., p. 7.

[13] Ibid., pp. 16-17.

The working fluid or storage media for solar collectors may contain toxic chemicals. A leak in the system could cause an environmental health hazard by contamination of surface water, groundwater and soil. Also, the air emissions from material production includes suspended solids. These emissions are significantly lower than those produced from utilizing nuclear-electric or fossil energy for cooling and heating purposes.[14]

The use of solar collectors for energy involves the direct conversion of a resource (the sun) to a usable product (heat). The prevailing acceptance of this technology has been in decentralized use, i.e., solar heating of buildings. Solar collectors which utilize a renewable resource (the sun) are just beginning to gain acceptance at the national level as an energy supply option.[15] The expected replacement of electrical energy used for heating and cooling by 1985 is 0.05 quads. Current estimates, assuming an active effort, predict that by the year 2000, 1 to 3 percent of total U.S. energy needs will be met by solar heating.

Photovoltaics. The generation of electricity directly from sunlight is accomplished by photovoltaic devices. This process includes the collection of solar radiation, its conversion into electrical energy (by transistor-like devices known as solar photovoltaic cells) and the alteration of the resultant electrical energy into a usable form. An

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[14]TRW, *Environmental Characterizations for Energy Technologies and End Uses: Renewable Energy Sources, Vol. II* (McLean, VA: TRW, 1978), pp. A:4-5.

[15]Goldsmith, p. 15.

array of photovoltaic cells are used to collect and convert solar radiation to electricity.[16] A prominent feature of photovoltaic technology is the possibility of "clean energy" and an abundant renewable fuel. However, mining and manufacturing (to produce the cells) will present severe environmental problems (e.g., chemical and thermal releases).

As evaluated in this report, photovoltaic energy is produced as a decentralized source through direct electrical conversion. The main problems with photovoltaic systems are cost of the solar cells and the need for energy storage (because of nights and cloudy days). Though the 1985 estimates predict 0.01 quads of electricity, it is unlikely that solar cells could provide more than 1/4 to 1/2 percent of U.S. electrical demand by the year 2000.[17]

Stages of Hazardous Waste Streams

The ultimate impact of RCRA on energy supply technologies/options is uncertain. But it is clear that regulations for management and disposal of hazardous wastes may have a significant impact on DOE's energy programs and the energy industry. Energy supply facility siting decisions may be influenced by regulations for developing hazardous waste disposal sites.[18]

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[16] U.S., Department of Energy, *Environmental Readiness Document: Photovoltaics* (Washington, DC: Government Printing Office, 1978), pp. 6-8.

[17] Goldsmith, p. 15.

[18] American Management Systems, Inc., *Management Plan for Responding to the Requirements of the Resource Conservation and Recovery Act (RCRA)* (Arlington, VA: American Management Systems, Inc., 1979), p. iv.

Table 3 indicates at what stage the production of energy from a particular technology produces a hazardous waste stream (also see Appendix B). The absence of an X on this table does not necessarily mean that no hazardous waste is generated at that stage. Rather, based on available information, the X's indicate where known and significant hazardous wastes are generated. Included in this evaluation of the hazardous waste stream is the *amount* as well as the product ("persons who produce and dispose of less than 100 kilograms of hazardous waste in any one month are exempted from the requirements"[19]). Those stages generating hazardous waste will have to dispose of the waste either on or off site. There is a disparity between the proposed RCRA regulations and the way most utilities now dispose of waste.[20]

Because the energy supply technologies themselves are so different, there are inconsistencies in the application of specific supply technologies to hazardous waste streams. For example, oil shale and petroleum refineries are both energy supply technologies in that they produce fuel for energy generation, but neither of these processes actually generate energy. Solar collectors and photovoltaics as energy suppliers do not produce hazardous waste in the generation of energy. However, the resources and processes involved in developing these systems and the final decommissioning will generate hazardous waste.

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[19]*Federal Register*, 43: 58969.

[20]Electric Power Research Institute, "Particulates Waste Disposal," *AWARE Magazine*, December 1978, p. 8.

Table 3. Hazardous waste stream for energy supply technologies[a]

Stages of energy supply technology generating a hazardous waste stream	Oil[b] shale	Petroleum[b] refineries	Coal combustion	Geo-thermal	Biomass		Solar collectors	Photo-voltaics
					Gas	Wood		
Extraction and refining	X[c]	X[c]	X[c]	X[c]			X[c]	X[c]
Mfg. of system components							X	X
Generation of energy			X[d]	X	X[e]	X[e]		
Decommissioning							X[e,f]	X

[a]Developed with the assistance of D. Weeter and S. Carnes.

[b]Oil shale and petroleum refineries produce fuel for energy generation but these processes do not actually generate energy.

[c]The extraction (mining) waste streams may or may not be regulated by RCRA.

[d]Hazardous wastes generated in the manufacturing of system components is regulated in the generation stage.

[e]This does not include household applications, if 100 kilograms or less of hazardous waste per month.

[f]Working fluids in solar collectors may be changed periodically, but the total system is decommissioned only once.

A more complete evaluation of the impacts of a particular technology necessitates the review of the waste stream of that technology at all affected stages: extraction and refining, manufacturing of system components, generation of energy, and decommissioning. The wide variation among these energy supply technologies prohibit equal treatment. It would be like comparing apples to oranges. This selection and review of hazardous waste streams is an attempt to focus on the most obvious and potentially consequential stages of hazardous waste generation. For this reason, oil shale, petroleum refineries, coal combustion, geothermal and biomass are treated from the perspective of what stage hazardous waste is generated because of the *fuel* used. On the other hand, solar collectors and photovoltaics focus on the *system* needed to utilize the fuel.

Extraction and refining. As interpreted for this analysis, extraction and refining is the removal of a natural resource from the ground (e.g., the mining of coal), and the processing of that resource so that the quality is improved and can be used for other purposes (e.g., processing oil shale to obtain crude oil).

The extraction and refining of oil shale, petroleum products, coal, and geothermal fluids generates mining and/or drilling wastes presently classified as special or hazardous. The extraction of materials used for the production of solar collectors and photovoltaic cells also generate mining wastes. Though this report assumes RCRA regulations apply, it is important to note that the waste stream from the extraction process may be regulated by other federal regulations (e.g., the Surface Mining Control and Reclamation Act).

Manufacturing of system components. The characterization of the energy supply technologies necessitates that the hazardous waste stream generated in the manufacturing stage be considered for solar collectors and photovoltaics. Review of the system rather than the fuel for these technologies enables a more realistic view of total, including environmental, costs. The hazardous waste stream for solar collectors and photovoltaics results from the processing of materials used to make the collectors and cells, e.g., metals and chemicals.

Generating of energy. That stage of the energy supply technology where the fuel is used to generate energy sometimes results in the generation of hazardous waste. This hazardous waste is a by-product of the generation/conversion process. Supply technologies which generate hazardous waste at this stage include coal combustion, geothermal and biomass.

Decommissioning. Solar collectors and photovoltaics yield hazardous waste in the decommissioning stage. When the solar panels and photovoltaic cells are no longer usable they must be disposed of — decommissioned. The materials used to make the panels and cells are hazardous, thus requiring management under RCRA.

Summary of Energy Supply Technologies

Technology development and commercialization are affected by many factors, including those which affect production capacity of the industry and those which affect the demand for the industry's product. While a given energy technology is often the object of analysis, it is actually the industry (or agency) employing a given technology which must be the central focus of policy goals.[21] DOE and the energy industries are responsible for compliance with federal regulations at all of their operating and contracted facilities. As such, they need to be aware of their responsibility under RCRA regulations, and also the possible impacts of their activities, including the siting of energy supply facilities which generate hazardous waste.

Table 3 designates those stages of the energy supply technology which generate a hazardous waste stream. Table 4 provides a summary of descriptive characteristics of the energy supply technologies. As the federal agency in charge of energy research and development, DOE is in a position to set an example as an environmental advocate for private utilities to follow. To do this, they must assess and act on all the impacts of energy development including hazardous waste disposal and its impact on land use issues.

As can be seen in Table 3, each energy supply technology reviewed does generate hazardous waste. Oil shale, petroleum refineries, coal combustion, geothermal and biomass produce hazardous waste by virtue of the type of fuel used to generate energy. The system rather than the fuel results in hazardous waste generation for solar collectors and

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[21]Lawrence H. Linder et al., *The Solar Photovoltaic Industry: The Status and Evaluation of the Technology and the Institutions* (Cambridge, MA: Massachusetts Institute of Technology, 1977), p. 1.

Table 4. Characteristics of energy supply technologies

Characteristics	Oil shale	Petroleum refineries	Coal combustion	Geo-thermal	Biomass: Gas	Biomass: Wood	Solar collectors	Photo-voltaics
Energy conversion/ transformation								
Direct						X[a]	X	X
Indirect	X	X	X[a]	X[a]	X			
Energy generation and distribution								
Centralized	X[b]	X[b]	X[b]	X[b]	X[b]			
Decentralized						X[b]	X[b]	X[b]
Resource supplies								
Renewable					X	X	X	X
Nonrewable	X	X	X	X				

[a]Though fuel conversion/transformation may be direct or indirect, this is expected to be the predominant use.

[b]Energy generation and distribution may be considered either centralized or decentralized, but this is expected to be the predominant use.

photovoltaics. As illustrated by Table 4, the characteristics of the energy supply technologies are common for the fossil fuels and geothermal, and for biomass/wood and solar based energy. Biomass/gas, other than the fact that it is a renewable resource, is similar to the fossil fuels and geothermal. Knowledge that hazardous waste is produced by all energy supply technologies reviewed, in conjunction with the characteristics of the supply technologies, should be used by decision makers as they develop alternatives and strategies for the near- and long-term energy mix in the U.S. This information can help policy analysts, energy planners and decision makers assess the impacts which will accompany the energy path chosen.

CHAPTER V

HAZARDOUS WASTE DISPOSAL AND LAND USE

Practically every dimension of the human environment is related in some manner to the use of land. This includes aspects of man's physical, psychological, social and economic well being. Land use planning should be a serious consideration of policy makers, because land use plays an important role in structuring basic patterns of activity.[1] By changing the use of land, i.e., improvement for a particular type of activity, the land itself may be rendered less attractive or even totally unsuitable for other activity types.

The term "land use" evokes different meanings to different people. It signifies the spatial distribution of activity functions – residential areas, or industrial, commercial, agricultural and recreational areas. To some, the term land use implies a framework for visualizing an area: activity patterns of the people, and physical facilities or improvements to the land to accommodate these activities.[2] For the purpose of this research, land use connotes both the spatial distribution of activity functions and behavior, or activities affected by that spatial distribution. Changes in land use are often both the cause and effect of other

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[1]James McEvoy III and Thomas Dietz, eds., *Handbook for Environmental Planning: The Social Consequences of Environmental Change* (New York: John Wiley and Sons, Inc., 1977), p. 109.

[2]F. Stuart Chapin, Jr., *Urban Land Use Planning*, 2nd ed. (Urbana, IL: University of Illinois Press, 1976), p. 3.

variables.[3] The use of land changes with the type of activity, the intensity of development, and the economics of land use. The siting of a hazardous waste disposal facility will impact the type, intensity and economic value of land.

The use capacity of land is influenced by its location (the location of the parcel with respect to resources) and quality (the effects or presence of necessary improvements).[4] A hazardous waste disposal facility as a land use activity will affect other uses by impacting the surrounding resources or improvements. These facilities will induce or retard growth in adjacent areas and thus affect land values. They will change patterns of growth and existing uses. This research is an attempt to identify land use issues involved in the interaction of the siting of hazardous waste disposal facilities associated with energy supply technologies.

Conflicts will arise over the locational siting of hazardous waste disposal facilities. What represents the preferred use of many individual property owners conflicts with the needs of the general public. The costs involved — social and environmental — must reflect a compromise between the conflicting parties. Land, like air and water, is a basic natural resource, a resource which must be protected and held in trust for future generations. Any decisions affecting the use of land should be considered

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[3]McEvoy, p. 109.

[4]Use capacity refers to the relative ability of a given unit of land to produce a surplus of returns and/or satisfactions above its cost of utilization.

from this perspective. Because of the many unknowns in dealing with hazardous substances, these facilities represent possible irreversible consequences with intergenerational time frames. The impact of hazardous waste disposal facilities on the natural environment affects to some extent the social values associated with various land uses, e.g., recreational, residential or industrial.

Interrelationship of Hazardous Waste Disposal Facilities and Energy Supply Technologies

In many instances, major land use activities responsible for the production and consumption of energy are also responsible for the primary generation of environmental pollutants.[5] Energy supply technologies produce varying amounts of solid and/or hazardous wastes, and these wastes must be disposed of somewhere. The cost of disposal and the availability of disposal capacity will influence the economic viability of some energy supply technologies. There is a pervasive interdependence and interrelatedness of energy, economics, and the environment. These factors must be appraised together in order to more fully comprehend the implications of any action. Trade-offs will have to be made, and the impact of these trade-offs will depend upon how the conflict among the variables of energy, economics and the environment is resolved. When reviewing the effect of these variables on land use issues, any one variable may not be the prime cause, rather one must consider the implications of the related variables.

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[5]T. Owen Carroll et al., *The Planner's Energy Workbook* (Springfield, VA: U.S., Department of Commerce, 1977), p. 40.

RCRA was intended to protect public health and the environment by the regulation of hazardous waste management, including the siting of hazardous waste disposal facilities. Proposed RCRA regulations include specific siting requirements for hazardous waste disposal facilities. Some of the siting criteria are exclusionary, some are regulated by the degree of protection, and some are the result of other environmental and administrative legislation (Chapter II). The energy supply technologies reviewed in this research all generate hazardous waste which must be disposed in compliance with RCRA regulations (Chapter IV). If energy supply technologies dispose of their hazardous waste on site,[6] then these energy supply sites must also be in compliance with RCRA hazardous waste siting regulations. Thus if a hazardous waste disposal site was excluded from certain areas, then an energy supply facility with on-site disposal would also be excluded. Consequently the energy supply facility with on-site disposal is ultimately restricted by RCRA hazardous waste disposal facility siting constraints.

If the hazardous waste from an energy supply technology is disposed at an off-site facility, the generator must comply with Subtitle C requirements regarding hazardous waste *management*, but not the actual siting constraints. For off-site disposal, the main concern of the generator is that the waste be transported safely by a permitted carrier to a permitted disposal facility. Energy supply technologies with decentralized generation will utilize off-site disposal. Since RCRA

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[6]"On site" means on the same or geographically contiguous property.

does not regulate low quality producers of waste (i.e., less than 100 kilograms per month and residential generators) it will have little impact on the siting of decentralized sources of energy (e.g., solar collectors), though it may impact the siting of centralized component manufacturing facilities as well as the commercialization of a technology. Depending upon which stage of an energy supply technology one evaluates, the interaction of RCRA hazardous waste disposal regulations with energy technologies may or may not impact land use issues.

Environmental impact assessment is a relatively current phenomenon, first mandated by the National Environmental Policy Act of 1970. Though much has been revealed since that time about the impact of siting various types of facilities, it is difficult to discern completely the type and level of impacts unique to different kinds of facilities. If an energy supply facility has on-site hazardous waste disposal, one cannot totally disaggregate the impacts of the energy supply facility from the impacts of the hazardous waste disposal facility. It is also difficult to distinguish between the cause and effect relationships of changes in the environment. Land use functions (e.g., hazardous waste disposal facilities) may cause an impact on activity patterns, but they may also be a result of the activity patterns. The level and direction of impact is not constant.

The effects and increased risks that normally accompany energy supply are tied to existing and future patterns of land use developments. The effects and risks associated with the generation, management, and disposal of hazardous waste as a result of that energy supply are also tied to existing and future patterns of land use. Energy planners and decision makers need to be aware of the land use considerations in order to plan for communities, states and regions where these facilities will be located. Analysis of these issues will be of use both to land use planners and energy policy analysts in their efforts to assess the implication of RCRA hazardous waste regulations.

Interrelationship of Hazardous Waste Disposal Facilities and Land Use

Private sector decisions regarding land use are affected by governmental legislation, regulation, and policies.[7] The decision to use land for the siting of hazardous waste disposal facilities is dependent upon RCRA, other federal and state environmental regulations (e.g., Clean Air Act, Clean Water Act), and other federal and state policies (e.g., Interstate Commerce Commission freight rates), in addition to private sector actions. Though the federal government has little direct control over the siting of facilities, environmental legislation and regulations are a significant influence. The siting decisions often become the focus of a broader controversy over how the costs and benefits of development should be distributed.[8] An improvement in environmental quality achieved through a reduction of pollutant emissions and reduction of ecological impacts is often accompanied by

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[7]University of Oklahoma, Science and Public Policy Program, *Energy from the West: Policy Analysis Report* (Washington, DC: Government Printing Office, 1979), p. 767.

[8]Ibid., p. 690.

inefficiencies in the use of resources. The social and environmental benefits of such improvements often justify the additional costs. But it is important that these external costs (social and environmental) be recognized as necessary for protection of the environment and those that use the land, air, or water must expect to pay them. Estimates of future demands on natural resources should account for both economic and environmental costs.[9]

Land use patterns can have very intense effects on the manner in which land and its associated resources are used. There is an interplay between numerous factual and policy issues when land use decisions are made. A single coherent body of substantive land use laws to direct consolidated land use decisions does not exist at any level of government.[10] Laws and regulations which govern facility siting are often uncoordinated and overlapping among and between levels of government.[11]

Any specific parcel of land to be used for a particular function should be assessed based upon its individual merits to fulfill that function. The assessment should include an analysis of existing conditions, identification of possible impacts, and an evaluation of the nature and possible magnitude of impacts. This assessment can then be used to select the most feasible (economically, politically and

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[9]Chauncey Starr and Stanford Field, "Economic Growth, Employment and Energy," *Energy Policy* 7 (March 1979): 10.

[10]Arbuckle, p. 190.

[11]University of Oklahoma, p. 690.

environmentally) alternative site for the desired use. There are, however, problems inherent in impact assessment of any kind, e.g., the uncertainties about the impact of any alternative (especially considering the time frame involved), the multiple-objective nature of the need for the site use necessitates making value trade-offs, and the lack of systematic procedures for resolving differences by members of the decision-making unit.[12] Delay may increase because more impacts will be identified, once identified interests sensitive to those impacts may oppose the project. However, the benefits gained from an assessment outweigh the problems by ensuring that opposition and/or delays are reduced or at least better accommodated.

For most types of development projects, including hazardous waste disposal facilities and energy supply facilities, there are likely to be two levels of impacts on land use. The development may immediately affect existing land use functions. It may also have secondary impacts on the area. These secondary impacts are likely to occur incrementally and often are reflective of activity patterns influenced by land use functions. These impacts on land use involve the types and intensities of land use activity, or primary and secondary impacts.[13]

There is competition among demands for different uses of land. Various elements of land use functions compete among themselves and with

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[12]W. A. Buchring, W. K. Foell and R. L. Keeney, "Examining Energy/ Environment Policy Using Decision Analysis," *Energy Systems and Policy* 2 (1978): 344.

[13]McEvoy, p. 112.

each other (e.g., economically productive, preservation and conservation, and leisure time and recreation). Again, there must be a decision system to resolve the differences. To minimize the generalized impacts of any one (or group) of land use function, appropriate sites for different types and intensities should be chosen beforehand. Coordination of land use activities is much more difficult *ex post facto* (after the fact) than before land use functions and activity patterns are established.

Land use is both a response to a broad range of natural and social aspects of the environment, and also an induced environmental factor which influences surrounding conditions.[14] The impact of energy facilities with on-site hazardous waste disposal may encourage different types of development at the macro level by increasing the supply of energy available. While a hazardous waste disposal facility may induce some types of growth, it may retard other types. The major categories of land use functions (residential, commercial, and industrial) should be evaluated to see how they will change. An assessment of the influence on land use functions and activity patterns can provide information to be used to avoid, reduce, or mitigate impacts from these facilities.

Limitations and Assumptions of Land Use Analysis

This analysis is based on an attempt to focus on a "moving target." Hazardous waste management regulations and guidelines were proposed in

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[14]Institute of Environmental Sciences, *Learning to Use Our Environment: Proceedings of the 1979 Institute of Environmental Sciences* (Mt. Prospect, IL: The Institute for Environmental Sciences, 1979), p. 238.

December of 1978 but are unlikely to be finalized before January 1980. This left substantial time to make numerous revisions to the proposed regulations, and revisions have and are being made (e.g., it has been proposed that management of underground injection of hazardous waste be incorporated into the EPA "Proposed Consolidated Permit Regulations").

Hazardous waste management is a political problem and issue. There is uncertainty in Congress, EPA and the Courts on what constitutes a hazardous waste, and on the best way to protect the public health and environment. The approach taken in this document is based on the proposed regulations, while realizing these regulations will probably change. Until regulations are finalized, the best one can do is indicate where we are now and suggest what the issues will be in the final attempt to resolve hazardous waste management problems.

This research is a general overview of the interrelationship of hazardous waste disposal regulations with energy supply facilities and the impact of these variables on land use issues. The analysis is conducted within certain limitations, parameters and assumptions. It is necessary to understand what these operating conditions are to be able to interpret the results. The subject itself, as well as the level of investigation attempted, precludes the inclusion of exact detail.

For a particular type of development (e.g., hazardous waste facility) the entire range of impact measures may not apply. A policy analyst must exercise selectivity when examining particular types and locations of development. The primary limitation for this research effort is that the impacts, to a great extent, are site specific. The whole idea of designating site selection criteria in the hazardous waste regulations was based on the assumption that some specific sites were naturally better than others. If the site's natural features are not adequate to protect the environment, then performance standards must be used.[15] However, the more protection the design must provide, the more expensive it is to construct the facility.

Site specific characteristics determine the magnitude of social, economic and environmental impacts. It is impossible to indicate what the impact will be on the community if nothing is known about the special characteristics of that community, e.g., what is the population, economic base, cultural background, existing land use, adequacy of the service infrastructure, etc. Therefore, at best, this analysis will serve as an *indicator* of *possible* impacts, not an exact prediction. The impact of hazardous waste disposal facilities on land use functions hypothesizes the existence and the direction of change. The extent of the change and its implications on land use issues are indicated as "possible" outcomes.

Lack of exact information about the technical parameters of both hazardous waste disposal facilities and energy supply technologies prohibit a detailed description of the consequences. As discussed earlier (Chapter I) there are several different categories of disposal alternatives, and within each of these categories, there are different technical designs and features. The same is true for the energy supply technologies.

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[15]Performance standards are part of the "Notes" mechanism. The EPA Regional Administrator may allow deviation from the specific Subtitle D standard if it can be demonstrated that the site will achieve at least an equivalent degree of protection.

There is a variety of designs within each category of energy supply. Hence, the lack of specific information about the technologies limits the level of analysis about the characteristics of the waste streams and the facilities. That information is needed for a detailed analysis of economic and environmental effects.

Detailed analysis of environmental impacts also requires site and technology specific parameters. There is too much variability otherwise. Costs are very much site and technology specific, including construction, operation and decommissioning costs. Transportation costs vary with the location of a hazardous waste disposal facility in relation to the source of waste generation. The zone (proximity) of impacts resulting from hazardous waste disposal cannot be determined without site specific information. Therefore when analyzing the impact of RCRA on national land use, the level of detail is preempted by the need for a broad overview of pertinent issues.

This research assumes on-site disposal of hazardous waste for most centralized energy supply facilities (based on the increasing cost of transportation for large volume hazardous waste from oil shale, petroleum refineries, coal combustion, geothermal and biomass/gas). That will not always be the case. For the decentralized technologies (biomass/wood, solar collectors and photovoltaics) it is not logical to assume that each consumer will have an individual, on-site hazardous waste disposal facility. The stage of the hazardous waste stream of many energy technologies is at a centralized generation point. The only decentralized phases generating hazardous waste streams are the disposal and decommissioning stages of solar collectors, photovoltaics and biomass/ wood. The impact of hazardous waste disposal facility siting regulations on energy supply facilities will be greater where there is on-site disposal as opposed to off-site disposal.

Siting constraints required by proposed RCRA regulations were identified in Chapter II. These constraints are exclusionary, administrative or restrictive because of other legislative requirements. Taken separately, each individual constraint would have some impact on national land use. However, impacts are more significant as a result of the sum of all constraints. The cliche "the whole is more important than the sum of the parts" is descriptive of the relative levels of impact of individual as compared to cumulative constraints. For evaluation of impacts at a national level, it is assumed that all proposed siting constraints will be implemented.

Impact of Hazardous Waste Disposal Facilities on Land Use

Analysis of the spatial distribution of land use activity functions for hazardous waste disposal reveals a change in the direction of growth for these functions. For the area surrounding hazardous waste disposal facilities, particular types of land use functions will either increase or decrease. Land use is under continual pressure to change in response to new needs and technologies. With a finite amount of land available and only portions of it suitable for development, there is competition among the various land use functions. The manner in which hazardous waste is managed today may limit future uses of the land. But, to the extent that regulations regarding hazardous waste disposal would prevent other lands from being contaminated, there is potential for RCRA to offset the costs (i.e., the use of land) by protecting the remaining land.[16]

All hazardous waste facilities are required to be located, designed, and operated in such a way as to minimize the potential for environmental degradation. This does not mean that environmental and other impacts will not occur. The establishment of hazardous waste facilities will cause impacts, and these impacts are partially reflected through change in land use functions and responses to those changes. At the first level (land use functions) the impacts will affect existing residential, commercial, industrial, recreational and agricultural land uses. Property values are affected by nearby owners' perceptions of the effects of surrounding land uses on their land utility. Adjacent owners may perceive of these industrial facilities as a nuisance because of adverse impact on the value of neighboring property. They affect future activities by inducing or retarding growth of these land uses. New industrial development (e.g., hazardous waste disposal facilities or energy supply facilities) often promote secondary impacts on the local community. Industrial growth frequently attracts immigration which translates into demand for new housing and supporting commercial development (both for the industry and the new residents).[17] The siting of centralized energy

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[16]Peltier, p. 239.

[17]Philip S. Schaenman and Thomas Muller, *Measuring Impacts of Land Development* (Washington, DC: The Urban Institute, 1976), p. 26.

supply facilities will result in more impacts on the local community due to the large number of employees needed, especially during the construction phase. Further, land use functions and their impacts on activities are influenced through interaction with each other.

Transportation advances have made it possible to locate industrial facilities outside of metropolitan areas. The operation of new industries (e.g., hazardous waste disposal facilities) indirectly affects the existing transportation network. Patterns of land use are largely dependent upon the locational siting of establishments and their spatial distribution in relation to other uses with which they interact.[18] While the establishment of industrial facilities will impact the transportation network, the network itself influences patterns of land use, including the location of industries.

Transportation is a service system which enables people, firms and various other entities to carry on activities at sites selected for those purposes in separated locations.[19] If new industry locates in predominantly rural areas, it will require the establishment of new transportation networks, i.e., roads. Other new development coming into the area will tend to follow transportation corridors as they radiate outward. As the new development follows transportation corridors, unorganized forms of land use functions evolve. A more optimal land use pattern could be

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[18]Gene F. Summers et al., *Industrial Invasion of Nonmetropolitan America* (New York: Praeger Publishers, 1976), p. 13.

[19]Chapin, p. 339.

cultivated if growth management techniques were used to encourage compatible rather than conflicting uses.

A land use decision such as the siting of a hazardous waste disposal facility establishes a precedent for the future that may assume an importance far more significant than would be implied by any immediate impacts of the specific development. As a new industry moves into an area, it sets the stage for similar development. An example of this "priming" is the siting of a hazardous waste disposal facility (or energy supply facility) and the associated intrastructure development. Other industries which utilize similar services will move into the area. Once the decision is made and approval granted, it is extremely difficult to reject similar development; both logically and for demands of equal treatment under the law.[20] Industrial uses, i.e., hazardous waste disposal facilities, tend to attract similar use industries within the same proximity because of compatibility. Because of common service and location needs, there is a clustering of similar land use functions, i.e., industries.

Industrial land use. Industries in general tend to locate in the same general vicinity since they often have common locational factors. Industries need reasonably level land, preferably with not more than 5 percent slope. They will seek locations which minimize their labor, transportation and raw material costs.[21] Industries prefer to be within

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[20]Schaenman, p. 27.

[21]John McMahan, *Property Development* (New York: McGraw-Hill Book Co., 1976), p. 192.

easy commuting distance of residential areas for their labor force. They need direct access to commercial transportation facilities (railroads, major trucking routes, cargo airports, and deep water channels). They consider availability of utilities such as power, water and waste disposal facilities at or near the site. Review of surrounding land and its uses is also important. Physiographic features (i.e., floodways, active fault zones, critical habitat areas, and severe terrain) will impose additional economic/environmental cost constraints on siting an industry. Compatibility with surrounding uses will lessen conflicts in both the short- and long-term.[22]

Locational factors which influence the siting of any industry will also apply to hazardous waste disposal facilities. Many of the specific siting constraints for hazardous waste disposal facilities could also be applied to the siting of other industrial plants. Both their locational and operational needs are similar. But, after the construction phase, the level of employment needed to operate a hazardous waste disposal facility is smaller than the employment force for centralized energy supply technologies. Hazardous waste disposal facilities, as a subset of the general industrial category, complement other industrial uses because of similar intervening variables.

Energy supply facilities are also a subset of the general category of industrial uses. As energy delivery systems have evolved in this country, their institutional structure has developed such that they are

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[22]Chapin, pp. 372-373.

restricted by the same kinds of siting requirements as are many other industries. There are specific characteristics of some energy supply industries which limit their siting options when compared with industries in general (e.g., water requirements for coal-burning power plants and fuel source availability for all energy facilities). Other industries could locate in a greater variety of areas, albeit at greater expense, but some energy supply industries will be precluded because of resource requirements, e.g., oil shale and geothermal. However, natural physiographic features and intervening variables reinforce the tendency toward siting industries (including hazardous waste disposal and energy supply facilities) in the same general proximity.

Industry, as a land use function, will probably grow in areas with hazardous waste disposal facilities. As noted earlier, common location factors will encourage development in the same general area. The availability of hazardous waste disposal facilities insures that capacity is available to support industrial needs. The close proximity of disposal facilities will tend to encourage those industries which generate hazardous waste.

It is hypothesized that a hazardous waste disposal facility and/or an energy supply facility with on-site disposal of hazardous waste will cause growth of other industries in the area. Growth of industry will lead to growth in the commercial and residential sectors. Each sector experiencing growth, and their interaction with each other, will require additional services and facilities. Therefore, location of the above facilities will impact local land use because of the additional growth that will accompany them.

Development of industry will stimulate other kinds of growth. Commercial development will be required to support the industries and their labor force. In-migration of the labor force will necessitate additional residential development. Industrial, commercial and residential development will interact, leading toward growth for all land uses. This growth, in turn, requires additional public services and facilities. The ripple effects of interacting uses will cause net growth in an area. The spatial distribution of land use functions caused by growth will influence the type and magnitude of impacts on the local area.

Commercial land use. Growth in the commercial sector accompanies additional economic activity, such as that caused by new industrial development. Industries themselves require convenient and available goods and services in their vicinity. This includes retail and wholesale trade facilities. Firms providing service support for the industries will also need office space. These types of commercial development often occur around special activity nodes in an area (e.g., industrial facilities).[23] Thus it would be expected that commercial development established to provide support and services for the industrial development would locate in easily accessible areas adjacent to those industries.

Commercial development siting requirements are somewhat similar to industrial siting requirements. Some of the necessities for commercial development include reasonably level land (preferably with not more than

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[23]McMahan, p. 182.

5 percent slope), direct access to major transportation routes, and availability of utilities.[24] But the most important requirement for commercial development is that it be easily accessible to its market.

The growth of economic activity brought on by industrial development will cause growth in the residential sector. The increased population also necessitates additional commercial development, especially retail trade which would suggest the development of new shopping centers. Again though, the commercial facilities must be easily accessible to their consumer market. Retail establishments often situate adjacent to other commercial uses. Thus it is logical that commercial support for both industrial and residential uses will probably locate in the same general area, with commercial/industrial closer to industries and commercial/residential closer to residences.

Residential land use. New residential development is normally discouraged in close proximity to industrial areas, especially if it is expected that the industries could have adverse effects on the population. Throughout the years, the tendency has been to protect the quality and value of residential property above all other uses. People spend a great deal of their time near their homes. A child's formative years are usually spent in residential areas. Thus it is important that residential areas be protected from the dangers that individuals might choose to expose themselves to otherwise. The perception of a safe dwelling place

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[24]Chapin, p. 373.

is one of man's strongest needs. Any adverse impacts that may result from living near industrial facilities necessitate the minimization of residential land use near those facilities. Supporting land use functions (e.g., commercial and industrial) may require an increase in residential development, but not within close proximity to those facilities perceived as harmful.

There are many things which influence how an individual views his living environment. These in turn influence his notion of personal safety and security. Studies of human perception suggest that physical environment is significant in terms of physical location as well as social orientation.[25] Enhanced perceptions of safety can be achieved by locating residential developments in functionally sympathetic areas immediately adjacent to activities that do not provide continued threat.[26]

Public perception of land use. As societies evolve and change so do the accompanying technologies. Hazards are more subtle than they used to be. For early humans, risks/hazards were the products of nature, e.g., tornadoes, forest fires, floods, etc. Now one must contend not only with natural risks but also manufactured risks such as industry generated hazardous waste. Human created hazards are not always as obvious as naturally occurring risks; chemicals buried ten to twenty years

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[25]John C. Holliday, *Design for Environment: Social Change and the Need for New Approaches in Planning* (London: Charles Knight and Co., Ltd., 1977), p. 23.

[26]Oscar Newman, *Defensible Space* (New York: The Macmillan Co., 1972), p. 9.

ago may just now be leaching into vital aquifers. Public recognition of problems is an essential link in the construction of desirable living environments. However the scale of real phenomena and consequences makes the issues hard to see. Attempts to consider the "overall picture" tend to make one lose perspective of micro level consequences.

The spatial distribution and design of land use functions have a direct influence on how the environment is perceived. Types of housing, location of retail establishments, transportation systems, industrial activities, and environmental ramifications of pollution and waste disposal are just a few of the ways in which the design of the environment is manifest. This means that better environments can come only through conscious realizations of the need to change, and development of adaptive systems for change in conjunction with technological change.[27]

As public concern about pollution continues, environmental impacts as they affect the safety and well-being of society are areas of concern. Earlier views of pollution (air and water), waste management and ecological issues were seen as separate problem areas. Today however, the predominant view is a systems approach. Environmental processes are interdependent.[28] As population increases and individually available space decreases, the effects of environmental pollution are more immediately felt by everyone. Thus it is necessary to develop specific

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[27]Holliday, p. 133.

[28]*Environmental Quality and Social Behavior* (Washington, DC: National Academy of Sciences Printing and Publishing Office, 1969), p. 5.

techniques, such as management of spatial patterns of land use functions, which minimize potential adverse impacts.

Hazardous waste disposal facility siting. Because of hazardous waste disposal facility siting constraints, RCRA will impact national land use, including the spatial distribution of land use functions. The siting constraints, taken as a whole, will preclude the siting of hazardous waste disposal facilities in many areas of the country. The siting of these facilities will in turn influence the location of industry which then interacts with commercial and residential land use functions.

Past mismanagement of hazardous waste has been well publicized by the media, e.g., Love Canal (Niagara Falls, New York), Valley of the Drums (West Point, Kentucky), and the Velsicol Chemical Corporation Dump (Toone, Tennessee). This further restricts the siting of hazardous waste disposal facilities because of public perceptions. People are concerned about the health and environmental effects of these facilities. They perceive adverse health effects because of highly publicized hazardous waste disposal problems. Their psychological well-being is impacted by their perceptions of the effects of that facility — perceptions of decreased property value and other quality of life amenities. Though there may not be an actual decrease in the quality of life or health for those living near properly managed hazardous waste disposal facilities, the perceptions are just as important as reality itself to those affected.

Hazardous waste disposal facilities, because of existing constraints (availability of land, zoning, public opinion, natural features, etc.)

are likely to be sited in rural areas. These smaller communities, which often lack an adequate supportive infrastructure for major new development will experience greater impacts from any kind of growth. However, because there is usually not a well-defined spatial distribution pattern in these areas, they represent an opportunity to implement growth management techniques to minimize adverse impacts. Based on these assumptions, it is hypothesized that, depending upon local planning decisions, the spatial distribution of land use functions may evolve or be directed toward a growth pattern which will minimize health and environmental effects, and maximize economy, convenience and amenities.

The results of the impact on change of land use functions by hazardous waste disposal facilities can be seen in Table 5. In terms of land use patterns this table provides a hypothetical indicator of the optimal spatial distribution of land use functions surrounding new hazardous waste disposal facility (Fig. 1). The siting of a hazardous waste disposal facility (HWDF) will probably result in a ripple effect on changing land use, with successive buffer zones developing, based on the interactive growth of each sector.

As an industry which experiences similar locational requirements as other industries, hazardous waste disposal facilities will be located in the same vicinity as other industries. Support commercial development for the industries will be located immediately adjacent to the industrial development, evolving outward with retail commercial development and toward residential areas, thus providing support for both industrial and residential areas. Both health and safety considerations, and the American

Table 5. Direction of change in adjacent or nearby land use functions for hazardous waste disposal facilities

Change	Residential	Commercial	Industrial	Recreational	Agricultural
Induce		X	X		
Retard	X			X	X

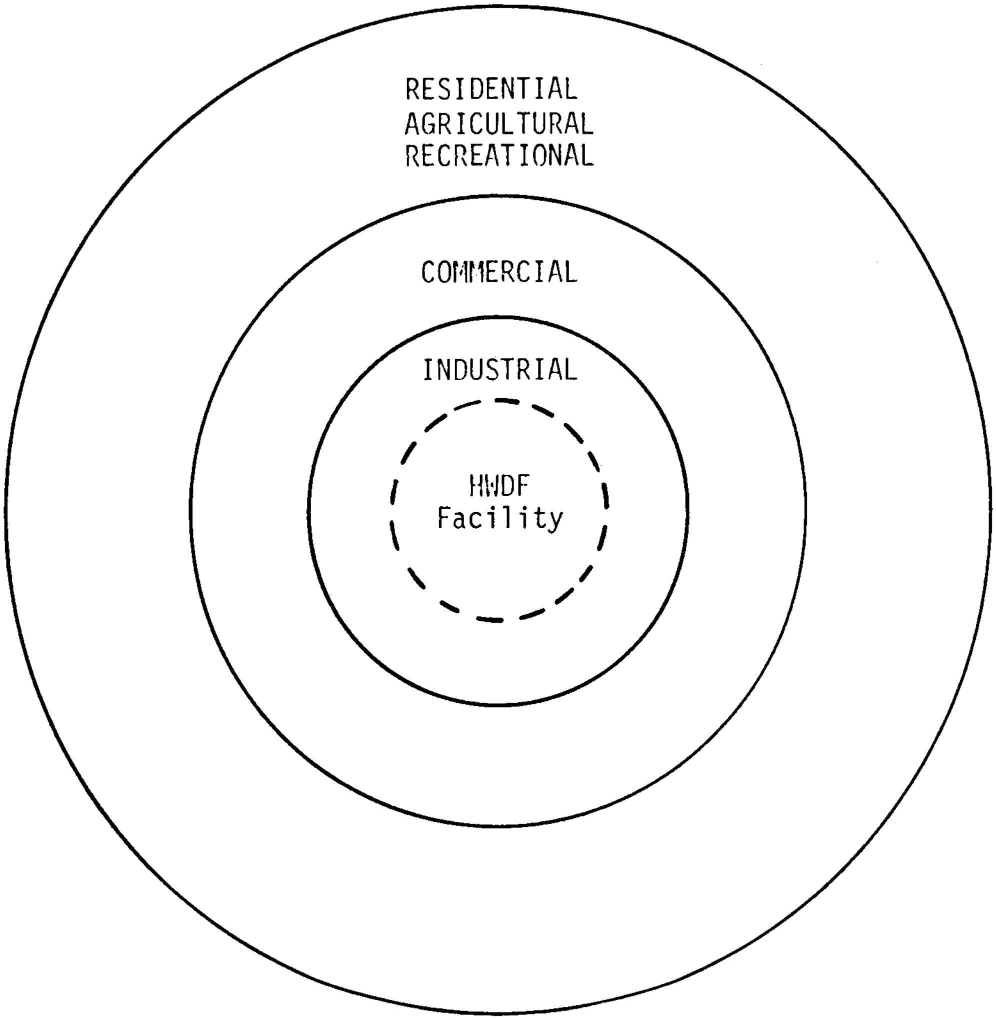

Figure 1. Hypothetical indicator of the optimal spatial distribution of land use functions around industrial development, including hazardous waste disposal facilities.

dream of "suburbia," will direct residential development on the outer periphery. Recreational and agricultural functions will also be interspersed on the outer periphery with residential. For some specific disposal techniques (e.g., land farming), the growth of food crops is prohibited by proposed regulations. Leaching possibilities would preclude the growing of food crops near the site.[29] Because of past media coverage of incidents such as "Love Canal," where children played in areas that had once been hazardous disposal sites, it is unlikely that recreational activities near the disposal sites will be permitted.

Summary of Land Use Impacts

The pattern of land use proposed in Fig. 1 hypothesizes a hierarchy of land use functions surrounding industrial development, including hazardous waste disposal facilities and energy supply facilities. This spatial distribution pattern has not applied and will not apply to all industrial development. What it does allege, however, is that a well-defined pattern of land use functions may be a desirable way to deal with "less desirable" development. If people know that there will be a buffer zone (i.e., commercial land use) between the less desirable (industry) and more desirable (residential) development, some of the problems of adverse public opinions toward the siting of any major industrial facility may be overcome. It becomes a matter of implementing growth management techniques to insure that the type of development occurs in conformity with a planned overall pattern.

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[29] *Federal Register*, 43: 58990-58991.

Assessment of the impact of retrofitting is an entirely different problem.[30] A thorough assessment necessitates site and technology specific information. However, the probable outcome will be the displacement of land use functions over time, leading to a spatial distribution pattern similar to that portrayed in Fig. 1. Depending on specific conditions and characteristics, the *total* impact may be greater for retrofitted facilities than for new facilities contingent upon the level and adequacy of planning. But, a primary difficulty with first siting the facility and then planning the surrounding development is the lack of support services for the facility itself during construction and early operation. For retrofits or sites in an already developed area, many of the support needs would be in place (e.g., labor requirement and public utilities). The variation in impacts demands that trade-offs be made.

Because major new industrial facilities such as hazardous waste disposal facilities and energy supply facilities will be located in rural areas, the lack of existing development presents an opportunity to manage growth. If new hazardous waste disposal facilities were located in sparsely developed areas, it would be possible to develop support from the public if the facility and its surrounding land use were the result of planned development. By planning in advance of any construction, those responsible for the facility could direct and manage the types and

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[30]Retrofitting means to equip the facility to meet current environmental protection standards.

timing of growth to complement what would otherwise be a "hazardous garbage dump." The key here is to start planning far enough in advance.

CHAPTER VI

ENERGY SUPPLY TECHNOLOGIES AND LAND USE

To identify the impact of RCRA hazardous waste regulations on energy supply technologies, it is necessary to look beyond the land use impacts of industry in general. As seen in Table 3 (page 80) all energy supply technologies reviewed do generate hazardous waste at some point. This analysis attempts to identify some of the types of land use impacts caused by specific energy supply technologies which generate hazardous waste. To do this, the stages at which hazardous wastes are generated for each technology are described and the specific hazardous wastes are identified (Chapter IV).

Energy supply technologies reviewed are oil shale, petroleum refineries, coal combustion, geothermal, biomass, solar collectors and photovoltaics. For these technologies, significant amounts of hazardous waste is generated in extraction and refining, manufacturing of system components, generation of energy, and decommissioning stages. Oil shale, petroleum refineries, coal combustion, geothermal, solar collectors and photovoltaics generate hazardous waste in the extraction and refining stage. Solar collectors and photovoltaics generate hazardous waste during manufacturing of system components and decommissioning of energy systems. The generation of energy from coal combustion, geothermal and biomass facilities produces hazardous waste. Depending upon the technology, energy waste stages may cause various land use impacts.

Oil Shale

Oil is extracted from oil shale rock in one of two ways: above-ground retorting or in situ retorting. In above-ground retorting the shale is first mined and then extracted in large furnaces above the ground called retorts. The in situ retorting involves heating the rock while it is still in the ground. Both methods generate hazardous waste streams in the extraction stages.

Above-ground retorting is the second phase of extraction after the mining phase (from either open pit or underground shafts). For a 50,000 barrel-a-day output, above-ground oil shale retorting would process 60,000 tons of shale and leave 50,000 tons of waste for disposal each day. Some estimates predict that the oil shale industry (with above-ground retorting) could disturb over 80,000 acres of land within thirty years. The above-ground retorting would use 6,000 to 9,000 acre-feet of water per year for underground mining; but 12,000 to 18,000 acre-feet of water per year would be needed for surface mining. Such an operation would be a significant impact for the semiarid regions in the West.[1]

In situ retorting does have some advantages over above-ground processing. It would reduce or eliminate the need for surface or deep mining thereby disturbing less land. This method would also mitigate some of the problems of waste disposal and land revegetation, and reduce water consumption by one-third to one-half (for the same amount of oil

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[1]Stewart W. Herman and James S. Cannon, *Energy Futures: Industry and the New Technologies* (Cambridge, MA: Ballinger Publishing Co., 1978), p. 359.

as for above-ground retorting). However, in situ retorting may contaminate large quantities of groundwater.[2]

Hazardous wastes generated in the extraction stage may or may not be regulated by RCRA. It is possible that these wastes will be regulated by the Surface Mining Control and Reclamation Act, or they may be exempted from RCRA requirements in order to expedite progress toward the goal of U.S. energy independence. Currently oil drilling muds and oil production brines, and other mining wastes (of which oil shale may be included in either category) are classified as special wastes by proposed RCRA regulations. If oil shale extraction wastes are designated as special wastes, their disposal will not be as stringently regulated as hazardous waste. Special waste disposal facilities need only meet the environmental and performance standards proposed for hazardous waste disposal facilities, whereas hazardous wastes must also comply with operating and design standards. Special waste disposal facilities will not have to be monitored for groundwater contamination as do hazardous waste disposal facilities. Special waste would be included in the manifest system in order to document their disposal. This classification will not solve the problems of large volume of waste disposal. The wastes will still be present and the problem will be how to protect the environment and other developments which may develop in close proximity to the employment centers.

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[2]Ibid., p. 360.

If extraction wastes are classified as special wastes, the siting of these facilities as a result of the interaction of RCRA hazardous waste disposal regulations with energy supply technologies may impact potential land use due to leaching into groundwater from unmonitored special waste disposal facilities.

Colorado, Utah, and Wyoming contain the richest oil shale deposits in the U.S. This resource is located in a limited geographical region that is primarily semiarid, rural, and isolated from large population centers.[3] The constraints of developing this energy supply technology are regional. The development of energy facilities in this region, with in-migration of large numbers of shale-industry employees, would disturb previously sparsely settled regions causing social and economic impacts, and problems for the region if not carefully managed.

Localized health effects, deteriorated air quality, severely altered landscapes and competition for water resources will tend to limit development within close proximity to oil shale facilities. A large influx of shale industry employees, will cause development pressures. Because of the location of the resource and competition for water, such development pressures may cause company or "oil-shale towns" to be developed. These boom towns, based on one industry (i.e., oil shale) raise several issues associated with such growth. One of the major issues is the large amount of water required by this technology and therefore its competition with other land use sectors for water, i.e.,

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[3]TRW, *Environmental Characterizations for Energy Technologies and End Uses: Executive Summary, Vol. I* (McLean, VA: TRW, 1978), p. 39.

commercial, residential, agricultural and recreational. Furthermore, there is the possibility that the water available could be contaminated by the extraction and processing activities. In oil shale production, waste is continuously generated. The disposal of this large waste volume will take land from other uses, further restricting development. Finally, because of the large volume of hazardous waste generated, economics dictate that there be on-site disposal. Transportation costs of such large amounts of waste would limit the economic feasibility of the technology. However, on-site disposal will increase (or maybe just move) the probability of local water contamination, which in turn limits practicality of other development.

The types of industry locating in these areas would probably be those which would not provide permanent housing for their immigrating employees. Public facilities, services and utilities are often not provided in a timely fashion for newly developing communities. Fringe area settlements (e.g., mobile home communities) may develop around centers of employment where generally there are inadequate urban services. Existing local governmental boundaries, tax structures and organizations probably will not fit new community patterns and therefore the new settlements are not adequately regulated or planned.[4] However, these land use impacts are not a result of the interaction of RCRA hazardous waste regulations with oil shale facilities. They are a result of the oil shale industrial processing facilities themselves.

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[4]John S. Gilmore and Mary K. Duff, *Boom Town Growth Management* (Boulder, CO: Westview Press, 1975), pp. 20-21.

Oil shale energy supply facilities present unique land use constraints and issues. They are regionally constrained because of the location of the oil shale resource. Oil shale development necessitates the use of large amounts of water in areas where there is already a water shortage. The competition for the required water could limit development. These facilities will probably adversely impact air and water quality and land use. Though the utilization of this technology may be limited because of federal and state environmental laws, these laws can be changed. The air quality of the localized area, as well as the water quality, will be degraded. The landscape in the vicinity of the oil shale plants will be altered (both by mining and waste disposal) and reclamation is uncertain. There are also potential health effects associated with oil shale production and residuals.[5]

The large amounts of land required for hazardous waste disposal, if not used for this purpose could be developed for other land use functions or preserved in its natural state. There is a given amount of land economically and environmentally suitable for various types of development. Land use functions compete for that land. If one use prevails, then the others are excluded. Because of the large volume of wastes to be disposed and hazardous waste disposal facility siting criteria which must be addressed, some of the best land for other types of activities may be preempted from other uses because of the scarcity of suitable sites for development, e.g., those meeting RCRA hazardous

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[5]TWR, *Executive Summary,* p. 39.

waste disposal facility siting constraints. In the predominantly rural areas of the country, any major facility such as a hazardous waste disposal facility or an energy supply facility will impact local communities by inducing growth, such as boom town growth, in areas which can not afford to provide the necessary services. The fact that there is a facility for hazardous waste disposal might induce some industries which generate hazardous waste to locate in the general vicinity. If this were to happen, the land use configuration around the facility might approximate that of the hypothetical model and thus have the same kinds of land use impacts.

The hypothesized spatial configuration model of land use around industries with on-site hazardous waste disposal should apply to oil shale technology. Though development could evolve in those directions, any land use in that area (the West) will be reflective of the competition for water resources. For oil shale facilities, the type and volume of waste will have more impact on land use issues than associated hazardous waste disposal facilities.

Petroleum Refineries

Hazardous wastes generated in the extraction and refining of petroleum products may or may not be regulated by proposed RCRA hazardous waste disposal regulations. Classification in the special waste category and/or special exemption may remove the requirements for this continuously generated, large volume hazardous waste to be managed like other hazardous wastes in the mining stage.

There are three major steps in petroleum refining technology: *separating* the petroleum from its original location (i.e., extracting crude oil from a geological formation); *converting* crude oil into various products such as gasoline, kerosene, naptha and heavy oil; and *treating and blending* these products to obtain the desired refinery products (e.g., regular gasoline, heating oils, aviation fuels and greases). The physical and chemical processes involved in these steps discharge a wide range of production wastes from diverse refinery sources. Environmental impacts of petroleum refining are functions of refinery location, size, crude oil, feedstocks, and variations in the end product mix.[6] Site specific land use impacts cannot be predicted without site specific information about the refinery facility.

The large volume of wastes generated in petroleum refining will impact air and water quality, and land use. The refining process will potentially cause visible, malodorous, and/or hazardous air emissions. Wastewater streams from refining contain substances with the potential to cause a severe decrease in water quality.[7] The volume of land needed for disposal of the hazardous wastes will be in competition with other land uses. Because of transportation cost, there will be on-site disposal of waste where feasible. Land in close proximity to the energy supply facility may be used for waste disposal rather than other kinds of developments because of the magnitude of the waste. If the petroleum refineries locate in rural-undeveloped areas, boom town effects can be

[6]Ibid., p. 45.

[7]Ibid.

anticipated unless there is adequate planning to mitigate such pressures. If they are located near established urban centers, the labor force may come from the urban area and inmigration will be less, thus causing fewer social and economic impacts on the area in general.

Mining wastes and drilling muds, and oil production brines are classified as special wastes by proposed RCRA regulations. Facilities which handle special waste will be exempted from operating and design standards which apply to hazardous waste.[8] The Surface Mining Control and Reclamation Act may also be responsible for the regulation of petroleum mining waste. Regardless of disposal practices, the mining of petroleum products will cause land use impacts due to the amount of land required. Adverse impacts will be minimized however, if disposal practices insure environmental protection.

Refining of petroleum products generate wastes which have been identified as hazardous by EPA (e.g., DAP sludge, kerosene filter clays, lube oil filtration clays, slop oil emulsion solids, etc.). These production wastes are large volume, continuously generated hazardous substances. As such, they must be disposed of in permitted hazardous waste disposal facilities. Location of raw materials partially dictates the location of petroleum refineries. The locational siting of refineries will in turn influence the siting of hazardous waste disposal facilities. Concurrently, the siting of hazardous waste disposal facilities will be constrained by proposed siting criteria. If refinery facilities choose

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[8] *Federal Register,* 43: 58992.

on-site disposal for their hazardous waste, then the location of the refinery itself will be limited by many of the same constraints which apply to hazardous waste disposal facilities.

Industrial development (such as energy technologies or hazardous waste disposal facilities) may induce growth in an area to support the industry itself, i.e., labor requirements, supporting commercial development, etc. However, growth in close proximity to petroleum refineries is not likely because of air and water pollution.

Land use issues will be dictated by the interaction of the siting of hazardous waste disposal facilities and the petroleum refineries — the petroleum refineries since their environmental effects may make them undesirable neighbors, and the hazardous waste disposal facilities because of public perception and concern. The sheer volume of land needed for these facilities will impact land use by removing its availability from development for other functions. If, however, the refineries have off-site disposal, there may be growth and development of other land use functions similar to the spatial configuration in Fig. 1 (page 111) with similar impacts. The type and magnitude of land use impacts is site specific and dependent upon on-site versus off-site disposal facilities for hazardous waste.

Coal Combustion

With oil becoming increasingly expensive and natural gas in short supply, coal as the United States' most abundant fossil fuel will play an important role in the energy future of this country. The environmental hazards of obtaining and using coal for energy are severe.

Current energy policy is to expand the use of coal and thereby reduce U.S. dependence on foreign sources of energy. Though this is a viable energy alternative, the consequences of this action must be considered, i.e., increased environmental damage. Coal combustion as an energy supply technology produces hazardous waste in the extraction and refining, and the generation of energy.

There are land use impacts associated with any mining operation, but to a large degree the impacts are site specific. The type and magnitude of the impacts are influenced by the type of mining (surface or underground), the characteristics of the site, pollution control measures used, land reclamation practices which follow cessation of mining, etc.[9] Hazardous waste generated from coal mining are classified as special waste by proposed regulations. These special waste will be disposed of in facilities which have less stringent requirements (as with special waste for oil shale). The Surface Mining Control and Reclamation Act also influences the magnitude of land use impacts from coal mining.

Mining potentially affects water and air quality and land use. Surface mining temporarily makes the land unfit for other uses. It can cause destruction of undisturbed wildlife areas and wildlife habitats. Mining may produce sources of air pollution and changes in water flow, depth or quality. It can also cause socioeconomic impacts for local communities. To the extent that environmental impacts are associated

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[9]TRW, *Executive Summary*, p. 45.

with mining, trade-offs have to be made between the environmental (including social) costs and the need for the resource.

Inclusion in the special waste category and the Surface Mining Control and Reclamation Act virtually guarantees that hazardous waste from coal mining operations will not have to be disposed in permitted hazardous waste disposal facilities with groundwater monitoring. This does not mean that there will be no land use impacts from coal mining. There are impacts — impacts such as degraded air and water quality and land use because of the lack of adequate protection for other resources. The impacts for land use issues from a polluted environment may not be greater than for a clean environment but they certainly are different in terms of future development potential.

The preparation of coal for use in coal combustion facilities generates hazardous waste. Coal preparation facilities require permanently dedicated land for waste disposal. The use of this land for disposal prevents its use for other purposes such as recreation or agriculture. Permanent removal of land from other uses will limit development in an area. Coal preparation plants generate a considerable amount of occupational noise and air pollution.[10] The facilities for preparation of coal are also water consumptive and discharge water contaminants. The environmental pollution potential from coal preparation is great. A combination of air, water, and noise pollution in conjunction with each other will tend to retard commercial,

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[10]Ibid., p. 28.

residential, agricultural and recreational growth within close proximity to the coal preparation facility. However, industrial development immediately adjacent to the coal preparation and special waste disposal facilities could serve as a buffer zone for other land use functions.

The generation of energy from coal combustion facilities will result in the continuous production of a large volume of hazardous (special) waste. Large amounts of land will be required for disposal of ash and calcium sulfate ($CaSO_4$) sludge.[11] Factors such as the geographic distribution and sizing of plants, and the effectiveness of environmental control technology determine the level of environmental impacts from this energy supply technology. Because of the large volume of hazardous wastes to be disposed of, RCRA could impact the widespread implementation of this energy supply system. In addition to the impacts on land use due to waste disposal, coal combustion may also impact local water resources and thus indirectly affect land use.

The large amounts of land needed for disposal, proposed hazardous waste disposal facility constraints, the need of the technology for adequate water supplies, and public opinion may work together to prevent (or delay) the increased utilization of coal combustion technology. In the U.S., the West may be most desirable in terms of available land for disposal and land which also meets the siting criteria constraints. However there is already a problem of how to resolve the conflicts over water rights in the West.

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[11]Ibid., p. 34.

The hypothesized models of land use functions surrounding hazardous waste disposal facilities will probably not apply for facilities which dispose of coal combustion wastes. In the first place, energy facilities will probably have on-site disposal. If other industries could not share these waste disposal facilities, there would be less incentive to develop areas in close proximity. Also because of lobbying efforts by the coal industry and utilities, and the direction of national energy policy, hazardous wastes from coal combustion may be exempt from compliance with RCRA hazardous waste disposal regulations.

If the commercialization of coal combustion continues, there will be increasingly greater volumes of special wastes. Greater volumes of waste lead to greater land use impacts. Large amounts of land needed for the disposal of these wastes will preclude the development of other land use functions. Even if these wastes were not regulated by RCRA they would still cause impacts, probably severe adverse impacts because public health and the environment would not be protected, as well as impacts on water quality.

Land use impacts will result from coal combustion as an energy supply technology and accompanying waste disposal facilities. Hazardous (special) wastes generated in both the extraction and refining, and generation of energy will be regulated by RCRA. The main impact will be to limit the areas of the country where the facilities can be built (because of locational siting need, e.g., the need for hazardous waste disposal facilities, available coal resources and need for water). This does not mean that coal combustion facilities will not be built elsewhere;

rather, if they are, they will be significantly more expensive due to environmental protection and transportation costs.

Geothermal

For geothermal energy supplies, hazardous waste is produced in the extraction and generation stages. The hazardous waste stream generated in the extraction stage may be regulated by the Surface Mining Control and Reclamation Act rather than by RCRA. As final regulations are being developed, some energy supply technologies are receiving special exemption from RCRA requirements. The geothermal power industry is requesting, and will probably obtain, special exemption.[12] If granted special exemption, RCRA hazardous waste disposal requirements will not apply to this energy supply industry in the near future. For the purposes of this research, it is assumed that RCRA regulations for hazardous waste disposal do apply.

If the land is available and suitable for hazardous waste disposal, hazardous waste generated during the extraction stages (i.e., drilling of wells to release the heat) will probably be disposed of on site. Transportation costs make off-site disposal unattractive when on-site disposal is a viable alternative. Land use impacts for geothermal energy at the extraction stage include intrusion into remote wilderness or recreation areas because of the location of U.S. geothermal resources. Geothermal exploration will require road and associated mining development

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[12] *Solid Waste Report* 10 (June 1979): 91.

in these remote areas. If wells drilled are productive, boom town impacts (as previously discussed for oil shale) will probably occur.

Because of its potential use as a long-term source of heat and electricity, new, planned communities could develop near geothermal reservoirs. Current wilderness and recreation land may be developed because of geothermal power resources. The main attraction for industry in these areas will be a virtually unlimited supply of cheap energy for electricity and steam for industrial purposes.[13] Development occurring in these areas should tend to follow the hypothetical model proposed in Fig. 1 (page 111). However, geothermal plant operations are sometimes very noisy. The steam itself often contains quantities of hydrogen sulfide with its characteristic odors. Well blowouts sometimes occur, spewing roaring steam into the air and creating foglike conditions.[14] For these reasons, residential development will not likely occur in close proximity to the geothermal energy facility. Industry would locate closer to the energy facility to utilize heat sources and electricity. The support commercial development between industrial and the residential, recreational and agricultural sectors would serve as a buffer zone. All sectors would probably use the heat sources and electricity but industrial uses would be more compatible within close proximity of the geothermal facility.

There is the possibility that very little, if any, land development will occur near geothermal energy sources. As mentioned above, they are

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[13]Herman, p. 313.

[14]Ibid.

noisy, foul smelling and subject to well blowouts. In addition to using large amounts of water (a serious constraint in the West), geothermal brine leaks can contaminate aquifers or surface water. The drilling and release of subsurface heat may potentially cause an increase in seismic activity (a hazardous disposal facility siting constraint). Noxious fumes may reduce air quality in the area. The sum of the potentially adverse environmental impacts may be greater than the incentives to encourage development and therefore trade-offs will have to be made.

As an energy supply technology, increased utilization of geothermal energy could impact land use on a national/regional level. For the foreseeable future in the U.S., all geothermal development will probably take place in the West.[15] If development does occur, it could draw industry and population migration to the West. That development, in conjunction with the energy supply itself, would severely impact water quantity and quality in the area. Because of seismic activity and scarcity of water it is not expected that these energy facilities will have on-site hazardous waste disposal if they must comply with proposed RCRA regulations. The interaction of RCRA hazardous waste disposal regulations with geothermal energy facilities will not impact national land use per se if these energy facilities are exempted from hazardous waste regulations. Nor will there be an interactive impact if the geothermal facilities cannot have on-site disposal. Geothermal energy facilities will impact land use, but not necessarily because of RCRA hazardous waste disposal regulations.

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[15] Ibid., p. 314.

Biomass

In the past biomass was the predominant generator of heat. Since the discovery of fire, man has burned wood and other organic matter to heat his dwellings and cook his meals. Interest in the use of biomass as an energy supply technology is being revived. Biomass fuel may be wood or other organic plant matter. Organic plant matter can be converted into gas (bio-gas from anaerobic digestion) rather than burned directly. The wastes generated from biomass energy sources, both wood and bio-gas, are hazardous.[16] These renewable energy technologies produce hazardous waste in the generation of energy. However, because biomass/wood technology is decentralized, it is possible that RCRA hazardous waste management regulation will not always apply (if 100 kilograms or less per month of hazardous waste is generated, then the generator is not required to comply with RCRA regulations).

Anaerobic digestion for bio-gas production from animal and agricultural waste can greatly reduce pathogen content, reduce waste volume and produce a high quality fertilizer. If materials used in digestion are free from toxicants and infectious materials, the waste sludge may be nonhazardous.[17] However, sludge from bio-gas production is expected to be hazardous, with large waste volume continuously generated from centralized production. Biomass combustion's greatest use will probably be wood or agricultural wastes in small decentralized operations.[18] Ash is the main hazardous

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[16]Weeter and Carson, pp. 14-21. [17]Ibid., p. 20.

[18]Ibid., p. 16.

waste generated. This waste material is continuously generated from noncentralized sources.

Impact on land use of hazardous waste produced from the generation of energy from biomass/gas will be similar to impacts discussed for the fossil fuel energy technologies. If there is off-site disposal in facilities in close proximity, other industries may be drawn into the area to utilize the same disposal facilities. If there is on-site disposal, siting of the biomass/gas energy facility itself will be constrained by proposed RCRA regulations.

It is difficult to assess the impact of RCRA on the interaction of the siting of hazardous waste disposal facilities with biomass/wood energy sources since this technology is decentralized. As a decentralized technology there will probably not be on-site hazardous waste disposal facilities. If the waste is disposed of by generators who produce 100 kilograms or less per month, over a period of time this practice (with the cumulative build up of wastes) will deteriorate environmental quality, and thereby impact remaining land use options. Hazardous wastes will impact the environment (and thus land use) regardless of the volume, but it stands to reason that the greater the volume, the more severe the impact.

Biomass energy sources will impact land use through promotion of decentralized energy systems. Decentralized systems lessen the need for transmission lines, added roadways, and centralized large energy facilities (and their impact on the local communities such as labor requirements, housing, infrastructure, etc.). The siting of these biomass facilities, unless they have on-site disposal facilities, is not expected to be impacted by RCRA regulations.

Decentralized generators will have to be made aware of their responsibilities under RCRA regulations since they are expected to be the predominant users and are not normally acquainted with hazardous waste regulations. An indirect impact resulting from biomass energy production will be the need for hazardous waste disposal facilities to accommodate many decentralized generators rather than fewer centralized generators. In areas of the country where biomass energy production is common there will be a need of disposal facilities which accommodate off-site generated waste. If areas of the U.S. are not suitable for siting hazardous waste disposal facilities, the commercialization of biomass energy technology may be limited.

Solar Collectors

Currently about 25 percent of U.S. energy production is consumed by space heating and cooling. As a substitute energy source, solar energy could substantially reduce the vast amounts of gas, oil and coal now consumed. The high cost of solar installations, relative to more standard energy systems is an impediment to the widespread use of solar heating and cooling. Though solar heating systems require little energy to operate, installation cost is two to four times that of a conventional heating system. Coupled with the high cost of installation is the fact that most builders are unfamiliar with solar heating and cooling systems.[19]

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[19]Herman, pp. 15-18.

Since the 1973 oil embargo, the general public has become more interested in solar energy utilization. In 1974 Congress passed the Solar Heating and Cooling Demonstration Act, establishing a governmental program to build and test solar systems for heating and cooling buildings, and for heating water.[20] Because of increasing cost of other energy sources, solar heating and cooling is now seen as a viable and attractive alternative for energy supply. Solar collectors as an energy supply technology are used for heating and cooling. This technology generates hazardous waste in extraction and refining, manufacturing of system components, and decommissioning stages.

There are no major adverse impacts associated with the operation of solar collector systems, but the production of components required for these systems (if widely used) will entail the use of large quantities of resources such as copper, aluminum and glass. Production of copper and aluminum generate hazardous wastes, i.e., copper production slage and aluminum production sludges are both large volume wastes. Mining wastes have been designated as special wastes by proposed RCRA regulations but these wastes may be regulated by the Surface Mining Control and Reclamation Act instead.

Based on a predicted 50 million square feet of solar collectors to be sold by 1982 and the need to change transfer fluids[21] every two years, calculations suggest that 1.7 million gallons of waste will be generated

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[20]Ibid., p. 21.

[21]A transfer fluid is the liquid medium circulated through solar collectors to carry heat.

per year by 1982.[22] If water is used as the transfer fluid then there is no problem with disposal. But, other than water, a water/ethylene glycol solution is the most commonly used heat transfer fluid. EPA has listed ethylene glycol as a toxic (therefore hazardous) waste.[23] The transfer fluids in solar collectors (which may be hazardous) should be changed periodically (often with 100 kilograms or less of liquid waste per month), but the total system is decommissioned only once. Thus the hazardous wastes generated from decommissioning will not always be regulated by RCRA, and it is probable at this time that the changing transfer fluids would not be regulated at all for most residential solar collector users.

The manufacturing of system components from copper and aluminum ore will generate hazardous wastes. The impact of RCRA hazardous waste disposal regulations on the copper and aluminum industries will indirectly affect the solar collector industry. Since the copper slag and aluminum sludges are large volume wastes, these industrial processes will utilize large amounts of land. The large volume of wastes will favor on-site disposal. If a hazardous waste disposal facility is located close to the site of generation but still off site, they might be an impetus for growth of other industries in the area which have common locational needs, such as available hazardous waste disposal facilities. In this instance, the location of a hazardous waste disposal facility, encouraging the development of industries which need these same services in close

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[22] Weeter and Carson, pp. 6-7. [23] Ibid.

proximity, could therefore promote development which would resemble the hypothesized spatial configuration land use model described in Chapter 5 with its associated impacts.

RCRA hazardous waste regulations will impact solar collectors as an energy supply technology, but the impact will result from the system components rather than the generation of energy. Mining wastes will probably not be regulated by RCRA. The hazardous wastes generated in manufacturing system components result from the impact of hazardous waste regulations on copper and aluminum industries. Here the interaction of regulations and the industry may impact land use, however the impact affects not only solar collector technology but also other industries which depend upon supplies of copper and aluminum. Copper and aluminum industries are not energy supply technologies per se but these industries indirectly (through cost and availability) impact the commercialization of solar collectors. Hazardous wastes resulting from decommissioning solar collectors will impact land use. It will either deteriorate water quality and usability of land if significant amounts of hazardous fluids are disposed of in facilities which are not permitted for hazardous waste disposal, or justify a need for easily available hazardous waste disposal facilities for use by many small disposers.

Since the majority of solar collector systems are expected to be installed on individual homes, the cumulative volumes of hazardous waste from transfer fluids in individual households could significantly impact sanitary landfills and public sewer system (Publicly Owned Treatment Works – POTW) if individual generators dispose of hazardous materials in facilities other than permitted hazardous waste disposal facilities. With an expected 1.7 million gallons of waste per year from solar collectors, this cumulative volume could damage public sewers and/or leach out of sanitary landfills into groundwater. One alternative for disposal of transfer fluids is resource recovery. Industries which replace the fluid could be made responsible for disposing of/or recovery of the used fluid.

Impacts on land use from decommissioning solar collectors will be indirect since this energy supply technology is characteristic of a decentralized energy system. According to proposed regulations, individual users (households) will not be regulated by RCRA. However, unregulated disposal of these hazardous wastes could cause severe environmental damage. Disposal of hazardous waste in sanitary landfills would degrade water quality. If the hazardous fluids are allowed in the public sewer system, it may cause deterioration of the sewer system or breakdown of the treatment processes. Either way public health and the environment would not be adequately protected.

In the sense that land would be made unusable by lack of protection, the absence of interaction between RCRA hazardous waste disposal regulations and solar collector decommissioning would impact land use. Less land would be available for other uses, thereby precluding other land use functions. If all volumes of hazardous wastes, and thus phases of decommissioning, were subject to RCRA hazardous waste disposal regulations there might be a need for a larger number of smaller hazardous waste disposal facilities to keep down transportation costs, or a mechanism for making information about transporters and disposers more readily available to the general public. The public would have to be educated about their responsibilities for hazardous waste management.

The primary impacts on land use from solar collectors will not be from hazardous waste disposal. This energy technology will instead impact land use due to its decentralized method of energy generation. The use of solar collectors will necessitate a different configuration for buildings and vegetation than what is currently practiced. To accommodate application of solar collectors, building height, the shape of lots, location of trees, and use of open space as buffer zones will need to be modified to prevent infringement upon other property owners' solar access. The development of state laws on sun rights would help protect individual access. These changes should not worsen urban sprawl (though they probably will not prevent it either) but they may impact land use at the micro level — the layout of streets, the orientation of buildings, the shape of lots, etc.[24] Solar collectors will also impact centralized energy supplies from major utilities; their output requirements needed to heating and cooling will decrease. Concurrently this decreases the need for other types of energy supply technologies — many of which do generate hazardous wastes on a larger scale and therefore preempts more land from other uses.

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[24]Martin Schweitzer, *Legal and Institutional Issues in the Use of Decentralized Solar Energy Systems* (Oak Ridge National Laboratory, forthcoming).

Photovoltaics

There are two fundamentally different ways to convert solar energy into electricity; by using the heat of the sun to produce steam and drive a turbine (as in a conventional power plant), or by direct conversion of sunlight to electricity (with solar photovoltaic cells).[25] The development of photovoltaic technologies is not expected to be impeded by existing RCRA regulations. However, the Toxic Substances Control Act may affect production costs and methods. Uncertainty — detrimental to the growth of the technology — may be created by the absence of laws on sun rights, testing procedures, performance standards, rate adjustment or tax status. Dissemination of photovoltaic technology as a common energy source will also be a function of availability of raw materials and hazardous waste disposal during the manufacture of the cells. Hazardous waste management provisions of RCRA will add increased cost to commercial manufacturing of photovoltaics, but it may be possible to lower these costs by recycling some materials.[26]

Direct generation of electricity using photovoltaic cells does not produce hazardous waste. The process is clean, safe, involves no moving parts, and utilizes an abundant source of fuel. However mining of raw materials and manufacture of photovoltaic cells presents more severe environmental problems. Depending upon the type of cell manufactured, there is potentially a variety of chemical releases. Hazardous waste is generated in the mining and refining of materials,

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[25] Goldsmith, p. 14.

[26] U.S., Department of Energy, pp. 1-2.

manufacturing of system components, and decommissioning/disposal of the system. With the exception of decommissioning (disposal), hazardous wastes generated are not "energy wastes" per se. The materials used to fabricate solar photovoltaic cells are also used to manufacture other products. The disposal of these hazardous wastes indirectly influences photovoltaic energy supply's impact on land use issues (as with solar collector technology). As industries involved in the production of photovoltaic cells are impacted by RCRA hazardous waste disposal regulations, the commercialization of photovoltaics will be affected.

Hazardous wastes resulting from mining of raw materials is classified as a special waste by proposed regulations. These wastes will be disposed of in less stringently regulated waste disposal facilities. Refining or processing of raw materials in cell manufacturing which generate hazardous wastes will be regulated by RCRA hazardous waste disposal regulations. The magnitude of these wastes is a function of the volume of photovoltaic cells produced. If there is widespread utilization of this energy technology, the volume of wastes will be great. Hazardous wastes generated in the mining and refining stage for production of photovoltaic cells will be probably less than for other energy supply technologies (e.g., mining and refining of all materials used to construct a coal combustion facility), thus the impacts on land use will be less.

The type and volume of hazardous waste generated will depend upon the type of photovoltaic cell manufactured. The three types of photovoltaics cells reviewed (cadmium sulfide, gallium arsenide and silicon) all generate hazardous waste. Production waste from cadmium sulfide and gallium arsenide plants are continuously generated. Waste oil from production of silicon is large volume waste. Not only will these hazardous wastes have to be disposed in a manner which will protect human health and the environment (thus impacting land use), plant employees are exposed to these substances during manufacture of the photovoltaic cells (thereby impacting human health and safety). Since photovoltaic production wastes are not "energy wastes" there is no interaction between the siting of hazardous waste disposal facilities and this energy supply technology.

Hazardous wastes generated from the manufacture of photovoltaic cells will impact the commercialization of this technology because of increased cost passed on to consumers, but it is not probable that the hazardous wastes generated at this stage will impact the siting of the photovoltaic cells themselves. Impacts on photovoltaics as a decentralized energy supply technology from hazardous wastes generated in the manufacturing stage will be indirect (as discussed for biomass/wood and solar collectors). Waste generated from production of cadmium sulfide, gallium arsenide, and silicon affect not only photovoltaic technology but any other technologies utilizing those materials.

Decommissioning/disposal of photovoltaic cells will entail hazardous waste disposal. These cells contain hazardous material which must be disposed of when the system is no longer operational. It is possible that resource recovery techniques could be used to recycle some of the hazardous material, e.g., cadmium recovery, thereby reducing the volume of wastes. Even with resource recovery, there will still be noncentralized waste produced as photovoltaic cells are disposed. Hazardous waste disposal will impact land use but probably not because of where the photovoltaic cells are used. It is not expected that there will be on-site disposal facilities for photovoltaic cell decommissioning/ disposal. If the primary use of photovoltaic technology is for decentralized energy, the public will have to be educated as to their role in hazardous waste management. Other users who are not normally concerned with hazardous waste disposal will also have to learn their responsibilities under RCRA.

The impacts on land use from decommissioning/disposal of photovoltaics (and solar collectors) will not be as great as for some energy supply technologies. RCRA hazardous waste disposal facility siting regulations will impact the energy technology more through its influence on the production/manufacturing stages. Land will be preempt for disposal of hazardous waste regardless of what stage the waste is generated. Adverse impacts can be minimized through protection of health and the environment (via RCRA regulations) but there will still be impacts.

Even though photovoltaics have been heralded as a "clean" energy technology, that statement can be misleading unless one also examines stages other than just the generation of energy. Photovoltaics, like solar collectors, are clean technologies in that neither generate hazardous waste in the generation of energy. However the manufacturing and decommissioning of these systems do generate hazardous waste. If all energy supply technologies were reviewed equally, solar collectors and photovoltaics are not as clean as many people say. They are much cleaner than most but still not perfect.

RCRA will impact land use via photovoltaic energy technology, but indirectly. Impacts on land use because of the interaction of the siting of hazardous waste disposal facilities and photovoltaics are minor. The impact of photovoltaics on land use is similar to the impact of solar collectors. Application of photovoltaics may require new configurations for buildings, lots and vegetation — the micro level — but the main impact will be to decrease the need for energy from other sources. Widespread use of photovoltaics cells could simplify complex energy systems and bring about decentralization of energy resources.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In 1976 Congress enacted RCRA, a multifaceted approach to insure the management of both solid and hazardous waste, with provisions for federal enforcement of hazardous waste management (Subtitle C). The focus of this research has been on the RCRA mandated proposed regulations for the siting of hazardous waste disposal facilities published in the December 18, 1978, *Federal Register*. It was assumed there would be an interaction between the siting of hazardous waste disposal facilities and energy supply technologies which would impact national land use issues. This research supports that assumption.

Industrial functions (hazardous waste disposal facilities and energy supply technologies) will cause impacts individually and in conjunction with each other. All energy supply technologies reviewed generate hazardous waste either in the fuel cycle or as an output from the energy supply system.

Hazardous waste disposal facilities will impact land use in close proximity to the facility. These facilities will induce industrial and commercial growth. They will retard residential, agricultural and recreational growth (Table 5, page 110). The micro-level impacts from the siting of hazardous waste disposal facilities will produce a ripple effect on land use with successive buffer zones developing, based on interactive growth of the land use sectors (Fig. 1, page 111).

State hazardous waste management officials often utilize subjective judgement in the siting of waste disposal facilities. It is the judgement of these state and local decision makers which actually decide how stringent the hazardous waste management program will be. Site specific characteristics of the local community will influence the type and level of impacts. Rural areas, because of their locations, size and lack of infrastructure are likely to experience more intensive impacts.

Of the energy supply technologies reviewed, the most obvious and immediate impacts resulting from the interaction between hazardous waste management regulations and energy supply technologies will be for the centralized technologies with on-site disposal. These energy facilities will be restricted by the RCRA regulations for hazardous waste disposal facilities.

The RCRA regulations for hazardous waste disposal facilities favor certain regions of the country, i.e., the West. The combination of available resources and a predisposition for on-site hazardous waste disposal facility siting may result in "boom town" like growth in the West, a trend which may reflect new regional growth patterns. If energy supply technologies such as oil shale or petroleum refineries do develop in the West, indirect impacts on land use such as water quality and quantity may be more significant than direct land use impacts.

Nonrenewable energy resources (oil shale, petroleum, coal and geothermal) and biomass/gas generate large volumes of hazardous (or special) waste. The volume of waste generated in conjunction with increasing transportation costs for these energy supply technologies will encourage on-site disposal facilities. If energy supply facilities have on-site disposal, the siting of the energy facility will also be limited by RCRA regulations.

To the extent that the system manufacturing industries are impacted by RCRA regulation, solar collectors and photovoltaics will be affected. If cost of disposal for system manufacturing is excessive, the commercialization of these solar technologies will be inhibited. If the solar technologies do achieve full commercialization, the general public will need to be educated about appropriate disposal practices.

Proposed hazardous waste disposal facility regulations have only two totally exclusionary constraints for the siting of a facility, active fault zones and regulatory floodways. All other siting constraints may be granted a variance by the Regional EPA Administrator. Because of seismic activity near geothermal resources, it is not likely that these energy facilities will have on-site disposal. The interaction of stringent siting constraints (if no variances are granted), economic responsibility and public opposition may result in an inadequate hazardous waste disposal capacity. This inadequacy will leave the land open for environmental degradation and jeopardize public health. This shortage will in turn impact energy supply technologies. If disposal facilities are not available then the energy suppliers will either (1) not produce energy, (2) dispose of the hazardous waste in inadequate facilities, or (3) reduce the waste material through resource recovery.

There is an interdependence of land use and energy. Land use functions structure basic patterns of energy consumption in many areas.

Social patterns affecting energy consumption and, thus, hazardous waste generation will develop as a result of land use patterns and activities.

Protection of the public health and environment will be assured if hazardous waste is disposed of in RCRA regulated disposal facilities. These facilities will impact land use by (1) protecting the environment, (2) interacting with other land use functions, and (3) influencing growth and development patterns. The interaction of the proposed regulations for the siting of hazardous waste disposal facilities with energy supply technologies also impacts land use functions and patterns. The types of impacts which can be expected have been identified but additional research is needed to better understand how effective planning can minimize adverse land, social, economic, and environmental impacts.

Recommendations

Adverse land use impacts (and their social, economic and environmental consequences) can be minimized by effective planning. Land use development, as depicted in the spatial patterns of Fig. 1 (page 111) can be encouraged by planning and implementation tools.

As with other planning issues, there are tools and techniques which can be used to achieve the desired goals and objectives of policy makers and planners. These implementation tools include the more traditional planning techniques as well as policy instruments, such as: regulations, economic incentives, eminent domain, taxation, public participation, governmental funding, police power, growth management, zoning, building codes, and health and sanitation standards.

A more efficient utilization of implementation tools would be assisted by *coordination of functions* by various levels of government. At both the planning and policy level, the siting of hazardous waste disposal facilities, and energy supply options and facility siting should be coordinated with a continuing consideration of the associated land use impacts.

Research should be conducted to ascertain *how* to integrate energy and environmental policy. The coordinated policy approach should investigate multifunctional dimensions of the problem, i.e., water, power, land use, etc. Federal policy should be based on an assessment of social, economic and environmental cost of the impact of the energy source itself, and the impact of energy related spinoffs, e.g., manufacturing facilities, hazardous waste disposal facilities, etc.

For some energy supply technologies such as oil shale or geothermal there are specific areas where the facilities must be located — the West. Future research, knowing the locational siting of these facilities, can focus on region specific impacts. However, the impacts of energy supply technologies with greater siting options such as biomass and coal combustion offer more opportunities for policy makers to direct growth and its associated impacts.

Land use impacts from the interaction of the siting of hazardous waste disposal facilities and energy supply technologies is but a "tip of the iceberg." Further research should investigate (1) resource recovery, (2) case studies of site specific land use impacts (such as labor force requirements), (3) conservation techniques, and (4) the achievement of nonhazardous waste producing energy supply technologies. For example, hazardous transfer fluids from solar collectors could be recycled.

One of the major constraints in siting hazardous waste disposal facilities is public opposition. There is a need for public education and involvement in hazardous waste management. The possibility of federal incentives and inducements offered to local communities to encourage the acceptance of a hazardous waste disposal facility should be explored.

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APPENDICES

APPENDIX A

QUESTIONS ON STATE SOLID/HAZARDOUS WASTE MANAGEMENT PROGRAMS

1. Is this agency the designated implementing agency for RCRA (both solid waste and hazardous waste)? If not, which agency is?

2. Has a state implementation plan (SIP) been prepared as required under Subtitle D of RCRA? If this plan (or a draft) is available, please send a copy or advise as to its availability.

3. Has a state plan, pertinent to Subtitle C of RCRA, been prepared for the regulation and control of hazardous wastes? If this plan (or a draft) is available, please send a copy or advise as to its availability.

4. How effective is the public participation program implemented according to EPA guidelines? Would you recommend any modifications?

5. What sub-state agencies (e.g., area planning districts, municipalities, etc.), if any, have been assigned responsibilities in the implementation of solid and hazardous waste management? What role do or will these sub-state agencies play in the planning process relevant to RCRA?

6. Please describe the progress towards implementation of the following RCRA programs in terms of regulations, implementation, and enforcement (please provide any quantitative data available).

   A. Closing of open dumps

   B. Upgrading of dumps to sanitary landfills

   C. Recycling facilities

      1. high technology

      2. low technology

   D. Hazardous wastes

   E. Other

7. What legislative and administrative activities do you anticipate in your state in 1979 relevant to solid and hazardous waste

management? Please provide copies of any available proposed legislation or draft regulations or advise to their availability.

8. What are the major problem areas you have identified with respect to solid and hazardous waste management? Please describe.

   A. Facility siting (please include public involvement)

      1. hazardous facilities

      2. sanitary landfills

   B. Hazardous waste transportation

   C. State/local resources to implement programs

   D. Adequacy of the specification of hazardous wastes (proposed EPA regulations)

   E. Availability of sound sites (geology, adequate cover soil, etc.) for

      1. hazardous facilities

      2. sanitary landfills

   F. Receipt of out of state hazardous waste for disposal

9. Could you provide us with budgetary information since 1975, including, if possible, a distinction between state and federal monies?

10. What implementation funds have you received under RCRA for implementation of

    A. Hazardous waste management?

    B. Solid waste management?

11. Please provide us with a copy of your hazardous waste survey or any other pertinent information on the distribution of hazardous wastes in your state, as available.

12. Identify costs for solid and hazardous waste management not included in the budgetary information (i.e., legal support from the state attorney general's office, laboratory tests for such enforcement, etc.).

13. What legal services are provided directly in your agency?

14. Describe any specific problem areas not addressed earlier unique to your state resulting from geography, industrial characteristics or concentration patterns, etc.

15. With regard to RCRA, what specific amendments or major modifications would you suggest and why? (Be sure to consider only the Act and not include problems resulting from federal regulations proposed or promulgated under the Act.)

16. Describe or provide as possible the existing or proposed monitoring requirements for hazardous waste generators, transporters, and disposers for

    A. The regulated community

    B. Compliance monitoring by the state agency

    Please include any available cost estimates for these activities.

17. A. Please provide your staffing for RCRA programs, distinguishing between level of effort on solid waste and the hazardous programs for 1975-1979. Also break down the number of professional personnel.

    B. Please provide projected staffing requirements as available over the next five years.

18. Please describe any existing or proposed programs for resource recovery projects.

19. A. How many hazardous sites are presently approved within your state? Please list and give approved capacity of these sites.

    B. How many approved hazardous waste disposal facilities (on-site and off-site) do you project in your state in the next three years? Do you anticipate any publicly owned and operated systems.

20. A. Do you have coordinated permitting mechanisms within your state?

    B. If not, what administrative mechanism exists to coordinate with other state/federal environmental regulatory agencies (e.g., air pollution permits)?

<u>Summary of Requested Documents as Available</u>

1. Proposed legislation

2. Proposed regulations

3. State Implementation Plan (Draft, if final not completed)

4. State RCRA-related agency budgets

5. Staffing (last five years and projected increases)

6. Hazardous waste survey

APPENDIX B

Table 6. Summary of waste products, hazardous potential, potential hazardous characteristics, and RCRA problem areas for renewable and oil based energy sources

	Solid or slurry waste	Hazardous potential	Potential hazardous characteristics	RCRA problem areas
I. Solar				
A. Passive	none	no		
B. Active				
1. Collectors	Copper production slag	yes	SIC	2
	Aluminum production sludges	yes	T	2
2. Transfer fluids	Waste fluids	yes	T,O,I,C	1,3,4
3. Storage media				
a. Sensible	Decommissioned system	yes	C	4
b. Phase change material	Decommissioned system	yes	C	4
c. Thermochemical	Decommissioned system	yes	C,T,R	4
C. Photovoltaics				
1. Cadmium sulfide	Cadmium mfg. plant production wastes	yes	SIC	3
	Spent cells	yes	T	4
2. Gallium arsenide	Production waste	yes	T	3
	Spent cells	yes	T	4
3. Silicon	Waste oil from production	yes	SIC	2
	Spent cells	yes	T	4
II. Wind	Copper production waste	yes	SIC	2
III. Biomass				
A. Combustion	Ash	yes	T,C	1,3,4
B. Pyrolysis	Oils	yes	O,M	1,3,4
	Ash	yes	T,M	1,3,4
	Chars	yes	T,M	1,3,4
	Cooling tower blowdown	yes	T,M	1,3,4
C. Alcohol production	Acid hydrolysis sludge	yes	C	2
	Enzyme hydrolysis sludge	yes	N	2
D. Anaerobic digestion	Sludge	yes	N,T	1,2,3,4
IV. Ocean thermal	Decommissioned system	no		
V. Energy storage				
A. Battery				
1. Lead-acid	Production waste	yes	T,C	3
	Spent cells	yes	T,C,R	2,4
2. Advanced				
a. Lithium-metal sulfide	Production	N/A		3
	Decommissioned system	yes	C,T	2,4
b. Sodium-sulfur	Production	N/A		3
	Spent cells	yes	R,C,T	2,4
B. Compressed air storage	Solution mining brines	yes	C,T	2
C. Pumped hydro	Construction	no		
D. Aquifer storage	Brines	yes	C,T	1,3,4
VI. Geothermal	Brines	yes	C,T	2,3
	Sulfur sludge	yes	T	2,3
VII. Oil sands (in situ)	$CaSO_4$ sludge	yes	T	2,3
VIII. Oil shales	Chars	yes	T,O,M	2,3
	$CaSO_4$ sludge	yes	T	2,3
IX. Petroleum refining	Production waste	yes	T,I	2,3

Key to potential hazardous characteristics: I = ignitable, C = corrosive, R = reactive, T = toxic, N = infectious, A = radioactive, M = mutagenic or carcinogenic, B = bioaccumulative, O = toxic organic, SIC = waste listed as hazardous[1].

Key to RCRA problem areas: 1 = analysis cost, 2 = large waste volume, 3 = waste continously generated, 4 = noncentralized waste production.

Source: Dennis W. Weeter and Hugh T. Carson, *Technical Impacts of the Resource Conservation and Recovery Act upon Renewable and Oil Based Technologies* (Oak Ridge National Laboratory, forthcoming).

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