ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 260, 261, 262, 264, 265, 268, 270, and 271

[SWH-FRL 2927-3]

Hazardous Waste Management System: Land Disposal Restrictions

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: The Environmental Protection Agency is today proposing a framework for a regulatory program to implement the congressionally mandated land disposal prohibitions. These actions are responsive to amendments to the Resource Conservation and Recovery Act (RCRA), enacted through the Hazardous and Solid Waste Amendments of 1984 (HSWAs) on November 8, 1984.

This action proposes procedures to establish treatment standards for hazardous wastes, to grant nationwide variances from statutory effective dates, to grant extensions of effective dates on a case-by-case basis, and procedures by which EPA will evaluate petitions demonstrating that continued land disposal is protective of human health and the environment.

In addition, EPA is proposing treatment standards and effective dates for the first classes of hazardous wastes to be evaluated under this framework: Certain dioxin-containing hazardous waste and solvent-containing hazardous waste.

This proposal establishes the framework under which all hazardous wastes will be evaluated in accordance with the schedule (when issued as a final rule) that was proposed, as published in the **Federal Register** of May 31, 1985 (50 FR 23250) and prohibits land disposal of certain dioxin- or solvent-containing wastes unless the treatment standards are achieved. The framework and treatment standards being proposed today do not apply to the disposal of hazardous wastes in underground injection wells.

DATES: Comments on this proposed rule should be submitted on or before March 17, 1986.

Public hearings are scheduled as follows:

1. February 4 & 5, 1986, 9:00 a.m. to 4:30 p.m., Dallas, Texas.
2. February 6 & 7, 1986, 9:00 a.m. to 4:30 p.m., Washington, D.C.
3. February 10 & 11, 1986, 9:00 a.m. to 4:30 p.m., Chicago, Illinois.

The meetings may be adjourned earlier if there are no remaining comments. Requests to present oral testimony must be received by 10 days before each public hearing.

ADDRESSES: Comments on this proposed rule should be sent to Docket Clerk, ATTN: LDR-2, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460. The public docket is located in Rm. S-212 and is available for viewing from 9 a.m. to 4 p.m., Monday through Friday, excluding legal holidays. The hearings will be held at the following locations:

1. The Lincoln Hotel/Dallas, 5410 LBJ Freeway, Lincoln Center Dallas, Texas 75240, (214) 934-8400 (toll free for reservations 800-228-0808).

2. Department of Health and Human Services, North Auditorium, 330 Independence Avenue SW., Washington, D.C.

3. Sheraton International at O'Hare, 6810 North Mannheim Road, Rosemont, Illinois 60018.

A block of rooms has been reserved at the hotels in Chicago and Dallas for the convenience of individuals requiring lodging. Please make reservations directly with the hotel and refer to the EPA hearing. The hearings will begin at 9 a.m. with registration at 8 a.m. and will run until 4:30 p.m. unless concluded earlier. Anyone wishing to make a statement at the hearing should notify, in writing, Ms. Geraldine Wyer, Public Participation Officer, Office of Solid Waste (WH-562), Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460. Persons wishing to make oral presentations must restrict them to 15 minutes and are encouraged to have written copies of their complete comments for inclusion in the official record.

To borrow (for copying) the computer tape containing the ground water and surface water modeling procedures contact: David Disney, Environmental Research Laboratory, Environmental Protection Agency, College Station Road, Athens, GA, 30613, (404) 546-5432 or (404) 546-3123.

FOR FURTHER INFORMATION CONTACT: For general information contact the RCRA Hotline, Office of Solid Waste (WH-562), Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460, (800) 424-9346 toll-free or (202) 382-3000.

For information on specific aspects of this proposed rule contact: Susan Bromm, Office of Solid Waste (WH-562B), Environmental Protection Agency, 401 M Street SW., Washington, D.C. 20460, (202) 382-4770.

SUPPLEMENTARY INFORMATION:

Format for Comments

Because of the complexity of the rule that is being proposed today, and because of the deadline of November 8, 1986, for a final rulemaking on this subject, the Agency is requesting that comments on the proposed rule be organized in a particular way. In suggesting a format for commentors, the Agency is not attempting to restrict the comments to specific topics, nor restrict the method of response, but is rather trying to focus comments to facilitate Agency review and analysis. This approach will also assure that comments are totally and adequately considered given the tight time constraints both on the public to comment on this proposal and on the Agency to develop and promulgate the necessary regulations with statutory timeframes.

1. *Overall Approach.* We would first like comments on the overall approach taken in preparing the proposed rule, including: the use of screening levels; the proposed relationships between the screening levels, best demonstrated achieved technology determinations, and the petition process; and the desirability of performing a comparative risk assessment to compare the risks of land disposal with those of treatment technologies.

2. *Specific Components.* In this section, we would like comments on specific components of the approach, including procedures for:

—Calculating screening levels (e.g., the selection of the back calculation starting points, the appropriate risk levels for carcinogens in light of the other model assumptions, the assumptions and inputs to the back calculation models, and the use of a Monte Carlo analysis);
—Selecting and identifying best demonstrated achievable technologies;
—Conducting comparative risk assessments;
—Establishing prohibition effective dates (e.g., making capacity determinations);
—Granting case-by-case effective date extensions;
—Evaluating petitions demonstrating that land disposal is protective of human health and the environment.

3. *Specific Decisions.* In this section, we would like comments on the way in which particular determinations are made for solvent and dioxin-containing wastes using the framework, models and assumptions laid out in the rulemaking package.

4. *Other.* Finally, we solicit any comments not specifically covered in the previous groupings, including all these requested in the various units of the proposal preamble.

Preamble Outline

I. Background

A. Existing Land Disposal Standard

On October 21, 1976, Congress enacted the Resource Conservation and Recovery Act (RCRA) to protect human health and the environment and to conserve material and energy resources. In Subtitle C of the Act, EPA is directed to promulgate regulations that identify hazardous waste and to regulate generators and transporters of hazardous waste and facilities that treat, store, or dispose of hazardous waste.

Since 1980, EPA has issued a number of regulations implementing these congressional mandates. The Agency has listed under 40 CFR Part 261, more than 400 wastes as hazardous wastes and employs characteristic tests to identify other wastes as hazardous based upon the properties of ignitability, corrosivity, reactivity, and the toxicity of specific chemical constituents identified in waste extracts (leachates). Standards have been issued under 40 CFR Parts 262 and 263 for hazardous waste generators and transporters, requiring generators and transporters to comply with, among other things, a manifest system intended to track the movement of hazardous wastes from "cradle to grave."

EPA has also promulgated extensive regulations governing the design, operation, and care of facilities used to treat, store or dispose of hazardous wastes under 40 CFR Parts 264 and 265. Standards governing existing "interim status" facilities prior to permitting were promulgated on May 19, 1980 under 40 CFR Part 265, requiring, among other things, that owners or operators of land disposal facilities install ground water monitoring wells and conduct periodic sampling and testing of underlying ground water. On July 26, 1982, EPA promulgated extensive permitting standards applicable to new and existing hazardous waste treatment, storage, and disposal facilities under 40 CFR Part 264. These standards require, among other things, that owners and operators of land disposal facilities monitor ground water and, if comtamination from the facility is detected, conduct corrective action. In addition, a number of engineered controls are required such as run-on and runoff controls and caps at facility closure. New units and expansions of existing units are required to have liners and leachate collection systems. Liners must exhibit the necessary properties of strength, thickness, and waste compatibility to prevent system failure or migration of contaminants through the liner. The leachate collection and removal system must also be able to withstand chemical attack from the waste or leachate. Requirements also apply to closure of units and the post-closure care period. Financial assurances are required to ensure that adequate resources are available to meet the requirements for closure and post-closure care.

In addition to these regulations, EPA has also restricted the land disposal of certain hazardous wastes. Previously issued restrictions dealt with two broad classes of problems: (1) Fires, explosions, production of toxic fumes, and similar problems resulting from improper management of ignitable, reactive, and incompatible wastes; and (2) contamination of surface and ground waters. The Agency has promulgated requirements specifically designed to prevent these problems (see, for example, 40 CFR 264.312, 265.312, 264.313, 265.313, 264.314, and 265.314) by conditionally restricting the land disposal of ignitable, reactive, incompatible, and liquid wastes. For example, ignitable and reactive wastes may not be placed in a land disposal facility: (i) Unless the waste is treated, rendered, or mixed before or immediately after placement so that the resulting waste, mixture, or dissolution of material no longer meets the definition of reactive or ignitable or (ii) under § 264.312, for ignitable wastes in landfills, unless containerized and protected from materials or conditions that might cause them to ignite. Incompatible wastes may not be placed in the same land disposal unit unless precautions are taken to prevent reactions that threaten human health and the environment under § 264.313. Regulations in effect prior to HSWA also conditionally restricted the disposal of bulk, non-containerized and containerized liquid waste, or waste containing free liquids in landfills. These regulations provided that the landfill disposal of bulk liquid wate would be prohibited unless the unit had a liner and leachate collection/removal system. These regulations also provided that bulk liquid waste could be landfilled if treated or stabilized before disposal so that free liquids are no longer present. These regulations have now been superseded by the HSWA, which bans the placement in landfills of bulk or non-containerized liquid hazardous waste or free liquids contained in hazardous waste (§ 264.314(b)). Existing regulations under § 264.314(d) also provide that containerized liquid waste may not be landfilled unless all free-standing liquid is removed or mixed with absorbent or solidified so that free-standing liquid is no longer observed.

B. Hazardous and Solid Waste Amendments of 1984

The Hazardous and Solid Waste Amendments of 1984 (HSWA), enacted on November 8, 1984, impose substantial new responsibilities on those who handle hazardous waste. In particular, the amendments focus on the land disposal of hazardous wastes. Recognizing that land disposal technology cannot guarantee perpetual containment of all waste constituents, Congress has added provisions designed to minimize reliance on land disposal. For example, as noted above, Congress has imposed additional bans and limitations on placement of liquids in landfills. Effective May 8, 1985, the direct placement of any bulk or non-containerized liquid hazardous waste in landfills has been prohibited. This provision applies regardless of the presence of liners or leachate collection/removal systems or the addition of absorbents (RCRA section 3004(c)(1), 42 U.S.C. 6924(c)(1)). EPA is directed to promulgate regulations by February 8, 1986, that minimize the disposal in landfills of containerized liquid hazardous waste, and minimize the presence of free liquids in conatinerized liquid waste. The statute also directs that these regulations prohibit the disposal in landfills of liquids that have been absorbed in materials that biodegrade or release the liquids when compressed (RCRA section 3004(c)(2), (42 U.S.C. 6924(c)(2)). Effective November 8, 1985, disposal of non-hazardous liquids in landfills is prohibited (RCRA section 3004(c)(3), 42 U.S.C. 6934(c)(3)). Congress has also added new technical requirements for land disposal facilities, such as requirements for double liners and leachate collection systesm (RCRA section 3004(o), (42 U.S.C. 6934(o)), and additional corrective action requirements (RCRA section 3004(u) and (v), 42 U.S.C. 6934(u), and (v)).

Amendments to section 3004 of RCRA (42 U.S.C. 6924), specifically prohibit the continued land disposal of hazardous wastes beyond specified dates, establishing a strong statutory presumption against such land disposal. In its enactment of HSWA, Congress stated explicitly that "reliance on land disposal should be minimized or eliminated, and land disposal, particularly landfill and surface impoundment, should be the least favored method for managing hazardous wastes" (RCRA section 1002(b)(7), 42 U.S.C. 6901(b)(7)).

The amendments specify that EPA may not find that a land disposal method is "protective" unless a petitioner demonstrates to the Administrator "to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" (RCRA section 3004 (d)(1), (e)(1), (g)(5); 42 U.S.C. 6924 (d)(1), (e)(1), (g)(5)).

However, wastes that meet the treatment standards established by EPA are not subject to land disposal prohibitions. The statute requires EPA to set "levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized" (RCRA section 3004(m), 42 U.S.C. 6924(m)). In setting treatment standards for a waste, whether it is a listed or characteristic waste, EPA may subdivide the waste and impose different standards on the subdivided wastes. Thus, for example, for a specific waste code (e.g., F001, D002, etc.), EPA may set more than one treatment standard based on factors such as the physical form of the waste.

Land disposal prohibitions are effective immediately upon promulgation unless the Agency sets another effective date based on the earliest date on which adequate alternative treatment, recovery, or disposal capacity which protects human health and the environment will be available (RCRA section (h)(2), 42 U.S.C. 6924(h)(2)). EPA may also establish different effective dates for different physical or chemical forms of a waste. (Vol. 130 Cong. Rec. S13818, (daily ed. Oct. 5, 1984)). However, these effective date variances may not exceed 2 years beyond the applicable statutory deadline.

In addition, two 1-year case-by-case extensions may be granted when an applicant demonstrates to the Administrator that there is a binding contractual commitment to construct or otherwise provide alternative capacity but, due to circumstances beyond the control of the applicant, such alternative capacity cannot reasonably be made available by the effective date (RCRA section 3004(h)(3), 42 U.S.C. 6924(h)(3)).

For the purposes of the land disposal restrictions program, the legislation specifically defines land disposal to include, but not be limited to, any placement oif hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome or salt bed formation, or underground mine or cave (RCRA section 3004(k), 42 U.S.C. 6924(k)).

Congress has also prohibited the storage of any hazardous waste that is subject to a prohibition from one or more methods of land disposal unless "such storage is solely for the purpose of the accumulation of such quantities of hazardous waste as are necessary to facilitate proper recovery, treatment or disposal" (RCRA section 3004(j), 42 U.S.C. 6924(j)). The legislative history accompanying this provision indicates that "the purpose of this amendment is to avoid the potential problem of waste generators, handlers, or disposers utilizing 'sham' storage to avoid a prohibition on the disposal of a particular waste from one or more methods of disposal" (Vol. 129 Cong. Rec. H8139 (daily ed. Oct. 6, 1983), section-by-section analysis of Breaux amendment). This provision is discussed in more detail in Unit III.H of this preamble.

Congress has also provided a conditional exemption from land disposal prohibitions for the treatment of wastes in a surface impoundment, provided that treatment residues that are hazardous are removed within one year of the entry of the waste into the impoundment (RCRA section 3005(j)(11)(B), 42 U.S.G. 6925(j)(11)(B)). In addition, section 3005(j)(11)(A) requires that such impoundments meet certain technological requirements, subject only to limited exemptions. This provision is discussed in more detail in Unit I.C.2 of this preamble.

The legislation sets forth a series of deadlines for Agency action. At certain deadlines, further land disposal of a particular group of hazardous wastes is prohibited unless the Agency has set a treatment standard that minimizes threats to human health and the environment. In such cases, if EPA has not established treatment standards by the applicable statutory date, land disposal of the affected wastes will be allowed only if the Agency finds that a case-specific petition successfully demonstrates that there will be no migration of hazardous constituents from a disposal unit for as long as the waste remains hazardous. Other deadlines cause conditional restrictions on land disposal to take effect if treatment standards have not been promulgated. However, in any case where EPA does not set a treatment standard for a waste by the statutory date, it is not precluded from later promulgating a treatment standard for that waste. Likewise, where EPA has set a treatment standard, it is not precluded from revising that standard after the statutory date through rulemaking procedures. The relevant statutory deadlines are explained in detail in the following units.

1. Solvents and Dioxins

Effective November 8, 1986, the statute prohibits further disposal (except with respect to underground injection into deep injection wells) for the following wastes:

Dioxin-containing hazardous wastes numbered F020, F021, F022, F023, F026, F027, and F028 [1] and solvent-containing hazardous wastes numbered F001, F002, F003, F004, and F005. (RCRA 3004 (e)(1), (e)(2), 42 U.S.C. 6924 (e)(1), (e)(2).)

If EPA fails to set treatment standards for solvents and dioxins by the statutory deadline such wastes are prohibited from land disposal (other than in injection wells, where the applicable statutory deadline is August 8, 1988), other than those wastes and sites for which a petitioner has successfully demonstrated that land disposal is protective of human health and the environment.

2. California List

Effective July 8, 1987 (32 months from November 8, 1984), the statute prohibits disposal (except with respect to underground injection into deep injection wells) for the following wastes, listed or identified under section 3001 [2]:

a. Liquid hazardous wastes, including free liquids associated with any solid or sludge, containing free cyanides at concentrations greater than or equal to 1,000 mg/l.

b. Liquid hazardous wastes, including free liquids associated with any solid or sludge, containing the following metals (or elements) or compounds of these metals (or elements) of concentrations greater than or equal to those specified below:

i. Arsenic and/or compounds (as As) 500 mg/l;

ii. Cadmium and/or compounds (as Cd) 100 mg/l;

iii. Chromium (VI and/or compounds (as Cr VI)) 500 mg/l;

iv. Lead and/or compounds (as Pb) 500 mg/l;

v. Mercury and/or compounds (as Hg) 20 mg/l;

vi. Nickel and/or compounds (as Ni) 134 mg/l;

vii. Selenium and/or compounds (as Se) 100 mg/l;

viii. Thallium and/or compounds (as Th) 130 mg/l.

c. Liquid hazardous wastes having a pH less than or equal to 2.0.

d. Liquid hazardous wastes containing polychlorinated biphenyls (PCBs) at concentrations greater than or equal to 50 ppm.

e. Hazardous wastes containing halogenated organic compounds in total concentration greater than or equal to 1,000 mg/kg. (RCRA section 3004(d)(1) and (2), 42 U.S.C. 6924(d) (1) and (2)).

If EPA fails to set treatment standards for the California List by July 8, 1987, such wastes are prohibited from land disposal at the levels indicated (other than in injection wells, where the applicable statutory deadline is August 8, 1988), other than for those wastes and sites for which a petitioner has successfully demonstrated that land disposal is protective of human health and the environment.

During the period ending November 8, 1988 (48 months from November 8, 1984), disposal of contaminated soil or debris resulting from a response action taken under section 104 or 106 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (Superfund), or a corrective action required under RCRA, is not subject to any land disposal prohibition or treatment standard for solvent- and dioxin-containing wastes and wastes covered by the California List. (RCRA section 3004 (d)(3), (e)(3), 42 U.S.C. 6924 (d)(3), (e)(3)).

Decisions on disposal restrictions for deep well injection of dioxin-containing hazardous wastes, solvent-containing hazardous wastes, and California List wastes must be made no later than August 8, 1988 (45 months from enactment). (RCRA section 3004(f), 42 U.S.C. 6924(f)).

3. Scheduled Wastes

Section 3004(g) of RCRA (42 U.S.C. 6924(g)) also requires the Agency to set a schedule for making land disposal

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[1] As discussed in Unit VI.A.1, the final dioxin rulemaking (50 FR 1978, January 14, 1978) added three more waste codes, F026, F027 and F028. The additional waste codes are a result of a reorganization and do not represent a substantive departure from the proposed rule.

[2] This list is based on regulations developed by the California Department of Health Services for hazardous waste land disposal restrictions in the state of California. Thus it has become known as the "California List."

restriction decisions for all hazardous wastes listed, as of November 8, 1984, under section 3001 which are not referred to under the Units I.B. 1 and 2 headings, "Solvents and Dioxins" and "California List." EPA is required to submit this schedule to Congress by November 8, 1986.

Section 3004(g)(2) (42 U.S.C. 6924(g)(2)) requires that the schedule be based on a ranking of the listed hazardous wastes which considers their intrinsic hazards and their volume such that decisions regarding the land disposal of high volume hazardous wastes with high intrinsic hazard shall be scheduled first and low volume wastes with lower intrinsic hazard shall be scheduled last.

Section 3004(g)(4) (42 U.S.C. 6924(g)(4)) requires EPA to make determinations on land disposal prohibitions within the following time frames:

a. At least one-third of all ranked hazardous wastes by August 8, 1988 (45 months from November 8, 1984).

b. At least two-thirds of all ranked hazardous wastes by June 8, 1989 (55 months from November 8, 1984).

c. For all remaining ranked hazardous wastes and for all hazardous wastes identified by characteristic under section 3001 by May 8, 1990 (66 months from November 8, 1984).

EPA issued the proposed schedule, as published in the **Federal Register** of May 31, 1985 (50 FR 23250), and expects to issue it as a final rule prior to November 8, 1986.

If EPA fails to set treatment standards by the statutory deadline for any hazardous waste in the first-third or second-third of the schedule, such hazardous wastes may be disposed in a landfill or surface impoundment only if the facility is in compliance with the technology requirements set forth in section 3004(o) of RCRA (42 U.S.C. 6924(o)).[3] Moreover, prior to disposal, the generator must certify to the Administrator that he has investigated the availability of treatment capacity and has determined that the use of such landfill or surface impoundment is the only practical alternative to treatment currently available to him. These conditions apply until EPA promulgates regulations establishing treatment standards for the waste concerned. If EPA fails to set treatment standards for any of the scheduled listed wastes by May 8, 1990, all such wastes are prohibited from land disposal unless EPA grants a case-by-case petition.[4]

4. Newly Listed Wastes

The land disposal prohibitions apply to all hazardous wastes identified or listed under section 3001 as of the date of enactment of the HSWA. EPA is required to make land disposal prohibition determinations for any hazardous waste identified or listed under section 3001 after November 8, 1984, within 6 months of the date of identification or listing (RCRA section 3004(g)(4), 42 U.S.C. 6924(g)(4)). The statute does not impose an automatic prohibition if EPA misses a deadline for any newly listed or identified waste.

C. Applicability

1. Scope

Pursuant to section 3004(k) of RCRA, land disposal is defined (for purposes of the land disposal restrictions regulatory program) as including, but not being limited to, any placement of hazardous waste in landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave. Under this statutory definition, waste management techniques considered as storage or treatment are subject to restriction if they involve placement of hazardous waste in or on the land. Thus, the restrictions program applies to units such as "storage" waste piles (including enclosed waste piles), and "storage" or "storage and treatment" surface impoundments. (The legislation does provide a conditional exemption for treatment in surface impoundments, see discussion in Unit I.C.2.) The definition of land disposal is not being limited to placement in the types of units specifically identified in section 3004(k). EPA is proposing specifically to include open detonation and placement in concrete vaults or bunkers intended for disposal purposes as methods of waste management subject to land disposal restrictions. This interpretation is consistent with EPA's existing policy to consider such practices as storage or disposal in the land and is also consistent with the overall intent of Congress in enacting this provision.

The Agency interprets the restrictions on land disposal to apply prospectively, that is, to placement of hazardous wastes in or on the land after the effective date of a restriction. Thus, wastes placed in land disposal units prior to the effective date of a restriction do not have to be removed or exhumed for treatment. Similarly, the Agency interprets the restrictions on storage of prohibited wastes to apply prospectively, i.e., storage restrictions apply only to wastes placed in storage after the effective date of an applicable land disposal restriction. However, if wastes are removed from either storage or a land disposal unit, subsequent placement in or on the land after an applicable effective date would be subject to restriction and treatment requirements. For example, hazardous wastes that were placed in storage in an impoundment or waste pile prior to an applicable effective date that are later removed generally would be banned from subsequent land disposal after the effective date unless the wastes met applicable treatment standards or were the subject of a successful petition. Likewise, waste placed in storage in a tank or container prior to an applicable effective date must meet applicable treatment standards or be the subject of a successful petition before any subsequent land disposal after the effective date.

The regulatory framework and resultant section 3004(m) treatment standards proposed today do not apply to the disposal of hazardous wastes through underground injection wells. Although injection wells are included in the statutory definition of land disposal, Congress established later deadlines and, for some wastes, employed different language, in directing EPA to restrict hazardous wastes from disposal through underground injection wells. Therefore, § 268.1(c) exempts disposal of hazardous wastes in injection wells from the requirements being proposed today. The Agency's plan for addressing restrictions on the disposal of hazardous waste in deep injection wells will be addressed in a later notice.

Under today's proposal, the conditional exemption from the requirements of Parts 262 through 265 for hazardous waste from small quantity generators (see 261.5) would be extended to include these proposed Part 268 requirements. Under existing 261.5, a small quantity generator is one who generates less than 1000 kg of hazardous waste in a calendar month. The conditions of exemption from the requirements of Parts 262 through 265 vary according to the generator's

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[3] In this situation, placement of such wastes in other types of land disposal units (e.g., deep injection wells), would not be precluded by operation of 3004(g)(6)). See Vol. 130 Cong. Rec. S9192 (daily ed. July 25, 1984).

[4] An automatic prohibition is not imposed for hazardous wastes "identified" under section 3001 if EPA misses the May 8, 1990, deadline for setting treatment standards. "Identified" wastes are wastes defined as hazardous because they meet one or more of the general hazardous characteristic tests in 40 CFR 261.21 through 261.24, rather than wastes "listed" as hazardous in 40 CFR 261.30 through 261.33 because they contain one or more specified hazardous constituents. For further discussion of this point, see 50 FR 23252.

generation and accumulation rates and also vary depending upon whether or not the generated waste is an acutely hazardous waste.

[Note.—Acutely hazardous waste are subject to full regulation when generated or accumulated in quantities as little as 1 kg.]

On August 1, 1985, the Agency proposed to redefine, in 261.5, a small quantity generator as one who generates less than 100 kg of hazardous waste in a calendar month. In so doing, the Agency proposed to remove hazardous waste from generators of greater than 100 kg but less than 1000 kg in a calendar month from the conditional exemption from the requirements of Parts 262 through 265 contained in existing 261.5. If, in the final rule, the Agency promulgates the August 1, 1985, proposed redefinition of small quantity generator, hazardous waste from generators of between 100–1000 kg/month will become subject to the Part 268 requirements contained in today's proposal.

2. Exemption for Treatment in Surface Impoundments

The land disposal restrictions arrived at through the regulatory framework proposed today do not apply to wastes that are treated in surface impoundments under certain conditions as indicated in § 268.1(e). Section 3005(j)(11)(B) provides that a waste that would otherwise be prohibited from one or more methods of land disposal nevertheless may be treated in a surface impoundment as long as treatment residues that are hazardous are removed within 1 year of the entry of the waste into the surface impoundment. EPA interprets this provision to apply to both permitted and interim status surface impoundments used for the treatment of wastes.

This provision does not apply to wastes that have already been pretreated in accordance with requirements established under section 3004(m) or exempted from the ban through the petition process. Such wastes would no longer be considered "prohibited" wastes and, accordingly, may be given additional treatment in a surface impoundment without complying with the restrictions imposed by section 3005(j)(11)(B). EPA believes that this interpretation of subparagraph (B) is the only interpretation that is consistent with the language of sections 3004 and 3005 and with the legislative history to section 3005(j)(11). The Agency considered whether subparagraph (B) could be construed to apply additional requirements to wastes that have already been treated by methods or to levels required under section 3004(m). However, section 3004(m)(2) provides that a waste which has been treated in accordance with section 3004(m) is no longer prohibited from land disposal.[5] Therefore, such a waste cannot be deemed to be a "hazardous waste which is prohibited" under section 3005(j)(11)(B).

EPA also considered whether section 3005(j)(11)(B) could be construed to apply to surface impoundments that accept hazardous wastes that have been determined to be protective of human health and the environment when land disposal in accordance with a petition demonstration pursuant to section 3004 (d), (e), or (g). However, like a waste treated under section 3004(m), a waste for which a successful petition demonstration has been made is no longer prohibited from land disposal and therefore could be given additional treatment in the surface impoundment without complying with the restrictions imposed by section 3005(j)(11)(B).[6]

Section 3005(j)(11)(B) applies to wastes that are banned from any method of land disposal, not just disposal in surface impoundments. Thus, if EPA were to ban a waste from disposal in landfills, but not surface impoundments, that waste nevertheless would be prohibited from treatment in a surface impoundment unless the treatment residues that are hazardous were removed within 1 year as required by the statute.

EPA does not construe the language of section 3005(j)(11)(B) requiring removal of "treatment residues which are hazardous" to mean that such residues must be delisted in order to avoid the removal requirement. Rather, the Agency interprets the term "residues which are hazardous" in this context to refer to any fractions of a waste (liquid, semi-solid, or solid) that do not meet treatment standards established under section 3004(m) or that have not been exempted from the ban through the petition process. The Agency interprets "subsequent management" as waste management other than in an impoundment. EPA believes that Congress did not intend for subparagraph (B) to authorize the perpetual management of prohibited wastes in surface impoundments.

Section 3005(j)(11)(B) does not appear to require that treatment impoundments necessarily be drained in order to remove treatment residues. This interpretation is supported by the following quote from the legislative history of the amendments:

> Section 3005(j)(11)(B) "does not apply to those wastes which have been subject to the pretreatment of [sic] detoxification requirements established by the administrator under section 3004(m). Removal of hazardous treatment residues does not necessarily require complete drainage of the impoundment, and in appropriate cases can be carried out by vacuum or mechanical devices which remove concentrated bottom sludges." (Vol. 130 Cong. Rec. S13815 (daily ed. October 5, 1984).)

In the case where the hazardous "residue" is a supernatant liquid, that residue may be removed by pumping. The two general methods available for removing residues with a lower water content are excavation and dredging. The technique used depends upon such variables as surface impoundment design characteristics (e.g., shape, surface area, depth, presence of liner, type of liner), waste characteristics (quantity and type), and accessibility of the impoundment.

Excavation is sometimes used to remove solids, thickened sludges, and other materials that have a low water content. Excavations may be performed using draglines, backhoes, or bulldozers. Excavation techniques are generally more appropriate for small impoundments; and, for some methods, the impoundment must be drained. Excavation is generally more useful for non-acutely hazardous and less aqueous sludges. Some of the excavation methods may pose a greater risk of damaging liners during the removal process than some of the dredging techniques.

Dredging techniques are more commonly used for removal of residues with a higher water content (e.g., liquid, slurry, or semi-solid). These techniques are generally appropriate for all sizes of surface impoundments and can be employed without interrupting the operation of the facility.

Both mechanical and hydraulic dredging techniques are available. Mechanical dredging equipment includes grapple, dipper, and bucket dredges. Grapple dredges are most suitable for removing medium-soft materials. The bucket dredge is an efficient mechanical dredge that employs a continuous work cycle. Hydraulic dredging includes plain suction and cutterhead pipeline dredging. The former is typically used to

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[5] Section 3004(m)(2) states that "if . . . hazardous waste has been treated to the level or by a method specified in regulations under this subsection, such waste or residue thereof shall not be subject to any prohibition promulgated under subsection (d), (e), (f), or (g)."

[6] Section 3004 (d), (e), and (g) provide that if the Administrator accepts a petition demonstration for a waste, he has determined that "the prohibition on . . . land disposal of such waste is not required."

remove soft, free-flowing materials. The cutterhead pipeline dredge is a versatile machine widely used for removing waterbound solids of all types.

In determining the appropriate removal technique, the benefit associated with removing the hazardous residues (i.e., reducing the danger of the waste permeating, corroding, or cracking the liner) must be weighed against the risk of damaging the liner during the removal process. Both compacted clay and synthetic liners are susceptible to damage during dredging or excavation operations. Hydraulic dredging equipment may be less likely to damage liners than dragline dredges (Ref. 60).

EPA is aware that there are additional risks associated with the removal process in the handling and transportation of the hazardous residues. The Agency may issue regulations or guidance at a later date regarding removal requirements such as testing for liner damage after removal of the residues and prohibiting certain types of removal methods. EPA solicits comment on the removal techniques available and the environmental risks associated with the use of these methods.

Section 3005(j)(11)(A) also addresses wastes subject to the restrictions program. Subparagraph (A) provides that if the Administrator "allows" a hazardous waste that is prohibited to be placed in a surface impoundment for storage or treatment, such impoundment must meet the liner and leachate collection system requirements imposed by section 3004(o)(1) unless the impoundment qualifies for certain exemptions. Because the only instance in which a prohibited waste is allowed to be placed in a surface impoundment is in accordance with subparagraph (B), EPA construes subparagraph (A) to impose additional requirements on impoundments that are used to treat prohibited wastes under subparagraph (B). Accordingly, EPA construes this provision to impose an additional condition on the placement of hazardous wastes in surface impoundments under subparagraph (B), i.e., such wastes may not be treated in a surface impoundment unless the impoundment meets section 3004(o)(1) standards. The legislative history to the amendment that added subparagraph (j)(11)(A) to section 3005 confirms that the purpose of the provision was "not to carve out an exemption to the land disposal restrictions . . . but rather to set minimum standards for surface impoundments which the Administrator allows to continue receiving a prohibited waste." (Vol. 129 Cong. Rec. H8140 (daily ed. October 6, 1983) (section-by-section analysis of Breaux amendment).) Thus, unlike subparagraph (B), this provision does not provide a separate exemption from land disposal restrictions.

One apparent problem in interpreting section 3005(j)(11)(A) as applying to impoundments exempted under section 3005(j)(11)(B) is that subparagraph (A) refers to placement in an impoundment for storage or treatment, while subparagraph (B) refers only to treatment in a surface impoundment. EPA believes that by using the term "storage," Congress acknowledged that under the existing RCRA regulatory program, treatment in a surface impoundment always occurs in the context of either storage (the temporary holding of hazardous waste) or disposal (the permanent holding of waste at a facility). See 46 FR 2808 (January 12, 1981).

Subparagraph (A) contains a parenthetical reference stating that it applies to interim status units. This provision would appear to impose more stringent requirements on interim status units than on permitted units. Such a construction runs counter to the general structure of EPA regulations, which provide that permitting requirements be at least as stringent as, if not more stringent than, interim status requirements. Thus, despite the explicit reference to interim status units in subparagraph (A), EPA construes subparagraph (A) to apply to both permitted and interim status surface impoundments. This reading is supported by both EPA's current regulatory structure, as noted previously, and by the legislative history. The amendment that added subparagraph (A) to the legislation also contained retrofitting requirments that were more stringent than the requirements that were finally enacted. See Vol. 129 Cong. Rec. H8136 (daily ed. October 6, 1983). Under the original version of the amendment, any permit issued for a surface impoundment would have required compliance with the minimum technological requirements. All interim status surface impoundments would have been required to be permitted within 4 years. Because all permitted units would have had to comply with the new liner standards, subparagraph (A) needed to cover only interim status units. Thus, in interpreting subparagraph (A) to apply to both permitted and interim status impoundments EPA believes that it will carry out the purposes of the original amendment, which in effect would have provided that all prohibited wastes would go to surface impoundments in compliance with the new liner standards or with specified exemptions.

Section 3005(j)(11)(A) mandates compliance with requirements applicable to new surface impoundments under section 3004(o)(1) unless the requirements of section 3005(j) (2) or (4) are met. Section 3005(j)(2) exempts a surface impoundment from liner and leachate collection system requirements if the impoundment has at least one liner that is not leaking, is located more than one-quarter mile from an underground source of drinking water and is in compliance with certain ground water monitoring requirements. Section 3005(j)(4) similarly exempts surface impoundments for which it is demonstrated that there will be no migration of any hazardous constituent to ground water or surface water at any future time. However, section 3005(j)(11)(A) does not reference two other exemptions found in section 3005(j); i.e., paragraph (j)(3) pertaining to certain wastewater treatment units, and paragraph (j)(13) pertaining to certain impoundments subject to corrective action requirements. Accordingly, an impoundment that is otherwise exempt from the minimum technological requirements under paragraphs (j) (3) or (13) nonetheless would be prohibited from treating restricted wastes under section 3005(j)(11)(B), unless it meets the requirements of section 3004(o).

3. Applicability to Wastes Resulting From Remedial and Response Actions Taken Under the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA)

Wastes resulting from remedial and response actions taken under sections 104 and 106 of CERCLA, when disposed of off-site, are managed at facilities in compliance with all applicable RCRA Subtitle C requirements. When land disposal restrictions go into effect, such facilities may not land dispose hazardous wastes subject to such restrictions unless applicable treatment standards are met, or a successful petition demonstration has been made. Accordingly, CERCLA wastes subject to land disposal restrictions and disposed of off-site must meet applicable treatment standards or be the subject of a successful petition demonstration prior to being land disposed at a RCRA Subtitle C facility. However, RCRA section 3004(d)(3) does provide a limited exception for certain CERCLA wastes. Contaminated soil and debris that would otherwise be subject to land disposal restriction under section

3004(e) (i.e., an F001 through F005 solvent-containing waste or an F021 through F023, F026 or F027 dioxin-containing waste) or section 3004(d) (i.e., a "California List" waste) can nevertheless be land disposed until November 8, 1988.

The CERCLA program will comply with the land disposal restrictions program in managing Superfund waste taken off-site. To the extent that the land disposal restrictions program is applicable or relevant and appropriate to the management of Superfund wastes on-site, the Superfund program will comply with the land disposal restrictions program in a manner that is consistent with the National Contingency Plan (50 FR 47912) and the compliance with other environmental statutes policy (50 FR 47946) contained in the preamble, published in the **Federal Register** on Wednesday, November 20, 1985.

II. Summary of Today's Proposal

EPA today is proposing and requesting public comment on a framework for a regulatory program to implement the land disposal prohibitions mandated by Congress under section 3004 (d), (e), and (g). EPA is also proposing the section 3004(m) treatment standard and associated effective dates for two classes of hazardous wastes: Solvent wastes and dioxin-containing wastes addressed by section 3004(e). (Unless otherwise specifically noted or contextually obvious, "treatment standards" in this preamble refers to RCRA section 3004(m) standards.) EPA used the decision-making framework described in today's proposal to develop these initial sets of proposed treatment standards and associated effective dates. The Agency hopes that its simultaneous proposal of the land disposal restrictions program framework and the initial treatment standards derived therefrom will assist the public in understanding the program's mechanics and its environmental and economic impacts, and serve to focus public comment. It may be desirable in the final rule, however, to separate the decision-making framework from the standards for solvent- and dioxin-containing wastes and issue them as two separate rulemakings.

This unit of the preamble provides a brief summary of the major program components and describes how they are integrated into a regulatory framework. Unit III, following, describes individually, and in greater detail, the development and implementation of each of these components, including descriptions of the various models used by EPA in implementing the program. Detailed mathematical descriptions of these models are provided in this preamble and in background documents available for public examination in the RCRA docket (see ADDRESSES). The proposed treatment standards and associated effective dates derived from this regulatory framework for the initial two classes of hazardous wastes are then presented in Units V and VI.

A. Statutory Prohibitions on Land Disposal and Section 3004(m) Treatment Standards

Section 3004 (d), (e), and (g) automatically prohibits continued land disposal of all listed hazardous wastes beyond specified dates. Each of these subsections, however, provides exceptions to the prohibitions for wastes and treatment residuals that comply with standards to be promulgated by EPA under section 3004(m). Section 3004(m) requires EPA to "promulgate regulations specifying those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste, or substantially reduce the likelihood of migration of hazardous constituents from the waste so that long-term and short-term threats to human health and the environment are minimized."

In addition to providing exceptions for wastes that comply with the treatment standards, section 3004 (d), (e), and (g) also allows the Administrator to determine that the statutory prohibition on one or more methods of land disposal is "not required in order to protect human health and the environment for as long as the waste remains hazardous." However, the Administrator is precluded from determining that a method of land disposal is protective "unless, upon application by an interested person, it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous."

Accordingly, EPA has two primary responsibilities under this statutory scheme:

1. To promulgate exceptions to the statutory prohibitions, in the form of treatment standards ensuring that the long-term and short-term threats to human health and the environment arising from continued land disposal are minimized.

2. To grant exemptions from the statutory prohibitions, through approval of petitions successfully demonstrating that continued land disposal of specific hazardous wastes is protective of human health and the environment.

The Agency also is responsible for establishing variances from and extensions to the statutory effective dates for the land disposal prohibitions, as well as for the implementation of statutory prohibitions on the storage of wastes that are prohibited from land disposal.

Before presenting and describing the entire regulatory and decision-making framework being proposed today, it is necessary to discuss in greater detail one of its central aspects: the establishment of treatment standards. As the following discussion explains, EPA will determine both technology-based levels and screening levels as intermediate steps in establishing a section 3004(m) treatment standard.

The objective of the treatment standards is to minimize the threats to ground water (due to leaching), air (due to emissions), and surface waters (due to leaching) associated with land disposal of hazardous wastes by substantially reducing the toxicity and/or mobility of such wastes prior to placement in land disposal units. The statute specifies that such standards may take the form of prescribed levels or methods of treatment. Treatment standards therefore, may take the form of performance standards governing the nature of quality of wastes or treatment residuals that may be placed in land disposal units. Such performance standards may be expressed as maximum acceptable concentration levels for individual chemical constituents in extracts from wastes (e.g., maximum leachate concentrations), or in the wastes themselves (e.g., maximum waste concentrations). The statute indicates that treatment standard also may take the form of specified treatment methods or treatment chains that must be applied to wastes prior to placement in land disposal units (e.g., incineration of organics; stabilization of metals: precipitation of metals from waste water streams, followed by fixation of precipitate sludges, etc.). The Agency prefers, however, to express treatment standards as performance standards wherever possible because such standards provide greater flexibility to the regulated community in developing and implementing compliance strategies.

Section 3004(m) specifies that treatment standards must "minimize" long- and short-term threats to human health and the environment arising from land disposal of hazardous wastes.

Congress indicated in the legislative history accompanying the HSWAs that "[t]he requisite levels of [sic] methods of treatment established by the Agency should be the best that has been demonstrated to be achievable", noting that the intent is "to require utilization of available technology" and not a "BAT-type process which contemplates technology-forcing standards." (Vol. 130 Cong. Rec. S9178 (daily ed., July 25, 1984).) EPA interprets this legislative history to suggest that Congress considered the "minimize" standard to be met by application of this best demonstrated achievable (or available) technology (BDAT) prior to placement of wastes or treatment residuals into land disposal units. In developing technology-based levels, treatment processes are evaluated based upon the performance of their residuals in the land disposal environment.

Congress acknowledged that current technologies may be incapable of completely eliminating threats arising from the land disposal of certain types of hazardous wastes. The legislative history notes, for example, that "for certain wastes, such as metals and inorganics, there are no practical treatment technologies at this time that permanently eliminate their toxicity." The legislative history specifically suggests that state-of-the-art stabilization techniques would meet the section 3004(m) "minimization" requirements for such wastes, even though such techniques are acknowledged to be less than completely effective in reducing long-term mobility of hazardous constituents.

However, the Agency does not believe that Congress intended all state-of-the-art technology to be deemed appropriate treatment, regardless of its level of performance. In noting that the Administrator shall specify "those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste," Congress clearly implies that a minimum performance standard, in the form of "substantial" reductions in toxicity and/or mobility, must be achieved under the section 3004(m) treatment standards.

EPA is concerned that some treatment technologies, when applied to particular waste streams, may result in significant releases of hazardous constituents to the environment in the process of achieving "substantial" reductions in the waste's toxicity or mobility prior to land disposal. Depending upon their nature and magnitude, the total risks associated with these releases may in fact be greater than the risks associated with land disposal of the waste. Therefore, to ensure that total human health and environmental risks are not increased as a result of EPA's implementation of the statutory land disposal prohibitions, the Agency will conduct risk assessments to compare the risks of managing wastes in land disposal units with the risks of managing wastes in alternative treatment technologies, including any subsequent land disposal of treatment residuals. Treatment technologies that are found through these comparative risk assessments to pose greater total risks than those posed by direct land disposal of the waste will be classified as "unavailable" for purposes of establishing the section 3004(m) treatment standard for that waste.

These comparative risk assessments, described in greater detail in Unit III.C, are not explicitly required under RCRA. The Agency believes, however, that Congress did not intend risks to human health and the environment to be increased in prohibiting the continued land disposal of hazardous wastes. EPA believes that it is desirable, reasonable, and consistent with the intent of Congress to include comparative risk assessments to classify as "unavailable" for purposes of establishing treatment standards those waste/treatment technology combinations that pose greater total risks to human health and the environment than those posed by direct land disposal of the waste. However, the statute does not allow a determination that one or more alternative treatment technologies pose greater risks than land disposal of the waste should not be used as a basis for allowing continued land disposal of the waste. Rather, when these comparative risk assessments identify specific, unacceptable risks for an alternate treatment technology or treatment train, EPA will endeavor to reduce these risks through development and promulgation of additional standards (e.g., air emissions controls). Unfortunately, these additional standards may not be developed by the time the restrictions take effect, thus, requiring that technologies posing risks greater than land disposal be considered "unavailable" for purposes of establishing BDAT Levels. As a result, the universe of candidate technologies for BDAT may be more limited. In addition, since technologies ruled out because of risk may be more efficient than other candidate technologies, the remaining technologies on which the BDAT treatment standard is based may allow greater concentrations of hazardous constituents in the residuals going to land disposal.

The Agency may also prohibit the use of technologies found to be riskier than land disposal. However, these prohibitions may not be effective prior to the effective date of ban restrictions. In cases where additional standards or prohibitions for riskier technologies are not promulgated prior to a restriction effective date, such technologies may be used to meet concentration levels set under section 3004(m) even though these technologies did not form the bases for selecting such levels. In an effort to avoid this result, EPA will attempt to regulate riskier technolgies prior to the ban effective date whenever possible.

In addition to developing technology-based levels, EPA will invoke the authority of section 3004(m) to establish screening levels. A screening level will be developed for each individual hazardous constituent and will identify the maximum concentration below which the Agency believes there is no regulatory concern for the land disposal program and which is protective of human health and the environment. The methodology used in establishing these levels is described in detail in Unit III. These screening levels will serve three major functions.

First, the screening level, or concentration level, will be used to avoid "excessive" treatment. In some cases, available technologies may be capable of achieving greater reductions in toxicity and/or constituent mobility than are actually necessary to provide protection of human health and the environment in subsequent land disposal of hazardous wastes. The Agency does not believe that Congress intended that EPA promulgate standards requiring treatment for treatment's sake (i.e., requiring more treatment than necessary to protect human health and the environment). Accordingly, in order to avoid setting treatment standards that require excessive treatment prior to land disposal, EPA in some cases will employ the screening levels thresholds to "cap" the reductions in toxicity and/or mobility that otherwise would result from the application of BDAT treatment, even though the efficiencies of available technologies may be capable of achieving more stringent levels (i.e., the levels will provide an upper limit on the stringency of the treatment standard). In the situation described above, the screening level would become the regulatory treatment standard since there would be no need, from environmental or human health perspectives, to set a more stringent standard.

Second, in some cases, while the application of BDAT will result in substantial reductions in toxicity and mobility, available technologies may not be able to achieve concentration levels that provide full protection of human health (i.e., the screening levels). Although the statute specifies that compliance with technology-based standards is legally sufficient in such a situation, the Agency believes that the screening levels should function as a goal for future changes to the treatment standards as new and more efficient treatment technologies become available. In this second situation, the screening levels identify constituent concentrations that are desird in land disposal in the long term, but which are not actually required in the short term due to limitations in technological capacities.

Finally, in certain circumstances, EPA may conclude that no candidate treatment technologies provide the "substantial" reductions in toxicity or mobility required under section 3004(m); or, that all candidate treatment technologies pose greater total risks than land disposal. Accordingly, the Agency would determine that there are no treatment technologies "available" upon which to base the treatment standard, because even the best demonstrated treatment technologies do not provide sufficient safeguards against the threats posed by land disposal or because application of treatment technologies would increase overall risks to human health and the environment. In such cases, the screening level will become the treatment standard, providing at least for land disposal of wastes containing constituents at concentrations determined to be protective of human health and the environment.

The development and use of these screening levels is not required explicitly under any of the amendments to section 3004 enacted through the HSWAs. EPA believes, however, that the development and application of such standards is reasonable and desirable from both environmental and economic perspectives. Economically, inclusion of these protective caps ensures that limited resources (natural resources as well as financial resources) are not expended needlessly in meeting treatment standards in excess of what is required to protect human health and the environment in the land disposal of hazardous wastes. In addition, since the screening level standard functions effectively as an alternative to the petition process (i.e., constituents that meet the screening levels naturally are exempted from treatment without going through the petition process) the Agency expects to realize internal savings by minimizing the costly and administratively burdensome petition review process. From an environmental perspective, EPA's efforts in developing the screening levels will identify those situations where even BDAT treatment cannot achieve protection of human health and the environment, and will provide goals in such cases for future technology development. Finally, EPA believes it is desirable to employ the screening levels as the treatment standards in cases where no treatment standard would otherwise be established (e.g., in cases where all treatment technologies are riskier than land disposal or when even the best demonstrated treatment technology does not provide substantial reductions in toxicity or mobility). If no treatment standard is promulgated for a waste, the waste and all residuals from treatment of the waste are completely prohibited from land disposal (unless, of course, EPA approves petitions for continued land disposal or applications for effective date extensions). By employing the levels as treatment standards in such cases, EPA avoids forcing all those seeking continued land disposal to submit petitions. Instead, those forms of waste (e.g., contaminated soils resulting from spills or cleanup actions under CERCLA; waste waters containing small concentrations of hazardous constituents; etc.) that meet the screening level constituent concentration levels may continue to be disposed of in or on the land because such disposal will not harm human health or the environment.

The relationship of the technology-based standards and the screening levels can be summarized briefly as follows. If application of BDAT treatment results in concentration levels equal to or more stringent than the screening levels, then the Agency will issue the screening level as the treatment standard, capping off required BDAT treatment at these protection levels. If application of BDAT treatment results in levels that are less stringent than the screening level, but BDAT does realize substantial reductions in toxicity or mobility and does not pose greater risks than land disposal, then the technology-based level becomes the treatment standard and the screening level remains as a goal that may be reached as new technologies emerge. If no technologies exist that result in substantial reductions in toxicity or mobility or if all treatment technologies pose greater risks than land disposal, then EPA will not be able to specify a technology-based level and the screening level becomes the treatment standard.

It is important to note that any waste naturally meeting the treatment levels (i.e., without actually undergoing treatment) would be, under the proposed approach, exempted from the ban. There would appear to be little rationale for allowing a waste treated to those levels to be exempted from the ban, while not exempting a waste that naturally contains acceptable levels so that treatment is not required to comply with the standard. Moreover, the language of section 3004(m) appears to support this conclusion. Section 3004(m) directs EPA to specify "those levels or methods of treatment, if any," required to substantially diminish toxicity or reduce mobility. The "if any" clause indicates that EPA may identify cases where no treatment is required to meet the standard; i.e., cases in which the standard can be met without application of technology. Accordingly, EPA is proposing to exempt from the land disposal prohibitions any waste treated to meet the applicable section 3004(m) standard, or meeting such standard without treatment.

In summary, in setting the effective concentration limits that govern the quality of land disposed wastes, the Agency will consider a set of relevant factors. The screening level is based on individual risk—the first factor. The strength of evidence for carcinogenicity is part of the individual risk assessment (see Unit III. A. 1.e). The performance of treatment technologies, alone and in relation to the screening levels has major influence on the chosen effective concentration limits. For example, when a treatment substantially reduces the concentration of a constituent in a waste, but does not attain the screening level the treatment performance will become the effective control level. Population risk will be added as a factor if the Agency can develop a method of using available population data. A possible approach is described in unit III. A. 1. i.

The Agency believes that the development of nationally applicable screening levels best implements its stated objectives of capping off necessary treatment, providing a goal for the development of emerging technologies and future treatment standards, and providing a concentration-based standard under section 3004(m) in cases where a technology-based treatment level is not developed. In general, however, the same objectives could be realized in the absence of national screening levels.

Accordingly, EPA may consider two alternative approaches.

The first alternative does not provide for the development of screening levels but instead relies entirely on technology-based treatment section standards and the petition process. Under a regulatory framework that provided only for the development of technology-based (BDAT) treatment standards (as opposed to screening levels and technology-based standards), the petition process could serve to "cap off" the required level of treatment so as to avoid treatment for treatment's sake. Under this approach, if a prescribed level or method of treatment under section 3004(m) resulted in concentration levels that an owner/operator believed to be overly protective, the owner/operator could petition the Agency to allow the use of an alternative treatment level or method or no treatment at all by demonstrating that less treatment would still meet the petition standard of protecting human health and the environment.

A second major function of the national screening level is to provide a section 3004(m) standard in cases where EPA is unable to develop a technology-based standard because BDAT has not been identified. As noted earlier, the benefit of this approach is that instead of banning a waste outright because there is no technology available to treat to acceptable levels, a waste may still be land disposed if it can meet the protective screening level naturally. However, this same function could be fulfilled by the petition process. Under the above scenario, if EPA fails to issue a treatment standard under section 3004(m), an owner/operator could still petition the Agency under § 268.5 to allow continued land disposal of the waste upon a demonstration that land disposal of the waste would not result in harm to human health and the environment.

There is no need to develop regulatory screening levels to meet the last major function of such nationally applicable levels i.e., the development of hazardous constituent concentration goals towards which emerging technologies can strive. This goal could be met by the development of screening levels in a non-regulatory context.

The major drawback of this first alternative however, is that it would increase the number of petitions received by the Agency. Pending determinations on individual petitions, wastes will be restricted from land disposal.

The Agency is also considering a second alternative to the approach outlined today. As noted in earlier discussions, EPA believes that it has authority under section 3004(m) to give screening levels regulatory effect in two situations. First, in cases where technology is capable of meeting or exceeding the screening level this protective concentration level becomes the regulatory standard under section 3004(m), effectively "capping off" the application of technology to avoid treatment in excess of that needed to protect human health and the environment. Second, the screening level also will have regulatory effect in cases where all candidate technologies are riskier than land disposal or where EPA is unable to identify a technology that substantially reduces the toxicity and diminishes the mobility of a constituent. In such cases, the screening level essentially becomes the section 3004(m) standard by default, i.e., because no acceptable technology has been identified upon which to base a treatment standard.

This second alternative approach would base the treatment standards established under section 3004(m) only on levels capable of being achieved by the application of BDAT technology. Under such an approach EPA would continue to use screening levels to cap off the use of technology, but would not establish the screening level as the treatment standard when no acceptable technology has been identified. If EPA were unable to identify a technology that substantially reduces the toxicity and mobility of hazardous constituents or if all technologies are riskier than land disposal, then the Agency would not set a section 3004(m) standard. In such a case, a waste banned from land disposal could be disposed of in land only if it is the subject of a successful petition demonstration under section 3004(d), (e), or (g).

The petition demonstration requires a showing that the hazardous constituents in a waste will not migrate to a point of potential human or environmental exposure in concentrations that will harm human health or the environment (see Unit III.G). As discussed in Unit III.A, the screening model will identify a maximum protective concentration level for each hazardous constituent. Accordingly, under this approach if a petitioner could show that all of the hazardous constituents in his waste are at concentrations equal to or less than the concentration established by the screening model, EPA may determine that land disposal of such a waste is protective. With this approach, the Agency could develop a simplified petition process to address such cases. The simplified petition would consist of a petitioner's certification, with supporting analytical data, that all hazardous constituents in the waste meet applicable screening levels.

EPA solicits public comment on its approach to developing treatment standards. The Agency is particularly interested in the public's views on the desirability of developing screening levels in addition to technology-based standards. In addition, EPA would welcome information indicating which wastes (and what physical states and what quantities) could be expected to meet the screening levels proposed today without treatment. To what extent does the regulated community believe that it will rely on compliance with screening levels to exclude waste from the restrictions in lieu of petitioning for an exclusion? (screening levels for certain solvents are identified in unit V.) The screening levels ensure protection of human health and the environment considering all significant routes of exposure. How will the establishment of these safe levels for all hazardous constituents affect other programs administered by EPA or other agencies?

Under certain circumstances, anticipated by EPA to occur extremely infrequently or not at all, the Agency may decide not to establish any treatment standard under section 3004(m). This situation would arise in cases where EPA has determined that all applicable treatment standard for a hazardous waste (either due to their failure to achieve "substantial" reductions in the waste's toxicity or mobility, or due to EPA's determination that they pose greater risks than those posed by land disposal) and where the Agency is unable to develop screening levels. Since the screening levels identify levels at which land disposal may be determined to be protective of human health and the environment, the Agency would not be able to establish them if, for example, critical data elements upon which calculation of these levels depends are absent or are of insufficient quality. In such a case, EPA will promulgate regulations that certify the statutory prohibition. Generators or facility owners or operators desiring to continue managing the waste in land disposal units will be required, in such cases, to submit petitions to EPA demonstrating such management to be "protective" of human health and the environment at specific facilities, as discussed in greater detail in subsequent units of this preamble.

B. Regulatory and Decision-Making Framework

The regulatory and decision-making framework that EPA is proposing to employ in establishing the section 3004(m) treatment standards and their associated effective dates is presented in schematic form in the following Diagram 1:

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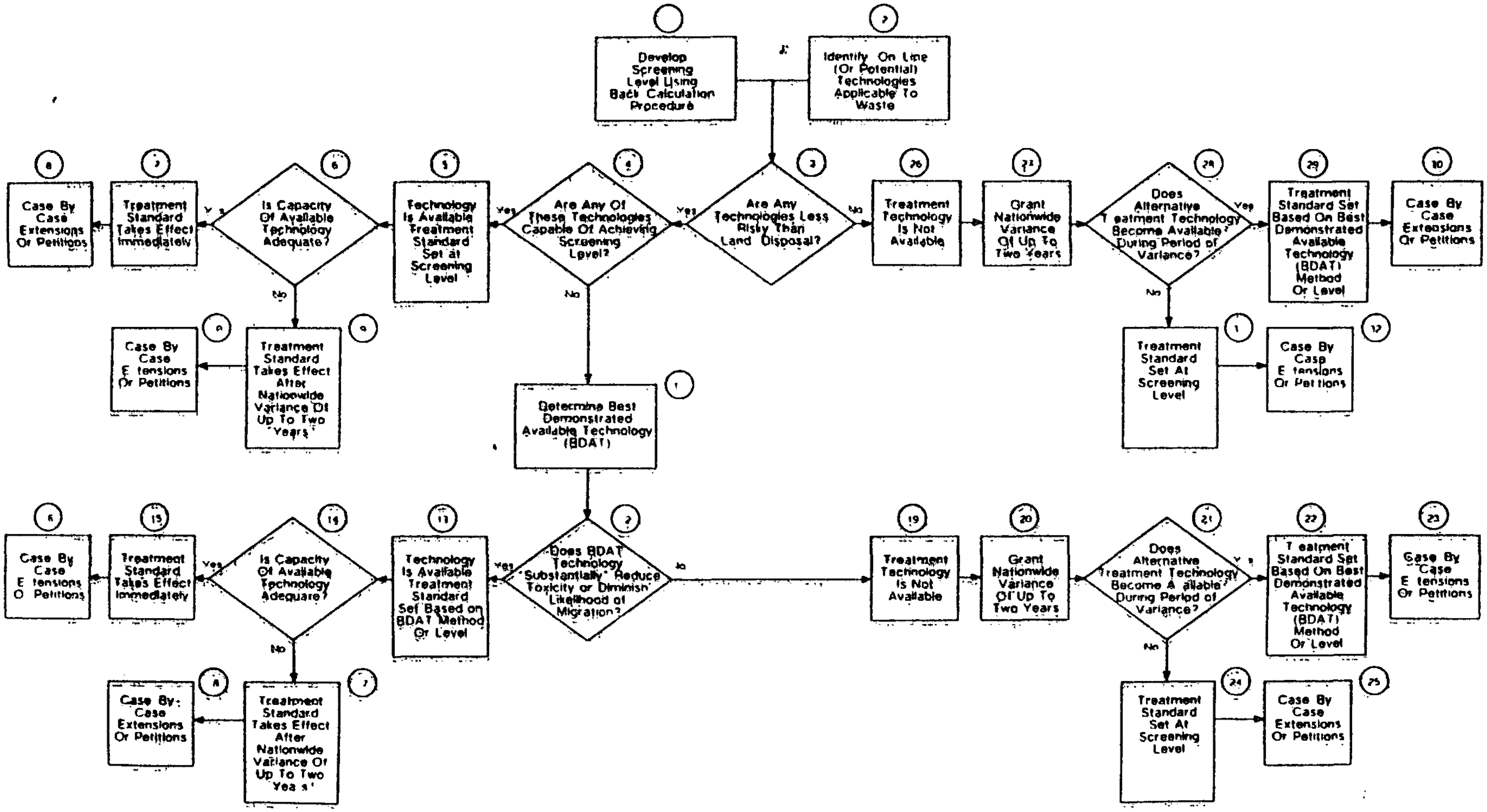
DIAGRAM 1

SCHEMATIC DIAGRAM OF EPA s PROPOSED FRAMEWORK FOR THE RCRA LAND DISPOSAL RESTRICTIONS PROGRAM



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[1] Nationwide Variance granted only if alternative recovery and disposal capacity also inadequate

[2] Alternative Treatment Technology must be less risky than land disposal and must either achieve health based threshold or substantially reduce toxicity and diminished likelihood of migration

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By each statutory deadline, the Agency will employ the proposed framework in promulgating treatment standards under § Part 268 Subpart D applicable to each hazardous waste. Once such standards are effective, hazardous wastes that comply with these treatment standards are exempted from the statutory prohibitions, and may be managed in land disposal units regulated under Subtitle C of RCRA. Wastes that do not comply with applicable treatment standards will be prohibited from continued placement in land disposal units as of the applicable effective date, unless the generator or owner or operator of a treatment, storage, and disposal facility does either of the following:

1. Under § 268.4 submits a successful application to EPA for an extension of time in which to comply with the treatment standard by demonstrating that he has binding contractual commitments to construct or otherwise obtain alternative treatment, recovery, or disposal capacity that is protective of human health and the environment, and that such capacity is not available by the date the treatment standard takes effect due to circumstances beyond his control (see Unit III.F).

2. Under § 268.5, submits a petition to EPA successfully demonstrating to a reasonable degree of certainty that continued management of specific hazardous wastes in land disposal units, including treatment and storage in surface impoundments and waste piles, is protective of human health and the environment for as long as the wastes remain hazardous (see Unit III.G).

The decision-making framework is preceded by two sets of Agency activities that occur simultaneously but are entirely independent of each other, indicated as Elements 1 and 2 at the top center of Diagram 1. Element 1 involves the development of the screening levels, or caps, for individual hazardous constituents contained in hazardous wastes. These screening levels identify the concentration levels of such constituents in hazardous wastes or waste extracts (e.g., leachates, emissions, etc.) at or below which continued land disposal is determined to be protective of human health and the environment. Element 2 incorporates the Agency's efforts to identify and evaluate the effectiveness of treatment technologies applicable to specific types of hazardous constituents, individual hazardous wastes, or groups of hazardous wastes exhibiting similar chemical and physical properties affecting their "treatability" (i.e., treatability subgroup). As noted in the previous unit, "effectiveness," for purposes of section 3004(m) treatment standards, refers to the technology's ability to diminish the toxicity of a hazardous waste or reduce the likeihood of migration of hazardous constituents from the waste to air, ground water, or surface waters.

In order to develop the screening levels, which identify levels in land disposal that can be deemed protective of human health, the term "protective" requires specific definition. Congress provided an explicit definition of "protective" for purposes of the land disposal restrictions program in specifying the standard for the petition process established in section 3004 (d), (e), and (g): "a method of land disposal may not be determined to be protective of human health and the environment for a hazardous waste unless, upon application by an interested person, it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous." EPA is using this statutory definition of "protective" for purposes of developing the screening levels. The Agency considered adopting a separate definition of the term "protective" for purposes of developing the thresholds, but concluded that standards less stringent than the petition standard could not be defended as "protective," given the clear statutory language.

EPA is not reading the statutory definition of "protective" as an absolute no migration standard. (See discussion of petition process in Unit III.G.) The Agency finds significance in Congress' inclusion of the clause "for as long as the wastes remain hazardous" as a modifier to what otherwise would have been a strict no migration standard, i.e., "no migration of hazardous constituents from the disposal unit." The Agency is today proposing under § 268.5 to interpret inclusion of this modifying clause as implying that the statutory standard allows for some migration of hazardous constituents beyond the immediate confines of the disposal unit, as long as such migration does not present any threat to human health and the environment. Support for this interpretation is provided in the legislative history, where Congress noted: "[t]he Administrator is required to find that the nature of the facility and the waste will assure that migration of the wastes will not occur while the wastes still retain their hazardous characteristics in such a way that would present any threat to human health and the environment" (S. Rep. No. 98-284, 98th Conf., 1st Sess. 15 (1983)). Accordingly, EPA is proposing to develop the screening levels, identifying "protective" levels in land disposal, using a conceptual system that allows migration of hazardous constituents beyond disposal units but ensures that such migration occurs at concentrations that do not pose threats to human health and the environment.

Screening levels are calculated for individual hazardous constituents based upon toxicological effects levels for these constituents and their behavior (fate and transport) in each of three environmental media: Air, ground water, and surface water. The levels are expressed as maximum concentration levels in extracts from hazardous wastes that may be released from land disposal units. The screening levels and their derivation are discussed in detail in Unit III of this preamble.

The quantitative procedures developed by EPA to calculate these levels involve the use of constituent fate and transport models (separate models are employed for transport through air, ground water, and surface water). The models are designed to assess the attenuative processes (e.g., advection, diffusion, dilution, and dispersion, chemical transformation or degradation) that occur during transport (migration) of contaminants from the point of their release from a land disposal unit (in subsurface leachates, surface run offs, or air emissions) to points of potential human exposure at a specified distance downwind, downgradient, or downstream from the disposal unit. The models are employed to back calculate the maximum constituent concentration that could be present in a hazardous waste extract (e.g., leachate, surface, runoff, or air emission) directly above, below, or adjacent to a land disposal unit such that its concentration (in air, ground water, or surface water) at the point of potential human exposure would not be expected to exceed a designated human health effect level for the contaminant (health effects levels are apportioned into each media through which exposure may occur).

The following Figure 2 illustrates the conceptual system that underlies EPA's proposed approach to back calculating the screening levels, using the ground water component as an example:

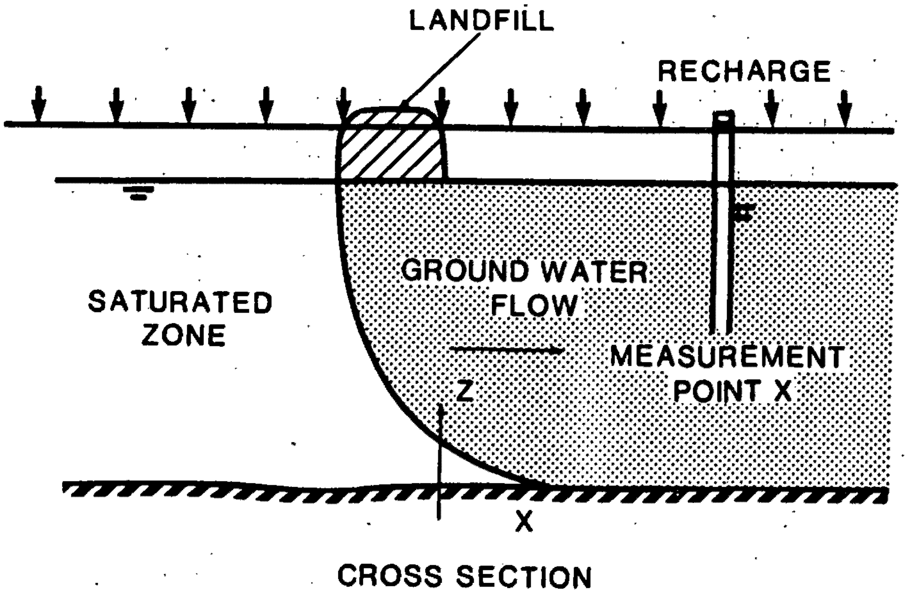

Figure 2: Cross Section of Conceptual System for Developing Screening Levels

The conceptual systems for air and surface water calculations are similar, though tailored to the specific characteristics of these other media and are presented in Unit III of this preamble. The ground water back calculation procedure commences from a point of potential human exposure at a specified distance directly downgradient from the unit, and specifies that the concentration of a contaminant in the ground water at this point cannot exceed the apportioned health effect level. Defining the "point of potential human exposure" and selecting a corresponding distance from the disposal unit to this point are tied to the statutory definition of "protective," and are discussed in Unit III.

The procedure then uses fate and transport models to determine (by back calculation) the concentration of the chemical constituent that may be present in a leachate emanating directly below the disposal unit without exceeding its apportioned health effect level at the point of potential exposure.

Simultaneously with establishing screening levels, the Agency will identify and evaluate treatment technologies that are applicable to the hazardous wastes included under each deadline (Element 2 in the flow diagram). Technologies to be identified and evaluated include those at commercial facilities or on-site facilities that have been "demonstrated" to treat these hazardous wastes and are deemed to be "available." [7] The process encompassed by Element 2 also includes the assessment of emerging treatment technologies that are expected to be on-line by the date the treatment standards take effect.

The purpose of the technology evaluations is to identify demonstrated, available treatment technologies for each hazardous constituent, waste, or groups of hazardous wastes with similar treatability characteristics. Key aspects of these evaluations, discussed in greater detail in Unit III, are:

a. Evaluations of the applicability of treatment technologies to specific hazardous constituents, waste streams, or groups of wastes.

b. Evaluations of the extent to which each technology is actually being used in the treatment of hazardous wastes, both at off-site commercial facilities and at on-site facilities.

c. Evaluations of the effectiveness of each technology in reducing the toxicity and mobility of hazardous constituents in wastes or groups of wastes included under each statutory deadline.

It is important to note that cost is not one of the factors that EPA will use explicitly in evaluating treatment technologies as a basis for setting the treatment standards. Cost is, however, implicitly accounted for in setting BDAT standards, since technologies that are not economically feasible are not likely to be found "on-line" at commercial or on-site facilities.

The proposed regulatory and decision-making framework is composed of four major decision-making sequences. Each decision-making sequence leads to establishment of a treatment standard (and an associated nationwide effective date) applicable to a hazardous waste, groups of hazardous wastes exhibiting similar treatability characteristics, or hazardous constituents contained in hazardous wastes.

For each waste, that is, a specific waste stream, hazardous constituent or waste subgroup, the first step in EPA's proposed decision-making framework is to exclude from consideration as a basis for the treatment standard those treatment technologies that pose greater total risks to human health and the environment in the management of the waste than the risks posed by direct land disposal (Element 3). As noted previously, to ensure that total human health and environmental risks are not increased as a result of EPA's implementation of the statutory land disposal prohibitions, the Agency will conduct risk assessments to compare the risks of managing wastes in land disposal units with the risks of managing the wastes in alternative treatment technologies, including subsequent land disposal of any treatment residuals. Treatment technologies that are found through these comparative risk assessments to pose greater total risks than those posed by direct land disposal of the untreated waste will be classified as "unavailable" for purposes of establishing the treatment standard for that waste. Thus, this sets the first "break point" in the decision process. The four decision cases, in the order of their discussion, are cases in which the demonstrated treatment technology poses one of the following:

i. Equal or less risk than land disposal and meets the screening level.

ii. Equal or less risk than land disposal and does not meet the

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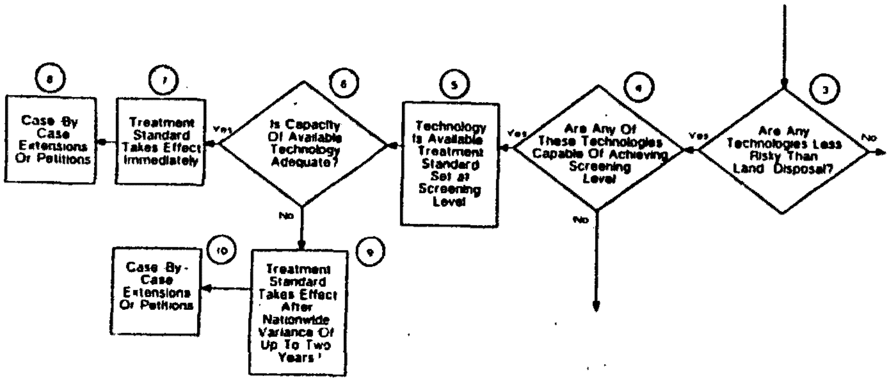
[7] The terms "demonstrated" and "available" are defined in Unit III.B. As used here, the term "available" means non-proprietary. The assessment of "availability" in terms of comparative risk takes place in Element 3. The assessment of "availability" in terms of meeting the substantial reduction test takes place in Element 12.

screening level, but does substantially reduce the waste's toxicity or mobility.

iii. Equal or less risk than land disposal, does not meet the screening level, and does not substantially reduce the wastes toxicity or mobility.

iv. Greater risk than land disposal.

Decision Case I—*Alternative technology poses equal or less risk than land disposal and can meet the screening levels.*



Three sequences in EPA's proposed decision-making framework commence with an affirmative response in the first critical decision component where, upon completion of the comparative risk assessments, treatment technologies or treatment trains are identified that pose risks less than or equal to those posed in direct land disposal of the waste. These sequences advance to the second critical decision component in the proposed decision-making framework, where the next question is posed (Element 4): are any of these treatment technologies or treatment trains capable of achieving the "screening" levels for all of the constituents known to be contained in the waste? For those waste streams where the answer to this question is "yes," the decision-making sequence proceeds with EPA's determination that treatment technology is "available" for such wastes and the "screening" levels are established as the section 3004(m) treatment standards for each hazardous constituent in each such waste stream (Element 5).

Once this treatment standard is established, the next step in this decision-making sequence is to determine whether the capacity of these "available" treatment technologies,[8] in conjunction with the capacities of alternative recovery and disposal technologies that are protective of human health and the environment, is adequate to accommodate the quantities of each waste subject to these threshold standards (Element 6). Capacity will be determined on a national, as opposed to a regional or State, basis and will consider capacities of currently demonstrated on-line technologies as well as capacities of technologies that are expected to be on-line by the statutory deadline for each waste.

For those wastes where EPA determines that alternative capacity is adequate, the "screening" level treatment standards will take effect immediately upon their promulgation (Element 7). Since, under this decision-making sequence, the standards are always expressed as performance standards (as opposed to required methods), generators and facility owners or operators whose wastes do not meet the standards naturally may employ any treatment technologies in achieving them.[9] As is the case at the end of each decision-making sequence, wastes that comply with applicable treatment standards may be managed subsequently in land disposal units, while wastes that do not comply with the standards are prohibited from continued land disposal upon the statutory effective dates unless generators of such wastes or owners or operators of land disposal units either submit applications for case-by-case effective date extensions under § 268.4, (which, if granted, will allow land disposal to continue temporarily under certain conditions), or submit petitions under § 268.5 successfully demonstrating that continued land disposal of the wastes is protective of human health and the environment for as long as the wastes remain hazardous (Element 8). Specific procedures and criteria to be employed by EPA in accepting and evaluating applications for section 3004(h)(3) case-by-case effective date extensions and petitions submitted under sections 3004(d), (e), and (g) are discussed in Unit III.

For those wastes where EPA determines in Element 6 that alternative capacity is not adequate on a nationwide basis, the Agency may exercise the discretion granted to it under section 3004(h)(2) and authorize a nationwide variance of up to 2 years from the statutory effective date (Element 9). The purpose of granting national variances in Element 9 is to provide time for development of additional treatment, recovery, or disposal capacity that is protective of human health and the environment. At the end of the national variance, the section 3004(m) treatment standard takes effect. Again, case-by-case extensions and petitions are available,

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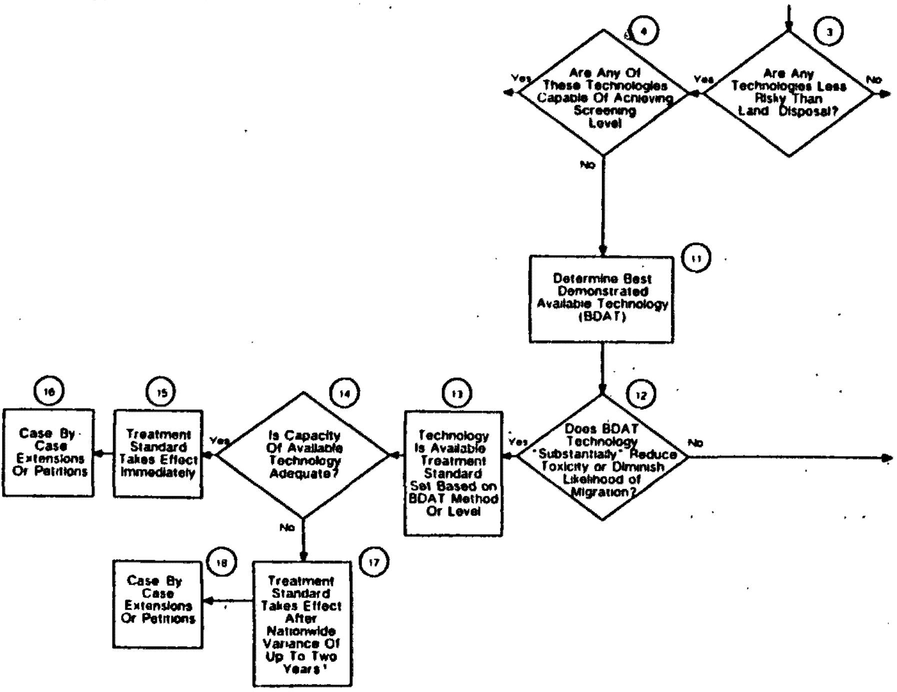
[8] Note that treatment processes that are not deemed "available" for the purpose of establishing BDAT levels because they are proprietary are considered in determining whether there is adequate treatment capacity.

[9] As noted earlier EPA plans to impose restrictions or prohibitions on treatment technologies that are riskier than land disposal. See also discussion at Unit III.C. Such restrictions or prohibitions may preclude or limit the use of certain technologies in meeting these standards.

subject to EPA approval, for those who cannot meet the standard (Element 10).

Decision Case II—Alternative technology poses equal or less risk than land disposal, does not meet the screening levels, but does substantially reduce toxicity or diminish mobility.



This sequence in EPA's proposed decision-making framework also commences from a favorable evaluation of the comparative risk assessments (Element 3). However, it (and the next sequence) subsequently proceed from a determination that none of the treatment technologies or treatment trains is capable of achieving the "screening" level for the hazardous constituent being evaluated or, where the evaluation pertains to a waste stream, for all hazardous constituents known to be contained in the waste. The next step in the proposed decision-making framework is to determine which of the treatment technologies or treatment trains is the "best" demonstrated treatment technology for the waste, based upon a ranking of the technologies' effectiveness in diminishing the waste's toxicity or in reducing the likelihood of migration of hazardous constituents (Element 11).

Once the "best" treatment technology or train for the waste is identified, the sequence advances tothe next critical decision component in the proposed decision-making framework, where EPA determines whether or not this "best" demonstrated treatment technology or treatment train "substantially" diminishes the waste's toxicity or "substantially" reduces the likelihood of migration of its hazardous constituents (Element 12). If EPA determines that the "best" demonstrated treatment technology does achieve substantial reductions, EPA concludes that alternative treatment technology is "available" for the waste, and establishes a BDAT treatment standard (Element 13).

As noted in Unit II.B, whenever the section 3004(m) standards are based upon the effectiveness of BDAT, they may be expressed either as performance standards or required methods. If, for example, incineration is determined to be the BDAT for the waste, the treatment standard may simply require that the waste be incinerated (according to specified design and operating standards) prior to its placement in land disposal units. Alternatively, in the same example, the treatment standard may specify maximum concentration levels for each of the waste's constituents in either an extract from the waste or in the waste itself based upon the expected efficiency of incineration. In this latter case, generators or facility owners or operators would have a certain degree of flexibility in selecting technologies to comply with the standard. While EPA prefers to provide such flexibility wherever possible, the Agency recognizes that it may not always be possible to specify performance standards, due to wide variations in waste characteristics.

Once the BDAT treatment standard is established, the next step in this decision-making sequence is to determine whether the capacity of alternative treatment, recovery, and disposal technologies that are protective of human health and the environment is adequate to accommodate the quantities of each waste subject to these standards (Element 14). These capacity assessments are similar to those described in Element 6 under the earlier decision case.

However, in the previous decision pathway, the BDAT technologies were capable of meeting the screening level and, accordingly, would be deemed protective of human health. In contrast, under this decision pathway, none of the technologies is capable of achieving the screening levels. The statute directs EPA to consider only those technologies that are protective of human health and the environment in evaluating whether sufficient capacity exists to accommodate banned wastes. Accordingly, those technologies that are not capable of achieving the screening level would not be considered in the capacity assessment. If EPA finds that no alternate treatment capacity exists that is protective of human health and the environment, and if it also finds that no protective alternative disposal or recovery capacity exists, it may, at its discretion, extend the effective date of a restriction for up to 2 years under section 3004(h)(2).

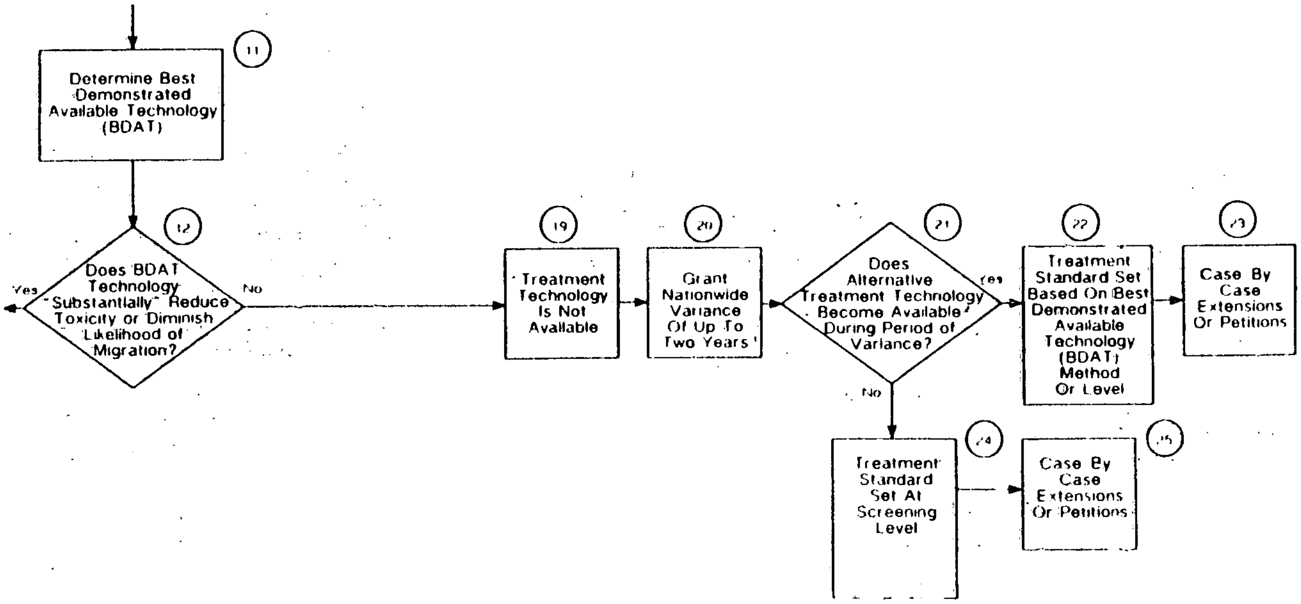
However, as a matter of policy, EPA will exercise its discretionary authority not to extend the effective date in cases where there is a shortfall in protective treatment, disposal, and recovery capacity if it determines in such cases that existing "protective" capacity, coupled with existing capacity of treatment technologies that meet technology-based section 3004(m) standards, is adequate to address the restricted wastes.

The Agency believes that this approach is consistent with congressional intent. The section 3004(h)(2) variance is intended to encourage the development of protective alternative treatment, recovery and disposal capacity. (S. Rep. No. 98–284, 98th Cong., 1st Sess. 18 (1983), H.R. Rep. No. 98–198, 98th Cong., 1st Sess. 37 (1983)).

However, the regulated community will have little incentive to develop protective alternative treatment methods during the variance period in light of the fact that, at the end of any such variance, hazardous waste may be land disposed if the wastes comply with less protective technology-based standards. In such a case, the effect of the variance would simply be to delay compliance with these technology-based standards and not, as Congress intended, to encourage the development of protective alternative technologies.

The remaining stages of this decision-making sequence are identical to those described under the earlier sequence: If a variance is not granted, the BDAT standards takes effect immediately (Element 15), and wastes that comply with them may be managed subsequently in land disposal units. Wastes that do not comply with the standards will be prohibited from continued land disposal unless generators or facility owners or operators have been granted case-by-case effective date extensions or have successfully demonstrated that continued land disposal of the wastes is protective of human health and the environment through the petition process (Element 16). The Agency may also exercise its discretion under section 3004(h)(2) to grant a nationwide variance of up to 2 years from the statutory effective date if capacity is not adequate (Element 17). At the end of the national variance, the treatment standard takes effect, with identical regulatory outcomes to those that occur under this sequence in the absence of a national variance (Element 18).

Decision Case III—Alternative technology poses equal or less risk than land disposal, cannot meet the screening levels, and does not substantially reduce toxicity or diminish mobility.



The third case in EPA's proposed decision-making framework follows a negative response in the third critical decision component (Element 12), where after identification of the "best" demonstrated treatment technology (Element 11), it is determined that technology does not "substantially" diminish the waste's toxicity or "substantially" reduce the likelihood of migration of its hazardous constituents. A treatment technology that does not meet this statutory standard is "unavailable" for purposes of establishing section 3004 (m) treatment standards (Element 19). If protective disposal or recovery capacity is also unavailable, EPA may grant a nationwide variance for up to 2 years under section 3004 (h) (2) (Element 20) to allow for the development of new or improved treatment technologies or treatment trains that meet the minimum requirements of section 3004 (m) for achieving "substantial" reductions in the waste's toxicity or mobility.

If new or improved treatment technologies or treatment trains that meet the minimum requirements of section 3004 (m) are developed by the end of the national variance (Element 21), EPA may utilize them as the basis for promulgating a BDAT treatment standard (Element 22), expressed either as a performance standard or as a required treatment method. Wastes that comply with such standards may be managed subsequently in land disposal units. Wastes that do not comply with the standards will be prohibited from continued land disposal unless a case-by-case effective date extension is granted under § 268.4 or a petitioner has successfully demonstrated that continued land disposal of the wastes at a specific site is protective of human health and the environment under § 268.5 (Element 23).

If new or improved treatment technologies or treatment trains applicable to wastes affected by this decision-making sequence do not develop during the period of the national variance, EPA will establish the screening level as the treatment standard (Element 24). For most generators of wastes affected by this decision-making sequence, the regulatory outcome resulting from this action is not anticipated to be significantly different from the regulatory outcome resulting from direct implementation of the statutory prohibitions. Even though a treatment standard will have been established for the waste, EPA will have determined that there are no technologies that are less risky than land land disposal that are available to treat the waste. Except for wastes that naturally meet the screening level, all hazardous wastes affected by this decision-making sequence will be prohibited from continued land disposal. Generators and facility owner/operators must then do one of the following:

i. Submit applications for case-by-case effective date extensions.

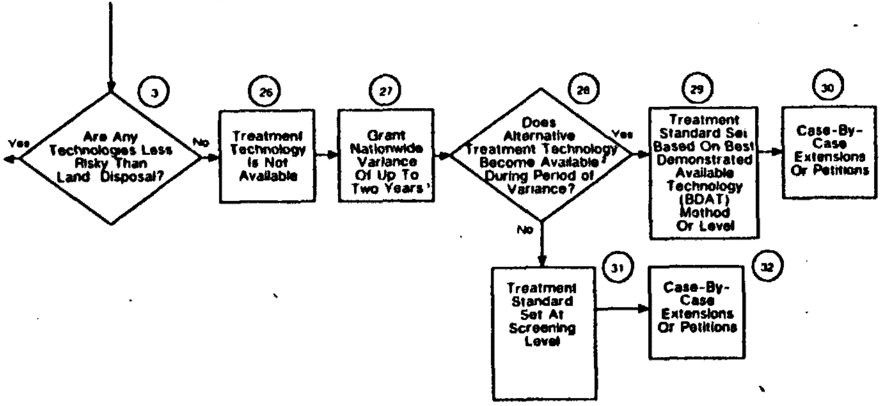
ii. Submit petitions successfully demonstrating that management of the wastes in land disposal units at specific sites is protective of human health and the environment.

iii. Manage the wastes by means of alternative recovery or disposal technologies (to the extent allowed by law or regulation).

iv. Cease generating the waste by means of process change or materials substitution.

While these options also are available under the first two decision sequences, what distinguishes this sequence (as well as the next sequence from the previous sequences) is that most generators and facility owners or operators are not expected to be able to comply with the treatment standard, since no technologies are available that are capable of achieving it.

Decision-Case IV—Alternative technology is more risky than land disposal.



The previous cases all stemmed from a favorable evaluation of comparative risk—that is, at least one alternative technology was of equal of less risk than land disposal (Element 3). This final case commences with an evaluation that all alternatives are more risky than land disposal, resulting in EPA's determination that treatment technology is not available (Element 26).

Under this discision-making sequence, EPA's first regulatory action may be to exercise its authorities under section 3004(h)(2) to grant a nationwide variance from the statutory effective date for the prohibition on placement of such wastes in land disposal units (Element 27). In this particular sequence, alternative treatment capacity is clearly not adequate, since the Agency will have concluded, based upon its comparative risk assessments, that no treatment technology is protective of human health and the evironment. If EPA finds that capacities of "protective" recovery and disposal technologies also are inadequate, the Agency may grant a variance for up to 2 years.

The purpose behind granting the nationwide variance under this final decision-making sequence is to provide affected generators and facility owners and operators an opportunity to develop new technologies or improve existing technologies such that the minimum requirements of section 3004(m) are achieved and the risks of managing wastes through these technologies are not greater than the risks associated with land disposal of the wastes (Element 28).

By the end of the nationwide variance (which may not exceed 2 years), EPA may promulgate a section 3004(m) treatment standard if, during the period of the nationwide variance, new or improved treatment technologies are developed that meet the minimum requirement of section 3004(m) and do not pose greater risks than those posed by land disposal (Element 29). The BDAT standard would take effect immediately at the end of the nationwide variance.

As indicated earlier, once the Section 3004(m) treatment standards take effect, wastes that comply with them may continue to be managed in land disposal units. Wastes that do not comply will be prohibited from continued placement in land disposal units after the effective date unless generators or facility owners or operators have been granted case-by-case extensions of the effective date or have submitted petitions successfully demonstrating that continued land disposal of the wastes is protective of human health and the environment (Element 30).

Under this decision-making sequence, however, if new or improved treatment technologies or treatment trains applicable to waste affected by this decision-making sequence do not develop during the period of the nationwide variance, EPA will continue to determine that treatment technology is not "available" for these wastes and will establish the screening levels as the treatment standards (Element 31). Options available to the generators and owners or operators are the same as those described in Decision III, when no treatment technology is "available" (Element 32).

This completes the description of EPA's proposed decision-making framework for exercising its responsibilities in implementing the statutory prohibitions on land disposal enacted in section 3004 (d), (e), and (g), including establishing section 3004(m) treatment standards and their associated effective dates. EPA has applied this framework in today's proposal to two classes of hazardous wastes—certain dioxin-containing wastes and certain solvent wastes. EPA requests comment on all aspects of these four decision pathways.

C. Treatment Standards and Effective Dates for Solvents

Pursuant to section 3004(e), EPA has applied the proposed decision-making framework in developing section 3004(m) treatment standards (40 CFR Part 268, Subpart D) for solvent wastes (EPA Wasts Codes F001 through F005, P002, U031, U002, U037, U052, U057, U070, U080, U112, U117, U140, U154, U159, U161, U169, U196, U210, U211, U220, U226, U228, U121, and U239).

1. Screening Levels/Liner Protection Threshold

Screening levels were back calculated for all applicable solvent constituents contained in these wastes, based upon their chemical, physical, and toxicological properties. However, in addition to toxicological threats, solvent wastes may also adversely affect liners and may mobilize other hazardous constitutents contained in land disposal units. Accordingly, EPA is proposing today to establish a liner protection threshold concentration level of 2 ppm to guard against these additional threats posed in the land disposal of solvent wastes, based upon the lowest concentration know to adversely affect synthetic liners in short term tests and a hundredfold safety factor. Wherever the toxicologically derived screening levels are greater than 2 ppm or where ever the levels are not developed due to the absence of toxicological data (e.g., for ignitable solvents), this concentration level will be used as an override, replacing the screening level for the constituent.

2. Best Demonstrated Achievable Technologies

EPA has determined that a number of technologies are applicable to the treatment/recovery of solvent wastes, including biological degradation, steam stripping, carbon absorption, distillation, incineration, and fuel substitution. The Agency is proposing to identify "best demonstrated achievable technologies for each solvent waste based upon the waste's physical form, the specific solvent constituents it contains, and the concentrations at which such constituents are present. For all solvent wastes subject to today's proposed rulemaking, best demonstrated treatment technologies are identified that are capable of achieving the screening levels for the applicable solvent constituents contained in these wastes. Furthermore, although final evaluations have not yet been completed, preliminary results indicate that these best demonstrated treatment technologies do not pose total risks to human health and the environment greater than those posed in the direct land disposal of most categories of the solvent wastes subject to today's proposed rulemaking. Detailed analysee are underway, however, to evaluate risks posed by the treatment of certain categories of solvent waste streams in steam strippers and incinerators. Since greater risks may be posed by these technologies only for a small subset of the solvent wastes subject to today's proposed rulemaking, EPA is continuing to classify both of these technologies as available treatment technologies for purposes of establishing the section 3004(m) treatment standards until the results of the detailed analyses are available.

3. Proposed Section 3004(m) Treatment Standards

EPA is proposing section 3004(m) treatment standards (40 CFR Part 268, Subpart D) for each of the subject solvent waste streams under Decision Sequence 1 of the proposed land disposal restrictions decision-making framework. The Agency has determined that the screening levels for each Appendix VII solvent constituent (including all situations in which EPA is proposing to override the toxicologically derived thresholds with the 2 ppm liner protection threshold) can be achieved by the best demonstrated achievable treatment technologies identified for the various categories of solvent waste streams. Accordingly, EPA is proposing the screening level or liner protection threshold as the section 3004 (m) treatment standards for each Appendix VII constituent contained in the solvent wastes subject to today's proposed rulemaking, capping off the required technology performance levels at these protective levels.

4. Effective Dates

EPA is proposing to establish immediate effective dates (i.e., November 8, 1986) pursuant to section 3004(e) for all but three of the categories of solvent wastes subject to today's proposed rulemaking. The Agency bases its proposed decision not to grant national variances under section 3004 (h)(2) for these solvent wastes upon determinations that available capacities of treatment technologies capable of achieving the proposed treatment standards for these wastes, in conjunction with the capacities of alternative recovery and disposal technologies, are sufficient to accommodate all of the quantities of these solvent wastes that are currently land disposed. Accordingly, solvent wastes subject to today's proposed rulemaking that do not comply with applicable section 3004(m) treatment standards will be prohibited from continued land disposal commencing November 8, 1986, unless case-by-case effective date extensions are granted under section 3004 (h) (3) or unless petitions for continued land disposal are approved under section 3004(e).

EPA is, however, proposing to grant a 2-year national variance, the longest effective date variance authorized under section 3004 (h)(2), for these categories of solvent wastes subject to today's proposed rulemaking: Solvent-water mixtures (wastewaters) containing less than 1 percent (10,000 ppm) of total organic constituents and less than 1 percent (10,000 ppm) of total solids; inorganic sludges and solids containing less than 1 percent (10,000 ppm) total organic constituents; solvent-contaminated soils. The Agency bases the proposed national variances for these solvent wastes upon a determination that the capacities of alternative treatment technologies capable of achieving the treatment standards for these wastes (wastewater treatment units and incinerators), in conjunction with the capacities of alternative recovery and disposal technologies, are insufficient to accommodate the quantites of these solvent wastes currently managed in land disposal units. Accordingly, the section 3004(m) treatment standards proposed for these two categories of solvent wastes will not take effect until November 8, 1988.

D. Treatment Standards and Effective Dates for Dioxins

Pursuant to section 3004(e), EPA has applied the proposed decision-making framework in developing section 3004(m) treatment standards (40 CFR Part 268, Subpart D) for dioxin-containing waste (EPA Waste Codes F020, F021, F022, F023, F026, F027, and F028, containing particular chlorinated dioxins, -dibenzofurans, and -phenols).

1. Screening Levels

Screening levels were back-calculated for each Appendix VII hazardous constituent contained in these wastes, based upon their chemical, physical, and toxicological properties. In many cases, the screening levels calculated for these constituents are below established detection limits achievable using standard EPA analytical methods.

2. Best Demonstrated Achievable Technologies

EPA has determined that the best demonstrated technology applicable to the treatment of dioxin-containing wastes is incineration at 99.9999 percent destruction or removal efficiency (six 9s DRE) or an equivalent thermal treatment technology. Furthermore, the Agency has determined that incineration to six 9s DRE does not pose total risks to human health and the environment that are greater than those posed in direct land disposal of the dioxin-containing wastes subject to today's proposed rulemaking. However, the Agency cannot state conclusively that incineration at six 9s DRE can achieve the screening levels for these dioxin-containing wastes, since many of the levels are below established detection limits (due to the highly toxic nature of the chlorinated constituents).

3. Proposed Section 3004(m) Treatment Standards

EPA is proposing section 3004(m) treatment standards (40 CFR Part 268, Subpart D) for each of the subject dioxin-containing waste streams under Decision Sequence 2 of the proposed land disposal restrictions decision-making framework. The Agency has not been able to determine that the screening levels for each Appendix VII constituent can be achieved by the best demonstrated available treatment technology identified for these wastes. Incineration at six 9s DRE has been identified as the best demonstrated available technology for these dioxin-containing wastes, and the Agency has determined that incineration at six 9s DRE achieves substantial reductions in the mobility and toxicity of these dioxin-containing wastes and their chlorinated constituents. Incineration at six 9's DRE is expected to reduce the concentration of the dioxins of concern to levels below established EPA detection limits (detection limit 1 ppb). Accordingly, the Agency is proposing to specify the section 3004(m) treatment standard at the detection limit (1 ppb), and to identify the back-calculated screening levels for these wastes as the long-term goals toward which future treatment standards will aim as current analytical methods are improved or new methods of detection are developed. Accordingly, under EPA's proposed treatment standard, all dioxin-containing wastes will be prohibited from placement in land disposal units unless first treated in accordance with the treatment requirements specified in §§ 264.343, 265.383, 265.352, if any levels of the chlorinated dioxins, -dibenzofurans, and -phenols are detected in extracts (leachates) from these wastes. Conversely, under today's proposed treatment standard, land disposal without prior incineration will be permitted for all dioxin-contaminated wastes whose chlorinated constituents are not detected in EPA's approved leachate test procedures.

4. Effective Dates

EPA is proposing to grant a 2-year national variance, the longest effective date variance authorized under section 3004(h)(2), for all dioxin-containing wastes subject to today's proposed rulemaking. The Agency bases the proposed national variance for these dioxin-containing wastes upon a determination that no incinerator or thermal treatment facility has yet been approved by EPA to treat dioxin-containing wastes, and that no alternative recovery or disposal technologies have been identified that are protective of human health and the environment in the management of these highly toxic wastes. Accordingly, today's proposed section 3004(m) treatment standard, requiring incineration of dioxin-containing wastes at six 9s DRE prior to placement in land disposal units, will not take effect until November 8, 1988. The Agency will reconsider the length of this national variance and may institute an earlier effective date if one or more facilities are certified to treat these dioxin-containing wastes.

III. Detailed Analysis of Proposed Regulatory Framework

A. Conceptual Approach To Establishing Screening Levels

As discussed in Unit II, EPA proposes to develop both technology-based levels and screening levels to establish treatment standards. This unit discusses the Agency's approach to establishing screening levels. In order to identify when land disposal of a hazardous waste is protective of human health and the environment for the purpose of determining screening levels, EPA has established a comprehensive modeling approach which will be used to assess potential adverse effects to human health and the environment through release of contaminants from land disposal units to ground water, surface water, and air. Today's notice specifies screening procedures for both ground water and surface water exposure. In addition, EPA's general approach to the air exposure model is described. However, this component has been sufficiently developed for inclusion as a specific proposal in today's rule. EPA anticipates issuing the specific proposal for the air exposure evaluation component for publication in the **Federal Register** within the next 6 months.

The ground water and surface water screening procedures use concentration-based fate and transport models that start from a potential point of human exposure at a concentration deemed to be protective of human health or the environment and back calculate the constituent concentration in a leachate immediately beneath or adjacent to the land disposal unit that will ensure that the specified protective level is not exceeded at the point of potential exposure. In those cases where EPA specifies the treatment standard as a leach concentration, a new extraction procedure will be used to determine if an extract from a waste exceeds the specified level. Use of an extraction, or leaching procedure, provides a mechanism for accounting for the entire spectrum of physical forms of a waste. Accordingly, use of the extraction procedure allows recognition of the fact that physical form (i.e., the waste matrix) will influence the leachability of constituents in the waste.

Generally, predictive modeling, such as that being used to back calculate acceptable constituent concentrations, is done on a site-specific basis. However, use of a site-specific approach would provide only for an evaluation of existing land disposal units, and would not guarantee protection of human health and the environment at future disposal sites. In addition, EPA would not be able to make site-specific evaluations of necessary treatment levels within the timeframes for decision-making provided by the statute. As a result, EPA has concluded that the most reasonable and efficient approach to carrying out the statutory directive is to develop a generic scenario on which to base the levels. Because these levels are intended to identify levels that are protective, to the best of EPA's knowledge, at all existing and future land disposal sites, and thereby define when wastes can be land disposed without prior treatment, the assumptions used in modeling must be conservative, i.e., representing a reasonable worst case.

The screening procedures are generic in two ways. First, a universal facility type was developed representing a closed landfill, waste pile, or surface impoundment. In other words, EPA is setting a single screening level for a constituent in a waste, regardless of what type of disposal unit the waste will be placed in, unless the waste will be injected into an underground injection well. (As explained previously, the framework and treatment standards being proposed today do not apply to injected wastes.) EPA is also considering distinguishing one other type of disposal facility—land treatment—in establishing treatment standards. EPA's considerations and plans in this area are discussed more fully in Unit IV of this preamble.

The Agency believes that the statute does provide the discretion to issue treatment standards that vary based on the type of land disposal unit that the waste will be placed in. However, the Agency further believes that the statute does not require that such distinctions be made in establishing treatment standards under section 3004(m). The Agency realizes that the generic approach to establishing screening levels does not take into account the multitude of variations that exist among different types of land disposal units and that some types of units may result in a higher level of protection than the generic unit used as the basis for calculating screening levels. Consistent with the overall philosophy of the proposed framework, EPA believes that, generally, variations in facility design and operation can best be considered on a site-specific basis through the petition process.

Secondly, the screening procedures are generic in the sense of the environmental setting of the modeled scenario. In order to address the range of possible environmental settings (e.g., climatic condition, hydrogeology), the Agency developed a Monte Carlo simulation method for establishing the back-calculated health-based thresholds. This approach accommodates possible variations in environmental settings, the uncertainties in specific chemical properties, and the range of impact of engineered system releases from land disposal units. Instead of specifying a single value for each input parameter to the model, representing a reasonable worst case, the Monte Carlo simulation method involves a large number of computer runs with values for each input parameter drawn from data sets describing the range of possible values for each parameter and the distribution of values within the range. Additionally, where parameters are correlated, and therefore dependent, the relationships are accounted for in the Monte Carlo routine. The output from the Monte Carlo routine (e.g., 1,000 runs) can then be organized into tabulated values or graphical presentations of cumulative frequency distributions. In this manner the back-calculated screening concentration selected for any hazardous constituent can be evaluated for its probability of occurrence.

As a matter of policy, the Agency proposes to select the 90 percent level of the Monte Carlo probability distribution as the appropriate regulatory level. In this case, the level of treatment selected will ensure that downgradient concentrations will not exceed the specified target concentration in more than 10 percent of all possible settings for RCRA Subtitle C land disposal units.

The Agency believes that selection of the 90 percent level is reasonable because of the extreme unlikelihood that hazardous waste land disposal facilities would be sited in the very worst locations. EPA believes that selection of a level higher than 90 percent would result in setting screening levels on highly improbable scenarios. Analysis based on currently available information on existing hazardous waste facilities indicates that the facilities analyzed fall well below this 90 percent level (Ref. 2). However, as further data becomes available, the Agency will continue to examine the appropriateness of this level.

The Agency is also considering an alternative method of deriving the effective screening levels for carcinogens from the distribution of results from the back-calculation models. Under this alternative, the Agency would choose a cutoff percentile such that the target protection level (e.g. 10^{-6}) is achieved in most cases and the risk to individuals falling beyond the cutoff also falls in the acceptable risk range.

To meet these objectives, the maximum risk posed in cases beyond the percentile cutoff (which can be no greater than the risk of directly ingesting full strength leachate) is required to fall within the Agency's acceptable risk range of 10^{-4} to 10^{-7}). Ingestion of full strength leachate is a conservative assumption but necessary to estimate the potential risk in cases beyond the cut-off point. (The actual risk in those cases is likely to be much less.) For example, if the 75th percentile point on the Monte Carlo distribution is selected, then the corresponding leachate level (screening levels) will assure that in 75 percent of the scenarios modeled, the chemical and physical characteristics of the waste disposal scenario will result in dilution of the leachate down to a 10^{-6} risk level (i.e., the target risk level) by the time it migrates a distance of 500 feet downgradient. The risk to exposed individuals in these scenarios will be less than or equal to 10^{-6}. In the remaining 25 percent of scenarios the MEI risk will be greater than 10^{-6}, but will never be greater than the risk posed by drinking pure undiluted leachate. Thus, the maximum risk can be assured to remain within the Agency's acceptable risk range of 10^{-4} to 10^{-7} by selecting a leachate limit (screening level) that itself is associated with a risk no greater than 10^{-4} (by comparing the leachate limit corresponding to each point on the Monte Carlo distribution with its associated risk from the constituent's dose response curve).

Accordingly, in selecting the percentile cutoff for each constituent, one would move down the Monte Carlo distribution to the lowest percentile point where the associated threshold concentration (leachate standard) still falls within the Agency's acceptable risk range. A more complete discription of this alternative may be found in the record for this rulemaking.

In developing the ground water and surface water screening procedures, it is necessary to specify a distance representing a potential point of human exposure. As discussed previously, EPA interprets the statute to require that there be no migration to a point of potential exposure at a level that can cause adverse health or environmental effects. Because the legislation and legislative history indicate Congress' concern with the long-term uncertainties associated with land disposal, selection of the exposure point based on the current location of exposed individuals is inappropriate. Rather, the exposure point must represent a point of potential exposure both during the active life of the facility, as well as after the closure and the post-closure care periods. This is because exposure, particularly to very persistent and slow-moving constituents, can occur many years after the facility has closed.

EPA has defined the point of potential exposure in terms of an area of effective control; i.e., the area over which an owner/operator can exercise control designed to ensure that there will be no exposure to hazardous constituents at concentrations that adversely effect human health or the environment. This approach is consistent with both the exposure point being proposed today for the petition process under § 268.5 as well as the definition of potential exposure for determining alternate concentration limits pursuant to the Part 264 ground water protection program (Ref. 98). Under this approach, constituent concentrations are predicted not to exceed the health effect levels beyond the area of effective control. Thus, the approach assures protection of resources such as ground water beyond the exposure point regardless of whether they are currently being used for human consumption. Designation of an appropriate exposure point is discussed in more detail in Unit III.A.2, 3, and 4.

In selecting appropriate models for the proposed screening procedure, a number of existing models were evaluated. The criteria for this evaluation were as follows:

(1) The model must be suitable for a generic application.

(2) To be suitable for use with an extraction procedure, (i.e., to be able to account for differences in physical form of a waste), the models must fit into or be easily modified for use in the back calculation procedure and model outputs must be expressed as a concentration.

(3) Because of the time constraints imposed by the legislation for refining existing data or developing additional data, the data requirements of the model should not be extensive.

(4) The models should account for, to the extent allowed by the state-of-the-art, the major physical/chemical processes known to affect the fate and transport of constituents through the environment.

Based on discussions with experts in the field, the Agency determined that the available ground water fate and transport models considered did not meet all four selection criteria. Specifically, although the analytical models required relatively limited data inputs, none satisfied all of the three remaining criteria. Most were developed for different applications and could not be applied to the desired generic scenario. The numerical models evaluated required extensive data inputs and were more applicable to site-specific evaluations than to the desired generic evaluation. Additionally, the Agency determined that none of the analytical or numerical models could easily be modified to meet all four criteria.

As a result, the Agency investigated alternatives including the use of a one-dimensional advective-dispersive equation which also accounted for first-order decay of hazardous constituents. Because this equation failed to account for processes known to occur in the ground water environment the Agency rejected its use. With assistance from experts in the field, the Agency selected a two-dimensional advective-dispersive transport model which met all of the evaluation criteria. This model accounts for most of the major physical and chemical processes known to influence movement and transformation of chemicals in ground water. The model was presented to EPA's Science Advisory Board (SAB) for review. Based on comments received from the SAB (available in the docket for this rulemaking), the Agency revised the ground water model to address the major points of concern including the assumption of complete mixing of leachate over the aquifer, speciation of metals in ground water, and the related subjects of variabilty and the generic nature of the screening procedure. The model relates, through mass balance principles, the mass flux of leachate emanating from land disposal units to the nature of the leachate (or penetration of leachate) after it is mixed in the aquifer. The Agency estimated long-term flux rates from a RCRA Subtitle C land disposal unit using the Hydrologic Evaluation of Landfill Performance (HELP) model. The HELP model was developed by EPA specifically as a tool for estimating water budget components of landfill designs. The water budget components include runoff, evapotranspiration, surface drainage and leachate resulting from infiltration. HELP uses climatologic, soils, and design data to produce daily estimates of water movement across, into, through and out of landfills. Precipitation in excess of losses due to surface runoff and evapotranspiration will result in net infiltration to soils. The Agency considered net infiltration to be comparable to long-term chemical flux from land disposal units.

Estimates of metal species distributions in ground water will be determined using the geochemical model MINTEQ. MINTEQ is an equilibrium model that uses the equilibrium constant approach to solving the chemical equilibrium problem. Because different species of a metal cause different biological effects, this model better relates metals concentrations and ground water chemistry to observed effects.

The proposed ground water screening procedure accounts for most of the major physical and chemical processes known to influence movement of chemicals in simple, homogeneous and isotropic porous media under steady flow conditions The mechanisms considered include the process by which solutes are transported by the bulk motion of flowing ground water; dispersion or spreading of contaminants as they move with the ground water in the longitudinal, lateral, and vertical dimensions (x, y, z planes); sorption or intereaction of dissolved contaminants with aquifer solids encountered in the flow path; first-order decay for organics limited to hydrolysis; and speciation of metals in ground water. The model also incorporates several reasonable worst-case assumptions, such as saturated soil conditions providing zero attenuation, and infinite source which supplies a continuous input to the ground water environment, and a receptor well directly in line with the source and ground water flow. A more detailed discussion of the ground water model, including the various component models such as HELP and MINTEQ, is contained in Unit III.A.2. Additional specific details on the MINTEQ component of the model will be published in the proposed rulemaking for constituents addressed by section 3004(d), i.e., the California List.

Development of the proposed surface water screening procedure was guided by the same requirements as the ground water component. The Agency determined that none of the existing analytical or numerical computer models could easily be modified to meet all the criteria. Since numerical solutions are more applicable to site-specific evaluations and not the desired generic evaluation, an analytical solution was chosen for its computational simplicity.

After reviewing available analytical solutions to the major zones of interest in the stream, the Agency selected lateral dispersion near the area of leachate entry into the stream and a one-dimensional zone downstream from the area of leachate entry where the stream is completely mixed. Two solutions were developed for the governing equations. Both approaches, based on mass balance principles but using different boundary conditions, produce similar results, thereby confirming the operational model (the computer code resulting from the equations).

The proposed surface water screening procedure accounts for the major physical and chemical processes known to influence a stream. The important mechanisms considered include initial dilution; advection; dispersion in the longitudinal and lateral dimensions; degradation; and sorption. The procedure also incorporates several reasonable worst-case assumptions, such as the contaminated ground water intercepting the stream continuously, the fish residing in the most contaminated portion of the stream, and no loss during overland flow (i.e., adsorption, dispersion, and chemical transformation). The mechanics of the surface water model are discussed further in Unit III.A.3.

Through the use of conservative modeling assumption, conservative back calculation starting points and selection of the 90 percent level in the Monte Carlo probability distribution, the Agency believes that the screening levels represent levels that are, to the best of EPA's knowledge, protective at future and existing hazardous waste land disposal sites. Constituents at levels below these screens are considered not to be of regulatory concern and thus may be land disposed at any Subtitle C facility. It is likely, however, that levels above these thresholds may be protective at specific sites. Under the framework established in today's proposed rule, site-specific factors that could result in a determination that higher levels are protective can be considered through the petition process described in Unit III. G.

A detailed description of the determination of the appropriate starting level for the back calculation, as well as the screening procedures for ground water, surface water and air exposure, follows.

1. Back Calculation Starting Points

a. *Constituents of concern.* As noted earlier, in developing screening levels that are protective of human health and the environment, EPA will define "protective" as that term is used in section 3004 (d), (e), and (g). Specifically, these subsections provide that EPA may not determine that a method of land disposal is "protective" for a certain waste unless it is demonstrated that "there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the waste remains hazardous." The term "hazardous constituents" is used in 40 CFR 264.93 to connote constituents listed in Appendix VIII to 40 CFR Part 261. It is presumed that Congress was cognizant of this usage and intended the term to have the same meaning in section 3004 (d), (e), and (g). Indeed, in the legislative history to new section 3004(u) of RCRA, which also uses the term "hazardous constituent," Congress explicitly states that "[the] term 'hazardous constituent' as used in this provision is intended to mean those constituents listed in Appendix VIII of the RCRA regulations" (H.R. Rep. No. 98-198, 98th Cong., 1st Sess. 60 (1983)). Absent an indication of contrary intent, it is presumed that Congress intends a term to be given consistent meaning throughout a statute.

Thus, in requiring a showing of no migration of "hazardous constituents" under section 3004 (d), (e), and (g), Congress appears to indicate that land disposal of a particular hazardous waste may not be found protective unless it is demonstrated that there will be no migration of the Appendix VIII constituents of that waste from the disposal unit for as long as the waste remains hazardous. This, in turn, implies that in order for land disposal of a waste to be deemed "protective" by virtue of compliance with screening standards established under section 3004(m), it must be demonstrated that all Appendix VIII constituents in that waste meet applicable threshold levels. In order to make this determination, EPA must set screening levels for all Appendix VIII constituents.

The foregoing interpretation seems consistent with congressional intent when applied to decisions on the "protectiveness" of a waste under section 3004(g). It seems clear that Congress intended EPA to consider directly or indirectly all Appendix VIII constituents in making a finding that a waste addressed by this section is safe for land disposal. However, EPA believes that Congress intended a different treatment for wastes regulated under section 3004(d) and (e). These subsections identify wastes that require attention in the near term to address specific enumerated constituents of concern. Thus, the wastes listed in section 3004(e) (i.e., solvent- and dioxin-containing wastes) are to be evaluated for their solvent and dioxin content within 24 months of enactment. The wastes identified in section 3004(d) (i.e., wastes containing certain listed constituents) are to be examined within 32 months to determine whether the specified metals, corrosives, PCBs and halogenated organics are present in unacceptable concentrations. EPA believes that these "fast-track" decisions are intended to focus only on the enumerated constituents of concern and not upon all Appendix VIII constituents in such wastes. Wastes containing unacceptable concentrations of the specified constituents will be banned from land disposal. Wastes containing such constituents in acceptable levels will be further evaluated for all other Appendix VIII constituents when EPA addresses listed and characteristic wastes under section 3004(g).

The Agency is now in the process of assessing data needed to establish health effect levels for all Appendix VIII constituents. The development of valid data is a time-consuming process. Little is known about the toxic effects of many of these constituents. Accordingly, EPA may not be able to generate information necessary to establish screening levels for all Appendix VIII constituents contained in the first group of scheduled wastes by the statutory deadline of August 8, 1988 (i.e., 45 months from enactment). If such an eventuality develops, the Agency is considering pursuing one of three alternatives to address the statutory directive.

First, EPA may consider developing data to support the establishment of surrogates for certain Appendix VIII constituents. Under this approach, EPA would attempt to draw an analogy between the toxic effects of a chemical for which there are well-documented toxicological data and the toxic effects of one or more Appendix VIII constituents with similar molecular structures for which few toxicological data are available. This process, quantatitive structure activity relationship (QSAR) analysis, has been used to predict the toxicity of chemicals to mammalian and aquatic species. The process relies heavily on the professional judgment of toxicologists and chemists, and to a limited extent, on computer modeling. Second, EPA may consider amending the existing regulations to delete, for purposes of the restrictions program, consideration of many of the exotic Appendix VIII constituents for which toxic effects data are not available. The constituents considered for deletion would be those that are expected to be present in very few, if any, hazardous wastes.

Finally, EPA may adopt an approach which provides that wastes containing hazardous constituents for which health effect levels have not been developed will be automatically banned from land disposal unless the waste complies with applicable technology-based pretreatment standards or is the subject of a successful petition. Under this approach, it is assumed that a successful petition would have to demonstrate that the constituents for which toxic effects data are unavailable will not reach the receptor point, or the petitioner would have to develop sufficient data on the toxic effects of the constituent in question to provide EPA a basis for determining that the constituents in question will not migrate to the receptor point at a level in excess of "safe" concentrations. It is also assumed that sufficient data will be available to conclude that a treatment technology that adequately addresses certain constituents (for which sufficient toxicological and treatability data are available) will also adequately address Appendix VIII constituents for which there are insufficient toxicological data, but which can be expected to respond to treatment in a similar manner because of similar molecular structure.

EPA solicits comment on these alternative approaches to addressing Appendix VIII constituents in the absence of complete toxic effects data.

b. *Chronic v acute effects.* There are two patterns of toxic chemical exposure—chronic and acute—which give rise to somewhat distinct responses in the individual exposed and require different strategies for control. The kinds of events unique to land disposal which result in chronic, recurrent exposure are the undetected, inevitable and widespread deterioration of synthetic liners and the underlying containment system. Thus, the primary intent of the restrictions program is to address the problems of the long-term, unpredictable failure of land disposal leading to chronic exposure. The legislative history clearly states this intent of Congress. "The objectives of this program are twofold . . . the second objective is to ensure that land disposal is used only for those wastes for which it can reasonably be anticipated to be protective of human health and the environment in the very long term even if there are no treatment alternatives." (H.R. Rep. No. 98-198, 98th Cong., 1st Sess. 30 (1983)). "The program is based upon a finding that land disposal in general is the least desirable form of waste management because of the problems associated with assuring long-term containment of hazardous waste." (S. Rep. No. 98-284, 98th Cong., 1st Sess. 13 (1983)). Events causing acute effects are usually sudden and not-recurrent e.g., fires, explosions and spills—problems inherent in any waste management activity. The Agency has already promulgated restrictions and other regulations to address these events, (see 40 CFR Parts 264 and 270); therefore, they are not the primary focus of the restrictions program. Moreover, concentration levels based on chronic effects should protect against acute harm. Tolerable levels for acute exposure are often set higher than the corresponding levels for chronic recurrent exposure because in the acute case physiological repair may take place before any subsequent exposure. For example, EPA-established emergency levels (health advisories) for brief exposure to containments in drinking water likely would be higher than the levels set for these same contaminants under chronic exposure.

c. *Single constituents v mixtures.* In establishing screening levels, individual constituents in each waste must be evaluated. Under the approach set forth in this proposed rule, each constituent will be considered independently.

The assumption that each chemical behaves independently means that no interactive effects (e.g., antagonism, synergism or additive) in the environment or upon the human system are considered in the initial screening levels. Interactions can be dependent on the nature of the chemicals, the mechanism of toxicological effect, as well as possible species-specific metabolism. EPA believes it does not have adequate data to characterize these relationships and, accordingly, is unable to set limits based on interactive effects. In the future it may be possible to modify existing reference doses (i.e., health limits) to reflect the potential interactions when more data are available.

d. *Noncarcinogenic constituents.* Implementation of the various back calculation models requires the initial input of a single health-based limit for each constituent. Determination of the appropriate health-based limit is dependent upon the nature of the toxic effect of the constituent, specifically whether or not the constituent is a carcinogen.

Substances which cause systemic toxicity (i.e., other than cancer), appear to do so through mechanisms which exhibit physiological thresholds. Thus, a reserve capacity, assumed to exist within an organism, must be depleted or overwhelmed before toxic effects are evident. Simply put, for each noncarcinogenic endpoint of toxicity there is some low level of exposure which should have no effect on humans. Protection against a toxic chronic effect for a noncarcinogen is achieved by keeping exposure levels at or below the threshold dose.

For noncarcinogenic (threshold) constituents, the Agency is proposing to use reference doses (RfDs) as the starting point for the back calculation models. A reference does is an estimate of a lifetime daily exposure of a substance to the general human population, which appears to be without an appreciable risk of deleterious effects. Historically, this concept was donated by the term Acceptable Daily Intake (ADI). However, the term "acceptable" implies that exceeding the set level is "unacceptable." Current scientific understanding does not consider this demarcation to be rigid, such that above this level adverse effects are necessarily evident. For brief periods and for small excursions above the RfD, adverse effects are unlikely to occur in most of the population. Several circumstances can be cited however, in which particularly sensitive members of the population suffer adverse responses well below the level represented by the RfD. Most of these special sensitivities cannot be anticipated before the fact and must be treated on a case-by-case basis. Likewise, excursions above the RfD cannot be anticipated to be without effect in general and each such case must be treated individually by examining factors such as toxicokinetics, metabolism, nature and severity of effect, shape of the dose-response curve and nature of the subpopulation exposed (Ref. 97).

Historically, ADIs were first used by the Food and Drug Administration in 1954 as specific guidelines and recommendations on the use of "safe" levels of toxic chemicals for humans (Ref. 68). Since their initial use for food additives and the ingestion of pesticide residues by the FDA, ADIs have been used by other public health agencies in establishing "safe" levels for toxic chemicals in other contexts. The Food and Agricultural Organization, World Health Organization and EPA have used ADIs for establishing pesticide residue limits in foodstuffs. The National Academy of Sciences and EPA have estimated ADIs for purposes of safe levels of contaminants in drinking water (Ref. 3).

The method for estimating the RfD for noncarcinogenic endpoints of toxicity is to identify the highest dose of a substance which causes no statistically or biologically significant effect in appropriately conducted tests usually in experimental animals. This no-observed-adverse-effect-level (NOAEL) is an estimate of a population, rather than individual threshold. The RfD is derived by dividing the NOAEL by a suitable scaling or uncertainty factor (Ref. 97).

NOAELs usually are obtained from chronic studies or subchronic studies (e.g., 90 day studies in rodent species). Other types of toxicological data such as metabolism and pharmacokinetics, are used to support the judgmental choice of a particular dose level as the NOAEL. Confidence in the NOAEL, and therefore in the RfD, is dependent on the quality of the experiment, the number and type of animals tested at each level, the number and range of dose levels, the duration of the study (i.e., chronic versus subchronic), and the nature of the biological endpoint measured (i.e., the severity of the observed effects). The longer the duration of the study, the smaller is the uncertainty factor applied to the NOAEL. Selection of the appropriate uncertainty factor involves scientific judgment in the application of general guidelines (Ref. 99). The derivation of RfDs used for establishing screening levels will be documented and available for public comment at the time that the specific thresholds are proposed.

It is important to note that information on exposure levels in the environment (e.g., background levels) are not considered in the development of an RfD. Rather the RfD reflects the total theoretical permissible daily human exposure from all sources, including air, water, and food. Thus, when analyzing only one of several possible exposure routes, it is necessary to "apportion" or fractionate the RfD to take into account other possible exposures. This concept is discussed in detail later in this unit.

RfDs, where available, were used by the Agency in the toxicity ranking for noncarcinogens, as part of the toxicity ranking scheme which formed, in part, the basis for the proposed land disposal restrictions schedule, as published in the **Federal Register** of May 31, 1985 (50 FR 23250). As indicated in the supporting documentation for that proposed rule, RfDs have been calculated for many, but not all of the noncarcinogenic constituents for which the Agency will be establishing screening levels. Because the RfD value is critical to the proposed approach for calculating screening levels, EPA has initiated a bioassay testing program to fill the existing data gaps. At a minimum, EPA will conduct 90-day subchronic studies in rodents on those hazardous waste constituents for which few or inadequate chronic or subchronic toxicological data exist. All chemicals for which RfDs have been calculated will be re-evaluated by an Agency workgroup and verified before being used as the basis for screening levels (Ref. 121).

Bioassay testing of compounds has not been completed for some of the constituents addressed in today's proposed rule. Accordingly, insufficient toxicological data exist for establishing an RfD. Therefore, in today's proposed rule EPA is using preliminary data for isobutanol, ortho-, meta- and para-cresol and 2,3,4,6-tetrachlorophenol while appropriate testing continues. EPA recently proposed a rule under section 8(d) of the Toxic Substances Control Act to require past, current, and prospective manufacturers, importers, and processors of certain compounds for which data gaps exist to provide EPA with lists and copies of unpublished health and safety studies on these chemicals, as published in the **Federal Register** of October 7, 1985 (50 FR 40874).

e. *Carcinogenic constituents.* The use of the RfD is appropriate only for noncarcinogenic toxic endpoints. In the absence of chemical specific information on mechanism of action or kinetics, EPA science policy suggests that no threshold dose exists for carcinogens. No matter how small the dose, some risk remains.

The dose-response assessment for carcinogens usually entails an extrapolation from an experimental high dose range and observed carcinogenic effects in an animal bioassay to a dose range where there are no experimental data, by means of a pre-selected dose-response model. The slope of the dose-response curve is determined by this model. EPA's Carcinogen Assessment Group has estimated the carcinogenic potency (i.e., the slope of risk versus exposure) for humans exposed to low dose levels of carcinogens. These potency values indicate the upper 95 percent confidence limit estimate of excess cancer risk for individuals experiencing a given exposure over a 70-year lifetime. In practice, a given dose multiplied by the slope of the curve gives an estimate of the number of individuals estimated to develop cancer over a lifetime. The slope can be used to calculate the dose which gives rise to a given risk level (number of responders, e.g., one in a million). By specifying the level of risk (no matter how small) one can estimate the lifetime dose corresponding to it. The dose of a carcinogen corresponding to a specific risk is called the Risk Specific Dose (RSD). To arrive at a starting health limit for a carcinogen, a risk level or range of concern must be specified. EPA proposes to specify a risk level of concern on a weight-of-evidence basis. EPA is also considering taking total population exposure into account in specifying the acceptable risk level. This concept is discussed in detail in Unit III. A.1.i.

If EPA is unable to operationalize the consideration of population risk, the only basis for deviating from the 10^{-6} risk level would be the weight of evidence. Since the 10^{-6} risk level is conservative, higher levels of the constituents, could also be acceptable in the environment. Therefore, the number set here should not be judged as general standards that provide clear demarkations between protective and unprotective conditions. There are numbers that are very clearly within the protective range. The screening concentration levels are based on smaller risks than those EPA has used as the basis of other regulations that protect human health and the environment.

EPA issued Proposed Guidelines for Carcinogen Risk Assessment, published in the **Federal Register** of November 23, 1984 (49 FR 46294), which defined a scheme to characterize substances based on the experimental weight of evidence of carcinogenicity. This scheme is based on considerations of the quality and adequacy of the experimental data and the kinds of responses induced by a suspect carcinogen. The classification scheme is generally an adaptation of a similar system developed by the International Agency for Research on Cancer (Ref. 59).

EPA's proposed system comprises five groups. Group A indicates human carcinogens based on sufficient evidence from epidemiological studies that support a causal association between human exposure to the substance and cancer. Group B indicates probable human carcinogens. The evidence of human carcinogenicity from epidemiological studies for substances within this group ranges from almost sufficient to inadequate. This group is subdivided into two categories (B_1 and B_2) on the basis of the strength of the human evidence. Where there is limited epidemiologic evidence of carcinogenicity the carcinogen is categorized as B_1. Where there is no evidence or inadequate evidence from human studies, but sufficient evidence of carcinogenicity in animals, the carcinogen is categorized as B_2. Group C comprises possible human carcinogens. This group includes agents with limited evidence of animal carcinogenicity. It includes a wide variety of animal evidence. Group D includes agents which cannot be classified because no data or insufficient data are available. Group E includes chemicals for which there are adequate negative animals bioassays. This category indicates no evidence of carcinogenicity in humans.

The Agency regards agents classified in Group A or B as suitable for quantitative risk assessment. The suitability of group C agents for quantitation is best judged on a case-by-case basis since some Group C agents do not have a data base of sufficient quality and quantity to perform a quantitative carcinogenicity risk assessment.

Since carcinogens differ in the weight of evidence supporting the hazard assessment, EPA believes that establishment of a single across-the-board risk level is not appropriate. The Agency proposes to set a reference risk level as a point of departure, along with a risk range keyed to the EPA weight of evidence approach. The dose for known and probable human carcinogenic agents (Classes A and B) thus would be determined at the 10^{-6} risk level. Choice of 10^{-6} as the initial risk level of concern is made on the basis of the following Agency decisions. Guidance on response action under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) requires that the analysis of cleanup alternatives include options in the 10^{-4} to 10^{-7} risk range with at least one alternative utilizing a 10^{-6} risk level (Ref. 109). Options are often chosen corresponding to a 10^{-6} risk level. Within the RCRA program the draft guidance manual for Alternate Concentration Limits (ACLs), under the ground water protection program (40 CFR 264.94) identifies 10^{-6} as the point of departure within a risk range of 10^{-4} to 10^{-8} (Ref. 98).

Class C carcinogens may be deemed acceptable at risk levels greater than 10^{-6} (i.e., 10^{-4} or 10^{-5}). Choice of the specific risk level depends on the particular scientific reasons for classifying the carcinogen as Class C. This determination will be made on a case-by-case basis and necessarily will be guided by the extent of data available. For those Class C carcinogens for which there are insufficient data to perform a quantitative risk assessment, the dose will be calculated on the basis of the lowest threshold effect with an additional uncertainty factor of 10 e.g., RfD/10. This approach is similar to that taken by the Agency in promulgating and proposing Recommended Maximum

Contaminant Levels (RMCL, i.e., health goals) for certain chemicals in drinking water published in the **Federal Register** of November 13, 1985 (50 FR 46880) (Phase I) and (50 FR 46936), (Phase II).

Some agents appear not to cause cancer by all routes of exposure (or entry). Conclusions about route specificity can be addressed only in circumstances where adequate data exist on carcinogenicity for more than one route of exposure. Where carcinogenicity findings are available from only one route of exposure, the substance is judged to represent a cancer hazard by all routes, unless it can be scientifically demonstrated that the material cannot gain access to target sites by the alternative routes of interest. Where the data from one or more routes are limited, the Agency will evaluate each case on its merits, placing particular emphasis on the totality of scientific evidence.

For a few chemicals (notably metals), the data base demonstrating that cancer is produced by one route of exposure but not by another is substantial and convincing. An example of compounds whose carcinogenic responses are characterized as route-specific are chromium and some of its salts that cause cancer by inhalation but apparently not by other conventional routes of entry. Therefore, the Agency will regulate such substances as carcinogens only by the relevant route and as noncarcinogens by all other routes.

f. *Use of existing Agency health standards.* EPA, under other statutory mandates, has investigated the adverse health effects due to specific chemical agents with a view towards controlling exposure through different media. Health criteria and standards have been proposed or promulgated for certain substances in particular media. Since these have received Agency and public review and evaluation, EPA is proposing to use such standards in lieu of the RfDs or RSDs as the starting point for the back calculation model. Standards established for drinking water are particularly relevant since ground water is a major pathway of exposure from waste mismanagement and potentially could lead to drinking water contamination. EPA has used the drinking water standards for 8 metals and 6 pesticides as the basis of its Extraction Procedure Toxicity Characteristic Test. Primary drinking water standards, i.e., the Maximum Contaminant Levels (MCLs), are enforceable and are based upon health, treatment technologies, costs and other feasibility factors such as the availability of analytical methods. The initial step in the standard setting process is the identification of Recommended Maximum Contaminant Levels (RMCLs) which are non-enforceable health limits. The assessment process for establishing these health goals includes evaluation of the quality and weight-of-evidence of the supporting toxicological studies, absorption rates of specific toxicants, the possibility of nutritionally essential lower levels for some elements, existence of route-specific toxicity, demonstration of other environmental exposures and finally, the apportionment of the permissible limit of constituent into media-specific amounts.

In general, if no compound specific data are available, the RMCLs for non-carcinogenic organic chemicals are established at 20 percent of the RfD and, for non-carcinogenic inorganic substances at 10 percent of the RfD. The RMCLs for carcinogens in Class A or B of the Agency's proposed scheme are established at zero. The RMCLs for carcinogens in Class C are established at a non-zero level, determined on a case-by-case basis. As directed by the Safe Drinking Water Act, MCLs are to be set at levels as close to the RMCLs as is feasible, taking cost and other factors into account as mentioned above. MCLs for carcinogens which have been promulgated or proposed to date generally fall into lifetime risk range 10^{-4} to 10^{-6}.

Since a number of the same factors are being evaluated for each of the constituents in hazardous wastes, standards derived under the Safe Drinking Water Act can be used as the starting point for the back calculation in today's proposed rule. EPA recently has proposed MCLs for eight synthetic volatile organic chemicals, as published in the **Federal Register** of November 13, 1985 (50 FR 46880). After public review and evaluation EPA will promulgate final MCLs. Should the final MCLs differ from the proposed MCLs, EPA will base its regulatory thresholds on these revised final MCLs.

As an alternative to the above approach, EPA is considering using as RfD or RSD as a starting point for the back calculation model in lieu of an MCL. Under the apportionment scheme discussed below, highly volatile constituents may contribute less than 20 percent to the ground water route, and hence EPA may conclude that levels more stringent than MCL standards are appropriate.

SYNTHETIC VOLATILE ORGANIC CHEMICALS

	Proposed MCLs (μg/l)
Benzene	5
Carbon tetrachloride	5
1,4 Dichlorobenzene	750
1,2 Dichloroethane	5
1,1 Dichloroethylene	7
1,1,1 Trichloroethane	200
Trichloroethylene	5
Vinyl Chloride	1

g. *Environmental effects levels.* Because the standard for protection relates to both human health and the environment, the Agency believes that effects other than human health, such as toxicity to aquatic life in surface water, should be considered in establishing regulatory thresholds.

It should be noted that the proposed chronic human health levels in some instances are likely to be protective of both human health and the environment due to the fact that some human toxicity thresholds are lower than those for non-human toxicological effects. For example, this is expected to be the case for most chlorinated hydrocarbons including dioxins and chlorinated solvents. In other instances, the values protective of human health are inadequate to protect sensitive important aquatic species. This is likely to be true for a few metals.

The Agency has developed and issued guidelines for deriving ambient Water Quality Criteria, published in the **Federal Register** of November 28, 1980 (45 FR 79318), and has issued a number of final ambient Water Quality Criteria to provide protection to aquatic life, published in the **Federal Register** of July 26, 1985 (50 FR 30784). These documents have undergone proposed and final rulemaking and full public review. In addition, the Agency has proposed a schedule for future development of additional Water Quality Criteria.

Separate aquatic life criteria have been developed for fresh water and salt water organisms because the fate and effects of some constituents differ in these two environments. Each criterion consists of two limits, one for acute exposures, and one for chronic exposures. The maximum concentration is designed to provide protection of aquatic life from acute toxicity. The lower concentration is designed to protect against chronic adverse effects.

The guidelines specify required data in four categories: acute, chronic, plants, and bioaccumulation. Other data, (e.g., physiological data) are used if pertinent. All data are evaluated for scientific acceptability concerning the length of the test, the age of the organisms, water quality characteristics, and consistency, etc.

A minimum of eight acute tests are conducted on a variety of aquatic species to derive ultimately the criterion maximum concentration (CMC). The CMC is a 1-hour average concentration that should not be exceeded more than once every 3 years on average. The CMC is intended to protect ecosystems from unacceptable effects due to brief (short) exposures to high concentration. A large number of different species is tested to assure ecological and toxicological diversity in the derivation of the criterion.

Chronic toxicity tests are conducted to obtain information concerning the highest constant concentration that would not unacceptably affect the survival, growth, or reproduction of a species. Plant toxicity testing is also required for the development of the criterion since algae are the beginning of the food chain. Although plant toxicity is often not as sensitive as animal toxicity, any effect on plant species may have significant consequences for smaller life forms which live on algae. Finally bioconcentration tests measure the steady state concentration of contaminants in muscle and whole body which may reach human food sources. A residue value is obtained by dividing maximum permissible tissue concentrations by bioconcentration or bioaccumulation factors. The final residue value is the lowest of available residue values. If no maximum permissible tissue concentration is available, no residue value can be obtained.

The criterion continuous concentration (CCC) is the highest 4-day average concentration that should not cause unacceptable effects on aquatic organisms and their uses if not exceeded more than once every 3 years on the average. The CCC is the lowest of the Final Chronic Value, the Final Plant Value, and the Final Residue Value.

In determining acceptable threshold levels for hazardous waste constituents in the leachate, the Agency is proposing to use appropriate health and environmental contaminant limits, including Water Quality Criteria that have undergone full rulemaking procedures. If a water quality criterion for the constituent of concern is not available, EPA will seek to identify, based on other available date, the level at which the hazardous constituent may cause harm to the environment.

The Agency solicits comments on this approach and welcomes additional information or suggestions that would be helpful in making regulatory decisions that consider environmental risk from land disposal of hazardous waste.

h. *Apportionment of health limits.* The RfD for humans is the maximum daily dose of a substance in mg/kg/day that should not be exceeded to assure no adverse effect over a lifetime of exposure. If exposure occurs by multiple routes, some tolerance level can be established for each route so that the sum of exposures by individual routes does not exceed the reference dose.

The concept of apportionment of a chemical by medium and by route of exposure is not new. The first NAS-National Research Council (NRC) Safe Drinking Water Committee (Ref. 81) calculated a suggested-no-adverse-response level (SNARL) for chronic exposure to noncarcinogens in drinking water while incorporating an "arbitrary assumption" that 20 percent of the intake of the chemical was from drinking water. In evaluating carcinogens, that committee estimated cancer risks using the assumptions that tap water exposure was either 1 percent or 20 percent of the total daily intake. EPA, in setting RMCLs for chemicals in drinking water, has followed the suggestion of the NRC and selected a fraction of the RfD (usually 20 percent for synthetic organic chemicals if no empirical data suggest some other fraction). As published in the **Federal Register** of November 13, 1985 (50 FR 46880).

When determining an RMCL, EPA considers the contribution from other sources of exposure such as air and food. On a case-by-case basis when sufficient data are available, the RMCL is determined by subtracting from the RfD the known contribution of the constituent in food and air. But such data are often not available and in these cases the amount permitted in drinking water is calculated by an estimation of the percentage of exposure attributable to an exposure route. The usual percentage of drinking water contribution in the absence of known exposures is 20 percent for synthetic organic chemicals. For inorganic chemicals a better data base generally is available and actual contribution from other sources can be factored into the RMCL. Where actual data are sparse, however, a 10 percent contribution usually is estimated for drinking water, since sources other than drinking water are more likely carriers for inorganics.

Apportionment also has been used in a risk evaluation procedure used to evaluate and manage the risks at specific remedial action sites under the Superfund program. In this procedure, concentrations are generally apportioned equally in environmental media (e.g., air and water) as an initial basis for calculating a rate of release. At times, unequal apportionment is selected if there are significant cost and feasibility differences in controlling exposures via the different pathways. This approach is appropriate under the Superfund program since CERLA provides for a consideration of cost-effectiveness in its decision process (Ref. 42).

Many of the chemicals EPA regulates today are ubiquitous in the environment and may also be associated with exposures from other media (e.g., water, food, air). The Agency is proposing to limit population exposure to some fraction (50 percent) of the RfD to reflect consideration of potential and actual exposure from all media. Although available scientific and technical information as well as past decisions will be considered in reaching decisions on the apportionment of RfDs, sufficient information is not available on the exposure to chemicals from different media for different sources and geographical locations to quantify reliably the portion of RfDs that should be allotted for each chemical under consideration in this rule. As such, an algorithm for the apportionment of RfDs has been developed. The Agency believes this provides a sufficient margin for other exposures to the chemical while allotting percentages to waste management activities that are meaningful and not unduly restrictive.

However, the Agency is not proposing to apportion the RSD for carcinogens. The RSD is estimated by a procedure which introduces unavoidable uncertainties and is deliberately conservative, so that a difference in dose of a factor of two is still well within the margin of uncertainty of the estimated RSD.

Moreover, for carcinogens, the determination of risk is the daily dose averaged over a lifetime. Small variations around the daily dose have little effect on the lifetime risk, providing that the average is not affected. For this reason, a two-fold reduction in the RSD is relatively insignificant. For non-carcinogens, it is possible that not applying the 50 percent reduction (the indirect effect of which is to permit an approximate doubling of the RfD), may cause the threshold to be exceeded on some or even many days of exposure. Exceeding the threshold for non-carcinogens may therefore have significant health consequences for some individuals. Thus, there is justification for treating non-carcinogens differently from carcinogens with respect to apportionment.

EPA proposes to apportion reference doses according to the scheme shown in the following Figure 2:

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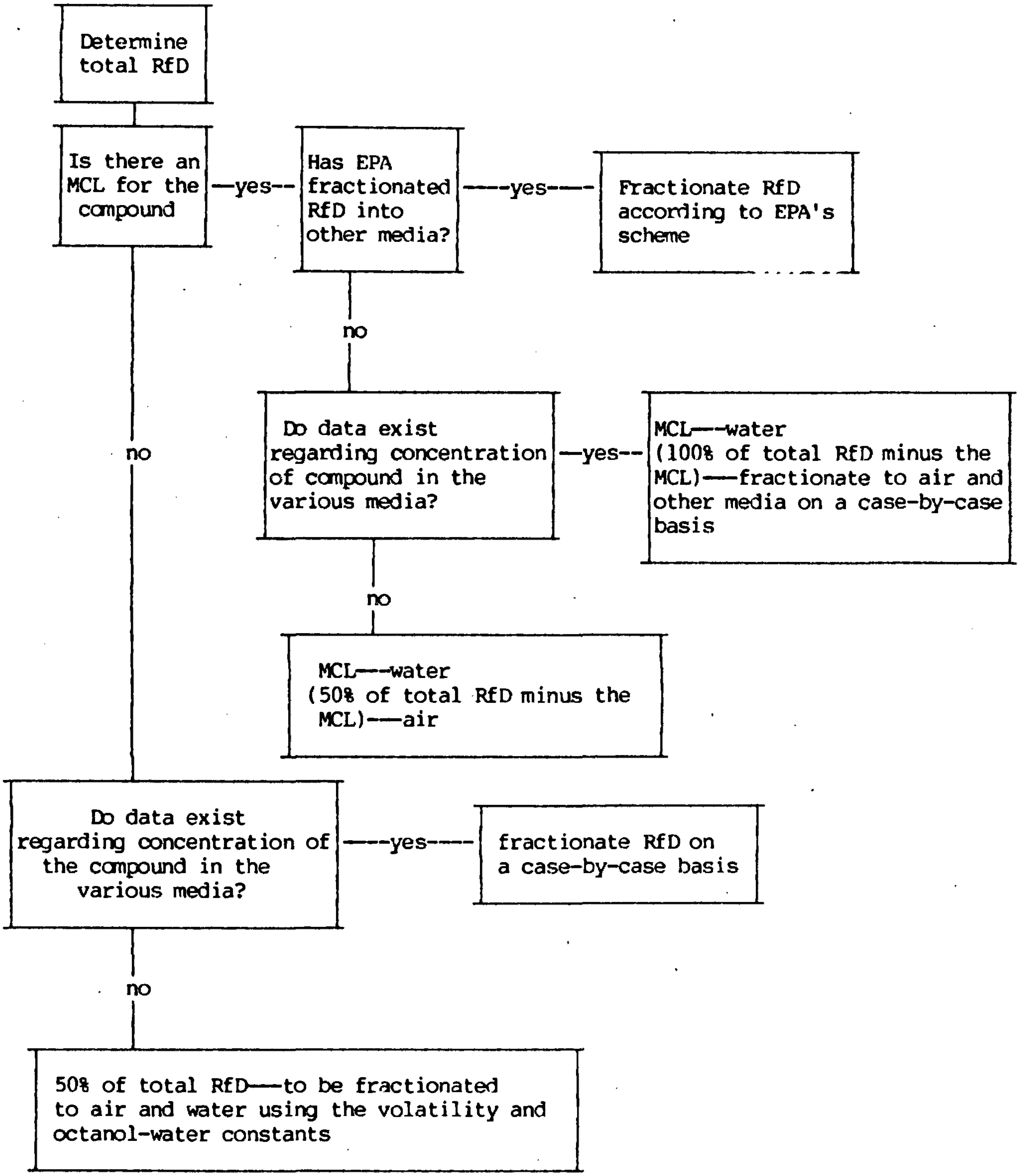
FIGURE 2--FLOW CHART FOR FRACTIONATION OF RfD



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The Agency will use any previously estimated percentage apportionment which it has specified under the Safe Drinking Water Act to establish the fraction permitted in water. As discussed in Unit III.A.1.f, Agency standards established for drinking water are considered particularly relevant. If the Agency, when establishing an MCL, has fractionated the RfD into other environmental media, those values will be used. If the Agency, when establishing a MCL, has not apportioned the RfD into other media and if there are actual data on the concentration of the compound in those media, the RfD will be fractionated on a case-by-case basis. However, if no data are available on exposure assessment, EPA will use 50 percent of the RfD and subtract from this 50 percent the fraction of the RfD allotted to water, using the remainder for air.

For those compounds for which the Agency has not developed an MCL but for which data are available on the distribution of the constituents in air, water, and food, EPA proposes to apportion the RfD on a case-by-case basis. Where neither an MCL nor data are available for a compound, EPA will apportion 50 percent of the total RfD to air and water according to a simplified scheme using Henry's Law constant (H_c) and the octanol-water coefficient (k_{ow}) to estimate environmental partitioning. (Henry's Law constant estimates the ratio of a substance between the vapor and dissolved state. The k_{ow} estimates the distribution of a compound between two liquids: Water and octanol i.e., lipid). Each distribution constant (H_c and k_{ow}) is subdivided into two equal parts according to its range of values as shown in the following Table 1:

TABLE 1.—RANGES AND CLASSIFICATION OF HENRY'S LAW CONSTANTS (k_H) AND OCTANOL-WATER COEFFICIENTS (k_{ow})

k_H	High in Air $\pm 10^{-5}$	Low in Air $< 10^{-5}$
k_{ow}	Low in Water ± 500	High in Water < 500

Another option is to subdivide each distribution constant into two unequal parts based on the actual values of H_c for volatiles or k_{ow} for very water soluble substances. The Agency is also considering an alternative simpler scheme which examines the relative concentrations between the two media through the use of Henry's Law constant only (Ref. 3). Each compound to be fractionated is classified as having a high or low value according to the general size of its distribution constants as shown in the following Table 2:

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TABLE 2—HENRY'S LAW CONSTANTS AND OCTANOL-WATER COEFFICIENTS FOR SELECTED HAZARDOUS CONSTITUENTS

Chemical	Henry's LAW CONSTANT (atm m^3/mol)	RELATIVE CONCENTRATION IN AIR	OCTANOL-WATER COEFFICIENT (k_{ow})	RELATIVE CONCENTRATION IN WATER
CARBON DISULFIDE	1.68E-02	HIGH	1.45E+02	HIGH
CHLOROBENZENE	3.46E-03	HIGH	7.41E+02	LOW
CRESOLS	5.05E-06	LOW	1.41E+02	HIGH
1,2-DICHLOROBENZENE	1.88E-03	HIGH	3.80E+03	LOW
ISOBUTYL ALCOHOL	1.23E-05	HIGH	5.50E+00	HIGH
METHYL ETHYL KETONE	2.61E-05	HIGH	2.00E+00	HIGH
METHYL CHLOROFORM	2.76E-02	HIGH	3.16E+02	HIGH
NITROBENZENE	2.40E-05	HIGH	7.94E+01	HIGH
PENTACHLOROPHENOL	4.62E-06	LOW	1.15E+05	LOW
PYRIDINE	1.95E-07	LOW	4.79E+00	HIGH
2,3,4,6-TETRACHLOROPHENOL	4.53E-06	LOW	2.14E+04	LOW
TOLUENE	5.93E-03	HIGH	6.61E+02	LOW
1,1,2 - TRICHLORO - 1,2,2 - TRIFLUOROETHANE	9.00E+00	HIGH	1.26E+03	LOW
TRI-CHLOROMONOFLUOROMETHANE	8.02E-01	HIGH	3.31E+02	HIGH
2,4,5-TRICHLOROPHENOL	2.84E-05	HIGH	7.24E+03	LOW

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A relationship between H_c and kH_{ow} and the distribution between air and water can be devised using a matrix as shown in the following Table 3:

TABLE 3.—Matrix To Select Distribution Between Water and Air Using k_{ow} AND k_H

	Air*	
	Low	High
Water*		
Low	Air: Water 50:50	Air: Water 80:20
High	Air: Water 20:80	Air: Water 50:50

* Determined by comparing actual or computed k_H and K_{ow} to ranges in Table 1.

To construct the matrix EPA assumed that a compound with equal ranges of k_{ow} and H_c i.e., high-high or low-low, will distribute between air and water into equal parts (50/50). For compounds that exhibit a high range for H_c and a low range for k_{ow}, EPA assumed that distribution would be in a ratio of 80 to 20, air to water. As an example, if 50 percent of the total RfD is available for fractionation into water and air and if Table 2 indicates a high H_c and a high k_{ow}, the fractionation of the total RfD is 25 percent of the total RfD into each medium. If the compound exhibits a low H_c and high k_{ow} then 10 percent of the total RfD will distribute to air and 40 percent to water.

EPA believes that the approach outlined above is reasonable in light of the difficulty in obtaining exposure data for many compounds within the statutory time limit. The Agency solicits comment on this general approach.

i. *Use of population risk in selecting starting level.* EPA is proposing to base the development of the screening concentration levels exclusively upon assessments of the risks to potential maximum exposed individuals (MEI risk) posed by the placement of individual hazardous constituents into land disposal units. However, the Agency would prefer to consider expanding the basis for these protective thresholds to include total population risk as a factor in conjunction with risk to the maximum exposed individual in setting screening levels.

The proposal to augment MEI risk information with data on risk to the total exposed population in calculating screening levels is intended for use only with carcinogenic constituents, due to the need to establish acceptable risk levels for carcinogens in identifying from their dose response curves the reference dose, or starting level, from which the back calculation commences. Population risk is not proposed as a factor in determining the reference does for noncarcinogens.

Whereas MEI risk with respect to carcinogenic constituents represents the probability of the realization of an adverse toxicological effect due to maximum chronic exposure to a hazardous chemical compound, population risk represents the actual number of additional cases where the toxic effect is expected to be realized, given the number of people estimated to be chronically exposed to the compound. For example, an MEI risk of 1×10^{-4} indicates that there is a 1 in 10,000 chance that cancer will develop in a person who is chronically exposed to a specified maximum concentration of a carcinogenic compound. The population risk, or incidence, corresponding to this MEI risk level depends upon the size of the population chronically exposed to the compound. If the total number of people chronically exposed is 1 million, the expected number of additional cases of cancer would be 100. If the total number of people chronically exposed is 100,000, the expected number of additional cancer cases among that population would be 10. Each of these estimates assumes, however, that all members of the exposed population receive the same dose, or concentration, as the maximum exposed individual (as would be the case, for instance, where the public drinking water supply is drawn from the point of maximum contaminant concentration in the ground water).

As described in Unit III.A.1.e, the Agency is proposing to establish an MEI risk to 10^{-6} as the point of departure in determining the level of control for all known and possible carcinogenic compounds, and to deviate from this point of departure within an MEI risk range of 10^{-6} to 10^{-4} in determining the acceptable risk level for individual compounds based upon the weight of scientific evidence indicating that the compound actually is a human carcinogen. The alternative being considered by the Agency is to include estimates of population risk, or incidence, as an additional factor in determining each constituent's appropriate level of control (i.e., acceptable MEI risk level) and, accordingly, in determining the acceptable concentration of the contaminant (in air, ground water, and surface water) from which the threshold back calculation procedures commence. Specifically, estimates of the size of the potentially exposed population for each constituent would be used in determining whether the level of control for that constituent should be increased or decreased from the MEI reference risk of 10^{-6} within a range of acceptable MEI risks between 10^{-4} to 10^{-7}.

For example, consider the case of a known human carcinogenic compound whose dose-response curve indicates that chronic human exposure at a concentration of 1 ppm corresponds to an MEI risk of 10^{-7} (i.e., 1 chance in 10 million that the individual will develop cancer), that an exposure concentration of 10 ppm corresponds to an MEI risk of 10^{-6}, and that exposure at 1,000 ppm corresponds to an MEI risk of 10^{-4} (i.e., 1 chance in 10,000 of developing cancer). In this example, EPA is considering using population risk in the following way: if a very large number of people is believed to be potentially exposed to releases of the contaminant from land disposal units, such that the number of additional cases of cancer expected to result from such exposure is relatively large, the level of risk-related control for the compound may be increased from 10^{-6} to as low as 10^{-7}, and a corresponding concentration of 1 ppm would be used as the starting point in the back calculation to determine the screening concentration level for the constituent. If the size of the potentially exposed population is estimated not to be very large, the point of departure MEI risk level of 10^{-6} would remain as the acceptable risk level for the compound and a concentration of 10 ppm would be use to commence the back calculation. If, however, a smaller number of people is believed to be potentially exposed to releases of the contaminant from land disposal units, such that the incidence of cancer is expected to be small from such exposure, EPA would consider increasing the acceptable MEI risk level from the 10^{-6} point of departure to an MEI risk level of 10^{-5} or 10^{-4}. In this example, adding population risk as a factor to be considered in determining the acceptable MEI risk level for the compound could result in back-calculated screening concentrations or protective levels, that vary by three orders of magnitude (i.e., one thousandfold) for small versus large populations.

There are advantages to including population risk as a factor in developing the screening levels concentrations. First, population risk provides a valuable piece of information in making a risk management decision on the acceptable MEI risk level, and the corresponding back-calculated concentration. In order to assure that screening concentration standards are truly protective of human health and the environment, EPA must assure not only protection of any exposed individual, but must also ensure that there will not be an unacceptable incidence of health effects in cases where large numbers of people may be exposed. Population risk allows the Agency to choose regulatory levels that will protect individuals and groups of exposed people.

Second, in accounting for total population in making regulatory decisions under the land disposal restrictions program, EPA will be proceeding in a manner that is consistent with certain Agency decisions in the air, water, and toxics programs. For example, decisions under section 112 of the Clean Air Act (CAA) consider risks to both individuals and exposed populations. Likewise, incidence is one of the factors that influence the National Ambient Air Quality Standards (under sections 108 and 109 of the CAA, and section 4(f) decisions under the Toxic Substances Control Act (TSCA)). Also, the Agency is committed to evaluating population exposure as one of the major factors needed to assure efficient risk reductions in new regulations (Ref. 120).

Section 4(f) of TSCA is a priority setting mechanism by which EPA identifies chemicals that require expedited regulatory consideration under section 7(f) of TSCA. In order to assign priority consideration under section 4(f), EPA is directed by statute to decide whether there may be a reasonable basis to conclude that a "significant risk of serious harm" or a "significant risk of widespread harm" is or will be presented. The "significant risk of serious harm" standard is interpreted to cover situations in which persons are exposed to particularly high risks. The "significant risk of widespread harm" standard is interpreted to cover situations in which the risks to exposed individuals are somewhat lower, but the number of persons exposed is very large. Accordingly, factors considered by EPA to be relevant in section 4(f) priority setting decisions have included: the chemical's potential to cause any of three designated health effects; the likelihood of harmful exposure levels; and, the number of persons exposed.

Section 112 of the Clean Air Act requires EPA to identify hazardous air pollutants and to develop appropriate national emissions standards for various types of sources (e.g., fugitive emissions, routine emissions, etc.). Under section 112, a finding that emissions of a chemical from specific types of sources pose significant cancer risks warrants EPA's establishment of national emission standards for those sources. Accordingly, factors considered by EPA to be relevant in section 112 determinations include: the human carcinogenicity of the chemical; the magnitude of the emissions of the chemical from specific types of sources; the ambient concentrations of the chemical in the vicinity of the emission sources; the proximity of people to these sources; the estimated maximum individual risks posed by emissions of the chemical; the estimated incidence of cancer in the exposed population; projected increases in emissions of the chemical from new sources of the same type; estimations of the reductions in emissions and health risks that can be achieved; and the uncertainties associated with the quantitative risk estimates (including effects of concurrent exposures to other substances and to other emissions of the chemical from other types of sources).

Section 109 of the Clean Air Act requires EPA to establish national ambient air quality standards for three classes of chemicals (excluding those chemicals identified as hazardous air pollutants under section 112), based upon findings that they may cause or contribute to air pollution according to criteria outlined in section 108. In establishing such standards, EPA is required to provide an "adequate margin of safety" so as to prevent pollution levels that have been demonstrated to be harmful and also to prevent lower pollution levels that may pose unacceptable risk of harm, even if that risk is not precisely identified as to nature or degree. In selecting a standard that provides an adequate margin of safety, EPA has considered such factors as the nature and severity of the health effects involved, the size of the sensitive population(s) at risk, and the kind and degree of the uncertainties that must be addressed.

The Agency also recognizes a number of disadvantages associated with including population risk as a factor in developing the screening concentration standards. EPA is concerned that it may not be able to assign different potentially exposed populations to different hazardous constituents or chemical compounds, a crucial element in the use of population risk as a factor for determining the acceptable MEI risk for each individual compound.

This concern rests upon two primary factors. The first, which is practical in nature, is that the Agency's existing data on hazardous waste management practices are limited with respect to the location of individual hazardous constituents at specific land disposal facilities. EPA's current sources of data on the more than 1,500 concurrently operating land disposal facilities include Part A and B permit applications and biennial reports. While these data sources do provide information on the wastes managed at facilities, by EPA waste code, they provide little information on the types of hazardous constituents contained in those wastes. Thus, EPA is concerned that it lacks the type of data that would be required to defend the assignment of different population distributions to different constituents.

The second reason for EPA's concern is that the Agency recognizes that hazardous wastes and hazardous constituents are extremely mobile. Today's location patterns for individual hazardous constituents across the more than 1,500 RCRA land disposal sites may not be adequately represented by their patterns in 1981 or even 1983. Location patterns in 1981 or 1983 are even less likely to represent disposal facility location patterns in 1990, the year 2000, and beyond. Waste shifts occur as capacities are used up, as the economics of transportation and commercial waste management practices continue to evolve, as industries change the location of their production process, and as new industries develop.

In addition, the Agency is concerned that including population risk as a factor in determining acceptable MEI risk levels in developing the screening concentration levels may complicate the decision-making process required to establish section 3004(m) treatment standards within the statutory timeframes and may create inconsistency over the many hundreds of such decisions that must be made. The Agency has not, to date, established any formal decision rules for determining acceptable numbers of additional cancer cases or for weighing MEI risk against population risks. The development of such decision rules is expected to be time consuming. The Agency is concerned that in the absence of such decision rules, its development of the screening concentration levels and associated section 3004(m) treatment standards may be inconsistent across the more than 350 constituents for which they must be developed.

Accordingly, EPA specifically requests public comment on the inclusion of population risk as a factor in developing the screening concentration levels, on specific aspects of the approach suggested for implementing this concept (described in detail in the remainder of this unit), on other approaches that the Agency should consider for implementing this concept, and on the nature, sources, and availability of data required to consider population risk in addition to MEI risk.

The remaining parts of this unit describe one approach the Agency is considering for including population risk (incidence) as a factor in setting the screening levels. Three major steps for assessing incidence are listed. A detailed approach for each step is offered. Potential sources of data—both the extent and quality—are described. Assumptions necessary to complete the evaluation are listed.

STEP 1: *Calculate population risk estimates.* Population risk estimates can be calculated in a similar manner for air, surface water, and ground water routes of exposure. To do so, the Agency would first gather population counts for areas surrounding existing hazardous waste disposal facilities. Where exposure through ground water and surface water is considered, the appropriate measure is the number of persons whose drinking water is supplied by ground water and surface water potentially affected by disposal facilities, as well as the number of persons consuming contaminated fish. EPA would consider populations living within a 50 km radius when assessing incidence due to exposure through air. Fifty kilometers is generally the largest distance that is used to model dispersion and exposure to airborne pollutants, and is also the distance used in the comparative risk assessments described in Unit III.C.

Using the address of each facility seeking a permit under RCRA, EPA can estimate the current surrounding populations using the most recent census data. Ground water usage data can be obtained from the Federal Reporting Data System (FRDS) maintained by EPA's Office of Drinking Water. This source contains records of all wells used as public water supplies. A major source of private well use data is the 1980 Census. The Census contains information on the water supply source for each U.S. household. The Agency is presently adding these data to the FRDS data base. In a related effort, EPA is matching water supply source data with the location of hazardous waste and other facilities. When supplemented with data gathered from Part B permit applications and from recent EPA visits and inspections of RCRA interim status facilities, the Agency may be able to estimate accurately the number of potentially exposed people currently near RCRA land disposal facilities.

Next, the Agency could develop a distribution that reflects the relative frequency at which a given number of people may be exposed to releases from each hazardous waste disposal unit.

Finally, current population risk would be estimated by multiplying the risk to the maximum exposed individual chosen as the basis of the health-based level by the number of exposed people. Note that for exposure through ground water, assuming steady-state exposure, risk to the maximum exposed individual equals risk to the "average" exposed individual. This is due to two factors: concentration at the well is estimated to be constant in time; and, since all consumers drink from the same well, there is no differential exposure.

STEP 2: *Estimate future population exposure.* These incidence estimates could then be adjusted for population change patterns. One approach would be to evaluate census data for each site for the past 40 years to determine population density and ground water use trends. The following Figure 3 illustrates population change trends for 6 major U.S. cities over the past 40 years:

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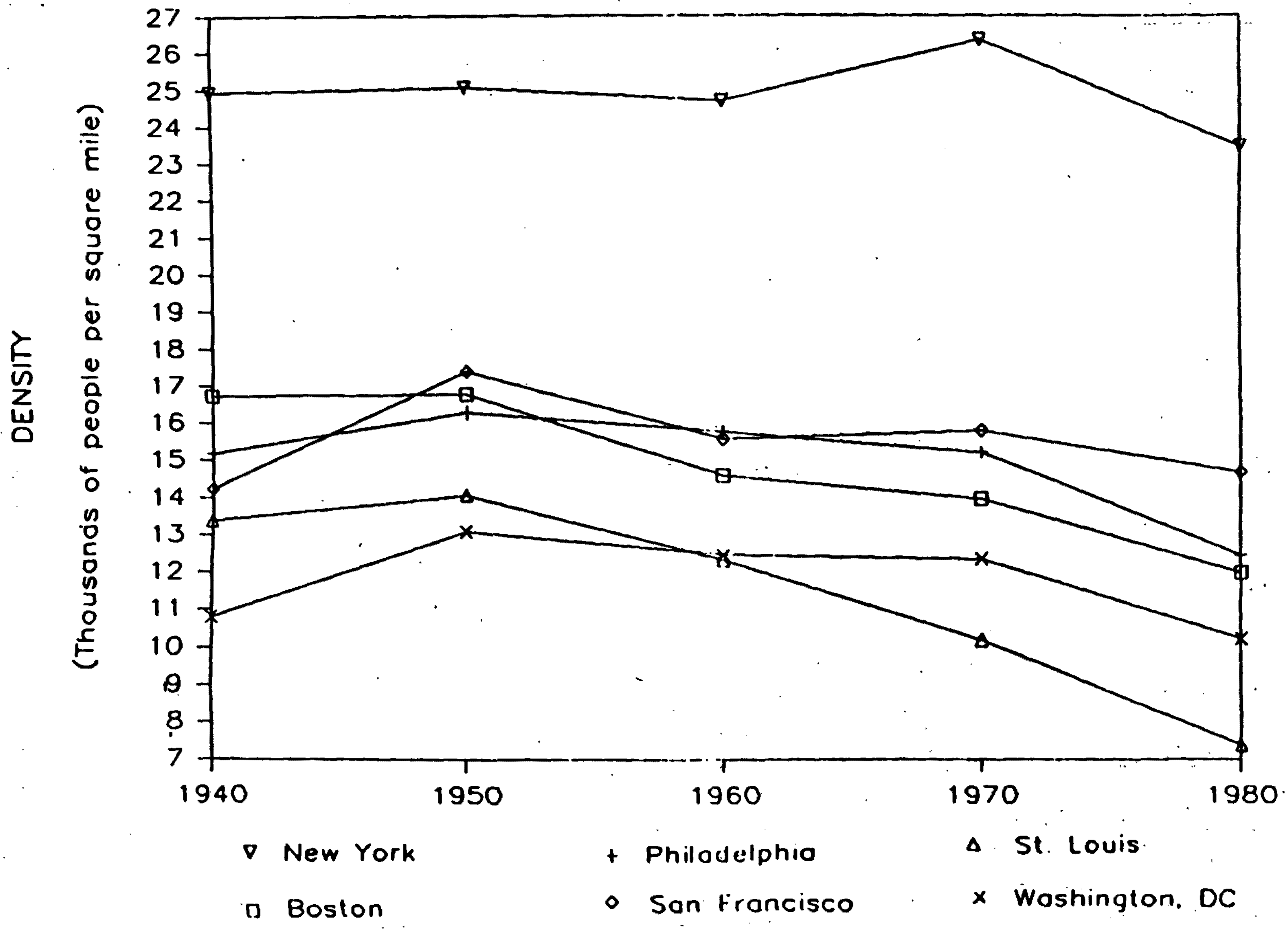
Figure 3

POPULATION DENSITY OF SELECTED CITIES OVER TIME



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EPA could adjust current populations at benchmark times in the future reflecting these trends. Data seem to indicate that the most densely populated and biggest cities are becoming less densely populated over time. For example, New York City reached the largest U.S. population density ever in 1970. New York's population density has been declining since that time. Instead of assuming that current trends continue, EPA may need to limit the decline in density using informed judgment. Otherwise population would shrink to nothing over a several hundred year time horizon. In a similar fashion, the Agency could cap the density of any rapidly growing smaller community, perhaps to that of New York City in 1970, to prevent estimation of densities growing so large that the entire population of the country could fit into a single city. Then, at each benchmark time, EPA could generate the population distribution for all current sites, and use this distribution to estimate potential future incidence. The Agency notes, however, that this process may not account for the development of entirely new communities, where previously none had existed, as in the case of the establishment of planned communities or the creation of new housing developments in rural areas.

STEP 3: *Incorporate population risk into the procedures to develop the screening concentration levels.* The final step is to include population risk (incidence) as a factor in determining the screening concentration levels. First, a reference dose based on the starting point of 10^{-6} MEI risk for carcinogens would be used as the starting levels to back calculate a corresponding screening concentration level using the back calculation models. The population risk corresponding to this individual risk would be estimated by multiplying individual risk by the exposed population (e.g., for an MEI risk of 10^{-6} and an exposed population of 1,000,000, the population is $10^{-6} \times 1{,}000{,}000 = 1$). Then, reference doses corresponding to alternative MEI risk levels from 10^{-4} to 10^{-7} would be used to back calculate corresponding screening concentration levels and associated population risks. This individual risk range represents the general historical range of Agency risk management decisions. Agency regulations have not often reflected individual risks greater than 1 in 10,000 and risk reductions to levels below 10^{-7}.

The following Table 4 illustrates a possible array of information that could result from this process for a given carcinogenic constituent:

TABLE 4.—EXAMPLE ARRAY OF INDIVIDUAL RISK AND POPULATION RISK

Constituent: example A		Health effect: liver cancer	
MEI risk	Corresponding reference dose (ppm) [1]	Screening concentration level (ppm)	Population risk (cases per 1 million exposed)
10^{-4}	10,000	240,000	1,000
10^{-5}	1,000	24,000	100
10^{-6}	100	2,400	10
10^{-7}	10	240	1

[1] Obtained from the example constituent's dose-response curve.

The Agency would then use this information to determine the acceptable MEI risk level for the constituent, its associated reference dose, and its back-calculated screening concentration levels that provides both acceptable individual and population risks.

The Administrator could weigh each of the relevant factors to decide which MEI and population risk levels are acceptable for the constituent as has been done in the previously cited regulutory decisions under the Clean Air Act and the Toxic Substances Control Act, or, alternatively, a "rule" for making decisions on appropriate screening levels could be developed. The Agency notes that past efforts to establish a decision "rule" for determining acceptable MEI and population risk levels have proven unsatisfactory, and that the Agency has instead relied on case-specific determinations. The Agency requests comment on these two approaches for determining the screening concentration levels. In particular, the Agency would like comment on the kinds of "decision rules" that might be appropriate for such decisions.

There are two potential complications to the approach that is described above. First is the problem of future site development. Second is the matching of wastes and constituents to RCRA facilities.

EPA has described an analytical system that includes present and future population risks at existing facilities. Future facilities, which theoretically could be located anywhere (and have any number of exposed persons) have not been evaluated. However, the following factors lessen the effects of this omission. New facilities will have to meet EPA's forthcoming location standards. These rules will limit new hazardous waste management facilities to a smaller, safer variety of locations than existing facilities currently used. The Agency's Groundwater Protection Strategy (Ref. 108) recommends limiting the siting of new hazardous waste facilities over irreplaceable Class I aquifers and certain highly vulnerable Class II aquifers. Specific guidance for implementation of the strategy will be available in the near future to aid the siting evaluation process. EPA believes that the permitting process will also create pressure for the location of new facilities in very acceptable locations only. Therefore, EPA believes that the environments in which new facilities will be located may resemble closely the type of locations upon which the health-based thresholds were established, limiting the population risk posed by future facilities to less than or equal to the population risk posed by existing facilities.

If the effect of distributed waste and constituents among hazardous waste management facilities is omitted, population risk will be the same multiple of MEI risk for all constituents. Thus, the incidence factor would not be useful, since no new or unique information would be offered by estimating population risk. It may, however, be possible to identify all the locations at which specific hazardous constituents are disposed. This first requires identifying the specific locations at which each hazardous waste is currently managed. As indicated previously, EPA has data on many facilities' wastes in the Hazardous Waste Management Data System (HWMDS), obtained from Part A permit applications, and in other EPA data files developed from random and nonrandom surveys. Each waste is associated with a limited, known set of Appendix VII constituents (constituents for which the waste was listed). EPA has very limited data for wastes concerning the presence and concentration of additional constituents, and is concerned that it may be unable to develop constituent distributions (and thus population risk estimates) for a limited set of constituents. Nonetheless, for some important constituents, EPA may be able to determine in exactly which wastes they are present. Then, the Agency could map the disposal location for these waste constituents. When EPA develops population distributions for each of these constituents, the Agency will only include facilities that currently accept the particular constituent under evaluation. Thus, individual constituents will have population risk estimates based on relevant population distributions. The Agency is concerned, however, that these population distributions may not reflect future or even current population distributions, since the data from which they would be developed are for 1980 and 1981, and due to the fact that hazardous wastes are easily transported. Furthermore, the Agency is concerned that many hazardous constituents already appear at such a broad variety of facilities that they will exhibit essentially the same location pattern with respect to potentially exposed population distributions. Accordingly, for most constituents EPA would be unable to specify accurate specific populations for use in incidence calculations. In these cases, the Agency would use population data from the entire set of hazardous waste land disposal units.

The preceding discussion assumes that waste distribution patterns among existing disposal facilities will remain constant. Once permits have been issued, facilities must obtain permit modifications to accept new wastes. To the extent that waste disposal patterns shift from on-site to commercial facilities, the Agency could include these effects in a sensitivity analysis to the incidence calculation. Otherwise, limitations in EPA's ability to account for this phenomenon present a weakness in its analysis of population risk. Comments on the importance of waste shifts, and, in particular, on the impact of the absence of any regulatory controls on the location of waste constituents in the calculation of incidence, and suggestions for addressing this problem are requested.

2. Ground Water Back Calculation Procedure

a. *Introduction.* Under the framework presented in this proposal, EPA will establish screening concentration levels for individual hazardous constituents contained in hazardous wastes. These levels are expressed as maximum acceptable concentrations for individual constituents in extracts of wastes. EPA has developed a quantitative modeling procedure to evaluate potential impacts on ground water and establish screening levels for this medium. The proposed ground water screening procedure involves a back calculation from a point of potential exposure at a specified distance directly downgradient from a land disposal unit to a point of release from a land disposal unit using a fate and transport model (Ref. 2).

This procedure considers a number of factors including:

i. The toxicity of constituents in the waste.

ii. The mobility of constituents in the waste.

iii. The persistence of constituents in the waste.

iv. The long-term uncertainties associated with land disposal. The toxicity of a constituent is considered in the procedure by specifying a reference dose (health effect level) at the point of measurement and back calculating the maximum acceptable leachate concentration that will not exceed the specified level.

The mobility of constituents is considered in the procedure through the actual leachate values and, for organics, through incorporation of sorption as a delay mechanism to travel in the ground water model. The inclusion of sorption in the ground water model acts to delay the time of arrival at the measurement point and is important only for organic constituents which degrade.

The persistence of constituents is incorporated into the ground water model for organics by considering hydrolysis. Metals do not degrade, so no degradation is assumed. However, speciation of metals in ground water is considered through incorporation of the MINTEQ speciation model (Ref. 2) in the procedure.

The long-term uncertainty of land disposal is considered by evaluating the long-term performance of engineered land disposal units. Specifically, the model assesses the long-term chemical flux or leaching to the ground water from RCRA Subtitle C land disposal units under certain assumed conditions. This leaching process depends on climatic conditions, soils, and the long-term performance of the engineered unit. EPA developed long-term quantitative estimates of leaching rates using the HELP model.

In sum, the ground water back calculation procedure involves the application of three model components: the HELP model which addresses performance of engineered controls, the fate and transport model (EPASMOD) which models the behavior of constituents in the ground water environment, and the MINTEQ model which models the behavior of metals in the ground water environment (Ref. 2). These major components of the ground water screening procedure are described in more detail below.

b. *The HELP model.* The HELP model was developed by EPA specifically to facilitate estimation of the amount of runoff, drainage, and leachate that may be expected to result from a hazardous waste landfill. In general the HELP model predicts the water balance by performing a mass balance between flow into various components of a landfill and water leaving these components. The model uses climatologic, soils, and design data to produce daily estimates of water movement across, into, through, and out of landfills. The HELP model conducts water balance computations on a daily time step and accounts for the effects of runoff, surface evaporation, infiltration, evapotranspiration, subsurface lateral drainage, and percolation. The model contains default data which can be used if alternative data are not available. Data requirements and inputs to the model are discussed below.

i. *Climatologic data.* The HELP model contains a climatologic data base for 102 reporting stations located in the U.S. The data base consists of 5 consecutive years of daily precipitation values in inches, one set of mean monthly temperatures, mean monthly insolation, and leaf area indices and winter cover factors. The model allows manual input of all or any part of the above input variables. The maximum data base size allowed by the model is 20 years of record. Because the built-in data files are not representative of climatic conditions in the U.S., the Agency developed representative climatic conditions for the U.S., then selected appropriate default climatic files from the model for further analysis.

To develop representative national climatologic conditions, precipitation and evaporation data from the National Oceanic and Atmospheric Administration were used to identify ranges of climatic conditions that are encountered in the 48 contiguous States. Using these distributions, the Agency selected six precipitation ranges and three evapotranspiration conditions as representative of the U.S. Thus, a total of 18 climatic conditions were identified for developing national distributions of leaching rates. A reporting station of climatic data was selected in each of these 18 areas from the 102 cities included in the HELP model data base. Cities selected represent the median range for each of the 18 climatic conditions. For each city selected, the 5 years of climatic data in the model were accessed and used to develop national leaching rates. The Agency believes that the selected cities and associated climatic data are representative of climatic conditions throughout the U.S. and are appropriate for use in this analysis.

Long-term chemical flux to ground water from land disposal units occurs as a result of precipitation (water) percolating through the waste and dissolving chemicals into this liquid. Precipitation in excess of losses due to surface runoff and evapotranspiration will result in net infiltration or deep percolation to soils below the root zone. The Agency considers net infiltration to be comparable to the long-term chemical flux at land disposal units. Thus, since EPA assumes that the land disposal unit is completely saturated at the end of the post-closure care period, if 1 inch of water is estimated to infiltrate into the unit, 1 inch of leachate will be released from the unit.

ii. *Facility design.* The goal of the design standards for hazardous waste land disposal units is to minimize the formation and migration of leachate to the ground water environment. The Agency assumes that land disposal units will contain hazardous constituents that will be capable of migrating out of the units during the active life, closure, and post-closure period. The goal of the liners and leachate detection/collection systems is to minimize the rate and volume of leachate and constituent migration so as to prevent ground water contamination during the operating, closure and post-closure care periods (the latter is normally assumed to be 30 years). During and after the post-closure care period, the final cover is required to minimize infiltration into the closed unit.

Data describing the physical design of the land disposal unit must be specified as inputs to the HELP model. The major design conditions which must be specified include cover and liner configuration (e.g., slope, soil types, barrier layer materials, vertical percolation layer and lateral drainage layers), type of vegetative cover, and depth of root zone. Specification of these design conditions was based on an evaluation of the requirements for RCRA Subtitle C land disposal units.

As noted earlier, the model addresses four major methods of land disposal, i.e., surface impoundments, landfills, waste piles, and land treatment (underground injection wells are to be addressed separately). Eventually, the Agency hopes to develop an additional component to the ground water model which specifically addresses land treatment units.

The Agency based its evaluation of the long-term performance of engineered controls at these units on several key assumptions. First, the Agency assumes that there will be no chemical flux resulting in ground water contamination during the active life, closure, and post-closure care periods at these units. This assumption is based on EPA's belief that the liner and leachate collection systems required by the new section 3004(o), together with corrective action requirements, will assure that hazardous constituents will not migrate to the ground water in unacceptable concentrations during this time period. Second, the Agency assumes that the engineering controls to be evaluated by the model, i.e., those remaining in place after the post-closure care period, are those controls applicable to a closed landfill.[10] The assumption is founded on the requirements of the existing regulations which specify that surface impoundments and waste piles must either remove or decontaminate all hazardous wastes at closure, or close in conformance with landfill closure standards (40 CFR 264,228 and 264.258). Third, the Agency assumes that the leachability of the waste is not diminished during the active life, closure, and post-closure care periods. Fourth, the Agency assumes no degradation of hazardous constituents through the postclosure care period. Fifth, the Agency assumes that infiltration resulting from precipitation is the major mechanism responsible for mobilizing wastes in the unit. Finally, the Agency assumes that, beginning immediately after the end of the post-closure care period, the engineering controls applicable to a closed landfill will have degenerated to the point that the primary engineered mechanism for controlling chemical flux through the unit will be the clay component of the cap. This is a worst-case assumption because it presumes the flexible membrane liners will cease to function immediately at the end of the post-closure care period. This last assumption is explored in more detail below.

The engineering components of a closed landfill include multi-layered cover and liner systems consisting of drainage layers, flexibile membrane liners and soil barriers. Performance of engineered units in the short term (i.e., during the operating life, closure, and post-closure care periods) depends on appropriate design, material selection, and specification, construction, waste screening, inspection, maintenance, and monitoring. In the long term (i.e., beyond the 30-year post-closure care period) the performance characteristics of cover and liner systems can be expected to change. Components such as flexible membrane liners may undergo dramatic changes in performance while other components, such as clay liner, may undergo more limited change in performance. The effect these changes have on component and unit performance will control the chemical flux rate.

The principal change affecting this long-term chemical flux rate is expected to be the degradation of the flexible membrane liners to a point where they are no longer effective in controlling leachate movement. Additionally, the leachate detection/collection systems that remove leachate from the unit are assumed not to be operating after the 30-year post-closure care period because the regulations generally do not require operation after this 30-year period. The clay layers are expected to have greater hydraulic conductivity as a result of geologic change and exposure to chemicals.

Practical experience with the performance of flexible membrane liners as barriers to leachate flow is limited to a few decades. (Limited data suggest that the long-term service life of flexible membrane liners may extend over several decades and possibly as long as 100 years.) Since EPA's long-term analysis of engineering controls considers performance over hundreds of years and the service life of flexible membrane liners is estimated to be a fraction of this period, the effectiveness of flexible membrane liners to control leaching rates after the end of the post-closure care period is assumed to be equal or less than that of clay barriers.

The use of clay soils in cover or liner systems is subject to both geologic weathering and alteration of the clay soil structure on exposure to chemicals. The extent of alteration is controlled by factors such as type of clay mineral, waste constituent, and constituent concentration. Naturally occurring clay soils near the ground surface can be considered representative of the extent of geologic weathering to which clay barriers in RCRA Subtitle C facilities will be exposed. A survey of clay soils across the U.S. indicates ranges of hydraulic conductivity from 1.4×10^{-6} to 4.3×10^{-5} cm/sec for soils at depths of 30 to 80 inches (Ref. 40). The Agency assumed that natural clays compacted to achieve the required hydraulic conductivity of 10^{-7} cm/sec will have long-term hydraulic conductivities similar to the upper limit for hydraulic conductivity found in geologically weathered naturally occurring clays. Additionally, evidence indicates that the

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[10] As will be explained later, the model assumes that the controls remaining in place after the post-closure care period will consist only of the clay components of the cap and liner systems. All synthetic components, as well as the leachate detection/collection system, are assumed not to affect the chemical flux following the post-closure care period.

hydraulic conductivities of clay soils may increase by a factor of 100 upon exposure to waste constituents (Ref. 2). While much of the current knowledge of chemical interactions with clay is based on laboratory studies, similar effects are expected under field conditions. A hydraulic conductivity range of 5×10^{-6} to 5×10^{-7} cm/sec is assumed to be a reasonable estimate of the long-term performance of clay barriers.

Based on the above evaluation, the Agency selected the following facility design conditions for a RCRA Subtitle C landfill for analysis in the HELP model:

(A) A cap consisting of:

(1) Two feet of cover soil consisting of a loam texture and good grass stand.

(2) One foot drainage layer at 2 percent slope to a free drain at the toe of the slope.

(3) Root zone of 3 feet.

(4) Clay cover of 3 feet with a long-tgerm hydraulic conductivity of 1×10^{-6} cm/sec; [11]

(B) A liner consisting of:

(1) A flexible membrane liner.

(2) A clay liner.

However, as previously discussed, the long-term effectiveness of flexible membrane liners is assumed to be equal to or less than that of the clay liner. The clay layer in the bottom liner system is assumed to be subject to similar conditions as the clay layer in the cover system and is also exposed to chemicals leaching from the waste. Therefore, the hydraulic conductivity of the bottom clay liner is expected to be equal to or greater than the clay layer in the cover, and to have no effect on the chemical flux through the unit.

Leaching (flux) rates were estimated for RCRA Subtitle C landfills using the HELP model for the climatic conditions and design specifications specified above. Leaching rates were estimated for the 18 climatologic conditions. As a whole, this set of conditions is considered representative of the entire U.S. These chemical flux rates were incorporated into the steady-state advective dispersive transport model through mass balance principles by relating the areal flux of leachate through a land disposal unit to the nature of the leachate after it is mixed in the aquifer. This mechanism is described later in this unit. EPA solicits public comment on the above-described application of the HELP model to simulate the containment provided at certain RCRA Subtitle C facilities. In particular, the Agency requests comment on the various assumptions articulated in the foregoing discussion.

c. *Fate and transport model.* The fate and transport of constituents in the ground water to a measurement point directly downgradient from a land disposal unit is approximated through a three-dimensional steady-state advective dispersive model. The mathematical techniques employed in the model are based upon analytical solution procedures well established in the scientific literature.

The proposed ground water model accounts for most of the major physical and chemical processes known to influence movement and transformations of chemicals in simple, homogeneous and isotropic porous media under steady flow conditions. The mechanisms considered include advection, hydrodynamic dispersion in the longitudinal, lateral, and vertical dimensions, absorption, and chemical degradation. Mechanisms not considered in the model include biodegradation and dilution of constituents in drinking wells due to well drawdown. The Agency requests comment on an alternative approach which would account for dilution caused by well drawdown. EPA requests submission of data on constituent dilution rates typically caused by well drawdown to assist its consideration of this matter by commentators concerned about this issue.

d. *Model assumptions.* The analytical solution described below is based on a number of key assumptions pertaining to the features of ground water flow, properties of the porous medium and the behavior of hazardous wastes in ground water. These assumptions include the following:

i. Saturated soil conditions (no attenuation of chemicals in the unsaturated zone).

ii. Flow regions of infinite extent in the longitudinal direction, semi-infinite extent in the lateral direction, and finite in the vertical direction.

iii. All aquifer properties are homogeneous and isotropic and of constant thickness.

iv. Ground water flow is uniform and continuous in direction and velocity.

v. Degradation is limited to hydrolysis and byproducts of hydrolysis are assumed to be nonhazardous.

vi. Sorption behaves linearly.

vii. Infinite source—supplies a constant mass flux rate.

viii. Precipitation recharge supplies water to the aquifer.

ix. The ground water is initially free of contamination.

x. The receptor well is directly in line with the source and the ground water flow.

xi. The receptor well is located 500 feet from the unit.

The effect of the first assumption is to presume that a waste is placed directly at the top of the saturated zone. Based on a survey of 163 Part B permit applications available within EPA as of October 1984, the Agency determined this assumption to be reasonable because approximately 10 percent of the land disposal units in the survey extended to the top or within a few feet of an aquifer. This worst-case assumption predicts that no attenuation occurs during the migration of constituents in leachates to the underlying aquifer. The Agency believes this conservative assumption, like the other conservative assumptions included in this analysis, is appropriate for the reasons noted in Unit III.A. The second assumption of infinite and semi-infinite flow regions in the longitudinal and lateral direction respectively is appropriate for all simplified analytical ground water flow models. However, aquifers have a finite areal extent and could be confined by impermeable layers. If an aquifer is confined by an impermeable layer, this assumption may underestimate or overestimate downgradient contaminant concentrations.

The assumption of homogeneous and isotropic aquifer properties is rarely encountered in the field, but the availability of data and the generic nature of this analysis require the use of a homogeneous and isotropic approximation. Also, this assumption is usually employed if the solution of the problem is obtained by analytical techniques.

The fourth assumption of uniform flow velocity presumes that the water volume entering from the source isnot large enough to affect the natural ground water gradient. This assumption is appropriate for simplified analytical solutions. In situations where the ground water flow system contains pumping or injection wells, drastic changes in the velocity distribution will occur. Under this situation, the steady-state downgradient contaminant concentrations may be overestimated or underestimated.

Degradation limited to hydrolysis, the fifth assumption, is the only mechanism for transformation considered in the proposed model. While other transformation mechanisms such as biodegradation and oxidation are also important, the Agency's present understanding of these mechanisms

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[11] Although the regulations require a synthetic liner in the cap if a synthetic liner is included in any liner under the waste, the presence of a synthetic liner component in the cap is ignored for purposes of this anaylsis because synthetic liners are presumed to provide equal or less control than clay liners.

does not yet permit a kinetic representation of these processes within the system modeled. The effects, relative importance, and interactions of these processes in the ground water environment are not well understood and are under investigation.

In general, all transformations are dependent upon both the chemical constituent and the prevailing environmental properties. For hydrolysis, ground water pH and temperature must be known. The Agency's analysis to date has identified more than 20,000 measurements for pH and temperature from which distribution functions can be assigned for purposes of evaluating variation and uncertainty. Similar data describing microbial populations, metabolizable carbon sources, etc., are not generally available. The Agency believes that with this limited understanding of the factors influencing biodegradation and oxidation in the ground water environment, these processes cannot be included in the proposed ground water screening model. By including only hydrolysis in the model, the Agency is being conservative. The Agency requests comment on an alternative modeling approach which would directly consider these phenomena. Accordingly, the Agency is interested in receiving any available data on constituent biodegradation, oxidation, and reduction rates in ground water.

The sixth assumption, sorption behaves linearly, specifies that sorption is instantaneous, of local equilibrium, and completely reversible. Sorption reactions for contaminants in ground water are viewed as being rapid relative to the flow velocity; and the amount of contaminant sorbed is commonly a function of concentration in the solution. At constant temperature and moderate concentrations, the relationship between the absorbed concentration and dissolved concentration is approximated by equilibrium isotherms. Based on this relationship, the Agency believes this assumption to be reasonable.

The seventh assumption of an infinite source presumes that the mass of a constituent in a land disposal unit is physically realistic to justify this conservative assumption. The Agency has evaluated the significance of this assumption and its impact on the outcomes of the ground water modeling procedure. The evaluation demonstrates that the mass required to justify this assumption is quite reasonable and physically realistic (Ref. 2).

The assumption of dilution of the contaminant plume by precipitation recharge accounts for the impact of water that infiltrates through the soil layers and enters the aquifer. The Agency believes it is appropriate to incorporate precipitation recharge in the ground water model because it is a process known to occur in the environment and representative values can be developed for the contiguous 48 States using the HELP model.

The assumption of placement of a well in the exact position to receive the highest concentration of a contaminant represents a worst case. The Agency believes this assumption is appropriate for use in the generic screening procedure because some drinking water wells may be directly in line with RCRA Subtitle C land disposal units and because it is impossible to determine the extent to which wells are not located directly in the path of potential plumes.

Finally, the back calculation is based on the assumption that the receptor well is located 500 feet from the unit. Existing RCRA regulations under §§ 264.120 and 265.120 require owners of disposal facilities to record a notation on the deed for the property (or other instruments examined during title searches), that the land has been used to manage hazardous waste. Since this will provide notice to subsequent owners of the property of the land's prior use, it may be reasonable to assume that no one would extract water for human consumption from within the property boundary. Accordingly, EPA could conclude that the area of effective control extends to the property boundary. A more conservative approach to defining the area of effective control is the waste management boundary—an imaginary line circumscribing the regulated units at the facility or, even more conservatively, the edge of the disposal unit. As described in further detail in Unit III.G of this preamble, on a site-specific basis, the area of effective control may extend beyond the unit, waste management area, or in limited circumstances, the property boundary.

In an attempt to quantify a distance representing the potential point of human exposure on a generic basis, the Agency did a survey of 163 Part B hazardous waste land disposal permit applications available to EPA as of October 1984. (This information is currently being updated to include permit applications received since October 1984.) Information from that survey on the ranges of distances to both the waste management boundary and the property boundary from the edge of land disposal units is presented in the following Table 5;

TABLE 5.—ESTIMATED DISTANCES TO PROPERTY BOUNDARY AND WASTE MANAGEMENT BOUNDARY FROM LAND DISPOSAL UNITS BASED ON PART B PERMIT APPLICATIONS

Estimated Distance to Downgradient Property Line from Edge of Largest Land Disposal Unit:		
*N=177	10% =	50 ft
Mean=1,365	25% =	166 ft
Median=500	75% =	1,388 ft
Range 0–19,000 ft	90% =	4,070 ft
Estimated Distance to Downgradient Property Line from Edge of Smallest Land Disposal Unit:		
*N=36	10% =	153 ft
Mean=1,504 ft	25% =	305 ft
Median=659 ft	75% =	1,906 ft
Range 71–9,500 ft	90% =	4,202 ft
Estimated Distance to Downgradient Waste Management Line from Edge of Largest Land Disposal Unit:		
*N=91	10% =	10 ft
Mean=456 ft	25% =	50 ft
Median=167	75% =	700 ft
Range 0–3,543 ft	90% =	1,137 ft
Estimated Distance to Downgradient Waste Management Line from Edge of Average Land Disposal Unit:		
*N=20	10% =	23 ft
Mean=584 ft	25% =	63 ft
Median=250 ft	75% =	986 ft
Range 20–3,228 ft	90% =	1,933 ft
Estimated Distance to Downgradient Waste Management Line from Edge of Smallest Land Disposal Unit:		
*N=39	10% =	10 ft
Mean=541 ft	25% =	40 ft
Median=100 ft	75% =	700 ft
Range=0–4,200 ft	90% =	1,820 ft

*"N" stands for the number of units evaluated.

Based on this information, the Agency believes that selection of a distance of 500 feet is a reasonably conservative estimation of the point of potential human exposure.

(A) *Characteristics of the model.* The three dimensional transport equation upon which the proposed ground water model is based has terms representing dispersion in three dimensions, and chemical-specific decay and velocity. It is presented as equation (1) written in the form (Ref. 23):

$$(1)\quad D_{xx}\frac{\partial^2 c}{\partial x^2} + D_{yy}\frac{\partial^2 c}{\partial y^2} + D_{zz}\frac{\partial^2 c}{\partial z^2} - \frac{V}{R_f}\frac{\partial c}{\partial x} = \frac{\partial c}{\partial t} + \lambda c + Ic$$

Where:

x, y, z=spatial coordinates in the longitudinal lateral and vertical directions, respectively, (m)

c=dissolved concentration of chemical, (g/ml)

D_{xx}, D_{yy}, D_{zz}=retarded dispersion coefficients

in the x, y and z directions, respectively, (m^2/yr)
V=ground water seepage velocity assumed to be in the x direction, (m^2/yr)
R_f=retardaton factor, (dimensionless)
t=elapsed time, (yr)
=effective first order decay constant, (yr^{-1})
θ=volumetric water content of the porous medium, (cm^3/cm^3),
I=net recharge due to precipitation (yr^{-1}).

The retardation factor, R_f, and the effective decay constant, are defined as follows:

$$(2)\quad R_f = 1 + \frac{\rho_b K_d}{\theta}$$

and,

$$(3)\quad \lambda = \frac{\lambda_1 \theta + \lambda_2 \rho_b K_d}{\theta + \rho_b K_d}$$

Where:
P_b=bulk density of the porous medium (g/cm^3)
K_d=distribution coefficient (cm^3/g)
θ=volumetric water content, (cm^3/cm^3)
λ_1=decay constant for dissolved phase, (yr^{-1})
λ_2=decay constant for sorbed phase, (yr^{-1}).

A schematic description of the three-dimensional region considered is presented in the following Figure 4;

The flow region is regarded as semi-infinite in the x-direction ($0 \leq x < \infty$), infinite in the y-direction ($\infty < y < \infty$) and finite in the z-direction ($0 \leq z \leq B$) where B is equal to the saturated zone thickness. Initially the aquifer is assumed to be free of contamination.

The analytical solution treats the source concentration (the contaminant concentration in the leachate directly below the land disposal unit) as a Gaussian distribution in the lateral direction (along the y axis corresponding to the leading down-gradient edge of the unit) and a uniform distribution over the vertical mixing or leachate penetration depth, H. The maximum dissolved concentration of the contaminant, c_o, occurs at the center of the Gaussian distribution, y_o. The Gaussian distribution of the contaminant concentration is defined by its standard deviation, σ The standard deviation is measured in terms of distance (meters) and is related to the width of the disposal unit.

The solution of equation (1), subjected to the initial and boundary conditions, is derived in the Background Document to the ground water screening procedure (Ref. 2). This three-dimensional analytical solution can be written in a functional form as follows:

$$(4)\quad c_p(x,y,z,t) = \frac{H}{B} c_f(x,y,t) + \Delta c_p(x,y,z,t)$$

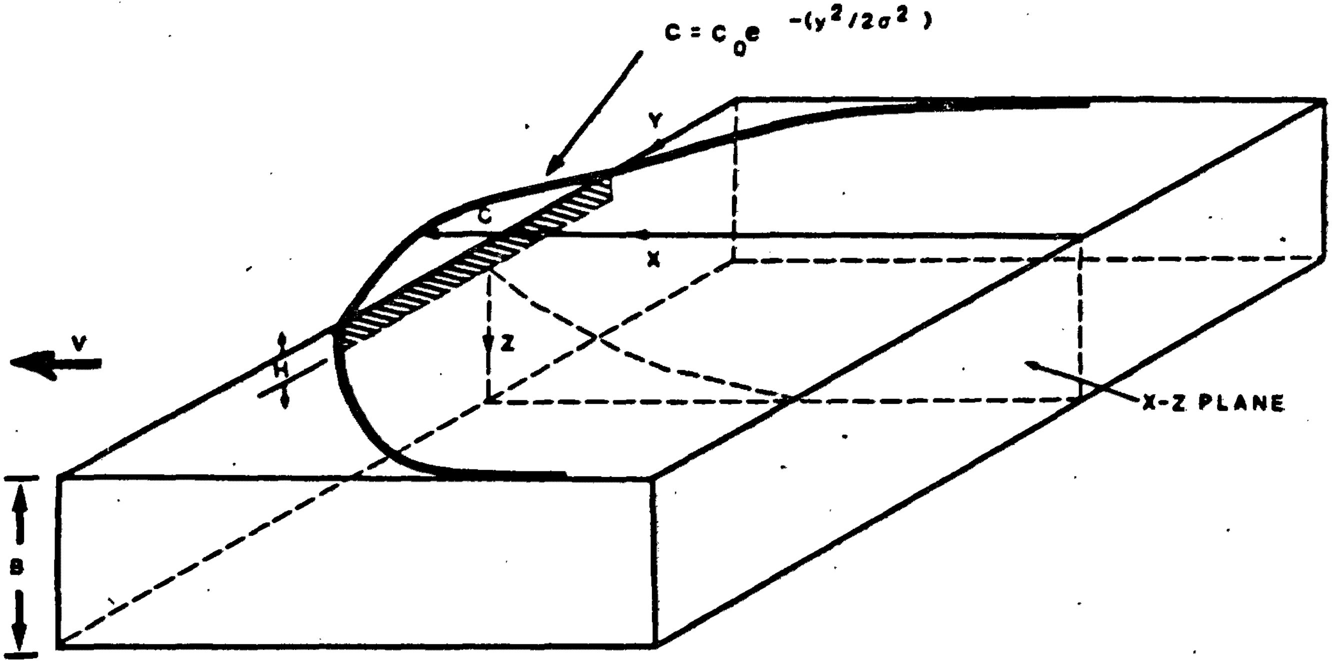

FIGURE: 4 Schematic Description of Three-Dimensional Region For The Analytical Solution.

where the function $c_p(x,y,z,t)$ represents partial penetration of the leachate source in the aquifer $c_f(x,y,t)$ represents full penetration of the leachate source in the aquifer and H/B represents the penetration ratio. The penetration ratio, H/B, is a correction term which accounts for the maximum leachate penetration in the aquifer at the waste unit boundary and has a value between 0 and 1. According to equation (4), the analytical solution for the general partial penetration case, $c_p(x,y,z,t)$, consists of two terms. The first term is the product of the penetration ratio (H/B) and the solution for the corresponding case where full penetration of the source (complete vertical mixing) over the entire saturated thickness is assumed. It can be interpreted as the concentration that would be predicted if vertical spreading of the contaminant plume is not allowed. The second term, $\Delta c_p(x,y,z,t)$, is a correction term necessary to allow for the partial penetration effect which leads to vertical dispersion. Vertical dispersion will cause the contaminant plume to grow in the vertical direction with increasing longitudinal distance from the source. However, vertical extent of the plume is limited by aquifer thickness. The functions for partial penetration and full penetration are derived in the Background Document to the ground water screening procedure (Ref. 2).

(B) *General dimensional relationships.* The apparent complexities of the mathematical solution have been simplified somewhat by the derivation of dimensionless quantities that combine appropriate variables into groups of related parameters. This procedure enhances the graphical display of both the solution technique and individual example solutions because the results are scaled to a much narrower numerical range. The general and simplified dimensionless relationships to equation (4) for steady-state concentration distributions along the x-axis are derived in the Background Document to the ground water screening procedure (Ref. 2). These relationships in combination with the graphical solution in the form of dimensionless type-curves and tabulated values of the dimensionless concentration and dilution factor, developed from the computerized analytical solution, can be used to evaluate steady-state maximum concentration values at any point along the x-axis. An example calculation demonstrating the utilization of the dimensionless relationships and type-curves or tabulated values is provided in the Background Document to the ground water screening procedure (Ref. 2).

The steady-state three dimensional anaytical solution has been programmed into a Fortran computer code, EPASMOD-P (Ref. 2). This code will be used to establish the back-calculated screening constituent levels for constituents evaluated under the land disposal restrictions program. To use the EPASMOD ground water model, input data for all model parameters must be identified. In general, however, the behavior of a specific constituent in the environment is highly dependent on both the environmental setting and the properties of the constituent. The assignment of specific values to describe the behavior of the modeled system is further complicated by uncertainty about how to specify a single value for each model parameter which represents a "worst-case" or "reasonable worst case." As an alternative to identifying reasonable worst-case values for each model parameter, EPA developed a procedure that accommodates the possible variation in environmental settings, the uncertainties in specific chemical properties, and the range of impact of engineered system releases from land disposal units. The developed approach, termed Monte Carlo simulation, involves large numbers of computer runs (e.g., 1,000 to 5,000) with values for each input parameter drawn from data sets describing ranges of possible values and the distribution of values within the range. Additionally, where parameters are correlated, and therefore dependent, the relationships are properly specified in the Monte Carlo routine. The Monte Carlo process proceeds as follows:

(1) Values from each input distribution are selected at random.

(2) A value for the desired output variable, G, (i.e., back-calculated concentration levels) is computed for each randomly selected set of inputs.

(3) The input selection and computation steps are repeated a large number of times (e.g., 1,000 to 5,000) to produce a well-defined distribution of outputs.

(4) The output values are analyzed for presentation as a distribution.

The ground water model parameters and input data requirements include the following: ground water velocity, porosity of the saturated media, dispersivity of the aquifer, distance to the measurement point, standard deviation of the Gaussian source, penetration depth of leachate into the aquifer, thickness of the aquifer, fraction organic carbon content of the soil, pH and temperature of the ground water, and acid, base, and neutral hydrolysis rates. To apply the Monte Carlo analysis properly, relationships between these environmental parameters must be determined. The following Table 6 illustrates the expected dependence among the ground water model parameters and input data:

This table was constructed from a combination of documented observations and engineering judgment. (See the Background Document to the ground water screening procedure (Ref. 2) for a discussion of the expected dependent and independent relationships among the input parameters to the model.) In some cases very weak dependencies may exist but an assumption of independence is made in light of the model's sensitivity to the assumption. The data points denoted by "D" are thought to be sufficiently dependent to require correlated input sequences. All pairs denoted by "I" are considered independent. Independent data sets can be developed as empirical distributions of observed data, as theoretical distributions from a "best-fit" analysis of observed data, or as assumed distributions. Dependent data sets can be developed as empirical, joint, or multivariate distributions, theoretical distributions, or from functional dependencies among the variables and parameters.

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Table 6—SUMMARY OF RELATIONSHIPS AMONG MODEL PARAMETERS AND INPUT VALUES

	V	θ	ρ_b	α_L	α_T	α_z	X	σ	H	B	f_{oc}	pH	T	k_a	k_n	k_b	k_D	I
V		D	D	I	I	I	I	D	I	I	I	I	I	I	I	I	I	I
θ	D		D	D	D	D	I	D	I	I	I	I	I	I	I	I	I	I
ρ_b	D	D		D	D	D	I	I	I	I	I	I	I	I	I	I	I	I
α_L	I	D	D		D	D	D	I	I	I	I	I	I	I	I	I	I	I
α_T	I	D	D	D		D	D	I	I	I	I	I	I	I	I	I	I	I
α_z	I	D	D	D	D		D	I	I	I	I	I	I	I	I	I	I	I
X	I	I	I	D	D	D		I	I	I	I	I	I	I	I	I	I	I
σ	D	D	I	I	I	I	I		D	I	I	I	I	I	I	I	I	I
H	I	I	I	I	I	I	I	D		D	I	D	I	I	I	I	I	I
B	I	I	I	I	I	I	I	I	I		I	I	I	I	I	I	I	I
f_{oc}	I	I	I	I	I	I	I	I	I	I		I	I	I	I	I	D	I
pH	I	I	I	I	I	I	I	I	I	I	I		I	D	I	D	D	I
T	I	I	I	I	I	I	I	I	I	I	I	I		D	D	D	I	I
k_a	I	I	I	I	I	I	I	I	I	I	I	D	D		I	I	I	I
k_n	I	I	I	I	I	I	I	I	I	I	I	I	D	I		I	I	I
k_b	I	I	I	I	I	I	I	I	I	I	I	D	D	I	I		I	I
k_D	I	I	I	I	I	I	I	I	I	I	D	D	I	I	I	I		I
I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	

D denotes dependence

I denotes weak or no dependence

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The summary shown in Table 6 suggests that none of the variables or parameters is totally independent of all other variables or parameters. In some cases, however, an independent "seed" distribution can be generated to which other variables are correlated. For example, the temperature (T) will influence the hydrolysis rate constants but the reverse is not true nor, for the system studied, does anything else influence temperature. Following this rationale, the parameters and variables are generated independently as follows.

(a) *Thickness of the saturated zone.* The thickness of the saturated zone, B, influences the opportunity for vertical dispersive mixing as the plume moves downgradient. Literature values taken from measurements and surveys were used to derive a distribution for this parameter. For the Monte Carlo analysis the thickness of the saturated zone is varied exponentially from 3 to 560 meters.

(b) *Fractional organic carbon content.* The fractional organic carbon content, foc, is used to determine the distribution coefficient, K_D. The distribution coefficient can be determined from the following relationship:

$$(5) \qquad K_D = (foc)\ (Koc)$$

where:
KOC-distribution coefficient normalized to organic carbon.

It is clear from this relationship that the variation in foc leads directly to variation in the K_D and hence retardation of the solute in ground water. Unfortunately, few if any comprehensive subsurface characterizations of organic carbon content exist. In general the values are known to be very low, typically less than .01. In the absence of evidence to the contrary, the approach taken was to assume a low range of Foc. A distribution shape for this range was determined by the distribution of measured dissolved organic carbon recorded as entries to EPA's STORET data base (Ref. 110). The assumption is that dissolved organic carbon reflects the existence (and hence distribution) of organic carbon in the subsurface environment being considered.

(c) *Ground water pH.* The model assumes that the ground water is sufficiently buffered to insure that the pH is not influenced by input of contaminants or changes in temperature. This permits a pH distribution to be derived independently. STORET data were analyzed, a distribution developed and summary statistics generated for pH.

(d) *Ground water temperature.* Assumptions about the independence of ground water temperature are essentially the same as for pH. Temperature influences hydrolysis reactions but the reverse is ignored. Temperature can also influence sorption, but such effects are ignored in this analysis because the influence of temperature on sorption is much less significant than its effect on hydrolysis and the data required to determine this relationship are not available.

(e) *Leachate penetration depth.* The depth, H, to which the leachate flow penetrates the saturated zone is probably related to the relative differences in the leachate velocity and the ground water velocity. Because this analysis is based on a closed landfill and given the fact that disposal of free liquids in landfills is now not permitted, density gradients or stratification of "floaters" or "sinkers" are not likely to occur. Lacking any meaningful data, a simple, independent, uniform distribution ranging from a fixed minimum of 2 meters to a fixed maximum of 10 meters was assumed.

(f) *Net recharge.* Recharge, I, is the amount of water that enters an aquifer system. It is a function of climate, topographic, and soil properties. A distribution for this parameter was developed using the 18 national climatic conditions previously identified in the HELP model discussion for estimating national distributions of leaching rates.

Since the ground water model assumes that the porous media is uniform, the effect of recharge causes the ground water to rise and fall uniformly. Thus, there is no change on the gradient or ground water velocity. The expression for estimating I is as follows:

$$(6) \qquad I = q'/H$$

where:
q'=net infiltration, m/yr
H=leachate penetration depth, m

A summary of the procedures used to generate the independent input data sets is given in the following Table 7:

TABLE 7.—SUMMARY OF PROCEDURES USED TO GENERATE INDEPENDENT INPUT DATA SETS

Input data	Method of generation	Source of data and/or reference
B	FD[1]	Various literature
F_{oc}	FD	STORET, assumptions
pH	FD	STORET
T	FD	STORET
H	AD[2]	
I	Modeling	Various literature

[1] Fitted Distribution to empirical data.
[2] Assumed Distribution.

The fitted distribution (FD) method refers to the development of a mathematically defined frequency distribution function by "fitting" various possible distributions (e.g., normal, log normal, exponential) or mixtures of distributions to the "observed" data and selecting the "best fit" distribution for use in the Monte Carlo process. In all cases, EPA recognizes the possibility that the data in STORET may represent a biased sample. However, lacking another alternative, EPA accepted the data as representative of ground water and subsurface conditions.

The remaining input parameters and variables are dependent and cannot be generated without properly "matching" each value with other related values. The main purpose of building in dependencies is to avoid unrealistic or impossible sets of data. For example, a uniform soil having high porosity because of high clay content will rarely if ever have high ground water velocities because of the low hydraulic conductivities. Failure to exclude such possibilities, however, by assuming that porosity and velocity are independent will lead to unrealistic if not impossible modeling results.

In general, precise functional relationships among all the dependent variables or parameters do not exist. Similarly, observed data for all values taken in sets do not exist or are inadequate in number to permit a statistical representation of the dependencies. Fortunately, however, equations do exist in the engineering and scientific literature to permit generation of sets of "possible" combinations of input data. Generation of consistent sets of input data is much easier to accomplish than the more rigorous but related task of predicting a precise, site-specific set of values given only one or two measurements at that site. The parameters and variables to be generated as dependent values are discussed below.

(g) *Dispersivity.* The spreading of solutes transported by ground water is usually described as a combination of molecular diffusion and mechanical mixing. The relative magnitudes of each are such that molecular diffusion can be ignored. The property of the soil or porous medium that is commonly used to define the magnitude and direction of dispersion is included in the dispersivity parameters. A generalized theory to describe dispersivity has not yet been developed but recent work has noted a strong dependence on scale (Refs. 16, 49, 79, 83, 84, and 94). Some investigators (Ref. 84) have reported simple, linear dependencies for longitudinal dispersivity, v, as 10 percent of the measurement distance, x.

$$(7)\quad \alpha_L = 0.1(x)$$

where:
X=mean travel distance.

More recently, Guven et. al. (Ref. 51) completed a detailed theoretical analysis and suggested an expression of similar form

$$(7a)\quad \alpha_L = 0.093\,X + 0.007$$

EPA believes that this relationship is a reasonable approximation for longitudinal dispersivity and appropriate for use in the Monte Carlo routine.

Transverse dispersivity, α_T, has been studied to a lesser degree but its magnitude is known to be less than longitudinal dispersivity while maintaining scale dependency (Refs. 16, 86, and 94). Typically, transverse dispersivity is related to longitudinal dispersivity by a simple ratio leading to the following expression

$$(8)\quad \alpha_L/\alpha_T = LTR$$

where:
LTR=longitudinal-transverse dispersivity ratio.

A range of LTRs has been reported and appears to center around a value of 3.0. Again, to insure consistency in input data while maintaining a straightforward approach, an LTR of 3.0 was selected for the Monte Carlo analysis.

For unidirectional flow in the longitudinal direction the vertical dispersivity, α_v, is quite low. Using the ratio α_L/α_v, to describe vertical dispersivity, Gelhar et al. (Ref. 49) reported a range of 30 to 1,860 meters with an average of about 400. Because less is known about vertical dispersivity, for the Monte Carlo routine, EPA assumed that it varied uniformly within the range of 40 to 400 meters.

The data generation approach for dispersivity can be summarized by the following equations:

$$(8a)\quad \alpha_T = 0.0333(x)$$

$$(9)\quad \alpha_z = 0.0025(x) - 0.01(x)$$

Where x is the downgradient exposure point distance selected for implementation of the decision rule.

(h) *Porosity.* Porosity, θ, is the ratio of the volume of the voids of a given soil or rock mass to the total volume of the soil or rock mass. Values for porosity may range from zero (no pore space) to one (no solid). The porosity of a uniform porous media is largely a function of particle size. For small particle sizes like clay, porosity increases to a maximum of around 50 percent. Porosities of coarser media like gravel decrease to a minimum of around 30 percent. These measured ranges of porosities suggest a strong correlation with mean particle diameter, d. Data reported by Davis (Ref. 38) were used to develop a regression equation relating porosity to the mean particle diameter as follows:

$$(10)\quad \theta = 0.261 - 0.0385 \ln d$$

where ln d is the natural log of the mean particle diameter.

Because porosities are generally known for a wide range of soils and porous media, another approach to generating input values is to determine a distribution for θ from observed data. It will be shown later, however, that porosity, θ, is linked to velocity, V, through the mean particle size, d. Thus, to preserve this relationship, the distribution for porosity is generated from a "seed" distribution for particle size diameter, shown above. The mean particle diameter as the single correlated property to porosity ignores the influence of particle sorting within porous media and hence may not be the most accurate approach in developing the dependence. Unfortunately, at the present time the distribution of sorting and mean particle size in materials in the saturated zones is not well enough known to be used in the methodology.

The distribution of particle sizes selected should reflect the distribution of subsurface characteristics in all areas subject to potential use for land disposal. While specific case studies exist, apparently no general characterization is available. One approach is to assume a distribution bounded by reported ranges. In the absence of data, both a uniform and a log-uniform distribuiton were investigated. The long-uniform distribution was selected because it more heavily weights the influence of smaller particle sizes and because the related, derived velocity distribution is more consistent with observed data.

(i) *Bulk density.* The soil's bulk density, ρb, is defined as the mass of dry soil divided by its total (or bulk) volume. Bulk density directly influences the retardation of solutes and is related to soil structure. In general, as soils become more compact their bulk density increases. This relationship produces a dependency between porosity and bulk density. Freeze and Cherry (Ref. 48) note that:

$$(11)\quad \theta = 1 - \frac{\rho_b}{\rho_p}$$

where:
ρ_b=particle size density, g/cm^3 and
ρ_p=bulk density, g/cm^3.

By assuming ρ_p=2.65, equation 11 can be rearranged to yield an expression for estimating bulk density given the porosity as follows:

$$(12)\quad \rho_b = 2.65\,(1 - \theta)$$

The particle density of soil materials varies over a very narrow range and can be fixed at a value of 2.65 gm/cm^3. The equation above can be used to derive a frequency distribution for bulk density given the previously generated distribution for porosity.

(j) *Velocity.* The velocity of ground water is a major determinant of the transport of solutes in subsurface systems. In uniform porous media, it is the dominant factor and must be properly specified in the Monte Carlo process. Dependencies among the input data (porosity and bulk density) must be preserved while generating realistic values of velocity.

Ground water flow velocities vary widely. Mackay et al. (Ref. 73) report that velocities typically range between 1 to 100 m/yr. These ranges apply to typical "natural gradient" conditions and higher velocities can exist under both man-induced (e.g., well-field drawdown) and extreme natural situations. For example, velocities in excess of 9,000 m/yr have been reported (Ref. 51) for a glacial outwash material. Such data sources could be used to develop an empirical frequency distribution for velocity, but the requirement to maintain dependencies with soil properties is not easily met using this approach.

Velocities are related to soil properties and other site-specific factors through Darcy's law. Using Darcy's law and assumptions of steady flow in uniform, saturated media yields the following expression for average pore velocity, V

$$(13)\quad V = \frac{K_S \cdot S}{\theta}$$

where:
K_s=saturated hydraulic conductivity, cm/sec
S=hydraulic gradient
θ=porosity

beause an expression for porosity, θ, has already been developed, this equation properly relates velocity and porosity. The saturated hydraulic conductivity, K_s, reflects the "ease" with which water is transported through porous media and for any given fluid, K_s is a function of porous medium properties such as particle size, grain shape, connectivity, and tortuosity. To the extent that K_s is related to such properties if functional relationships exist for K_s, then dependencies among V, K_s and θ can also be represented.

Individual, site-specific measurements for K_s are usually difficult to make and the spatial variability of "point" measurements is the subject of much current research. Also, site-specific variations in K_s values introduce considerable uncertainty in modeling ground water flow when point estimates or averaged point values are used as model inputs. The objective here is to insure consistency in results while representing the wide variations expected from site to site. Given this objective (that is much less demanding than an attempt to predict an accurate K_s for any given site), it is reasonable to use an approximate functional relationship. The most notable among these is the Karmen-Cozeny equation (Ref. 23).

$$(14)\quad K_S = 478\ [\frac{\theta^{3}}{(1-\theta)^{2}}\ d^{2}]$$

where:
θ = porosity
d = mean particle diameter

Note that this equation relates saturated hydraulic conductivity to porosity and particle size diameter. Furthermore, porosity, θ, is derived from the particle density, ρp, that is generated from a "seed" distribution.

The remaining factor in the previous equation for velocity is the gradient, S. In general, the gradient is a function of the local topography, ground water recharge volumes and locations, and the influence of withdrawals (e.g., well fields). It is also likely to be indirectly related to porous media properties. Rarely are large gradients associated with very high conductivities. No functional relationships exists, however, to express this association. Thus, another independent "seed" distribution is required. The potential problem with the independence assumption is in "extreme" values. Data sets having large values for both K and S will also have very large values for velocities, resulting in unrealistic conditions. These conditions can be prevented by bounding the velocities such that a fixed maximum is not exceeded. The observed value of 9,250 m/yr was selected for this purpose.

The distribution for the gradient can be assumed or derived from observations. Gradient data were included in the survey of Part B permit applications and were analyzed to develop a frequency distribution.

(k) *Standard deviation of the Gaussian distribution for the source concentration.* The standard deviation of the Gaussian source, σ, defines the nature of the leachate after it has mixed with the underlying saturated zone. Because σ, reflects the nature and extent of the leachate interaction with the ground water beneath the facility, it also reflects the failure of the engineered controls on the facility (e.g., liners, caps). From mass balance principles the standard deviation, σ, is related to the environmental setting by:

$$(15)\quad \sigma \qquad q\ A_w\ c_L\ /\sqrt{2\pi}\ V\ \theta \cdot H \cdot c_o$$

where:
q=unit areal flux of leachate through the land disposal facility, m yr^{-1}
A_w=area of disposal facility, m^2
V=ground water velocity, m yr^{-1}
θ =saturated zone porosity
H=leachate penetration into the saturated zone, m
c_L=contaminant concentration in the leachate
c_o=contaminant concentration in the mixing zone beneath the facility

If we assume that the leachate concentration, c_L, is the same as the maximum concentration c_o (at y=0) of the Gaussian concentration distribution, then this equation enables direct calculation of given the other, known variables. Setting $c_L=c_o$ in the above equation simply means that the leachate displaces the ground water and dilution occurs after advective transport is initiated, a reasonable assumption given the low velocities for leachate fluxes. In other words, the leachate is mixed at a constant concentration over the penetration depth and dilution in the vertical direction is initiated in the model during ground water transport.

Values for chemical flux, q, vary depending on the location of facilities, their vertical configuration (e.g., liners, caps), and their performance over time. The procedure used to produce a distribution for q has been described previously. A distribution for the area term, A_w, was generated from the survey of Part B permit applications. Velocity, V, porosity, θ, and penetration depth, H, were generated as previously discussed. For mathematical reasons (boundary effects) the constraint that the ratio, H/B, where B is the saturated zone thickness, be less than 0.5 must also be made. The minimum saturated thickness is set to 3 meters.

(l) *Hydrolysis rates.* Hydrolysis rate constants are unique to each chemical and will be determined from the literature or from laboratory experiments. All rates (acid-catalyzed (k_a), neutral (k_n), base-catalyzed (k_b)) are influenced by ground water temperature. Acid and base catalyzed hydrolysis, k_a and k_b respectively, are also influenced by pH. The pH dependency is included directly in the ground water model and the rates will be adjusted accordingly via the independently derived distribution for pH. The temperature dependency requires further elaboration.

Rate constants are often adjusted for temperature effects by the Arrhenius equation. Because the rate constant values are given for a specific temperature, the need exists to adjust these values to account for different temperatures in the ground water. Using the generic activation energy recommended by Wolfe (Ref. 126) of approximately 20 k cal/mole, the temperature correction factor can be written as:

$$(16) \quad \frac{K^{T}_{a,n,b}}{K^{T_r}_{a,n,b}} = \exp \ 10^4 \left(\frac{1}{T_r} \quad \frac{1}{T} \right))$$

where:

$K^T_{a,n,b}$ = second-order hydrolysis rate constants for acid, neutral, or base conditions at temperature T

$K^{T_r}_{a,n,b}$ = second-order hydrolysis rate constants for acid, neutral, or base conditions at reference temperature, T_r

T, T_r = temperature, °Kelvin

The temperature can also influence the base-catalyzed hydrolysis rate through influence on autoprotolysis of water. Porous medium properties and ground waters are sufficiently buffered, however, to minimize this effect, temperature corrections to pH are not made.

(m) *Distribution coefficient.* The relationships most suited for relating the chemical distribution coefficient, K_D, to soil or porous medium properties are discussed in detail by Karickhoff (Ref. 65). In cases where reliable relationships do not exist, measurements are required. For many cases, hydrophobic binding dominates the sorption process and it is possible to relate the distribution coefficient directly to soil organic carbon. For these cases, the dependency is given by:

$$(5) \qquad K_D = (K_{OC}) \ (f_{OC})$$

where

K_{oc} = normalized distribution coefficient normalized to organic carbon

f_{oc} = fractional organic carbon

The values for fractional organic carbon, f_{oc}, were generated as an independent parameter as previously described. The equation above is used to preserve dependency between porous media properties and chemical sorptive properties. For other binding mechanisms described by Karickhoff (Ref. 65), including those for polar, ionizable compounds, adjustments will be made on a case-by-case basis as appropriate.

(n) *Data generation results.* The combination of data sources and approaches described above were used to generate input frequency distributions for each of the parameters and forcing function variables (see Ref. 2). In some cases intermediate or precursor variables were also generated to enable representation of appropriate dependencies among the variables and parameters. The following Table 8 gives a summary of the distributon types and parameters for each model parameter or variable. For derived distributions, only the mean and range of the synthesized data are given. In some cases only single, fixed values were selected largely based upon their nature (e g., a chemical specific rate constant).

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Table 8--SUMMARY OF RESULTS FOR INPUT DATA GENERATION

Parameter or Variable	Distribution Type	Distribution Parameters		Range
		mean	std. dev.	min-max
Temperature, °C	Normal	14.4	5.29	(0.0 - 30.0)
pH	Normal	6.2	1.28	(0.3 - 14.0)
Dissolved Organic-C, mg/l	Lognormal	1.99	1.09	(0.01 - 6.99)
f_{oc}	Lognormal	-5.76	3.17	(.001 - .01)
d, cm	Log_{10}uniform	.00063	--	(.0004 - 0.10)
θ, cm^3 m^{-3}	derived from d			(.30 - .56)
ρ_b, gm cm^{-3}	derived from θ			(1.16 - 1.8)
K_s, cm sec^{-1}	derived from θ, d			(.0001 - .48)
S	exponential	.0309	--	(.00001- 0.10)
V, myr^{-1}	derived from S, K_s, θ			(.01 - 9250)
B, m	exponential	78.6	--	(3.0 - 560)
A_w m^2	mixed; exponential uniform			(23 - 930,000)
H, m	derived from uniform	6.0	--	(2.0 - 10.0)
q, m	modeling			(0.0 - .3)
I, myr^{-1}	modeling			(0.0025 - 0.91)
σ, m	derived from q, A_w, V, H, θ			(.001 - 60,000)
α_L, m	single values			(0.1x)
α_T, m	single values			(0.0333x)
α_V, m	uniform			(0.0025x - 0.01x)
X, m	single values			(152.4m)
k_a MM^{-1} yr^{-1}	chemical specific value			
k_n yr^{-1}	chemical specific value			
k_b MM^{-1} yr^{-1}	chemical specific value			
k_D	chemical specific value			

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The ground water model was implemented with the input data generated by the data, assumptions, or modeling reported in the previous units. Two general cases can be described: Modeling results for non-degrading constituents, and for degrading constituents. The behavior of all non-degrading organic chemicals will be identical because sorption, as implemented in the model, does not influence dissolved concentrations. Thus, a single cumulative frequency distribution in the form of a graphical presentation or tabulated values can be produced for all such compounds. For constituents which degrade, a unique cumulative frequency distribution will be produced for each individual constituent. To illustrate the results of the Monte Carlo simulations, tabulated values for the frequency distribution for non-degrading chemicals are shown in the following Table 9:

TABLE 9—MODEL SIMULATION RESULTS FOR NON-DEGRADING CHEMICALS AND CHEMICALS WITH A ONE YEAR HALF-LIFE

	CD [1] value non-degrading case	1 year half-life
Cumulative Percentile:		
0.25	1×10^{-7}	1×10^{-6}
0.50	1.8×10^{-5}	1.8×10^{-5}
0.75	4.5×10^{9}	4.8×10^{-3}
0.90	4.4×10^{-2}	4.3×10^{-2}
0.95	7.7×10^{-2}	8.7×10^{-2}

[1] CD = C_{ADI}/C_L
where:
C_{ADI} = Screening level.
C_L = leachate concentration.

The cumulative frequency distribution provides estimates of the likelihood or probability that the target concentration level (e.g., reference dose) would not be exceeded if the extract levels are achieved, given the range and distribution of values that may be expected for each of the various environmental parameters known to affect such concentrations. Using this approach, EPA can be assured that the level of treatment selected will ensure that downgradient concentrations will not exceed the specified target concentration at any desired confidence level.

The Monte Carlo approach, thus, allows the Agency to evaluate the uncertainty in the characterization of the input data to the model. The Agency believes that the Monte Carlo approach provides a sound basis for evaluating land disposal of hazardous wastes and establishing the concentration levels for all hazardous constituents.

(o) *Peer review.* The proposed ground water screening procedure was presented to the Environmental Engineering Committee of EPA's Science Advisory Board for its review. The SAB concluded that the procedure was technically and mathematically valid given the underlying assumptions (Ref. 2). EPA responded to specific recommendations by the SAB on the following subjects: Accounting for dilution of leachate entering the aquifer; speciation of metals in ground water; and considering the variability and uncertainty in properly specifying a generic environment. The Agency believes that today's proposal properly addresses the major concerns of the SAB.

The Agency recognizes that some of the assumptions and components of the ground water screening procedure, as described above, may need to be re-examined and adjusted if necessary. Specifically, the Agency believes that the analysis of chemical flux rates from Subtitle C land disposal units using the HELP model may need to be further evaluated. The HELP model was designed to facilitate estimation of flux rates from landfills. EPA specifically requests comment on the appropriateness of using the HELP model to develop estimates of long-term flux rates from land disposal units. The Agency seeks comment on whether flux rates should be estimated for operating landfills, surface impoundments, and waste piles as well as information on alternative models or methods which may be appropriate for estimating flux rates.

The Agency believes that its assumption that the leachate penetration depth, H, varies uniformly from 2 to 10 meters, may need to be re-examined and adjusted if necessary. Limited data are available describing the depth to which leachate may penetrate into an aquifer at all types of land disposal facilities. Rather than assume a single value for H, the Agency decided to vary it uniformly over a small range to account for possible differences in disposal unit sizes and potential leachate volumes entering the aquifer. The Agency requests comment on the appropriateness of this assumption and requests further information to characterize better the depth to which leachate may penetrate into the saturated zone.

The Agency believes that this ground water screening procedure will identify hazardous constituent concentration levels that insure that land disposal of such constituents protects human health and the environment from harm due to exposure to ground water. The procedure accounts for variability in both land disposal settings and in chemical properties. The Agency specifically requests comments on all of the parameters and variables considered in the ground water fate and transport model and the characterization of the data describing the parameters and variables used in the Monte Carlo process. If a commenter believes that any of the data is incorrectly characterized, the Agency would like comments on how it can be better characterized.

The ground water modeling procedure, as all modeling procedures, has limitations. This procedure assumes the waste leachate is mixed with fresh water. This neglects the effect of prior contamination of the aquifer. The procedure also does not consider the possibility that constituents which hydrolyze can form more toxic components. These components potentially may be more toxic than the parent constituent. Moreover, as noted in the discussions, the model of necessity incorporates a number of assumptions, such as uniform, homogeneous, and isotropic porous media, that do not represent real world conditions. Although these factors are of importance, the Agency is unable to take them into account in this generic screening procedure.

The Agency believes that this procedure, with its limitations, is reasonable. EPA requests comment, however, on the use of the models incorporated in the ground water screening procedure and how to deal with these limitations.

(p) *Metal speciation component.* Although EPA is not specifically proposing an approach for evaluating metal fate and transport in ground water in today's proposed rule, the following outlines the Agency's current thinking on how the application of the ground water equation will be developed for metals.

Because the conditions and processes by which metals exist and react in the environment are not considered in the ground water fate and transport equations it is not appropriate to apply the equations to metals without further analysis. The ground water fate and transport equation limits degradation to hydrolysis. This is a reasonable assumption for organic constituents, but is inadequate to describe metals since they cannot be "degraded" by this mechanism. Yet metals and other chemical elements, usually combined in the form of ores and minerals, are a natural part of the environment. In fact, many metals are too reactive to remain in the metallic state, and tend to form such combinations. The particular compound formed is determined by conditions such as the availability of the particular anion species, the pH of the environment and the oxidation state of the metal. Usually, metals undergo a variety of complex reactions resulting in the formation of multiple compounds.

Each metal will exist in the subsurface environment as a relatively complex distribution of different species, each having a specific set of properties. Relative concentrations of individual species within the distribution are controlled by equilibrium constants governing the individual reactions, and by the chemical environment in which this speciation process occurs. Some metals exist in several oxidation states simultaneously and form a number of individual species of widely differing chemical characteristics. Because such chemical and physical characteristics determine the ability of the species to be transported, it is virtually impossible to estimate the overall transport potential of a given metal without consideration of these processes.

To account for multiple species distribution, and immobile solids formation, a speciation model component will be added to the ground water back calculation model. In the initial calculations the metal is treated as a non-hydrolyzing (non-degrading), non-sorbing entity. The contribution of dispersion is accounted for by means of the ground water fate and transport equation, and the metal is speciated using an equilibrium-speciation model.

Initially, the 10 metals included in the California List will be evaluated. These include arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and thallium. The basic assumptions of the speciation model component for analyzing the transport of metals in ground water are:

(i) Metals exist in ground water environments as distributions of multiple, dissolved-phase species and precipitated solids.

(ii) All dissolved species are freely mobile and available for transport as implemented by the ground water back calculation model.

(iii) Metals (excluding radionuclides) are conservative (non-degrading) entities.

(iv) Overall metal speciation distributions are sensitive to properties of the subsurface environment, including pH, redox potential (E_h) and dissolved solutes.

(v) pH and E_h) of the aquifer are effectively buffered against changes caused by introduction of the leachate.

(vi) Transport of individual metal species is governed by the specific properties of that species (mobile versus immobile); however, individual species are related to each other through the equilibrium constants.

Estimates of metals species distributions are determined using the geochemical model MINTEQ (Refs. 113 and 114). MINTEQ is an equilibrium model that uses the equilibrium constant approach to solving the chemical equilibrium problem. The mathematical structure of MINTEQ is derived from MINEQL (Ref. 123) and the data base and sorption algorithms are from WATEQ3 (Ref. 19).

Consistent with the overall approach to the back calculation model, generic ground water chemical specifications will be developed to reflect a national median ground water chemical environment. This will be accomplished by extracting data tabulated for well waters in the EPA STORET (Ref. 110) data base. Backgroud analytical concentrations of the 10 metals will be determined from this data base along with concentrations of several key anions cations, organic carbon contents, E_h, and pH. Analysis of the data base indicates that wide variations in ground water chemical specifications exist. Mean values are strongly influenced by a few extreme values. For this reason median will be used in establishing generic ground water specifications. The final specifications will consist of the median values for all variables except E_h, pH, and organic carbon content.

For the variables of E_h and pH, EPA believes that a single set of generic specifications cannot be selected which accurately reflects the range of conditions existing at all sites. For this reason, jan "uncertainty window" encompassing a range of E_h and pH values, will be defined. Speciation equilibria calculations are performed repeatedly using several E_h and pH combinations in conjunction with the median values of other variables such as anion concentration. Total dissolved metal concentrations are calculated for each combination. The universal influence of E_h and pH on the overall speciation equilibria is reflected in the range of metal concentrations obtained. This approach to the uncertainty problem, generated by using generically derived input sets, differs from the Monte Carlo sensitivity analysis used in other parts of the procedure, in that E_h and ph are the only variables tested. Variation of other input variables is not feasible given the statutory deadlines and the computationally intensive nature of MINTEQ (Ref. 114) along with the almost infinite range of possible background chemistries.

An attempt will be made to evaluate sensitivities of the 10 metals for reacting with each other. Precipitation and formation of solid phases may result if the cation of one metal compound reacts with the anionic species of another metal compound, thus reducing the dissolved (mobile) concentration of each. Taken separately, either metal might remain in solution at a somewhat higher concentration. To evaluate some of these possibilities, the 10 metals under investigation will be introduced into the speciation model at different analytical concentrations ranging up to 1,000 times the health-based starting limit.

Sorption is not considered a speciation process for the purpose of this analysis. This constraint is made to be consistent with the assumptions applied to organic constituents in the ground water fate and transport equation. For organics, sorption influences only the time of transport. Thus for constituents that do not "degrade," sorption will not affect the concentration levels predicted by the ground water model.

Because of the very complex nature of the metal speciation mixtures investigated, formation of a large number of solids is possible. To avoid complicating the speciation calculations past the point of manageability, only those solids which contain 1 or more of the 10 test metals as a component will be specified. Final selection of solids is a critical issue and is discussed further in the following paragraph.

Many organic compounds form complexes with metal ions causing some metal solubilization. To estimate the impact of these organic ligands on the overall speciation equilibria requires information on the amount and nature of specific organic compounds present in various types of leachates as well as thermodynamic data on the metal-organic complexes. In the absence of these data, a simple model system of six common organics will be used to mimic performance of real systems. This approach was used by Morel et al. (Ref. 80) in modeling speciation reactions in sewage effluents. The model compounds represent several key functional groups and a broad span of abilities to complex metals. Acetate, tartrate, glycine, salicylate, glutamate and phthalate were selected as the organic compounds for analysis because thermodynamic data have been measured for these ligands. Concentrations of each are set by apportioning the median ground water organic carbon concentration determined from STORET data equally (molar basis) among the six compounds.

The procedures mentioned above for modeling metal speciation are based entirely on an equilibrium model and it is difficult to estimate how nearly ground water systems approach equilibrium conditions. Lindberg and Runnels (Ref. 69) investigated a number of redox couples in ground waters and concluded that none of the 30 representative waters investigated reflected internal redox equilibrium. Potential errors due to nonequilibrium are partially accounted for in the E_h, pH uncertainty treatment noted earlier. It should, however, not be assumed that all potential errors have been eliminated.

One of the greatest potential impacts of using an equilibrium model is reflected in the prediction of solid phases. MINTEQ (Ref. 114) allows the user to select the solid phases. By judiciously eliminating solids which are known to be kinetically limited, a major weakness of using the equilibrium model can be removed. These are judgment calls which will be accomplished through review by a panel of experts.

All speciation models rely on a wide range of data from many sources. The MINTEQ data base (Ref. 114) has been carefully assembled over time and can be considered state-of-the-art. It is, however, still subject to further validation.

3. Surface Water Back Calculation Procedure

a. *Introduction and objective.* In establishing back-calculated screening levels, the Agency has evaluated the potential for human and environmental exposure to hazardous constituents resulting from migration from land disposal units via surface water pathways. Surface water contamination may result in exposure of humans and aquatic life to hazardous constituents as shown in the following Figure 5:

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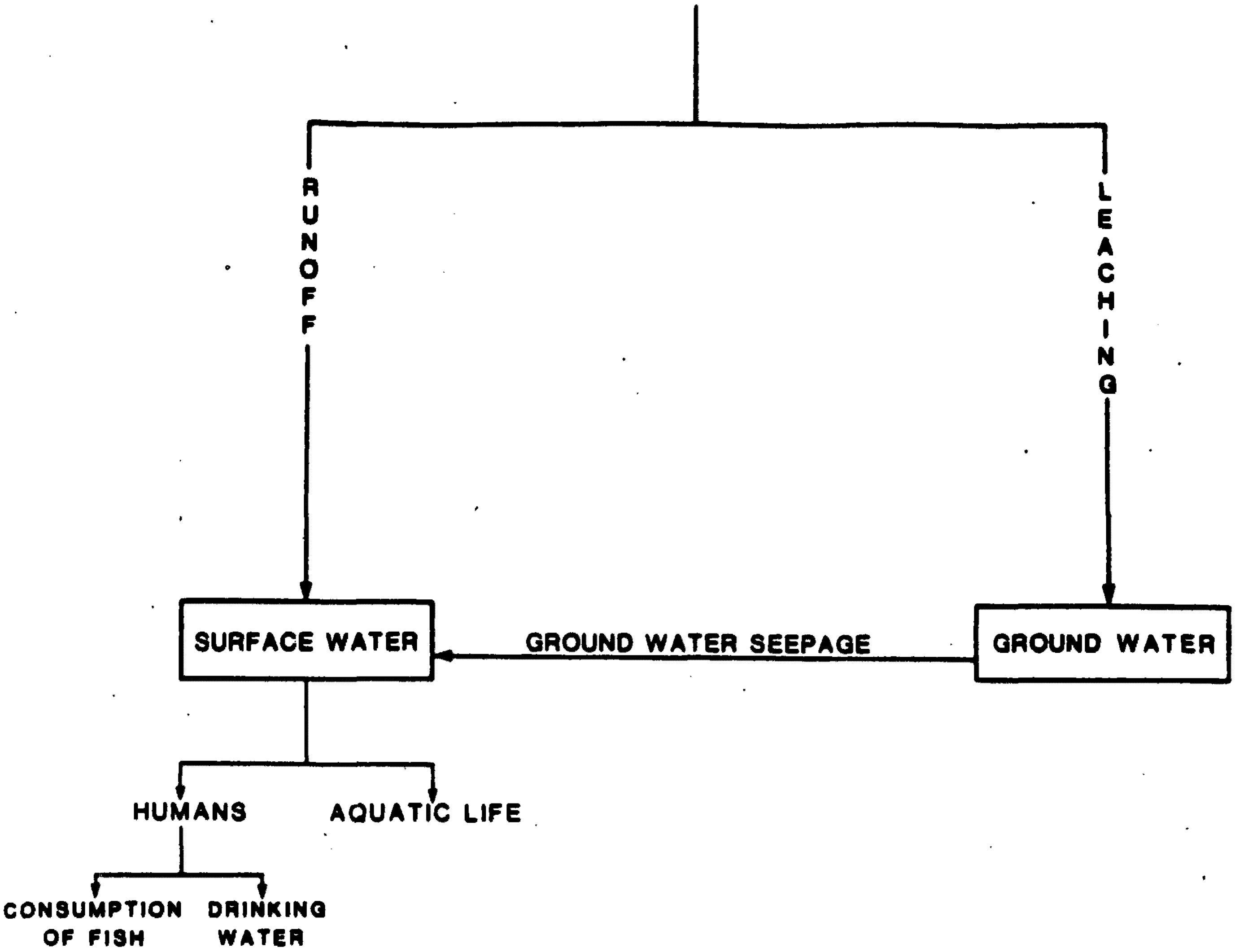

FIGURE 5 --ROUTE OF EXPOSURE FROM LAND DISPOSAL THROUGH THE SURFACE WATER MEDIA

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The Agency considered three scenarios, or routes of exposure via surface water, defined as streams in this proposal. The scenarios considered include: (i) Human exposure via drinking water, (ii) human exposure via fish consumption, and (iii) direct exposure of aquatic organisms.

The potential for exposure of humans and aquatic life to contaminants due to runoff from a storm event is not reflected in this analysis. Existing regulations require that all landfills, land treatment systems, waste piles, and surface impoundments be designed such that, at a minimum, runoff from a 25-year, 24-hour storm event is contained (40 CFR Parts 264 and 265). The Agency believes that these performance standards provide an acceptable level of containment, and thus has not calculated constituent screening levels based on surface water exposure from such events.

The proposed surface water screening procedure involves a back calculation, using a fate and transport model, from concentrations that will not adversely affect human health and the environment at points of potential exposure to the constituent concentration in leachate emanating from a land disposal unit. As illustrated in the following Figure 6, this analysis encompasses contamination of streams through interception with ground water contaminated by releases of hazardous constituents in leachate from land disposal units:

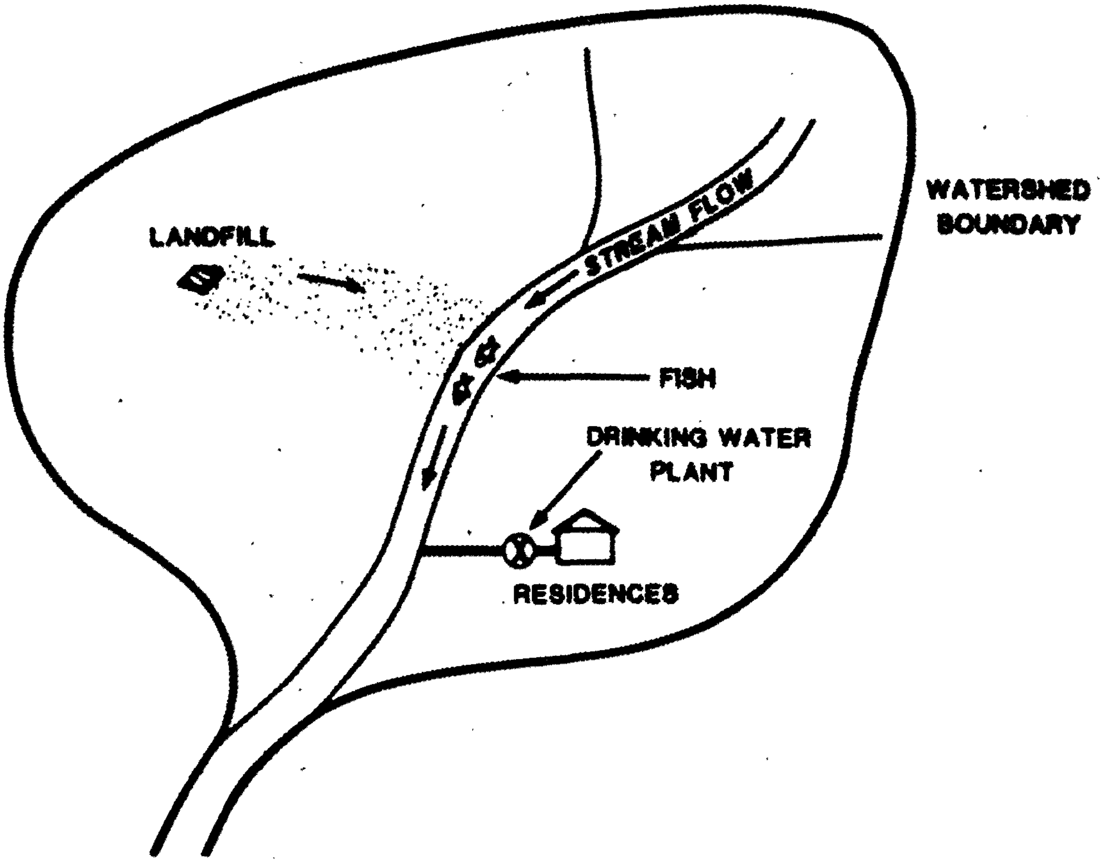

FIGURE 6 —SCHEMATIC DESCRIPTION OF SURFACE CONTAMINATION PATHWAYS

The Agency has characterized specific surface water pathways leading to human and environmental exposure and evaluated the likelihood of exposure from each pathway. Where the back-calculated surface water concentration level for a constituent is more stringent than the screening level developed through the ground water model, the surface water screening level replaces the ground water screening level for purposes of establishing the section 3004(m) treatment standards for that constituent according to the proposed decisionmaking framework presented in Unit II.

When the ground water and surface water screening levels for the relevant constituents in the solvent- and dioxin-containing wastes addressed in today's proposed rule were compared, only the surface water screening level for pentachlorophenol was more stringent than the ground water screening level. Thus, the screening level for pentachlorophenol is based on the surface water model.

b. *Pathways leading to contamination of surface water and exposure to humans and the environment.*

Scenario 1: *Exposure of humans through drinking water to surface water contaminated by leachate carried through the ground water.* Exposure of humans to surface water through drinking water contaminated by leachate transported in ground water consists of six stages, commencing with failure of the waste containment unit, continuing with transport of the contaminant in ground water, mixing of the contaminant with uncontaminated stream water at the point of entry to the stream, downstream transport of the contaminant in the stream, treatment of the contaminant in a drinking water plant, and concluding with exposure of the contaminant to humans via drinking water (Ref. 13). This scenario is described schematically by the flow chart in the following Figure 7(a):

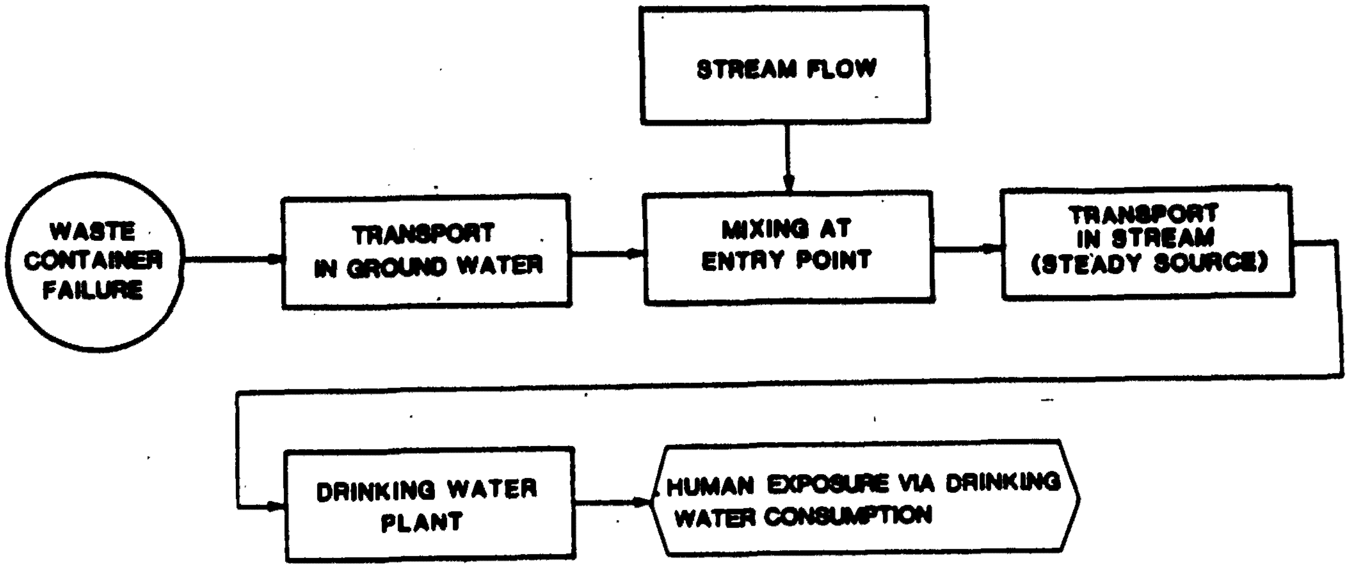

FIGURE 7 (a)—FLOW CHART FOR SCENARIO 1

Through these stages, the concentration is successively reduced from the leachate concentration to the concentration at the drinking water source. The attenuation factors that are derived in Units III.A.3.e and f account for the effects of contaminant transport in ground water, initial mixing at the area of leachate entry into the stream, contaminant transport in the stream, and treatment in the drinking water plant.

Scenario 2: *Exposure of humans through fish consumption to surface water contaminated by leachate carried through the ground water.* Humans may also be exposed to hazardous constituents in leachate carried through the ground water to surface water through the consumption of fish residing in the contaminated surface water. Scenario 2 consists of five stages commencing again with waste containment unit failure, continuing with transport of the contaminant in ground water, mixing of the contaminant with uncontaminated stream water at the area of entry to the stream, uptake of the contaminant by fish, and concluding with exposure of the contaminant to humans via consumption of fish (Ref. 13). This scenario is depicted in the following Figure 7(b):

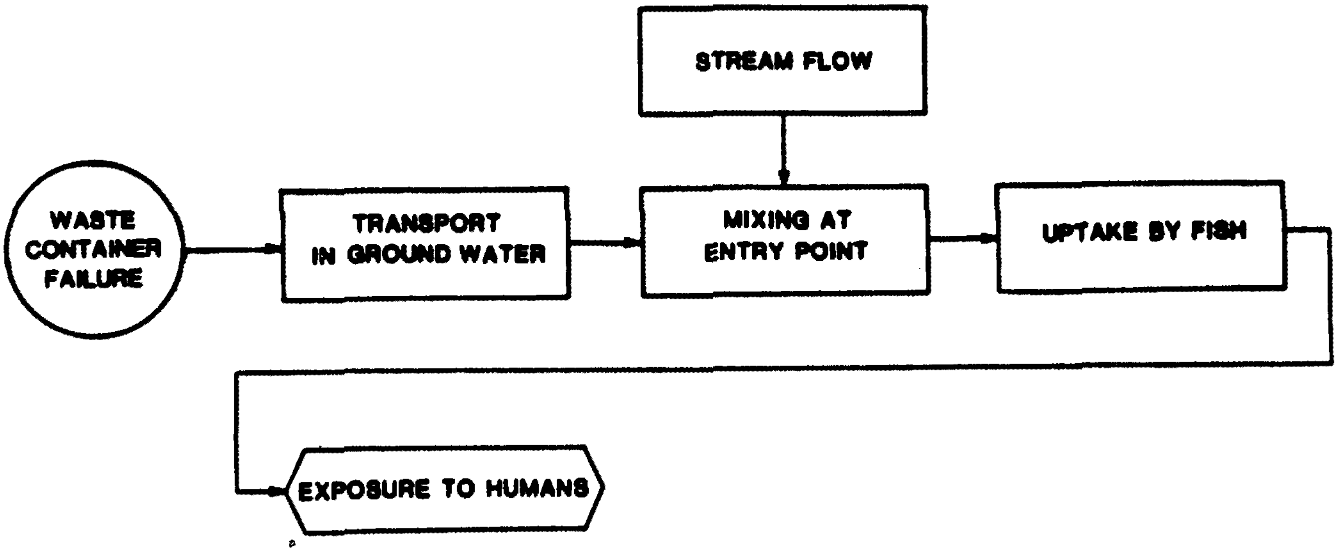

FIGURE 7 (b)--FLOW CHART FOR SCENARIO 2

Through these stages, the input concentration is reduced from the leachate concentration to the concentration in the stream and then increased to the bioconcentrated level in the fish. Attenuation factors account for the effects of contaminant transport in the ground water, initial mixing at the area of leachate entry into the stream, and biochemical exchange processes between fish and the contaminated surface water ("reverse" attenuation). The derivation of these attenuation factors can be found in Unit III.A.3.e.

Scenario 3: *Direct exposure of aquatic life to surface water contaminated by leachate carried through ground water.* Aquatic life may be exposed continuously to hazardous constituents in leachate carried through the ground water to surface water. Scenario 3 consists of four stages commencing again with waste containment unit failure, continuing with transport of the contaminant in ground water, mixing of the contaminant with uncontaminated stream water at the area of entry to the stream, and concluding with exposure of the contaminant to aquatic organisms residing in or near the initial mixing zone (Ref. 13). This scenario is depicted in the following Figure 7(c):

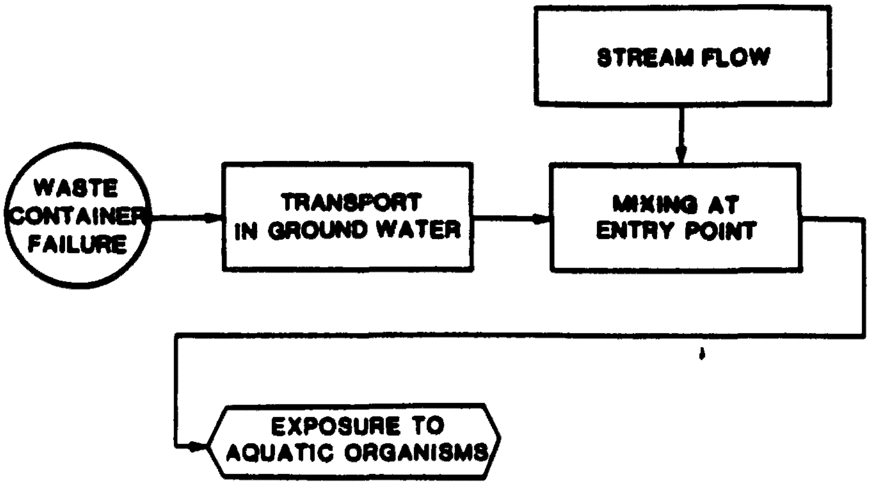

FIGURE 7(c) -- FLOW CHART FOR SCENARIO 3

Through these stages, input concentration is reduced from the leachate concentration to the concentration in the stream. Attenuation factors account for the effects of contaminant transport in the ground water and initial mixing at the area of leachate entry into the stream. The derivation of these attenuation factors can be found in Unit III.A.3.e.

c. *Description of scenario stages.* In this analysis, the Agency assumes that the land disposal unit is located in an upland watershed and is hydraulically connected to a stream as shown in the following Figure 8:

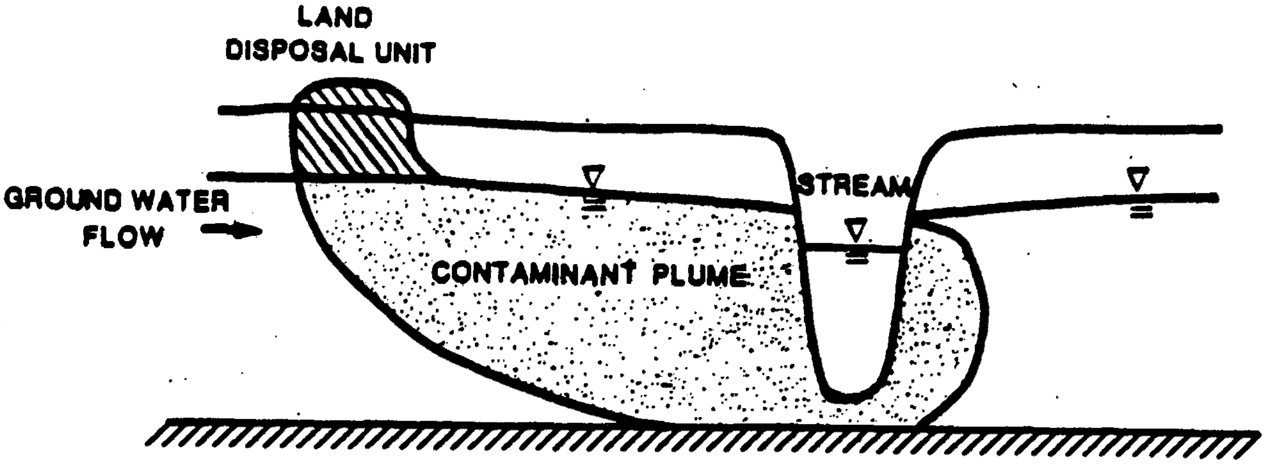

FIGURE 8 —CONTAMINANT TRACKING AND TRANSPORT IN GROUND WATER SYSTEM

All three surface water scenarios addressed in today's proposal commence with failure of liners and leachate collectors at the land disposal unit, resulting in release of hazardous constituents in leachate to the aquifer directly below the land disposal unit. The transport of hazardous constituents through the ground water pathway is described by a one-dimensional ground water equation (Ref. 13). The Agency is conducting further analysis to determine the effect of including dispersion on the surface water screening levels. The average contaminant concentration at the area of leachate entry into the stream is related to the leachate concentration directly below the land disposal unit by a ground water attenuation factor. This attenuation factor is a function of the fraction of the chemical not transformed by hydrolysis or removed by speciation (over a distance of 500 feet), the initial leachate plume flow, and the contaminated plume flow at the edge of the stream.

In today's proposal, contaminated ground water is assumed to travel a distance of 500 feet from the downgradient edge of the disposal unit before it intercepts the nearest surface water body. The distance of 500 feet was selected to be consistent with the distance employed in the ground water component. However, the Agency is further evaluating the appropriateness of the use of this distance in the surface water component and may revise it (upward or downward) if it is determined that it does not accurately reflect a conservative point of interception of ground water with surface water. The Agency requests comments on the appropriateness of 500 feet and data supporting this or other distances.

The contaminants are then discharged into the surface water through ground water seepage along the side and the bottom of the stream where the ground water system and the stream intercepts. As the contaminated ground water plume enters the surface water, it mixes with uncontaminated water supplied by the oncoming streamflow as shown in the following Figure 9:

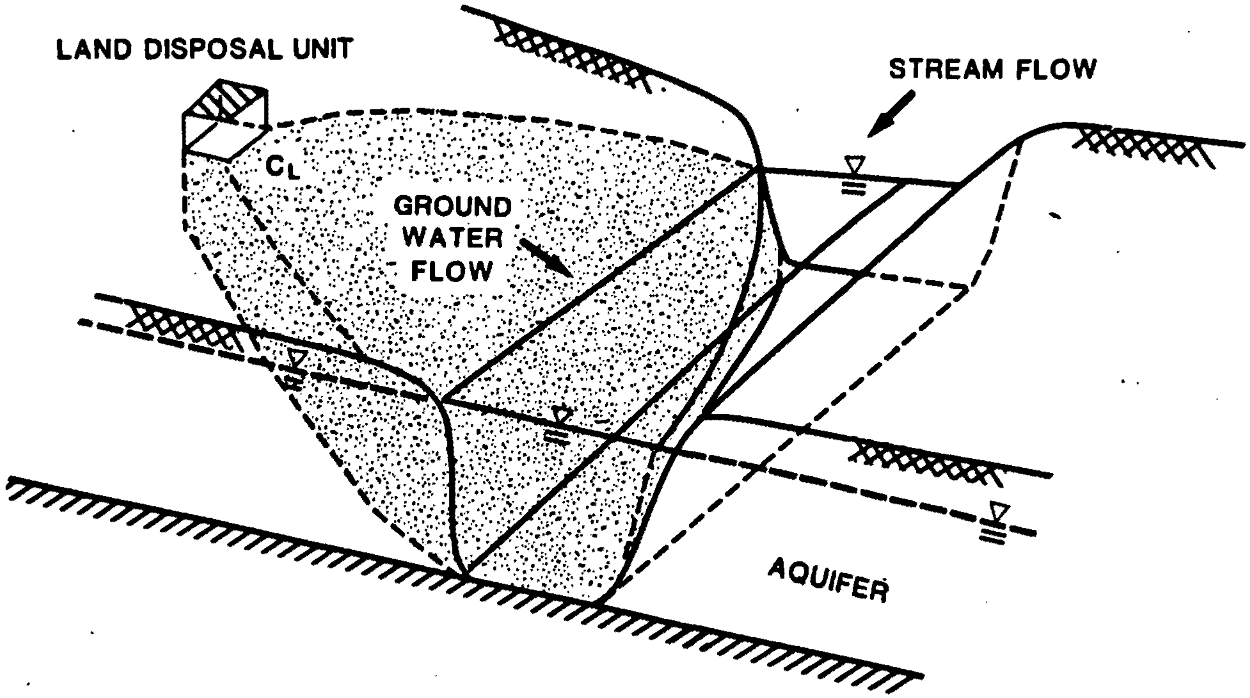

FIGURE 9 --GROUND WATER LOADING OF CONTAMINANT INTO THE STREAM

The potential hydraulic impacts on the ground water flow field by the adjacent surface water are assumed not to impede the discharge of contaminated ground water to the surface water. Consistent with the ground water component, the surface water model assumes continuous ground water loading. As the ground water enters the stream through the subsurface sediment, areas of contaminant concentration greater than that of the average concentration in the water column will develop. For example, the concentration of the contaminant in the stream bed during discharge will be greater than the contaminant concentration in the water column where mixing with the uncontaminated water has occurred. The Agency requests comment on methods to account for these "hot spots" and their effects on bottom-dwelling organisms.

An initial mixing zone in the stream is developed over the contaminant discharge area. The Agency assumes that within the mixing zone the depth of the stream is small, since it is assumed to be located in an upland watershed. Therefore, vertical mixing is complete (Ref. 13). However, lateral mixing may be incomplete. Based on mass balance considerations, the laterally averaged concentration reaches a maximum near the leading (downstream) edge of the mixing zone. The contaminant mass being loaded into the stream is the product of the volumetric ground water discharge rate and the average contaminant concentration in the ground water as discussed in Unit III.A.3.e. The average contaminant concentration at the downstream edge of the mixing zone is related to the average contaminant concentration in the ground water by a stream flow dilution factor. This dilution factor is the contaminated ground water plume flow at the area of interception with the stream divided by the total stream flow at the downstream edge of the mixing zone.

Since fish are mobile over the length and width of contaminated stream, the Agency assumes that an individual fish will be exposed to a wide range of contaminant concentrations during its lifetime. Therefore, the average contaminant concentration in the surface water in which the fish resides is related to the ground water contaminant concentration by the stream dilution factor previously discussed, which accounts for the width and depth of the portion of the contaminated stream where significant chemical degradation has not yet occurred. Essentially, the Agency is proposing not to base its evaluation of surface water impacts on the maximum concentration of hazardous constituents in the stream, but instead to average the maximum concentration that would be found along the bank of the stream with the lower concentrations that would be found in other less contaminated or non-contaminated areas of the stream. Public comment on this issue is specifically requested.

If contaminant concentrations are sufficient, aquatic organisms may suffer chronic toxic effects. Water Quality Criteria have been established by EPA to protect against these effects. The derivation of these Water Control Criteria is discussed in Unit III.A.1.g. These criteria specify acceptable concentrations, durations of averaging periods, and frequency of allowed excursions. To prevent a potential hazard to aquatic life, in this analysis the average contaminant concentration in the surface water is directly equated to the Criterion Continuous Concentration Water Quality Criteria.

For each constituent subject to today's rulemaking, a back-calculated surface water concentration level was developed using the entire WQC as the starting point. Comparing the ground water and surface water screening levels for the chemicals included in today's proposed rulemaking indicates that pentachlorophenol is the only case where the back-calculated surface water concentration level should be based upon concern for aquatic species. The Agency notes, however, that this conclusion is based upon the assumption that 500 feet is an appropriate generic estimate of the distance from RCRA land disposal units to the nearest surface water bodies. If a distance shorter than 500 feet is used in the calculation, additional constituents covered by today's proposal may be affected.

Chronic toxic effects in humans may be caused by the consumption of contaminated fish and are addressed in Scenario 2. The dissolved contaminants are taken up by the fish residing in or near the initial mixing zone through exchange across the gill and gut membranes and through the skin and stored in the fatty tissues. The ability of aquatic organisms to bioconcentrate contaminants is a function of their lipid content. Lipid content of fish varies with species, age, and time of year. In this analysis, a range of lipid content values accounts for the variation among species. By assuming steady-state discharge of contaminated ground water, the analysis results in a contaminant concentration in the body of the fish that is in equilibrium with the contaminant concentration in the surface water. When these exchanging processes have reached equilibrium, the average contaminant concentration in the whole body of the fish is related to the contaminant concentration in the stream by the product of the dissolved aqueous contaminant concentration and a contaminant-specific bioconcentration factor, which depends upon the nature of the contaminant and the species of the fish. To prevent a potential hazard to human health, the average concentration in the whole body of the fish is equated to an apportioned human reference dose that is calculated using a consumption rate of 6.5 grams of fish per day (45 FR 79353, November 28, 1980). For certain compounds (those with high K_{ow} coefficients), use of apportioned human references doses in fish as the starting point of the surface water back calculations would result in maximum acceptable contaminant concentrations in surface water that are lower than maximum acceptable contaminant levels in drinking water or the human drinking water reference dose, due to their high bioaccumulation potential. Accordingly, the Agency has not accounted for bioaccumulation in fish in the surface water back calculation levels but rather is proposing to cap off the stringency of the surface water back calculations such that contaminant concentrations in ground water entering streams are never required to be lower than human drinking water concentration limits. The Agency specifically requests comment on this proposal.

Following initial dilution in the stream, the contaminant is routed a specified distance downstream from the edge of the initial mixing zone to the intake of a drinking water treatment plant. The contaminant concentration at a specified downstream intake point is related to the contaminant concentration in the initial mixing zone by an attentuation factor (derived in Units III.A.3.e and f) that accounts for the combined influences of advection, longitudinal and lateral dispersion, degradation and sorption occurring during downstream transport over the specified distance.

Humans are exposed to the dissolved chemicals through the consumption of drinking water obtained from the treatment plant whose intake is assumed to be located in the zone of contamination downstream from the initial mixing zone. The Agency invites comment on the method for determining the appropriate distance from the initial mixing zone to a downstream drinking water plant. As a result of this treatment occurring in the drinking water treatment plant, the contaminant concentration is further reduced by a final attenuation factor accounting for the reduction in contaminant concentration achieved through a treatment process in which solids and sorbed chemicals are removed (derived in Unit III.A.3.e).

To ensure that there is no health hazard due to human ingestion of contaminated surface water, the concentration in the treated drinking water is equated to the specified human drinking water reference dose, and the surface water back calculation commences to derive the maximum acceptable leachate concentration. However, as long as the same distance is used in the ground water and surface back calculation, the surface water back calculation need not be conducted. EPA is confident that its proposed ground water component will ensure that contaminant concentration levels in ground water plumes entering surface water will be no greater than the drinking water portion of the human reference dose. Further reductions in the contaminant concentration result from initial mixing with the stream, dilution and chemical transformation during downstream transport, and drinking water treatment. Given the above assumptions, releases of leachate from RCRA land disposal units can be presumed not to cause harm to human health through treated surface water ingestion as long as they are confined to the leachate thresholds derived through the ground water component. However, if a distance of less than 500 feet is employed as a more appropriate conservative generic estimate of the distance from disposal units to nearest surface water bodies, the key assumption that contaminated ground water entering surface water bodies will do so at concentrations no greater than the fractionated human drinking water reference dose will no longer be valid, and the surface water back calculation would have to be conducted.

d. *Implementation.* The steady-state analytical solution has been programmed into a Fortran computer code, D4WATER. This code has been used to establish the back-calculated surface water concentration levels for hazardous constituents subject to today's proposed rulemaking.

As in the ground water component, the Agency has utilized a Monte Carlo uncertainty analysis to allow for the possible variations in environmental settings and the uncertainties in the specific chemical properties (see Unit III.A.2.d, General dimensional relationships). Further detail on the Monte Carlo analysis is provided in Background Document for the Surface Water Screening Procedure (Ref. 5.).

e. *Equations describing transport and dilution processes.* In this unit, equations for determining the dilution factors corresponding to various contaminant pathways are presented (Ref. 13). Where appropriate, the key equations are derived. Major symbols used are listed under Notations in Unit III.A.3.g.

i. *Ground water loading and initial dilution.* For the ground water pathway, the edge-of-stream concentration is back calculated to the leachate concentration via the ground water equation, which considers, among other things, lateral dispersion and chemical hydrolysis.

The ground water dilution factor in Equation (A1) can be calculated using mass balance. The average concentration at the ground water outlet or surface water entry area, C_g, and the leachate concentration, C_L, may be related by:

$$C_g = \zeta_g C_L \qquad \text{(A1)}$$

where ζ_g, is the ground water attenuation factor. Consider the situation illustrated in the following Figures 10 (a) and (b):

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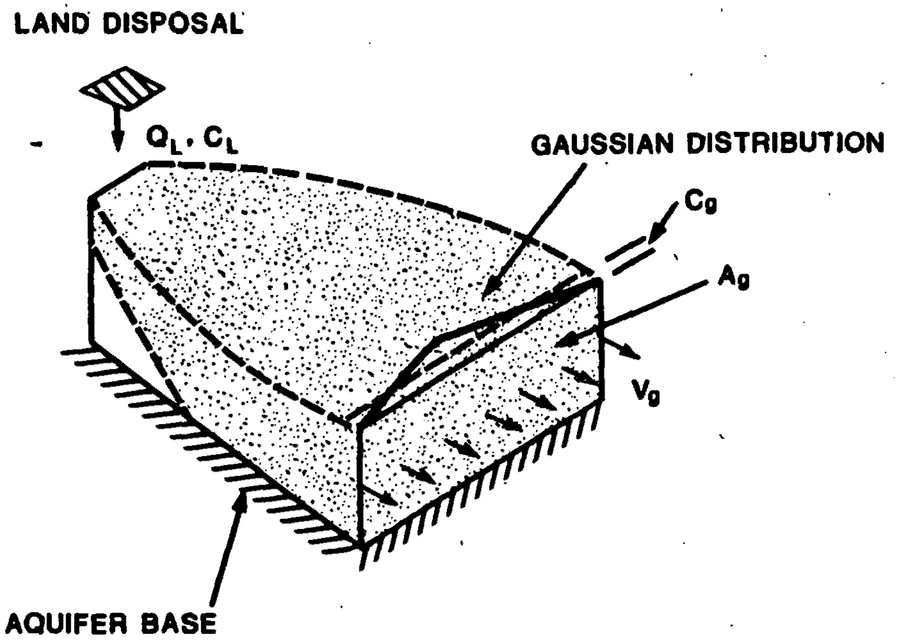

FIGURE 10(a)

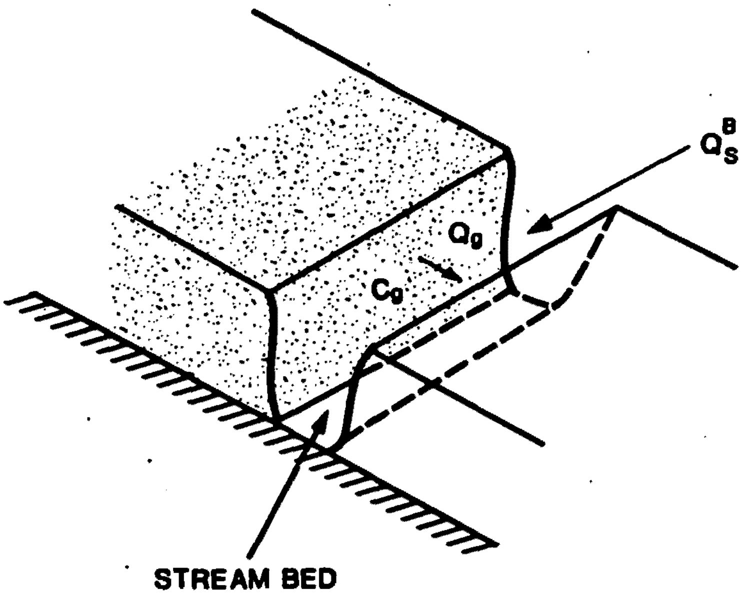

FIGURE 10(b)

FIGURE 10 --SCHEMATIC DECRIPTION OF GROUD WATER CONTAMINANT LOADING AND AND DILUTION DUE TO MIXING OF CONTAMINATED GROUND WATER WITH FRESHWATER FROM STEAM FLOW

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It is assumed that the transport in ground water has reached a steady-state condition. The contaminant mass flux leaching from the land disposal unit into the ground water system, m_L, is given by:

$$\text{(A2)} \qquad \dot{m}_L = Q_L C_L$$

where Q_L is the volumetric rate of percolation through the land disposal unit and C_L is the leachate concentration. The contaminant plume intercepts the stream over the area, A_g, where the average concentration is denoted by C_g. Physically, C_g corresponds to the average of the actual concentration, which is a Gaussian distribution over the effective flow area A_g. If the ground water seepage velocity is V_g, then the contaminant mass flux exiting the ground water system into the stream, m_g, is given by:

$$\text{(A3)} \qquad m_g = V_g A_g C_g = Q_g C_g$$

where Q_g is the contaminated ground water discharge rate. At steady-state, the quantities m_g and m_L are related by:

$$\text{(A4)} \qquad \dot{m}_g = f_H \dot{m}_L$$

where f_H is the fraction of the contaminant mass not transformed by hydrolysis or initial speciation in ground water. (Note that Equation (A4) is the consequence of mass conservation. Lateral dispersion of the contaminant plume affects the concentration, but not the total mass loading to the stream. At steady-state, only chemical transformation reduces the mass loading.) Combining equations (A2)-(A4), one obtains:

$$\text{(A5)} \qquad Q_g C_g = f_H Q_L C_L$$

which may be expressed as:

$$\text{(A6)} \qquad \frac{C_g}{C_L} = \zeta_g$$

where

$$\text{(A7)} \qquad \zeta_g = \frac{f_H Q_L}{Q_g}$$

Equation (A7) gives the required expression for the dilution factor due to transport in ground water. The parameters Q_L and f_H may be estimated as follows:

$$\text{(A8)} \qquad Q_L = \bar{P}(1-f_R)A_w/(86400 \quad 365.24)$$

and

$$\text{(A9)} \qquad f_H = \exp(-K_g \cdot \tau_g) \qquad \tau_g$$

where:

Q_L=rate of percolation through the land disposal unit, m^3/sec

P=average annual precipitation rate, m/year

f_R=runoff fraction

A_w=surface area of the waste site, m^2

K_g=total effective decay constant in ground water, years^{-1}

T_g=time taken by the contaminant to travel from the land disposal unit to the stream entry point, years

Values for K_g and T_g can be calculated just as in the ground water analysis. For those chemicals that hydrolyze, K_g is equal to the overall hydrolysis rate constant given by Equations (B23) and (B25) in Unit III.A.3.f. The travel time of contaminants in ground water is given by:

$$\text{(A10)} \qquad \tau_g = \frac{X_g}{V_g \cdot f_{Dg}}$$

where:

X_g=distance from site to stream, m

V_g=ground water seepage velocity, m/yr

f_{Dg}=fraction of compound that is dissolved (see Equation (B16) in Unit III.A.3.f.

For metals, f_H represents the fraction not precipitated upon entry to the ground water.

As the contaminated water from the ground water system enters the stream along the side and bottom, it mixes with surface water supplied by the upland watershed as illustrated in the following Figure 11:

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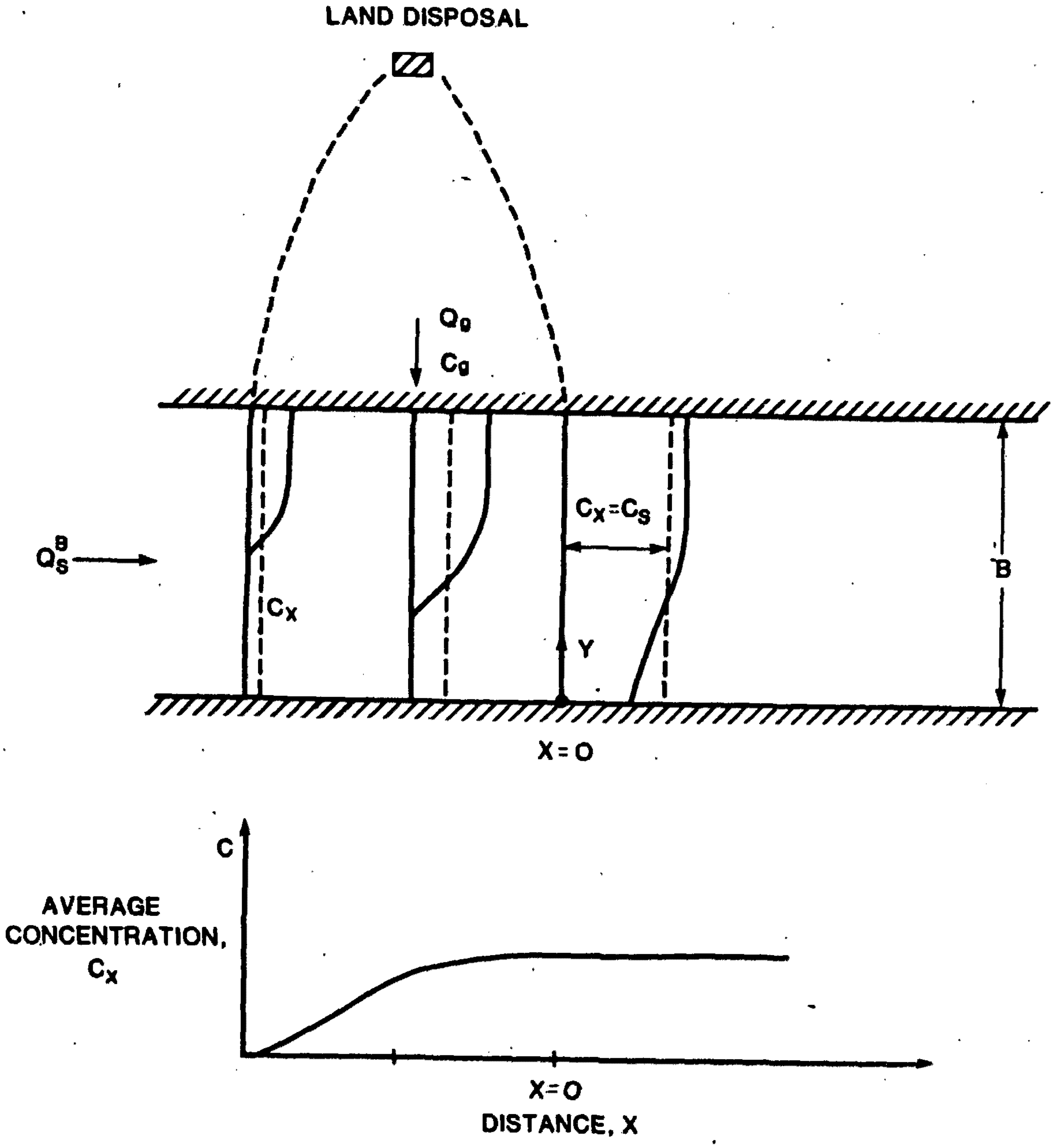

FIGURE 11 --GROUND WATER LOADING TO THE STREAM SHOWING MASS BALANCE AND CONCENTRATION PROFILES

BILLING CODE 6560-50-C

Lateral mixing spreads the contaminants until lateral concentration gradients disappear. The laterally averaged concentration, C_x, increases with increasing distance reaching a maximum near the downstream edge of the contaminated ground water plume, where x=0. At the section where x=0, C_x corresponds to C_s and can be calculated by a single mass balance. Assuming no in-stream degradation, one obtains

$$Q_s^B C_s = Q_g C_g \tag{A11}$$

which can be rearranged in the form

$$C_s = \frac{Q_g}{Q_s^B} C_g = \zeta_s C_g \tag{A12}$$

where Q^B_s is the stream base flow at x=0, and ζ_s is the initial stream dilution factor, which is simply the ratio of the contaminated ground water flow to the stream base flow. Combining (A11) and (A6) yields the relationship of C_s and C_L:

$$C_s = \zeta_s \zeta_g C_L \tag{A13}$$

which upon substituting for ζ_s and ζ_g gives

$$C_s = \frac{Q_g}{Q_s^B} \cdot \frac{Q_L f_H}{Q_g} \cdot C_L \tag{A14}$$

or

$$C_s = \frac{f_H Q_L}{Q_s^B} \cdot C_L \tag{A15}$$

Note that Q_L is given by Equation (A8), Q_{Bs} is given by

$$Q_s^B = \bar{P}(1 - \bar{f}_R) A_s / (86400 \cdot 325.25) \tag{A16}$$

where A_s is the surface area of the stream watershed. It is assumed that the average annual precipitation rate, $\bar{P}$, and the average runoff coefficient, f_R, are the same for the waste site and the entire watershed. Combining equations (A15), (A16) and (A9) gives

$$C_s = \frac{f_H A_w}{A_s} \cdot C_L \tag{A17}$$

where A_w is the surface area of the waste disposal unit.

ii. *Transport due to continuous ground water loading.* The laterally averaged concentration at the downstream edge of the ground water plume (x = 0) is C_S (see Figure 11).

At a given measurement point located at distance x from the edge of the mixing zone, the concentration will quickly reach a steady-state value and this value will be approximately the same as the laterally averaged concentration. The steady-state, laterally averaged solution for concentrations at the measurement point, ζ_T, is given by:

$$\zeta_T = e^{-\beta} \tag{A18}$$

(A19) where $\beta = K \cdot x/U$

K = decay rate constant, sec^{-1}

U = mean downstream velocity, m/sec

For calculating bioconcentration in Scenario 2 or chronic toxicity in Scenario 3, we assume that the fish reside continuously in the upstream area where the effect of degradation is insignificant (x=0). Therefore, in this case, ζ_T, is 1, and C_x becomes C_S.

iii. *Delivery of contaminant through drinking water.* Drinking water plants take in raw water at a distance, x, downstream from the point of discharge. As a minimum requirement, it is assumed that in any drinking water plant, the raw water having contaminant concentration C_X is treated by allowing suspended solids and absorbed chemical to settle out. This leads to a reduction of concentration from C_X to C_{DW}. The relationship between C_{DW} and C_X is given by Equation (A20) with ζ_{DW} being the dilution factor corresponding to the fraction of the compound that is dissolved, f_D.

$$C_{DW} = \zeta_{DW} C_x \tag{A20}$$

The expression for f_D is developed in Unit III.A.3.c. This may be written as:

$$\zeta_{DW} = f_D = \frac{1}{1 + 0.41 K_{ow} \cdot f_{oc} \cdot s \cdot 10^{-6}} \tag{A21}$$

where:

K_{ow}=octanol-water partition coefficient, *l*oct/*l*water

f_{oc}=organic carbon fraction of sediment

S=sediment concentration, mg/l

(4) *Delivery of contaminant through fish.* Dissolved neutral organic compounds in the water can be taken up by fish through exchange across the gill and gut membranes, and through the skin. Contaminated food can be ingested, resulting in further exchange of compounds across the gut membrane. Concentration levels in the fish will rise until the activity of the compound in the blood equals the activity of the compound in the water. This condition represents chemical equilibrium. Further uptake of the compound resulting in higher blood concentration will lead to net exchange out of the fish through the

gill, gut, kidney, and skin. Consequently, any chemical buildup above the equilibrium level is controlled by the relative rates of ingestion, metabolism and exchange. If gill and gut exchange is rapid compared to metabolism, the equilibrium concentration will not be exceeded, and

$$\text{(A22)} \qquad C_B = f_D C_x$$

where C_B is the dissolved concentration in the blood, expressed in mg/l, and f_D is the fraction of chemical dissolved. Note that f_D is assumed to be the same as ζ_{DW} given by Equation (A21).

If the fish is exposed to steady aqueous concentrations over a long period of time, the distribution of the compound within the various fish tissues will equilibrate, so that:

$$\text{(A23a)} \qquad C_\ell = K_\ell C_B$$

and

$$\text{(A23b)} \qquad C_{n\ell} = K_{n\ell} C_B$$

where:

C_l=lipid (or fat) biomass concentration, mg/kg
K_l=lipid phase partition coefficient, *l*/kg
C_{nl}=non-lipid (blood, muscle) biomass concentration, mg/kg
K_{nl}=non-lipid partition coefficient, *l*/kg

The average whole fish concentration C_F (mg/kg) is the weighted sum of the tissue concentrations:

$$\text{(A24)} \qquad C_F = f_\ell C_L + (1 - f_\ell) C_{n\ell}$$

where f_l=fraction of biomass that is lipid.
Substituting Equations (A 22) and (A 23) into (A 24) gives:

$$\text{(A25)} \qquad C_F = K_f f_D C_x$$

where K_F is the entire fish partition coefficient, or bioconcentration factor given by:

$$\text{(A26)} \qquad K_F = K_\ell f_\ell + K_{n\ell} (1 - f_\ell)$$

Equation (A25) reduces to Equation (A20) provided that the parameter ζ_F is defined as:

$$\text{(A27)} \qquad \zeta_F = K_F f_D$$

Note that unlike the dilution factors, ζ_F is not dimensionless. The units for ζ_F is l/kg. For strongly hydrophobic compounds, lipid storage dominates $_F$F. The lipid phase partition coefficient can be replaced by the octanol-water partition coefficient, so that, approximately:

$$\text{(A28)} \qquad K_F = K_{ow} \cdot f_\ell$$

For less hydrophobic compounds, K_nl may contribute significantly to K_F. Non-lipid tissue is composed primarily of water, along with protein and carbohydrates. Assuming that partitioning to non-lipids is always less than or equal to 1 percent of the partitioning to lipids, a conservative estimate of K_F is approximately (Ref. 5):

$$\text{(A29)} \qquad K_F = K_{ow} \cdot (f_\ell + .01)$$

For highly polar compounds and metals, the bioconcentration factor K_F can not be estimated from the octanol-water partition coefficient and lipid fraction. In this case, observed field or experimental values of K_F must be used directly.

(5) *Direct Exposure of Aquatic Organism.* If contaminant concentrations are high enough, aquatic organisms may suffer chronic toxic effects. Water Quality Criteria have been established to protect against these effects. The derivation of the Water Quality Criteria is discussed in Unit III.A.1.g. These criteria specify criteria concentrations, durations of averaging periods, and frequency of allowed excursions. Only permitting an excursion once in 3 years implies that the criteria were developed based on low flow conditions when dilution of the contaminated plume is least. During these base flow conditions, both stream flow and leachate flow are proportional to average precipitation, as described by Equations (A8) and (A16). Consequently, lower average rainfall will produce both lower stream flow and lower leachate flow, resulting in a constant dilution factor. While the presence of sediment in the stream causes a slight reduction in the dissolved concentration due to sorption, it may also cause faster uptake of the chemical by fish. The net effect on toxicity is not clear. Because of this, and the fact that criteria are designed for total, not dissolved concentrations, the exposure concentration, C_{EXP}, will be set equal to the stream concentration C_x:

$$\text{(A30)} \qquad C_{EXP} = \zeta_{EXP} \cdot C_x = C_x$$

Where ζ_{EXP} is the dilution factor for exposure of aquatic organisms to stream concentrations. Consequently, a concentration that will not be exceeded more than one in 3 years will nevertheless be equalled often in a 3 year period. Thus, the stream may approach chronic toxicity conditions and leave little margin for error in the stream criteria. It may be advisable to back calculate allowable leachate concentrations using a fraction of the stream criteria number.

f. *Advection, dispersion, and chemical transformation in stream.* In this unit procedures and formulas for estimating physical parameters of advection, dispersion and chemical transformation in surface water are presented.

i. *Advection.* A compound introduced to a water body will be advected downstream with the bulk water at mean velocity U such that

$$U = Q/(B \cdot d) \quad \text{(B1)}$$

where:

Q=stream flow, m^3/sec
B=stream width, m
d=mean stream depth, m

For a given flow in a specific stream reach, width, depth, and velocity are related empirically by the following equations (Ref. 5):

$$B = aQ^b \quad \text{(B2a)}$$
$$d = cQ^f \quad \text{(B2b)}$$
$$U = kQ^m \quad \text{(B2c)}$$

where the sum of the exponents $(b+f+m)$ and the product of the constants $(a \cdot c \cdot k)$ must each equal 1.0. Although theoretical considerations predict that $b=0.23$, $f=0.42$, and $m=0.35$, considerable variations have been observed among sites. The following Figure 12 presents the exponents observed at 139 sites, as analyzed by Park (Ref. 82):

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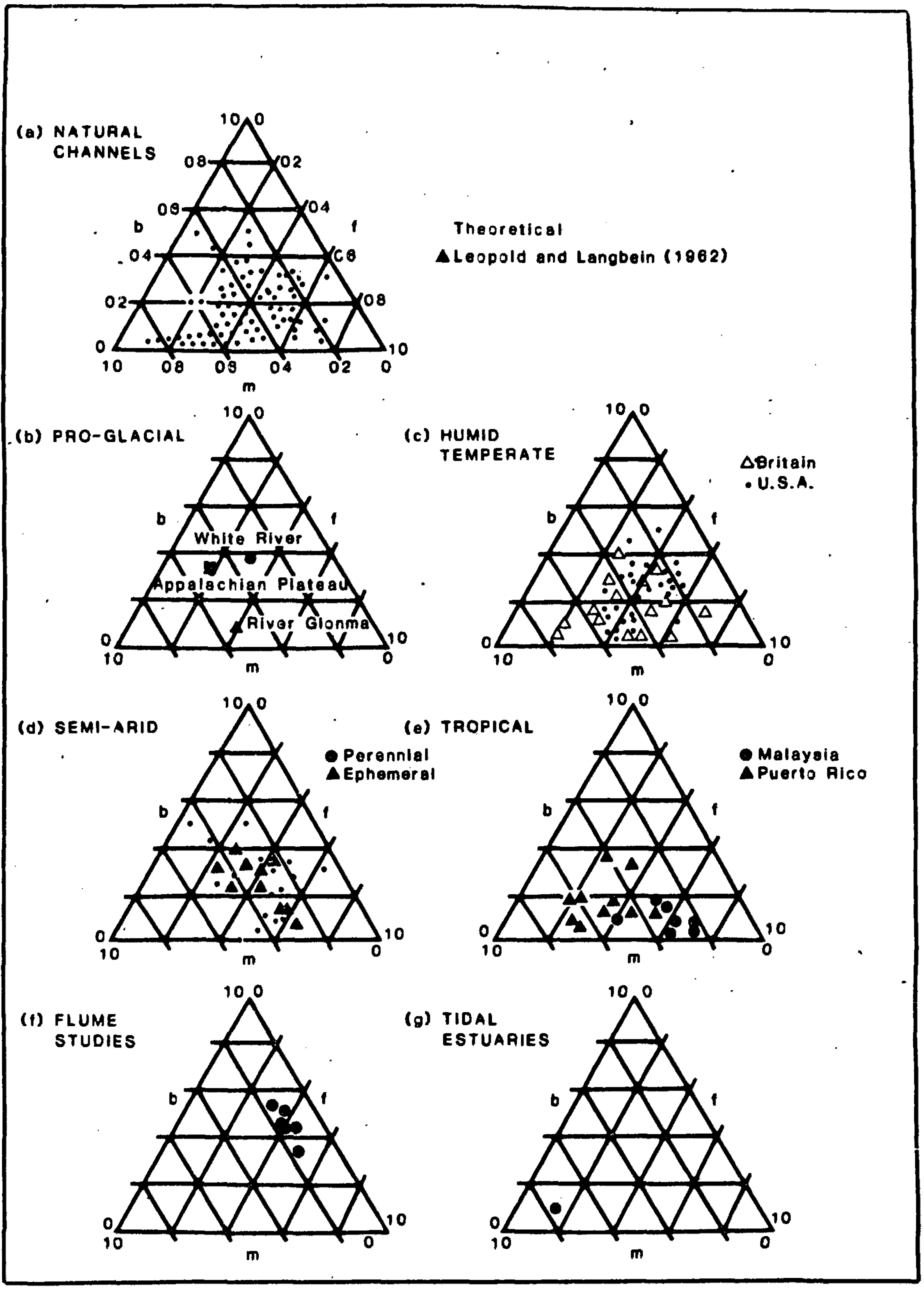

FIGURE 12 --TRI-AXIAL GRAPHS OF AT-A-STATION HYDRAULIC GEOMETRY EXPONENTS

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The stream base flow for subwatersheds, Q_o, can be calculated from the relationship

$$\text{(B3)} \qquad Q_o = A_s \cdot q$$

where q=average flow per unit area

$$\frac{m^3/sec}{m^2}$$

Velocity at baseflow, U_o, can be calculated by Manning's equation:

$$\text{(B4)} \qquad U_o = d_o^{2/3} \cdot s^{1/2}/n$$

where:

d_o=depth baseflow, m

s=channel slope, m/m

n=Manning's roughness coefficient, sec/$m^{1/3}$

The width at baseflow B_o, can be calculated from U_o, d_o, and the baseflow Q_o using Equation (Bl) rearranged:

$$\text{(B5)} \qquad B_o = Q_o/(U_o \cdot d_o)$$

The stream flow during a storm includes both baseflow and runoff:

$$\text{(B6)} \qquad Q_s = Q_s^B + A_s P_{25} f_r$$

Given the baseflow values B_o, d_o, U_o, and Q_o and the stormflow value Q, the widths, depths, and velocities for stormflow conditions can be calculated as

$$\text{(B7a)} \qquad B = B_o \; (Q/Q_o)^b$$

$$\text{(B7b)} \qquad d = d_o \; (Q/Q_o)^f$$

$$\text{(B7c)} \qquad U = U_o \; (Q/Q_o)^{1-b-f}$$

When the theoretical values for b and f hold, U increases with Q to the ⅓ power. A tenfold increase in flow, then, results in a doubling of velocity.

Streamflows and the associated hydraulic variables, then, can be synthesized from distributions of watershed areas A_s, areal flows q, channel slopes s, channel roughness factors n, precipitation totals P_{25}, runoff coefficients f_R, and the hydraulic geometry exponents b and f.

ii. *Dispersion.* A compound advected through a water body will be mixed vertically, laterally, and longitudinally from areas of high concentration to areas of low concentration. The rate of mixing is proportional to the concentration gradient and either a turbulent mixing coefficient or a dispersion coefficient. A turbulent mixing coefficient in rivers is proportional to the length scale d and the intensity of turbulence, which is represented by the shear velocity:

$$\text{(B8)} \qquad U^* = \sqrt{g \cdot d \cdot s}$$

where:

U^*=shear velocity, m/sec

s=channel slope

d=mean depth, m

g=acceleration of gravity, m/sec^2

Because vertical mixing in streams occurs very quickly, we assume completion during the initial dilution stage. Lateral mixing is most important in the near field. It is smallest for uniform straight channels, and increases with curves and irregularities. Fischer et al. (Ref. 44) suggest calculating the lateral diffusion coefficient as:

$$\text{(B9)} \qquad Ey = 0.6 \times d \times U^*. \pm 50\%$$

The proportionality factor can vary evenly between 0.4 and 0.8.

Longitudinal turbulent mixing is generally much smaller than shear flow dispersion, which is caused by velocity gradients. Fischer et al. (Ref. 44) suggest calculating the longitudinal dispersion coefficient with the approximate relationship:

$$\text{(B10)} \qquad Ex = 0.11U^2 \cdot B^2/d \cdot U^*$$

Here, again, the proportionality factor can vary ±50 percent.

iii. *Chemical Transformation.* A compound transported through a water body can undergo several physical and chemical transformations. Fast reactions are treated by assuming local equilibrium conditions. Sorption is considered to be in equilibrium with desorption:

$$\text{(B11)} \qquad S' + C_w = \hat{C}_s$$

Where:

S'=sediment concentration, kg/l

C_w=dissolved aqueous concentration, mg/l

$\hat{C}_s$=sorbed concentration, mg/l

The local equilibrium concentrations C_w and C_s are governed by the equilibrium distribution coefficient K_p (l/kg):

$$K_p = \frac{C_s}{S' \cdot C_w}$$

It has been shown that for sorption of hydrophobic organic compounds:

$$\text{(B13)} \qquad K_p = K_{oc} \cdot f_{oc}$$

Where:

K_{oc}=organic carbon partition coefficient, l/kg

f_{oc}=organic carbon fraction of sediment

and K_{oc} has been correlated with K_{ow} (Ref. 66):

$$\text{(B14)} \qquad K_{oc} = 0.41 \, K_{ow}$$

Combining Equations (B12)–(B14) and rearranging terms gives an expression for the fraction of the compound that is dissolved:

$$\text{(B15)} \qquad f_D = \frac{1}{1 + 41 \cdot K_{ow} \cdot f_{oc} \cdot S \cdot 10^{-6}}$$

The sorbed chemical fraction f_s is equal to $1-f_D$.

The fraction of the compound that is dissolved in ground water can be calculated from an equivalent expression:

$$\text{(B16)} \qquad f_{Dg} = \frac{o_g}{o_g + 0.41 \cdot K_{ow} \cdot f_{ocg} \cdot \rho_{bg}}$$

where:

o_g=volumetric water content of porous medium,

f_{ocg}=organic carbon fraction of porous medium

ρ_{bg}=bulk density of porous medium, kg/l

and

$$\rho_{bg} = 2.65(1 - \theta_g) \quad (B17)$$

The sorbed chemical fraction f_{sg} is equal to $1 - f_{Dg}$.

Slower chemical transformation reactions can be treated generally by using mixed second order kinetics (Ref. 13):

$$C_w + [E]_i \rightarrow P \quad (B18)$$

where:

$[E]_i$=environmental property for process "i"
P=transformation product, mg/l

The reaction rate R_i (mg/l-sec) for Process "i" is:

$$(B19)\quad R_i = k_i \cdot Y_i \cdot f_D \cdot C$$

where:

k_i=second order rate constant for process "i"
Y_i=yield coefficient for process "i"
C=total concentration of compound (mg/l).

Given a local value for $[E]_i$, a pseudo-first order rate constant K_i (sec.$^{-1}$) can be calculated:

$$(B20)\quad K_i = k_i \; [E]_i \cdot Y_i \; f_D$$

For a compound undergoing several competing reactions, the overall pseudo-first order rate constant K(sec. $^{-1}$) is

$$(B21)\quad K = \sum_i K_i$$

This general second order reaction method can be used to predict reaction rates for photolysis, hydrolysis, oxidation, and bacterial degradation. For short reaches of rivers with travel times of hours, these reactions are not likely significant to reduce instream concentrations. For transient loads during storms, darkness should further reduce photolysis and, indirectly, oxidation. Bacterial communities are unlikely to acclimatize within hours to the transient loads. Of these transformation reactions, then, only hydrolysis will be considered for those few compounds with large rate constants. The hydrolysis rate constant is calculated from the acid-catalyzed, neutral, and base-catalyzed pathways (Ref. 5):

$$(B22)\quad K_{HO} = K_{HA}[H^+](\alpha f_s + f_D) + K_{HN} + K_{HB}[OH^-]\, f_D / 3600$$

where:

k_{ha}=second-order acid-catalysis hydrolysis rate constant (l/mole-sec)
[H+]=hydrogen ion concentration=10^{-pH} (mole/l)
pH=stream pH
α=acid-catalysis hydrolysis rate enhancement factor for sorbed compound=10
k_{hn}=neutral hydrolysis rate constant (sec−^{1})
k_{hb}= second-order base-catalysis hydrolysis rate constant (l/mole-sec)
$[OH^-]$=hydonium ion concentration=10^{-pOH} (mole/l)
pOH=stream pOH=14−pH.

For ground water, the nominal hydrolysis rate constant (in years $^{-1}$) is calculated from an equivalent expression:

$$(B23)\quad K_{go} = (K_{HA}[H^+]_g(\alpha \cdot f_{sg} + f_{Dg}) + K_{HN} + K_{HB}[OH^-]_g \cdot f_{Dg}(24)(365 \cdot 25)$$

where $[H^+]_g$ = hydrogen ion concentration = 10^{-pHg} (mole/ℓ)
pHg = ground water pH
$[OH^-]_g$ = hydronium ion concentration = 10^{-pOHg} (mole/ℓ)
pOHg = ground water pOH = 14^{-pHg}

The nominal hydrolysis rate constants K_{Ho} and K_{go} apply to a reference temperature, T_R (usually 25 °C). These can be corrected to ambient surface or ground water temperatures (T or T_g) with the following expressions:

$$(B24)\quad K_H = K_{HO} \cdot \exp\left[10^4 \cdot \left(\frac{1}{T_R + 273} - \frac{1}{T + 273}\right)\right]$$

$$(B25)\quad K_g = K_{go} \cdot \exp\left[10^4 \cdot \left(\frac{1}{T_R + 273} - \frac{1}{T_g + 273}\right)\right]$$

A final transformation pathway to consider is volatilization. The volatilization rate constant K_v (sec^{-1}) can be calculated from the Whitman, or two-resistance model (Ref. 5):

$$(B26)\quad K_v = \frac{1}{d} \cdot \frac{1}{R_L + R_G} f_D$$

where:

d=river depth (m)
R_L=liquid phase resistance (sec/m)
R_G=gas phase resistance (sec/m).

The second term in Equation (B26) represents the conductivity of the compound through a liquid and a gas boundary layer at the water surface. The liquid phase resistance to the compound is assumed to be proportional to the transfer rate of oxygen, which is limited by the liquid phase only:

$$R_L = \frac{1}{K_{02} \cdot d \cdot \sqrt{32/mw}} \qquad \text{(B27)}$$

where:

K_{02} = reaeration rate constant (sec^{-1})
MW = molecular weight of the compound
32 = molecular weight of oxygen.

The gas phase resistance to the compound is assumed to be proportional to the transfer rate of water vapor, which is limited by the gas phase only:

$$R_G = \frac{1}{\frac{H}{RT'} \cdot WAT \cdot \sqrt{18/mw}} \qquad \text{(B28)}$$

where:

WAT = water vapor exchange constant (m/sec)
18 = molecular weight of water
H = Henry's law constant ($atm\text{-}m^3$/mole)
R = ideal gas constant = $8.206 \times 10^{-5} m^3\text{-atm./mol°K}$
T' = water temperature (°K = 273 + T.

The reaeration and water vapor exchange constants will vary with stream reach and time of year. They can be calculated using one of several empirical formulations. The reaeration rate constant will be calculated by the Covar method using stream velocity, U, and depth, d, then corrected for temperature T (Ref. 35). The water vapor exchange constant will be calculated using wind speed and a regression proposed by Liss (Ref. 70):

$$WAT = 5.16 \times 10^{-5} + 3.156 \times 10^{-3} \cdot W \qquad \text{(B29)}$$

where:

W = wind speed at 10 cm above surface (m/sec).

Wind speed measured above 10 cm can be adjusted to the 10 cm height assuming a logarithmic velocity profile and a roughness height of 1 mm (Ref. 62):

$$W = W_z \cdot \log(0.1/0.001)/\log(Z/0.001) \qquad \text{(B30)}$$

where:

W_z = wind speed at height z (m/s)
Z = wind measurement height (m)

In summary, three transformation processes are considered in this analysis: sorption, hydrolysis, and volatilization, Sorption of hydrophobic organic compounds is calculated by Equation (B15) using data for K_{ow}, f_{ow}, and s. Sorption of metals is calculated by MINTEQ using data for pH, T, alkalinity or TIC, DOM, major cations and anions, and metal partition coefficients. Hydrolysis is calculated by Equations (B22) and (B24) using data for pH, k_{HA}, k_{HN}, and k_{HB}. Volatilization is calculated by Equations (B26) through (B30) using data for U, d, W, T, MW, and H. When insufficient data are available, conservative analyses can be completed by ignoring any of these processes.

g. *Notation for equations in Unit III.A.3.e.*

A_g	area through which contaminated groundwater flows into stream, m^2
A_S	surface area of stream watershed above entry of leachate to stream, m^2
A_W	surface area of water disposal unit, m^2
B	stream width, m
C	concentration of dissolved contaminant, mg/*l*
C_{ADI}	acceptable daily intake concentration, mg/*l*
C'_{ADI}	acceptable daily intake fish concentration, mg/kg
CCC	criterion continuous concentration to protect aquatic life, mg/*l*
C_B	dissolved concentration in fish blood, mg/*l*
C_{DW}	concentration of dissolved contamination drinking water, mg/*l*
C_F	average bioaccumulation concentration of dissolved contaminant in fish, mg/kg
$\bar{C}_g$	average concentration across contaminated area of interception between groundwater system and stream, mg/*l*
C_l	lipid (fat) biomass concentration in fish tissues, mg/kg
C_L	concentration of contaminant in leachate, mg/*l*
C_{nl}	non-lipid (blood, muscle) biomass concentration in fish tissues, mg/kg
C_R	concentration of contaminant in the surface runoff, mg/*l*
$\bar{C}_S$	average concentration of contaminant in the mixing zone adjacent to the stream entry point, mg/*l*
$\hat{C}_S$	sorbed concentration, mg/*l*
C_X	concentration at distance x downstream from the stream entry point, mg/*l*
d	mean stream depth, m
d_i	impoundment depth, m
d_r	impoundment freeboard required to contain a 24-hr, 25-hr storm, m
d_o	mean stream depth at base flow, m
E_x	longitudinal dispersion coefficient, m^2/sec
E_y	lateral dispersion coefficient, m^2/sec
E	longitudinal dispersion factor = $(4E_x(t_r))^{1/2}$
E'	longitudinal dispersion factor = $(4E_x(t\text{-}t_r))^{1/2}$
$[E]_i$	environmental property for process "i"
f	depth exponent for stream hydraulic geometry
f_D	fraction of contaminant that is dissolved
f_h	fraction of contaminant mass not transformed by hydrolysis or initial speciation in groundwater
f_l	fraction of fish biomass that is lipid
f_{oc}	organic carbon fraction of suspended sediment
f_{ocg}	organic carbon fraction of aquifer medium
f_R	fraction of precipitation that goes into surface runoff
f^*_R	stream flow recassion factor
f_S	fraction of chemical that is sorbed
g	acceleration of gravity, 9.81 m/sec^2
H	Henry's law constant, atm-m^3/mole
$[H^+]$	hydrogen ion concentration $= 10^{-pH}$ mole/*l*
K	surface water decay rate constant, sec^{-1}
k_{HA}	second-order acid-catalysis hydrolysis rate constant, *l*/mole-hour
k_{HB}	second-order base-catalysis hydrolysis rate constant, *l*/mole-hour
k_{HN}	neutral hydrolysis rate constant, $hour^{-1}$
k_i	second-order rate constant for process "i"
K_F	fish partition coefficient (bioaccumulation), *l*/kg
K_H	Pseudo first order rate constant for hydrolysis, sec^{-1}
kl	lipid fish tissue partition coefficient, *l*/kg
K_{nl}	non-lipid fish tissue partition coefficient, *l*/kg
K_{oc}	organic carbon partition coefficient, *l*/kg
K_{ow}	octanol-water partition coefficient, *l*oct/*l*water
K_{02}	reaeration rate constant, sec^{-1}
K_p	equilibrium distribution coefficient for sediment, *l*/kg
K_v	pseudo first order volatilization rate constant, sec^{-1}
m	velocity exponent for stream hydraulic geometry

$\bullet_g$ contaminant mass flux exiting the groundwater, g/sec
$\bullet_L$ contaminant mass flux leaching from land disposal unit, g/sec
$\bullet P$ mass loading rate to stream from surface runoff, g/sec
MW molecular weight of compound
n Manning roughness coefficient, sec/m⅓
$[OH^-]$ hydronium ion concentration$=10^{p}{}_{-OH}$ mole/l
p^H stream pH.
$p^H{}_g$ groundwater pH
p^{OH} stream pH
$p^{OH}{}_g$ groundwater pOH
P transformation product, mg/l
$\bar{P}$ average annual precipitation, m
P_{25} average precipitation for 25-year, 24-hour storm, m
q average flow per unit area, m^3/sec/m^2
Q stream flow, m^3/sec
Q_g contaminated groundwater discharge, m^3/sec
Q_L rate of percolation through the land disposal, m^3/sec
Q^R storm runoff flow, m^3/sec
$Q^*{}_R$ flow rate of spill delivered to the stream, m^3/day
Q_S stream flow, m^3/sec
$Q^B{}_S$ stream base flow, m^3/sec.
R ideal gas constant, 8.206×10^{-5} m^3—atm/mol°K
R_G gas phase resistance, sec/m
R_i reaction rate for process "i", mg/ l-sec
R_L liquid phase resistance, sec/m
s channel slope
S sediment concentration, mg/l
S′ sediment concentration, kg/l
t time since beginning of discharge, sec
t_R time duration of the contaminant loading, sec
T water temperature, °C
T′ water temperature, °K$=273+T$
U mean downstream advective velocity, m/sec
U^* shear velocity, m/sec
V_g groundwater seepage velocity, m/year
W wind speed at 10 cm above surface, m/sec
WAT water vapor exchange constant, m/sec
W_z wind speed at height z, m/sec
x downstream distance from discharge, m
Y_i yield coefficient for process "i"
Z wind measurement height, m
α acid-catalysis hydrolysis rate enhancement factor for sorbed compound
β kinetic reduction exponent $= k\equiv x/U$
β_1 exponent in plane source equation $= xU/2E_x$
β_2 exponent in Plane source equation $= xw/2E_x$
w advective-dispersion factor, m/sec
ξ_{EXP} aquatic exposure factor
ζ_{DW} drinking water treatment reduction factor
ζ_F biomagnification factor in fish, l/kg
ζ_g groundwater attenuation factor
ζ_S dilution due to mixing at the stream entry Point
ζ'_S stream flow dilution factor (pulse load for first runoff event)
$\zeta^*{}_S$ stream flow dilution factor (pulse load for second runoff event)
ζ_T attenuation factor for transport in the stream (groundwater loading)
ζ'_T attenuation factor for transport in the stream (surface runoff loading)
$\zeta^*{}_T$ attenuation factor for transport in the stream (catastrophic runoff loading)
ζ time taken by the contaminant to travel from the land disposal unit to the stream entry point

4. Air Back Calculation Procedure

a. *Introduction.* Although migration through the ground water is most often considered the prevalent pathway of exposure to contaminants released from land disposal units, the volatility and toxicity of some hazardous waste constituents indicate that potential exposure through the air may also be of concern. The legislative history of HSWA seems to indicate Congress' desire that EPA evaluate all potential pathways of exposure from land disposal units in establishing treatment standards. The Senate Committee report for HSWA states, "The Administrator is required to find that the nature of the facility and the waste will assure that migration of the wastes will not occur while the wastes still retain their hazardous characteristics in such a way that would present any threat to human health and the environment." (S. Rep. No. 98–284, 98th Cong., 1st Sess. 15 (1983).) The House Committee report states, "Wastes which remain hazardous for a long period of time, or are mobile in the air, soil or ground water, or which are highly toxic, are prime candidates for the land disposal restrictions." (H.R. Rep. No. 98–198, 98th Cong., 1st Sess. 32 (1983)).

EPA Field Inspection Team (FIT) files document damage incidents resulting in the contamination of ground water, surface water, and air from treatment, storage, and disposal units. EPA File WV–71, for example, documents air contamination from landfill and surface impoundments resulting in trichloroethylene air emissions at a level of 1.1 ppm, and toluene at a level of 27 ppm, in addition to methylene chloride, benzene, and PCE at unspecified levels. Another example is EPA FIT File 02–8009–02. This file documents air contamination resulting from landfill emissions of methane, vinyl chloride, toluene, enthylene methylene chloride, dichloroethylene, and tetrachloroethylene.

Although the Agency is not specifically proposing an approach for analyzing air emissions from land disposal units in today's notice (see Unit III.A.4.e, Timing of air component), the following outlines the Agency's current thinking on how to address this aspect of the land disposal restrictions program, and solicits comments and information that would be useful in establishing screening concentrations for human exposure to hazardous constituents through the air. In addition, the Agency solicits comments on environmental effects and existing methodologies for assessing them that should be considered in this aspect of the land disposal restrictions program.

EPA's conceptual approach to establishing screening concentrations for human exposure to air contaminated with hazardous waste constituents emitted from a land disposal unit is the same as for human exposure to contaminated ground water and surface water. The analysis begins with an acceptable exposure level for an individual, at a downwind distance from a land disposal unit, based on an appropriately apportioned reference dose for each of the hazardous constituents in a waste. Using emission and dispersion models, a back calculation is performed in conjunction with a Monte Carlo uncertainty analysis to arrive at the acceptable hazardous constituent equilibrium concentration in the air phase at the air/land-disposal-unit interface. This value, will be the concentration that ensures that exposure to the constituent at a potential human receptor point will not result in harm to human health. (It should be noted that the constituent concentration in the waste could also be estimated provided that adequate waste characterization data are available.)

b. *Air modeling.* In practice, it is useful to conceptualize the relationship between waste characteristics and air-exposure levels in terms of two processes which are modeled in different ways. First is the process by which contaminants are released from the land disposal unit to the atmosphere, and second is the subsequent dispersion as the contaminant is transported to the point of exposure. In order to calculate the equilibrium concentrations of hazardous waste constituents in the air phase at the air/land-disposal-unit interface, the Agency is evaluating both emissions and dispersion models.

i. *Emissions.* Air emission models are specific to waste disposal unit type and require waste characteristics, parameters describing the unit (such as surface area), and meteorological parameters as input. The output of the model is an emission rate. EPA will develop an emission model for each of the following unit types: waste piles, surface impoundments, landfills and land treatment facilities. Other land disposal units, for example salt beds, will be evaluated to determine whether they are a significant source of air emissions.

To select the appropriate emissions model to be used to calculate screening concentrations for air exposure, EPA will conduct an analysis to screen these models. Each land disposal unit type will be characterized in terms of both emissions and area. The potential human exposure will be determined for each land disposal unit type and compared.

ii. *Dispersion.* Atmospheric dispersion models relate the emission rate of hazardous constituents at the source of contamination to the ambient air concentration at the downwind receptor. These models are specific to emissions rate, physical configuration, meterology and distance from the contaminant source to the human receptor.

Because the reference dose used by EPA as the exposure concentration for the downwind human receptor is a daily exposure, hourly meteorologic data will be used to back calculate the equilibrium constituent concentration in the air phase at the air/land-disposal-unit interface. As a result, EPA will use the Industrial Source Complex Short Term Model (ISC-ST) as the dispersion model for analyzing exposure via the air route. The ISC-ST model is listed as the preferred model in the revised Guideline on Air Quality Models. The original guideline is incorporated by reference in 40 CFR 51.24 and 52.21. The December 7, 1984 rulemaking (49 FR 48018) proposed to replace the original with the revised guideline.

iii. *Monte Carlo approach.* EPA plans to use a Monte Carlo approach for determining screening concentrations for exposure to air contaminated with hazardous waste constituents. The Monte Carlo simulation technique combines the variability in emission rates with the results of dispersion model computations. This technique simulates the effect of random variations in input variables by randomly selecting values from an appropriate probability distribution and accumulating results over many samples to obtain a picture of the form that a long-term series of results should take (i.e., a probability distribution of equilibrium concentrations in the air phase at the air/land-disposal-unit interface for each constituent).

c. *Volatilization test procedure.* The output of the air modeling described above will be an equilibrium concentration for each hazardous waste constituent in the air phase at the air/land-disposal-unit interface. This value would become the screening concentration for air exposure.

In order to enable a comparison of the concentrations of volatile constituents from an actual waste to the screening concentration determined for air, the Agency is developing a volatilization test procedure. This test is an analytic method designed to determine the equilibrium concentration of volatile hazardous waste constituents emitted from the waste into a static head space. A sample of a waste would be placed in a test apparatus designed to capture the volatile constituents of each waste. The equilibrium concentrations of these captured constituents would then be analytically measured and compared to the screening concentration.

d. *Determination of distance to potential point of exposure.* In performing the ground water back calculation procedure, a distance is selected representing a point of potential human exposure. This distance represents the point at which human exposure to constituents in ground water could occur through ingestion of drinking water. As discussed previously, selection of the distance is based on the concept of effective control.

Although a distance of 500 feet has been selected as the potential point of human exposure for the ground water back calculation model, this distance may not be appropriate for calculating human exposure through the air. As noted in Unit III.A, the distance used in the calculation of screening concentrations for ground water represents the area of effective control. It is presumed that owner/operators can, at a minimum, effectively control access to ground water within this area and thereby prevent human exposure to unacceptable concentrations of hazardous constituents in ground water. When applied to an analysis of air emissions, the concept of "control" may be very different. Unlike the ground water area, one cannot control exposure simply by owning the land and prohibiting the drilling of ground water wells. In order to "control" exposure to air emissions, options such as mandatory mask requirements or ingress restrictions should be considered. Existing RCRA regulations at 40 CFR 264.14 already require that warning signs be posted at hazardous waste facilities and that measures be taken to avoid unauthorized entry onto the facility. In deciding upon the proper exposure point, it is also important to note that EPA is concerned about the health and safety of facility personnel. "RCRA's mandate to protect human health and the environment is not limited to dangers occurring outside hazardous waste management facilities" (45 FR 33184 (May 19, 1980)).

e. *Timing of air component.* EPA intends to propose the air back calculation procedure as soon as possible. Most likely, it will be published with the proposed rulemaking addressing the California List. If, based on the proposal, it appears that the treatment standard for any of the solvent or dioxin-containing wastes subject to the November 8, 1986 statutory deadline, will be driven by the screening level calculated based on air exposure, necessary adjustments to the treatment standard will be proposed and every effort will be made to issue final standards by the applicable ban effective date. It is also possible that the concentrations calculated based on the ground water and surface water components will be at a level that also provided protection from exposure via the air.

EPA is also analyzing other possible effects, such as ozone effects, resulting from emissions of hazardous constituents from land disposal facilities in conjunction with the statutory mandate of section 3004(n) to promulgate regulations for the monitoring and control of air emissions at hazardous waste treatment, storage, and disposal facilities, as necessary to protect human health and the environment. EPA believes that section 3004(n) is a more appropriate authority for considering effects, such as ozone effects, that are influenced by the cumulative waste management activities that may occur at the facility. Under section 3004(n), the Agency can consider all waste management activities that may contribute to air emissions, including activities like waste transfer operations and non land-based management, that are not covered by the land disposal restrictions program.

B. Determination of Best Demonstrated Achievable or Available Technologies and Performance

This unit describes in more detail EPA's proposed approach to evaluating alternative treatment technologies for hazardous wastes otherwise prohibited from land disposal. The purpose of this evaluation to to determine which treatment methods are the best demonstrated for treating these hazardous wastes, and to determine the performance that is achieved by these methods. BDAT and its performance must be established so that the Agency can develop treatment standards for hazardous wastes in accordance with the regulatory framework described in Unit II. As discussed in Unit II, and stated in RCRA section 3004(m), treatment methods "should substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste." Also, the "levels and methods of treatment established by the Agency should be the best that have been demonstrated to be achievable." (Vol. 130 Cong. Rec. S9178, July 25, 1984.)

1. Waste Treatability Subgroups

Because of the large number and variable nature of the wastes within most EPA waste codes, it is usually not appropriate to evaluate treatment methods and their effectiveness on a waste code basis. Rather, in most cases EPA will divide wastes into treatability subgroups based on similar physical and chemical properties. Factors that will be considered in establishing these subgroups include physical and chemical properties such as pH and heat value. For instance, one waste group may consist of acidic wastes of pH less than or equal to 2, and another group may contain basic wastes of pH greater than or equal to 12.5. The heat value of a waste determines whether the waste can be used as a fuel substitute or incinerated, and usually depends on the concentration of organic constituents in the waste. Wastes may also be grouped according to the constituent properties since these properties influence waste treatability. For example, all wastes containing volatile organic constituents may form one treatability group, while wastes containing soluble organics may form another group. Other groups may consist of wastes containing metals or cyanides.

All of the waste groups described above may require further subdivision according to constituent concentration. Wastes containing high concentrations of solvents may be amenable to distillation, whereas wastes containing lower concentrations of the same solvents may require steam or air stripping. Physical form (i.e., liquid, sludge, or solid) also influences treatability. Many treatment processes are appropriate only for aqueous or liquid wastes; other apply only to sludges or solids.

In this proposed rulemaking EPA categorizes solvent waste codes F001 through F005 into two major treatability groups based on the factors given above. The first group is solvent-water mixtures which require wastewater treatment, such as steam stripping or biological treatment. The second group is comprised of liquids, sludges, and solids which contain solvents, but are too concentrated or too high in solids to be amenable to wastewater treatment, and thus require treatment or recovery using incineration, distillation or fuel substitution. The first group is further subdivided based on constituent characteristics: solvent-water mixtures containing highly soluble solvent constituents are amenable to biological degradation; those containing solvent constituents of low solubility and high volatility are amenable to steam stripping; and those wastes containing insoluble (high molecular weight, nonpolar) constituents, as represented by chemical isotherm data, may be amenable to carbon adsorption. However, if wastes contain solvent constituents of different properties, more than one treatment technology or segregation of the waste prior to treatment may be required.

The data available to describe the many and varied characteristics of hazardous wastes are limited. This lack of data limits the Agency's ability to account for all of the waste properties that may influence treatability. Therefore, EPA must often group many wastes together that have some, but not all, characteristics in common. EPA will often rely on knowledge concerning waste constituents whose properties are often well established. In all cases, the Agency will present all pertinent data in the preamble or background documents to the rulemaking and will request comment and information concerning the way in which hazardous wastes are grouped.

The legislative history supports this approach. It provides that treatment determinations do not have to be by waste code, and that the Agency may make "generic" determinations of appropriate levels or methods of treatment for similar wastes. (Vol. 130 Cong. Rec. S9179, July 25, 1984.)

Once EPA has established the waste treatability groups, it will evaluate all of the treatment technologies potentially applicable to each waste group. EPA will determine which technologies are "demonstrated" and "available" to treat the wastes in question, and the performance to be expected from such technologies. If BDAT is different for different waste groups, the treatment standards for each group may also differ. This situation would occur only if the screening levels for individual constituents could not be achieved for all waste groups. The procedures for conducting the evaluations of treatment technologies to determine BDAT is described below in Unit III B.2.

2. Determination of "Demonstrated" Technologies

In order to determine which technologies are demonstrated for a waste group, the Agency will study the available data on the types of treatment (including recycling methods) currently used to treat the wastes and constitutents within the group. For the purposes of EPA's evaluation, a treatment system could be a single unit operation (e.g., incineration) or a sequence of unit operations (e.g., precipitation, sedimentation, and filtration). Therefore, a demonstrated technology or method may actually consist of a series of treatment units. To be considered a demonstrated method for a waste treatability group, EPA must judge that the method has been used to treat a representative sample of wastes falling within the group.

To make this determination, EPA will first evaluate available data from facilities operating specific full-scale treatment technologies, and the types of wastes that they treat. If the treatment of certain wastes or constituents has not been demonstrated by any full scale facility employing any applicable treatment method, or if data pertaining to existing full-scale facilities are insufficient or inadequate, EPA will study pertinent data from pilot-scale and bench-scale treatment operations to determine if a technology is demonstrated. In this case, absent use of pilot- or bench-scale data, EPA would be unable to set a technology-based standard (because no technology would have been demonstrated for the waste and the health-based level would become the treatment standard by default (see discussion in Unit II)). These data may also be used to calculate treatment performance. For example, EPA may consider data for the removal of a constituent from a full-scale operation insufficient if the full-scale facility was not designed to remove that constituent or if, in EPA's judgment, the facility was operated to achieve performance short of which it is capable. In addition, when no adequate full-scale data are available for a specific waste or constituent, but is available for a similar constituent, pilot- and bench-scale data may be used to show that similar treatment performance can be achieved for the other constituent or waste. Pilot- and bench-scale data may also be used to further support full-scale data. Where experimental data do not exist for some waste or constituents, EPA may choose to base the determinations of which technologies are demonstrated (as well as the performance evaluations) on similarities in waste or constituent physical and chemical properties.

In most cases, data do not exist showing that all wastes and constituents within a waste group can be treated by a specific method. This is because the Agency does not have sufficient data to characterize completely either wastes that appear to have similar treatability or the treatment of such wastes. EPA may rely on the similar physical and chemical characteristics of wastes to determine if a treatment technology applies to an entire waste group. EPA will make the best determination possible as to the applicability of a treatment technology to a waste group and its constituents based on available data, and will present all pertinent data in the preamble or background documents.

If the only data available on treatment of some wastes are from pilot- or bench-scale operations, then it is unlikely that any existing full-scale operations are designed and operated to achieve the limits. In these cases, although the Agency will establish a treatment standard based on experimental data, alternative capacity will probably be insufficient. Therefore, EPA is likely to grant a variance to the effective data of the land disposal restrictions. This variance will allow additional time to provide the full-scale facilities with the proper design and operation required to meet a treatment standard. Unit III.E describes the methodology for capacity and effective date variance determinations.

3. Criteria for "Available" Technologies

a. *Proprietary or patented processes.* Proprietary or patented processes will be considered available if EPA determines that the method can be purchased from the proprietor. However, if the technology is a proprietary or patented process that is not readily available, EPA will not consider the technology as available for determining BDAT. Exclusion of such technologies from EPA's analysis may result in a less stringent treatment standard. All commercial facilities using proprietary methods will be included in the capacity determination discussed in Unit III.E. The services of the commercial facility offering this technology can often be purchased, even though the technology itself cannot. In all cases, the technology is available to treat wastes generated by the owner of the proprietary process.

b. *Treatment technologies that present greater totcl risks than land disposal methods.* EPA will evaluate the risks associated with treatment technologies relative to land disposal methods. Those technologies that are found to present greater total risks than land disposal of the untreated waste will be excluded from (i.e., considered "unavailable" for) the determination of best demonstrated achievable technologies. All demonstrated treatment technologies will be included in this analysis. Also included will be technologies that are not demonstrated for a waste group, but that are methods EPA estimates may be capable of achieving the treatment standard for some wastes within the groups. Because these technologies would be used in some cases to meet the treatment standard, an analysis of the total risks associated with their use is important. Unit III.C explains in detail the methodology for performing this comparative risk assessment.

A technology may be demonstrated for more than one group of wastes. The comparative risk assessment may show that the technology poses greater risks than land disposal methods for only one of these groups. In this case, the technology would still be considered "available" to treat wastes in the other waste groups, and therefore the technology would be considered in determining BDAT for these groups.

If no treatment technologies present fewer risks than land disposal for a particular waste group, the Agency will not set a technology-based treatment standard. If capacity of alternative recovery and disposal technologies is also insufficient, alternative capacity will not be available, and the Agency may grant a variance (i.e., extend the effective date of the ban for up to 2 years) to allow sufficient time for the development of adequate technologies, additional standards to control the risks of existing technologies, or alternative protective recovery or disposal capacity. (See Unit III.C for an explanation of additional standards and Unit III.E for a discussion of effective date variances).

c. *Substantial treatment.* In order to be considered available, treatment technologies must "substantially diminish the toxicity" of the waste or "substantially reduce the likelihood of migration of hazardous constituents" from the waste in accordance with RCRA section 3004(m). By requiring that substantial treatment be achieved in order to set a treatment standard, the statute ensures that all wastes are adequately treated before being placed in or on the land, and ensures that the Agency does not require a treatment method that provides little or no environmental benefit. Treatment will always be deemed substantial where the technology can achieve the protective screening concentration levels. In addition, treatment methods will be considered substantial if they result in nondetectable levels of hazardous constituents of concern in the residuals. Therefore, EPA will evaluate only whether or not a treatment technology is substantial when it is contemplating technology-based standards, and the technology does not achieve either the screening concentration levels or nondetectable constituent concentrations. EPA will make these determinations on a case-by-case basis considering the following factors:

(i) Number and types of constituents treated;

(ii) Performance (concentration of the constituents in the treatment residuals); and

(iii) Percent of constituents removed.

For instance, in considering percent removal for some wastes, such as those containing high concentrations of constituents or those that are more difficult to treat, less of a reduction may be considered substantial; for other wastes, a greater reduction may be required before a significant decrease in concentration is achieved. Also, a treatment method may not be considered substantial if the concentration of constituents in the residual differs too greatly from the screening concentration levels.

EPA considered applying a rigid definition to "substantial" treatment (e.g., 50 percent reduction of constituent concentration in the leachate). EPA believes, however, that applying one definition of substantial treatment for all wastes would be arbitrary. Furthermore, available EPA data show that few, if any, demonstrated technologies will not achieve a high percentage of removal, destruction, or immobilization in wastes for which it is demonstrated. Accordingly, EPA believes that serious questions concerning whether there has been substantial reductions will arise only in a few circumstances. Furthermore, the Agency prefers to remain flexible in determining whether BDAT provides substantial treatment in each case the health-based concentration levels are not achieved. For these reasons, a case-by-case showing appears to be the best approach. In each case, the public will have the opportunity to comment on the way in which substantial treatment was defined. EPA solicits comments on this methodology for detemining if the best demonstrated treatment technology achieves substantial reductions in waste toxicity and mobility.

If even the best technology that is demonstrated for a waste group does not achieve substantial treatment of a waste, the Agency cannot establish technology-based treatment levels for the constituents in that waste. Therefore, if the capacity of alternative recovery and disposal technologies is insufficient, alternative capacity will not be available, and the Agency may extend the effective date of the ban for up to 2 years under a variance (see Unit III.E). The variance will allow time for the development of treatment technologiês that achieve substantial reductions in waste toxicity and mobility, or time for the development of alternative recovery or disposal capacity.

4. Identification of "Best" Technologies

After identifying all demonstrated and available technologies for a waste group, EPA will evaluate the performance of these technologies in order to identify the best technology(ies), i.e., those technologies that achieve the lowest concentrations in either the treatment effluents or in the extracts from treatment residuals.

As described in Unit II.B on the development of treatment standards, EPA prefers to develop performance standards expressed as the concentration of constituents in the waste extract. These performance standards will be based on the concentrations achieved by the best demonstrated technology or technologies. In defining BDAT, EPA will normally set a single achievable concentration for each characteristic or constituent in the waste under consideration. In doing so, EPA will assure to the extent possible that the performance data are representative of the destruction, removal, or immobilization of all waste that must be treated. The Agency recognizes that many waste matrix variables exist that can impact the performance of individual treatment units. However, it is the Agency's judgment that most of these matrix impacts (including influent concentration) can be overcome by modifications in treatment that are not prohibitive, i.e., additional unit operations, longer residence times, blending or equalization of wastes. EPA solicits comments on this approach and specifically solicits data documenting matrix impacts for any hazardous wastes, that cannot be overcome with any available technology combination.

Although EPA will normally develop performance standards to achieve BDAT, EPA may specify a method as the treatment standard under certain circumstances. In order to specify a treatment method, EPA must establish that the residuals of a treatment method are consistently low in the constituents restricted from land disposal. Therefore, the design, operation, and performance of the method must be controlled by regulation to ensure this residual quality. Currently, only incineration appears to have sufficient regulatory controls associated with it.

For some wastes, more than one technology will be considered the best. EPA may define a group of technologies as the best technologies if the concentrations achieved by several technologies do not differ significantly. In identifying technologies that achieve similar results, EPA will consider the concentrations achieved and the uncertainty associated with the performance data. Also, different technologies may apply to different constituents in the same waste. In this case, not only will BDAT for a particular constituent be a series of processes, but BDAT for a waste containing constituents of different treatabilities may also consist of more than one best technology in sequence.

When a listed waste is treated, the treatment residue is still a hazardous waste, unless delisted under 40 CFR 260.20 and 260.22. However, when a characteristic waste is treated so that it no longer meets a given characteristic, the waste is no longer a RCRA hazardous waste. For this reason, in some cases few data are available to document the performance of treatment technologies when applied to characteristic wastes. EPA will often have to assume that characteristic wastes have treatability similar to listed wastes. For instance, many metal-bearing sludges are characteristic EP toxic wastes. Others are listed wastes or the treatment residuals of listed wastes. Since the primary sources of data for the treatment of metal-bearing sludges are delisting petitions, only listed wastes are represented by the data. Data show that EP toxic wastes are usually treated by the same methods as listed wastes containing metals. Therefore, EPA will assume in this case that the performance data for listed wastes also apply to characteristic wastes containing metals.

Where EPA or EPA-verified test data and survey data are available on technologies, they normally will be used to determine treatment performance. EPA is currently conducting studies on the operational parameters and performance of many treatment technologies. These studies look at concentrations of hazardous constituents in the treatment effluents and residuals themselves, as well as extracts from the residuals. The results of these studies will be incorporated in the determination of BDAT and performance as they become available.

If such data are unavailable, engineering judgment and data and information from other sources, such as industry, may be used. Data available from pilot- and bench-scale tests of a technology also may be considered. If both full-scale and experimental data are available, the Agency will evaluate the full-scale data to determine if it equals or exceeds the performance of experimental data. If full-scale data do not show equal or better performance, EPA will consider pilot- and bench-scale data as described above. In these instances EPA will, where possible, resolve the difference in performance by evaluating the wastes treated and the design and operating characteristic of the full-scale versus experimental equipment. Unless EPA finds adequate support for a conclusion that the difference in performance is related to specific waste matrix interferences not encountered in the development of the experimental data, difficulties in operating the technology at full-scale, or that the experimental data represent unreasonably repetitive treatment, EPA will adopt the pilot- and bench-scale performance as BDAT. Thus, EPA's approach requires the performance of the technology to be equal to the best achieved in any representative application. EPA solicits comment on this approach.

When new pilot-, bench-, or full-scale data verfied by EPA testing and analysis become available, EPA may modify past performance determinations and treatment standards, where necessary. In summary, EPA does not intend to consider data that are not representative of well-designed, well-operated treatment systems. It also does not intend to determine the performance of a technology based on unusually repetitive treatment or other treatment system designs or operations that are beyond what the Agency judges to be normal engineering practice.

5. Dilution as Treatment

The legislative history to the RCRA section 3004(m) states:

> The dilution of wastes by the addition of other hazardous wastes or any other materials during waste handling, transportation, treatment, or storage is not an

> acceptable method of treatment to reduce the concentration of hazardous constituents. Only dilution which occurs as a normal part of the process that results in the waste can be taken into account in establishing concentration levels.—(S. Rep. No. 98-284, 98th Cong., 1st sess. 17 (1983)).

EPA is proposing today under § 268.3 to prohibit the use of dilution as a partial or complete substitute for adequate treatment of hazardous wastes restricted from land disposal. This discussion involves only the question of dilution as treatment for purposes of meeting section 3004(m) treatment standards. EPA is not expressing any new opinion, nor did the Congress, on use of dilution as a means of removing a hazardous waste characteristic. (See 40 CFR 261.3(d)(1).) The Agency believes that this is consistent with the congressional intent cited above.

In evaluating treatment technologies, EPA will consider dilution which is a normal part of the production process or a necessary part of the process to treat a waste. EPA believes that adequate treatment in this sense should render a waste nonhazardous or should decrease the mass of hazardous constituent available to the environment through either removal, destruction, or immobilization. For example many treatment methods require the addition of reagents, which is, in effect, dilution. These reagents, however, produce physical or chemical changes, and do not merely dilute the hazardous constituents in a larger volume of waste so as to lower the constituent concentration.

C. Comparative Risk Assessments

1. Relationship to Proposed Framework

As introduced in Unit II, EPA is proposing to use comparative risk analyses as part of its evaluation of treatment technologies in conjunction with establishing section 3004(m) treatment standards. Although not explicitly required by statute, these analyses are included in today's proposal to prevent situations in which regulations restricting hazardous wastes from land disposal encourage their treatment in technologies that pose greater risks to human health and the environment than those posed by direct land disposal. (Treatment technologies may be riskier than land disposal because of routine releases, accidental releases, and the fate of their residuals.)

As described in Unit II, a number of criteria affect the determination of which treatment technologies are "available" for purposes of setting treatment standards. Among the criteria considered in determining whether a treatment technology or train is "available" is whether application of the technology to a waste (including subsequent land disposal of treatment residuals) poses greater risks to human health and the environment than land disposal of the waste in its current form. This unit describes the procedures EPA is proposing to employ in conducting these comparative risk assessments, and the criteria EPA is proposing to employ in evaluating the results of these comparative risk assessments.

Treatment technologies that are determined through these analyses to pose greater risks than direct land disposal of a waste will be considered "unavailable" as a basis for establishing the section 3004(m) BDAT treatment standard for the waste. If the best, or most efficient, treatment technology for a waste is determined to be riskier than land disposal, the decision to classify it as unavailable will have a direct impact on the level or method established as the section 3004(m) treatment standard. The treatment standard, which must be based on the capabilities of the best demonstrated available treatment technology for a waste (unless "capped off" at fully protective levels identified by the health-based thresholds described in Unit III.A and B), would then be based upon the capabilities of the next best treatment technology that does not pose greater risks than land disposal. To the extent that the next best treatment technology performs less efficiently than the best technology (in terms of the performance of its residuals in the land disposal environment), the resulting section 3004(m) treatment standard will be less stringent.

Treatment technologies classified as "unavailable" due to their greater risks may still, however, be used by waste managers in complying with treatment standards expressed as constituent concentrations. Accordingly, EPA is committed to developing sufficient regulatory controls or prohibitions over the design and operation of these technologies to ensure that their use in complying with the treatment standard does not result in increased risks to human health and the environment. The analyses conducted in support of these comparative risk assessments will provide a basis for developing such controls or prohibitions, but will most likely need to be augmented by additional technical studies. EPA will attempt to promulgate necessary regulatory controls or prohibitions on riskier treatment technologies by the time the section 3004(m) treatment standards take effect.

2. Methodology

a. *General approach.* The risk assessments proposed for inclusion within EPA's decision-making framework are designed to compare the risks of land disposal of untreated wastes with the risks of managing the wastes in specific treatment technologies or treatment trains. These comparisons consider the effects on human receptors (and are being expanded to consider other-than-human environmental consequences) resulting from all releases of hazardous constituents associated with treatment and land disposal processes, including accidental releases to air, the discharge of effluents to publicly owned treatment works (POTWs) and directly to surface water bodies, and releases from wastes and treatment residuals upon placement in land disposal units (as leachates, air emissions, and surface run-on/runoff). For land disposal, the most common technology for a given waste is selected as the baseline—usually a landfill or a disposal surface impoundment. Least risk disposal processes are modeled to be conservative in assessing the performance of treatment alternatives (i.e., if worst-case land disposal process were selected, some treatment technologies might be found to be less risky in the modeling exercise, even though they pose greater risks than certain forms of land disposal). For alternative treatment, selected technologies or combinations of technologies will generally include those that are expected to produce residuals and effluents that meet applicable regulatory levels (e.g., effluents from wastewater treatment process must meet national pollution discharge elimination system (NPDES) discharge standards). Whenever treatment processes produce residuals that must be subsequently land disposed, releases associated with land disposal of these residuals are also modeled to provide estimates of the total risks associated with management of the waste.

Releases to all media are estimated, and the movement of toxic constituents to human and other environmental receptors will be modeled. From these estimated exposures, the analyses calculate expected numbers of additional cases of cancer and other toxic effects for total exposed populations (i.e., population risk) and also calculate the probability (i.e., risk) that cancer and other toxic effects will be realized in maximum exposed individuals (i.e., a person at the nearest point of full exposure). These estimates of human health effects are used to compare the risks posed by land disposal to those posed by management of wastes in treatment alternatives. The analyses will also calculate various estimates of non-human environmental risk associated with land disposal and alternative treatment processes.

b. *Selection of models.* To conduct these analyses in the timeframes required by the statute, EPA's RCRA Risk-Cost Analysis (WET) Model was selected as the analytical tool for the comparative risk assessments. During the last several years, EPA has developed this model to consider the interactions between wastes, environments, and technologies, and the effects of these interactions on risks (and costs). The model is structured to compare hazardous waste management practices. Because of this, the model already contains the major components required for these comparative risk analyses. The Agency recognized, however, that it would be necessary to upgrade many of these components in the context of this particular application.

The Agency considered alternative existing tools to conduct the comparative risk analyses. Other existing multimedia risk models designed to evaluate hazardous waste management, however, do not consider alternative treatment technologies. These other models included the Liner Location Risk-Cost Analysis Model and the health-based back calculation model used in setting health-based thresholds.

EPA considered developing entirely new models, but rejected that option because of time limitations. Also, the Agency desired to draw on the risk assessment capability it has developed during the last several years.

c. *Discussion of methodology.* To design the comparative risk analyses and evaluate alternative tools, the Agency reviewed the WET model in the context of the land disposal restrictions application (a complete description of the WET model is available as a Background Document in the RCRA docket (Ref. 118). The framework of the model is very well suited to these analyses. The model's equations evaluate releases and exposures at an appropriate level of detail, considering the generic nature of the analyses. That is, the equations capture important differences in releases and exposures, yet do not require unreasonably detailed input data.

The model evaluates a myriad of waste, technology, and environment combinations. The model's data bases include 267 wastestreams, 22 treatment and disposal technologies, and 12 environments. To calculate human health risks, the model estimates releases of wastes from technologies, fate and transport of toxic constituents through the environment, exposures to these constituents, and health and environmental effects from these exposures. The model uses point estimates to characterize typical conditions, including waste composition, release rates, environmental parameters, exposure patterns, and constituent toxicity.

A number of modifications were, however, deemed necessary to suit the particular requirements of these comparative risk analyses. A number of potential changes were considered, and those that were most important and feasible were adopted for the initial analyses, the results of which are presented in today's proposal. Major modifications to the WET model include:

i. Waste stream data were updated and a broad range of representative waste streams will be specified.

ii. Constituent data are being expanded and updated.

iii. Characterizations of treatment and disposal technologies were expanded and revised to reflect the specific management trains targeted for analysis.

iv. The model's procedures for specifying values for the environmental parameters were modified to allow the the model to function stochastically, providing for the use of Monte Carlo simulation routines in the comparative analyses.

v. Data describing population (exposure) patterns around RCRA disposal and treatment facilities were expanded to provide information on the ranges and distributions of population sizes across different exposure distances.

vi. The model's output presentation procedures were modified in conjunction with incorporation of the stochastic features and Monte Carlo simulation routines.

The specific modifications adopted in each of these areas are described in greater detail below and in the Background Document to the Comparative Risk Assessments (Ref. 1).

(A) *Waste stream specifications.* The first step in using the comparative analyses involves specifying the characteristics of waste streams to be analyzed. Since waste streams vary considerably across processes and over time within the same process, representative waste streams must be specified in conducting generic comparative risk assessments. In the next few months, EPA will modify the specification procedures to employ Monte Carlo simulation techniques in specifying representative waste streams for each waste group of concern. For the initial comparative analyses, however, representative waste streams had to be specified manually. Representative streams were therefore specified for the first two groups of waste subject to today's proposed rulemaking: (1) Solvent wastes (F001 through F005 and associated U and P wastes); and (2) wastes containing dioxins.

In general, the waste streams modeled must represent as much as possible the variability found in three key waste characteristics: type of constituent, concentration of constituent, and physical form. In addition to their influence on risk, these characteristics also influence the type of treatment that is required for a specific waste. In addition to these major characteristics, other waste characteristics considered include chemical and physical characteristics such as biodegradation rate, pH, heating value, and solids content.

Primary constituents represented by the waste streams analyzed in the first sets of comparative risk assessments included halogenated solvents, nonhalogenated solvents, and TCDD (dioxin). In addition, secondary constituents that may also be contained in wastes were also modeled. For example, solvent waste streams were modeled with and without the presence of metals that may also be contained in such waste streams. The presence of metals may significantly affect the nature and degree of releases from treatment and disposal process, as well as the risks corresponding to those releases. Similarly, waste streams were specified with high and low concentrations of key constituents, and in various physical forms (e.g., as solids, sludges, and liquids). The representative waste streams actually specified for the solvent and dioxin comparative risk assessments are described in detail in Units V and VI. Similar efforts to specify representative waste streams will be undertaken in future comparative analyses, particularly after the model is modified to specify waste stream characteristics stochastically.

(B) *Constituent data.* In conjunction with development of the health-based concentration level, EPA is developing additional and updated information on the chemical and physical properties of hazardous constituents. This information includes data on toxicity, mobility, persistence, and bioconcentration. These new data are incorporated into the model's constituent database as they become available.

(C) *Management trains (treatment and disposal technology specifications).* The treatment technologies to be analyzed in each of the comparative risk assessments include all technologies and combinations of technologies identified as "demonstrated" for a waste stream in Element 2 of the proposed land disposal restrictions decision-making framework (see Figure 1, Unit II). In order to be considered in the analyses, treatment technologies must also achieve at least the "substantial" reductions required under section 3004(m). Included in the analysis of treatment alternatives are also the risks associated with land disposal of any treatment residuals (e.g., landfilling of incinerator ash). Also modeled are routine emissions from treatment technologies, such as stack emissions from incinerators, as well as accidental releases, such as spills or fugitive emissions.

There is a wide variety of treatment technologies that are applicable to the waste streams currently land disposed and that are demonstrated in use at commercial and on-site facilities. All such applicable technologies, alone and in sequence, are evaluated. For example, in the current analyses, all liquid wastes containing greater than 50 percent total solvents are evaluated for (1) incineration, and (2) distillation followed by incineration of the still bottoms resulting from the distillation process. In some cases, however, EPA's analyses in Element 2 of the program framework have identified only one treatment sequence as "demonstrated" for treatment of the waste at commercial or on-site facilities, and capable of achieving at a minimum the "substantial" reductions called for in section 3004(m).

(D) *Environmental parameters.* A general evaluation of the WET model conducted during the last year has revealed that the changes in values specified for the model's environmental parameters, taken together, can have the strongest effect on risks. This is because many environmental parameters have nonliner (e.g., exponential) effects on concentrations. These parameters include air and ground water dispersion constants, wind speed, stream and ground water flow and velocity, other ground water aquifer characteristics, and distances to points of exposure or potential exposure. These factors have a large effect on changes in contaminant concentrations, and they are known to vary a great deal across different locations. For example, reported ground water velocities in the U.S. range from one-hundredth of a meter per year to nearly 10,000 meters per year.

Therefore, the model's procedures for specifying values for environmental parameters (e.g., ground water velocity, soil porosity, etc.) were revised to expand its capability to simulate the variability in the real world conditions in which hazardous wastes are managed. Rather than try to estimate some average or worst-case values for these parameters, the model was modified to allow it to draw parameter values over repeated runs from data sets describing each parameter's range and distribution of values across the U.S. When appropriate, parameters with correlated values were linked together so that the model would not select unrealistic or impossible combinations of values for its input variables. These modifications provide for the use of Monte Carlo simulations routines in the comparative risk assessments. Although these analyses do not employ all of the environmental parameters that are employed in the model used to develop the screening concentration levels (see Unit III.B), efforts were undertaken to ensure consistency in the specification of the ranges and distributions of values for parameters common to both models, as well as in specifying their interrelationships (i.e., correlations and dependencies are specified similarly in both the screening back calculation model and in these analyses). Unit III.B provides a detailed description of these specifications.

(E) *Exposed populations.* Unlike the development of the screening concentration levels which are based exclusively on estimates of risk to potential maximally exposed individuals, EPA is proposing in the comparative risk assessments to consider both MEI risk and total population risk. Total population risk is represented as estimates of the expected number of additional case where toxic effects are realized due to releases of hazardous constituents to the environment in the management of hazardous wastes. Population risks can be presented as expected numbers of cases (e.g., 327 expected additional cases), or as average probabilities that effects will be realized (e.g., 1 expected additional case per 1,000 population, or 10^{-3} risk).

EPA's rationale for basing the screening concentration levels exclusively on MEI risk is presented in conjunction with the discussion of program alternatives in Unit III.A. However, the primary obstacle to including total population risk as a factor is developing the thresholds—the Agency's inability to defend assigning different population distributions to different hazardous constituents—does not impede considering total population risk in the comparative risk assessments. In comparing the risks posed by land disposal and its treatment alternatives, a single population distribution may be assigned to each of the management alternatives to be evaluated. Since the analysis is relative in nature, the assigned population distribution can be entirely arbitrary, as long as it is held constant for all of the alternatives to be considered. The purpose of the comparative risk assessments is to evaluate the differential effects resulting from differences in the nature and magnitude of releases from land disposal units and from treatment technologies or treatment trains. Only by assigning the same population distribution in both sides of the analysis can the performance of various management alternatives be evaluated in and unbiased manner.

Consistent with other stochastic modifications to the WET model, its procedures for calculating population risk were modified to allow it to draw upon distributions of population densities at specific distances (radii) from disposal units or treatment processes. Data used to specify these "ring" distributions for populations exposed via air were drawn from EPA's Graphic Exposure Modeling System (GEMS). GEMS uses current U.S. Census data in calculating the population density, within a specified radius, around any location in the United States, based upon the longitude and latitude coordinates of the site. For convenience, EPA developed population distributions based upon the coordinates of current RCRA interim status and permitted disposal and treatment facilities (although, since the assignment of population distributions in the comparative analyses is entirely arbitrary, the Agency could also have relied upon a randomly drawn set of coordinates or arbitrarily assigned population densities within each ring). The "ring" distances were specified, ranging from 100 meters to 50 kilometers from the disposal unit or treatment process. These population distributions were then apportioned between ground water and surface water consumption, using EPA national estimates on sources of drinking water (Ref. 1).

It is important to note that the WET model employs a "severity factor" to weight different types of toxic effects in estimating population risk, or numbers of additional cases where toxic effects are expected to be realized. The severity factor assigns equal weight, or severity, to all forms of carcinogenic effects (e.g., cases of skin cancer are counted equally with cases of colon cancer). However, the severity factor discounts, or assigns weights of less than 1, to other forms of toxic effects, such as neurotoxic effects (e.g., if 10 cases of neurotoxic effects are anticipated, the model adds only 5 cases to the total number of estimated additional cases where toxic effects are expected to be realized). This discounting is employed as a mechanism to reflect the judgment that carcinogenic effects are more severe than noncarcinogenic effects. Reasons supporting this judgment include properties such as reversibility and the likelihood of avoiding fatalities. EPA is concerned, however, that use of the severity factor may in some cases bias the evaluation of the performance of land disposal and treatment alternatives. These concerns are reflected in the procedures and criteria proposed by the Agency to evaluate the results of the comparative analyses, as described later in this unit. Nonetheless, EPA specifically requests comment on whether it is appropriate to employ a severity factor. A complete explanation of the severity factor is provided in the Background Document on the Comparative Risk Assessments (Ref. 1).

(F) *Environmental risks.* The restrictions program may or may not decrease environmental risks, that is, harm to plants and animals. Because the program, in general, shifts hazardous constituents from ground water to the other media, there exists the potential for increased environmental risks.

EPA is now evaluating the potential for environmental harm in land disposal and alternative treatment processes, particularly that resulting from surface water releases. Land disposal technologies may release wastes to ground waters that subsequently inercept surface waters. Treatment technologies may release constituents to surface waters from spills and routine effluents.

EPA is developing a methodology (as part of the WET model) to evaluate environmental damages in surface water, using a damage function, or scoring system. This damage function is essentially a dose response curve to measure the severity of damage to an ecosystem. The lowest score is associated with an appearance of contaminants in surface water at the lowest concentration believed to result in toxic effects to the most sensitive aquatic species (i.e., the lowest score is associated with the threshold at which toxic effects begin to be to realized in the ecosystem). Scores increase as surface water contaminant concentrations increase, with the highest score for ecosystem damage associated with the surface water contaminant concentration believed to result in catastrophic damage to the ecosystem. Catastrophic damage is defined as the contaminant concentration believed to result in actual breakdown of the ecosystem due, for instance, to the loss of species whose presence is critical to the system's continued operation, or survival. Based upon several case studies on the effects of hazardous constituents, EPA estimates that the surface water contaminant concentration resulting in catastrophic ecosystem damage is approximately 2.5 orders of magnitude greater than the lowest concentration believed to result in the occurrence of toxic effects in the most sensitive species.

At present, the results of these analyses of environmental effects are being developed. The first measure is based upon the most severe ecosystem damage predicted to occur (i.e., the ecosystem damage associated with the highest contaminant concentration resulting from releases of hazardous constituents to surface waters). This first measure is analogous to MEI risk estimates for humans.

The second measure of surface water environmental risks being developed is a weighted estimate of the total volume of surface water contaminated with a constituent at any concentration greater than the minimum concentration believed to result in toxic effects in the most sensitive species. The volume of water contaminated is weighted by the severity of effect on the ecosystem, as indicated by the damage function described above. This second indicator is somewhat analogous to estimates of human population risk, and will be used by EPA accordingly.

(G) *Monte Carlo simulation routines/output presentation.* In order to evaluate explicitly the effects of the environmental and population distributions on risks, distributions of risk estimates are produced for each waste and technology combination over the course of 2,000 iterations, or WET model runs. Under the Monte Carlo simulation routine, the model selects values at random from each environmental and population parameter distribution for each iteration. This methodology generated distributions of population, maximum exposed individual, and environmental risks, in total and by media, for each waste and technology combination. Also calculated are means, standard deviations, and other statistics describing these output distributions. The results of these runs are then formatted into risk matrices, broken out by constituent and environmental media. In addition, these output distributions are plotted as relative and cumulative frequency distributions to allow for visual inspection and comparison.

3. Decision-Making Criteria

The distributions of risk estimates corresponding to management of each representative waste stream in each assigned treatment technology or treatment train will be compared with the risk distribution developed for direct land disposal of this waste (i.e., the baseline). The purpose of this comparison is to identify treatment technologies or trains that, when applied to a specific waste stream, pose risks greater than those posed by management of the waste in land disposal units. Those treatment technologies or trains that are determined to be riskier than land disposal will be considered "unavailable" for purposes of establishing the treatment standard, as outlined in Unit II, and in addition will be the subject of additional regulation or prohibition, as described in Unit III.C.4.

In evaluating the relative risks of land disposal and the potential treatment alternatives, four general outcomes are anticipated:

a. The treatment alternative is always less risky than land disposal.

b. The treatment alternative is always more risky than land disposal.

c. The treatment alternative has lower average risks, but is still more risky than land disposal under certain conditions.

d. The treatment alternative has higher average risks than land disposal, but is less risky than land disposal under certain conditions.

In cases a and b, the availability decision is relatively straightforward; less risky treatments would generally be considered "available" and more risky treatments considered "unavailable." Cases c and d, however, pose more difficult problems because EPA must evaluate the "tradeoffs": higher or lower average risks versus the likelihood that there will be some outcomes in which average risks are poor indicators of the actual relative risks. For example, analysis might indicate that incineration of a waste has lower risks on average than land disposal, but in 10 percent of the outcomes the incinerator risks are much higher than those of land disposal.

In this situation, EPA must determine the appropriate level of risk avoidance to incorporate into the availability decision for incineration. In the same example, if, in the 10 percent of the outcomes where incineration is indicated to be more risky than land disposal, the consequences associated with these risks are many orders of magnitude greater than those associated with land disposal, the Agency might prefer to designate the treatment alternative "unavailable" so as to avoid setting BDAT based on this technology and, in turn, avoid the risks of these catastrophic consequences. Conversely, if the consequences of these more risky outcomes are only slightly worse than those associated with land disposal, an "available" designation for incineration might be more appropriate. In this case, the Agency would be choosing to incur the possibility of minor, infrequent risk increases in order to take advantage of the risk reductions indicated to be provided by the technology in the vast majority of the waste management scenarios.

Initially, EPA investigated the application of a rigorous statistical approach for analyzing relative risks in the scenarios outlined above. In this framework, hypothesis tests were considered for evaluating statistically significant differences in the mean values of the risk distributions. Differences in the variance of the land disposal and alternative treatment risk distributions were investigated as indicators of scenarios where the risk of one alternative is high relative to that of the other in at least some of the outcomes. Based on statistically significant differences in means and variances of the risk distributions generated by the WET model, a method was considered for assessing the availability of alternative treatment technologies.

Further analysis of the rigorous statistical approach, however, suggested some severe shortcomings. First, parametric statistical tests measure differences in central tendencies. Measures of central tendencies, however, may not be appropriate in cases of skewed distributions. Skewed distributions of risk are frequently observed due to the occurrence of "outliner" situations in which risks are estimated to be substantial, although highly infrequent. After reviewing the procedures that predict these outliers, the Agency judged that they represent possibilities that should not be discounted. Second, significant uncertainty about the mean risk is not captured in the variance of the risk distributions likely to be developed through the analyses. Factors not considered in the model, such as uncertainty over unit risk estimates for adverse toxic health effects, contribute additional uncertainty to the model results. Tests of the statistical significance of differences in means and measures variance would not capture these additional uncertainties.

Given the problems with rigorous statistical analyses of the risk distributions, EPA is instead proposing an evaluation procedure that relies on qualitative case-by-case assessments of the relative risks of land disposal and alternative treatment technologies when availability decisions are not straightforward. Such analyses are performed in a sequence of stages, as illustrated in the following Figure 13:

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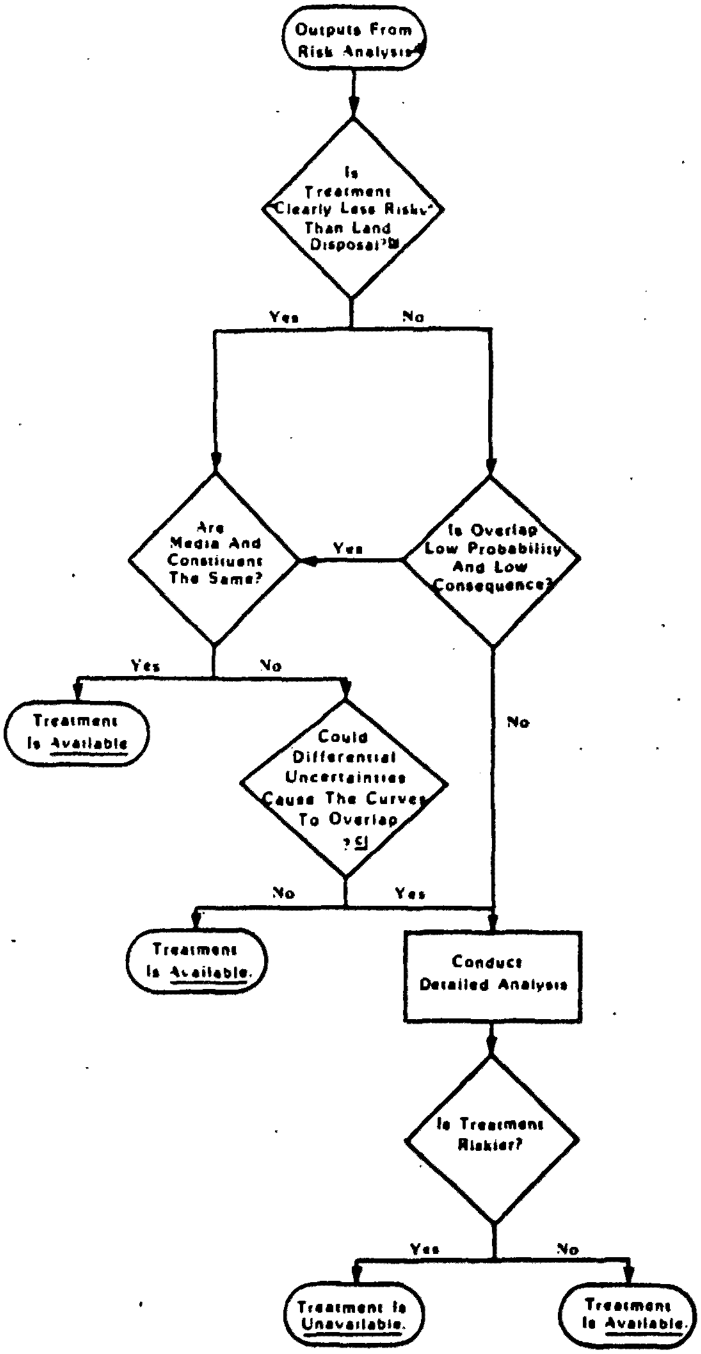
DECISION TREE FOR COMPARATIVE RISK ANALYSIS



a/ For each waste stream, plot the counter - cumulative distributions of risk (Log risk vs percentile) due to the land disposal baseline and the treatment alternatives.

b/ Does the treatment curve ever overlap the baseline curve?

c/ An overlap other than low probability and high consequence.

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In the first stage, land disposal and treatment risk estimates (distributions) generated by the analyses are plotted to produce "risk profiles." Separate profiles are produced for MEI risk, population risk, and (other-than-human) environmental risk. The plotted risk profiles organize the risk estimates in each of these categories (generated using the Monte Carlo simulation routines over the course of 2,000 model runs) from highest to lowest, forming a cumulative frequency distribution curve as illustrated in the following Figure 14 (using log of risk versus percentile):

Figure 14

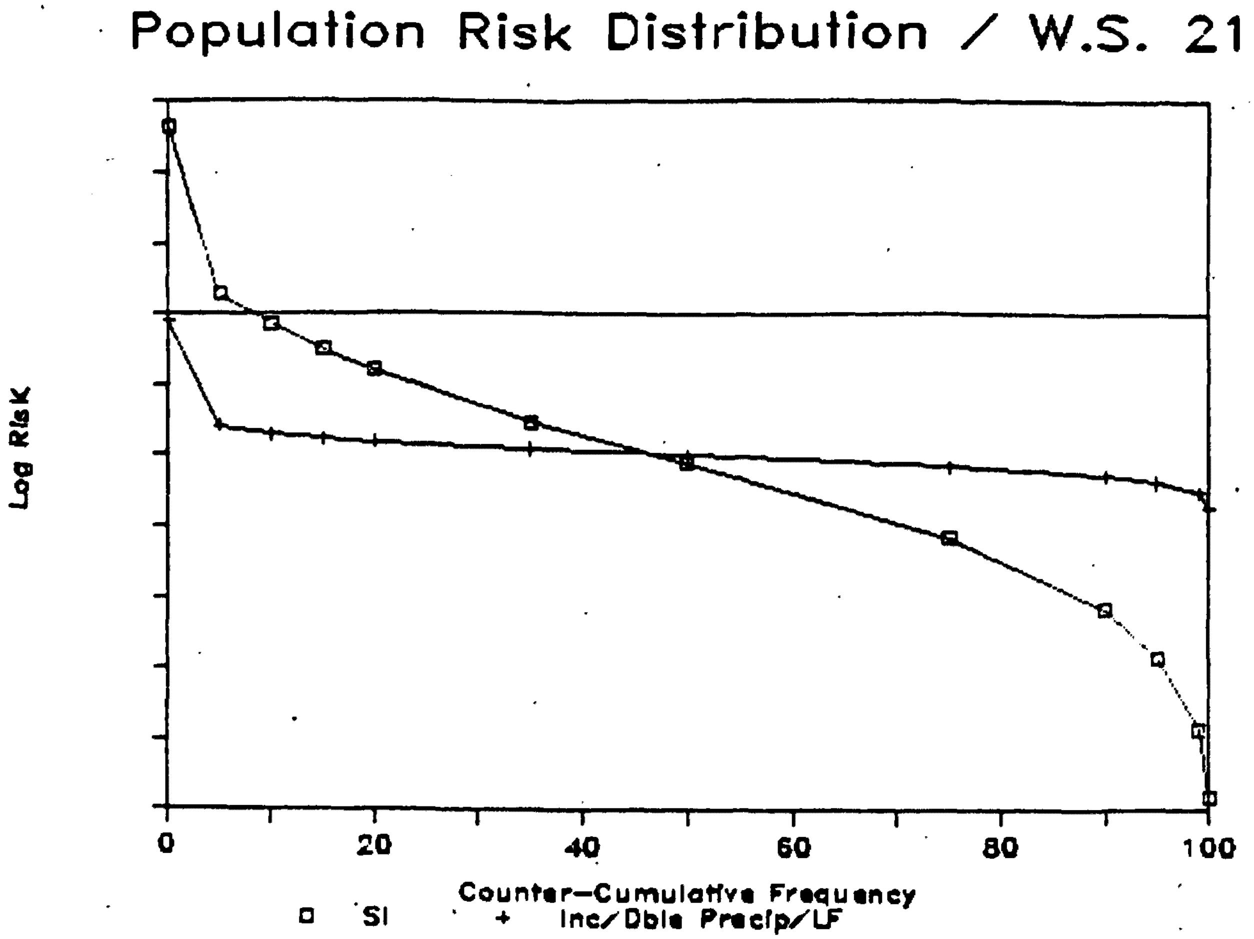
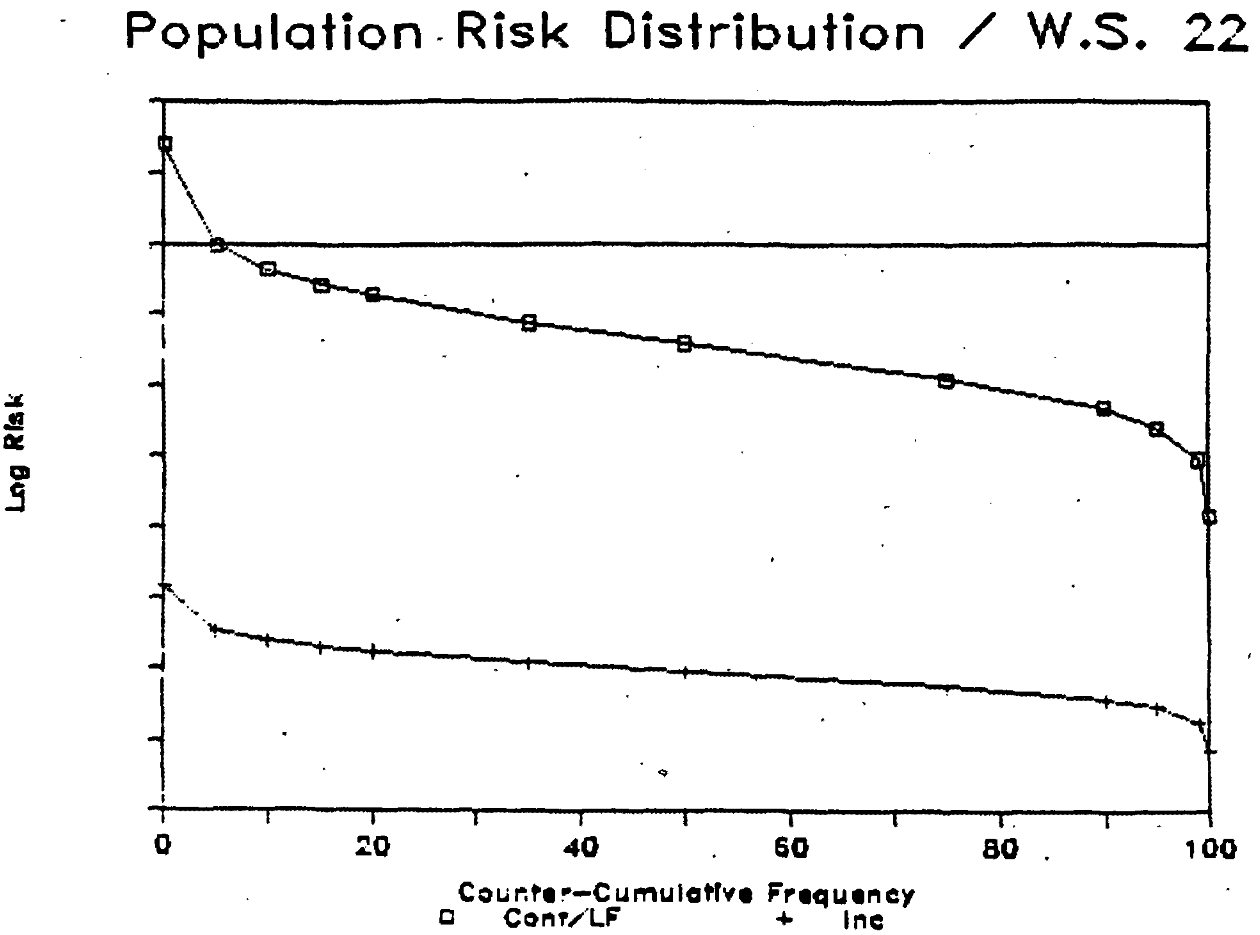


Figure 14 presents a hypothetical plot of the risk profiles for the treatment alternative (crossed line) and for land disposal (boxed line). The "x" coordinate of each "x" "y" pair on the curve indicates the percentage of the outcomes in which the risk exceeds each value indicated by the "y" coordinate. (Note that the actual values on the "y" axis are an arbitrary scale; in the comparative risk analyses, absolute risk scores are unimportant and the evaluation focuses on the differences, or relationships between the treatment and land disposal risk distributions.) As can be seen in this example, land disposal population risks exceed treatment risks in nearly 50 percent of the observations, but in the remaining 50 percent of the expected outcomes treatment risks are greater than those posed by land disposal.

The purpose of the first stage of the analysis is to identify treatment technologies that are always less risky than land disposal. In the context of the risk profiles, treatment alternatives are considered always less risky than land disposal when all points on the treatment's risk profile curve are inside (below) the risk profile curve for land disposal, as illustrated in the following Figure 15:

Figure 15



In this scenario, the probability that risks exceed the value on the "y" axis is always greater for the land disposal technology.

For a treatment process or treatment train to be identified as always less risky than land disposal in the first stage of the analysis, land disposal must always be riskier than the alternative treatment in each of the MEI, population, and environmental risk profiles. If the treatment alternative is more risky than land disposal in any of these risk metrics, the case is designated for further study in subsequent stages of the analysis. Thus, detailed analyses are performed for Cases b through d discussed above.

As an initial screening procedure, the risk profile comparison is conservative in identifying technologies that are likely to be designated as "available" for purposes of establishing section 3004(m) treatment standards, since a treatment alternative's risks must always be lower than those for land disposal. However, because uncertainty does exist around the precise values plotted in the risk profile curves, it is possible that a treatment alternative that appears to be always less risky than land disposal could, in fact, be more risky than land disposal at some or even all points along the curve. While recognizing this possibility, the Agency believes that where this type of uncertainty exists, the statutory presumption against land disposal generally suggests the alternative should be designated "available." Specifically, in such cases the comparative risk assessments will not have provided evidence that the treatment alternatives pose risks that are significantly greater than those posed by land disposal—evidence that is required under EPA's proposed decision-making framework in order to determine that a treatment alternative is "unavailable" for use as a basis for a BDAT treatment standard.

Nonetheless, two overrides to immediate "availability" designations based on the risk profile analyses have been incorporated into the proposed relative risk evaluation methodology in order to address concerns over key areas of uncertainty in the analytic results. Cases will be automatically designated for more detailed evaluation in subsequent stages of the analysis, regardless of the nature of their risk profiles, where:

i. The primary medium by which the risks occur is different for land disposal than for treatment alternatives; and/or,

ii. The constituent responsible for most of the risk is different for land disposal than for treatment alternatives.

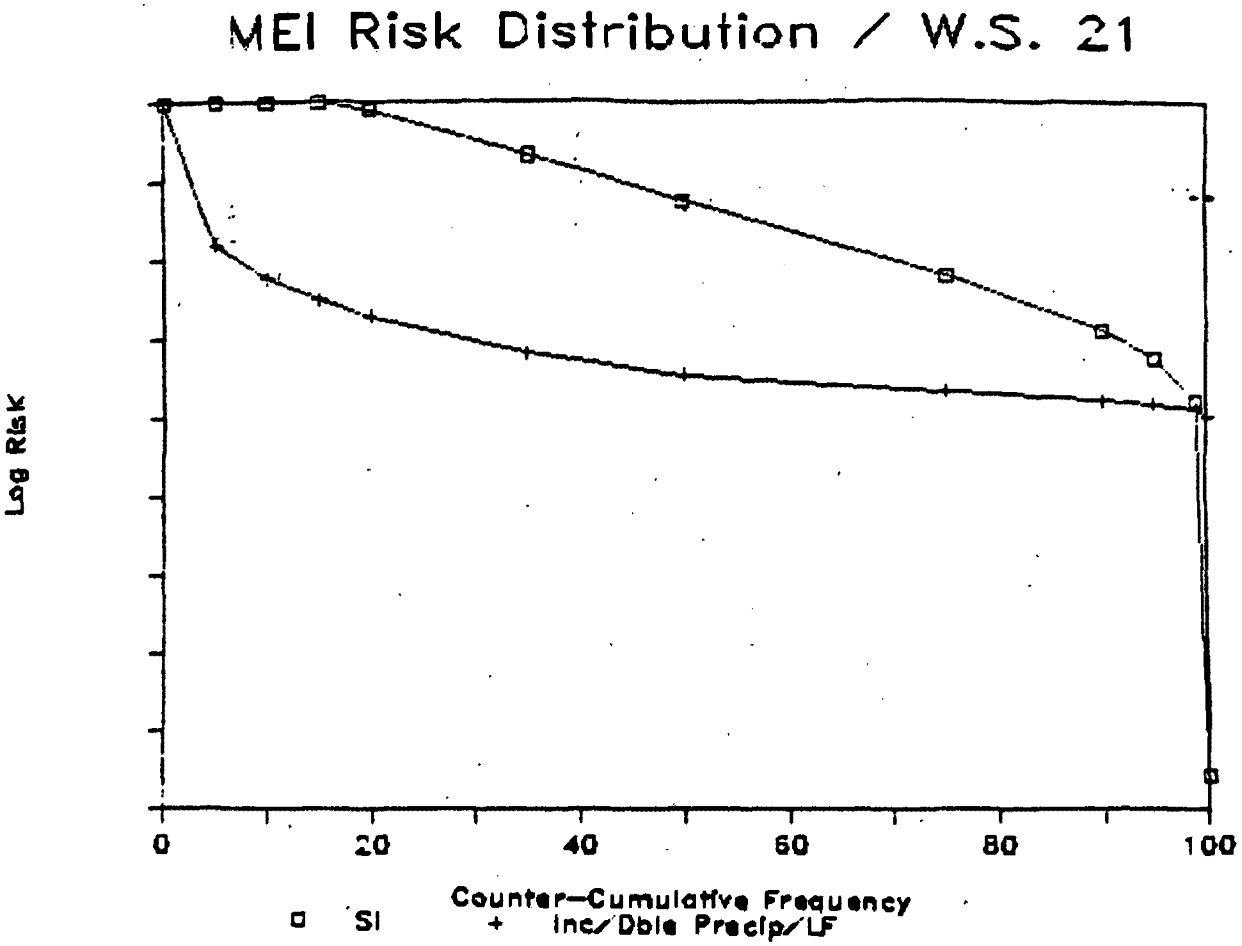
Cases where treatment risks are dominated by a constituent or environmental media different from those observed for land disposal risks are automatically designated for further analyses in order to consider the effects of uncertainties not considered in the Monte Carlo simulation routines. Areas of uncertainty not addressed through the Monte Carlo process include those associated with the specific algorithms and assumptions used to model transport through specific media, uncertainties about technology characteristics and associated performance, and uncertainties about the physical and chemical properties of hazardous wastes, their constituents, and the nature and magnitude of their toxic effects. These uncertainties, referred to as "differential" uncertainties, are particularly important in the cases identified above because they may result in non-parallel shifts in the risk profile curves, causing curves to overlap even where the quantitative results indicate that they do not.

Accordingly, observations of cross-media risks and cross-constituent risks will be used as indicators of potential differential uncertainty impacts. Before determining that treatment technologies are available in these cases, the potential impacts of differential uncertainties will be evaluated. In situations, for example where treatment risks occur via air while land disposal risks occur via ground water, the WET model's fate and transport equations will be evaluated for their handling of the specific wastes and technologies involved to determine if any systematic biasing of the results is occurring. While attempts have been made to eliminate such biases from the WET model, it is difficult to ensure that air modeling is equally as conservative as ground water modeling. When treatment and land disposal risks occur via the same media, concerns about biased results do not arise, since the model evaluates each technology identically. Evaluations of differential uncertainties will involve more indepth examination of the WET model's algorithms and assumptions, and may include the use of other fate and transport models to determine the potential effects of these uncertainties.

If these evaluations indicate that differential uncertainties are not likely to change the conclusions drawn from the original risk profile curves, treatment alternatives will be determined to be "available" for purposes of establishing section 3004(m) treatment standards. If, however, these evaluations indicate the possibility that the risk profile curves could shift significantly enough to result in substantial overlap, these cases will be the subject of further detailed analyses, as in cases where the risk profile curves indicate substantial overlap. The nature of these detailed analyses are described below.

In cases where the risk profile curves cross (as in Figure 14) or where analyses of differential uncertainties indicate that the curves might cross, EPA will attempt to quantify the nature and extent of the overlap (or potential) overlap. Specifically, how frequently are treatment risks likely to be greater than those posed by land disposal? When treatment risks are greater, how much greater are they? Do the greater treatment risks occur at the low end or the high end of the risk spectrum? Depending on the answers to these and other questions, treatment technologies whose risk profile curves indicate that they may in some instances pose greater risks than land disposal may nonetheless be designated as "available" for purposes of establishing the section 3004(m) treatment standards. For example, consider the case illustrated in the following Figure 16 where MEI risks from treatment are greater than land disposal in less than one percent of the observations:

Figure 16



In almost all cases, treatment risks are substantially less than those of land disposal. Furthermore, when treatment risks are greater than land disposal risks they do not appear to be substantially greater (e.g. many orders of mangnitude), indicating that the consequences of these greater risk events are not likely to be significantly greater than these associated with land disposal. It should be noted that the WET model is primarily a relative risk model. Accordingly, estimates of absolute, or actual, risk are not developed in this exercise and, as noted earlier, are not required in conducting comparative analyses. EPA is likely in situations such as those illustrated in Figure 16 to designate treatment alternatives as "available" for purposes of establishing the section 3004(m) standards, trading off the possibility of highly infrequent, low relative consequence increases in risks in order to take advantage of the substantial risk reductions offered by the treatment technology in the vast majority of waste management scenarios.

Alternatively, consider the case presented originally in Figure 14. Here, treatment resulted in greater population risks than land disposal in nearly 50 per cent of the observations. Furthermore, treatment risks are substantially greater than land disposal risks in many of these observations. EPA is not likely to designate technologies exhibiting these types of risk profiles as "available" without conducting further indepth analysis. Further stages of detailed analysis include evaluations of the sources of increased risk through examination of release estimates provided by the WET Model (i.e., which part of the treatment process or train is responsible for the increased risks?), followed by potential revisions to the input specifications where modeling algorithms or assumptions are believed to be inappropriate for specific conditions. These revisions may result in risk profile curves that no longer cross, in which case the Agency is likely to designate the treatment alternative as "available."

Alternatively, the revised risk analyses may continue to indicate greater risks in treatment. At this point, EPA will have exhausted the resources of the WET model in conducting comparative risk assessments. Before making a determination that the treatment alternative is "unavailable" for purposes of establishing section 3004(m) treatment standards, however, EPA will conduct an indepth case study to characterize fully the risks posed by its use in the management of specific hazardous wastes. Case studies will review available literature and examine actual operation of land disposal and treatment alternatives in the management of specific hazardous wastes at "representative" RCRA facilities, and will utilize more sophisticated modeling techniques than those employed in generic WET model analyses. The purpose of these case studies is twofold: to make a final determination as to whether a treatment technology should be considered "available" or "unavailable" for purposes of establishing section 3004(m) treatment standards; and, if the technology is determined "unavailable," to provide sufficient data to support additional regulation of the technology by EPA (see Unit III.C.4). The Agency does not expect many treatment technologies to require these indepth case studies in order to determine their "availability" for purposes of establishing section 3004(m) treatment standards for specific hazardous wastes. To the extent that more technologies require such case studies than are anticipated, other factors such as the volume of the waste currently being land disposed will be used to establish priorities to indicate which treatment alternatives will first be the subject of these analyses.

4. Additional Regulation of Treatment Technologies

Where the results of the detailed evaluations described in the previous unit conclude that a treatment technology or train should be designated as "unavailable" for purposes of establishing treatment standards for one or more specific hazardous wastes, EPA intends to develop additional regulatory controls for such technologies to reduce these unacceptable risks. For example, if the comparative risk assessments indicate that air stripping of volatile solvent wastes results in unacceptable releases of hazardous constituents to the air, the Agency may develop regulatory controls on the design and operation of air stripping processes to reduce these risks. If these additional regulatory controls are promulgated by the time the treatment standards take effect, the technology may be designated as "available" for use in achieving the standard (and the standard may be revised to reflect the improved performance of air stripping, if air stripping represented the best demonstrated achievable technology). There may be situations in which additional regulatory controls are not possible, do not sufficiently reduce the unacceptable risks, or cannot be promulgated by the time the section 3004(m) treatment standards take effect. In such cases, EPA will attempt to promulgate regulations prohibiting the use of riskier technologies by the effective date of the treatment standards.

Additional standards for treatment technologies may be developed under RCRA, as in the case of additional incineration standards, or under other statutory authorities. For instance, the Agency could establish appropriate standards for surface water discharges or discharges to publicly owned treatment works under the Clean Water Act.

5. Results of Initial Comparative Risk Analyses

The procedures described above were employed in conducting comparative risk assessments for the solvent waste streams and dioxin-containing waste streams for which section 3004(m) treatment standards are proposed today. The results of these initial analyses are presented in conjunction with discussion of the proposed treatment standards for these wastes in Unit VI.

D. Application of Standards

1. Leaching Procedure

As indicated previously, when treatment standards are expressed as an extract concentration, the Agency is proposing to use the recently developed toxicity characteristic leaching procedure (TCLP) to determine whether applicable levels have been achieved. The TCLP was developed for use in conjunction with an expanded Toxicity Charateristic. The current Extraction Procedure Toxicity Charcateristic (40 CFR 261.24) entails use of the EP, a leaching test used for identifying wastes as hazardous based on their likelihood to leach toxic contaminants. While the EP was optimized for inorganic constituents EPA's intent in developing the TCLP is to produce an improved leaching test method suitable for use in evaluating wastes containing organic constituents, as well as inorganic constituents. Thus the new TCLP represents a single test procedure that can be used to evaluate the leachability of all toxic contaminants in a waste.

The TCLP is also an improvement over the existing EP in several operational aspects. For example, the EP currently involves continual pH adjustment (titration) with 0.5 M acetic acid to a pH of 5.0 + 0.2. This can involve more than 6 hours of operator attention and can be difficult for some waste types, particularly oily wastes. In developing the TCLP, the need for continual pH adjustment has been eliminated. In addition, the EP involves separating the initial liquid from the solid phase of the waste, as well as separation of the liquid (extract) derived from the leaching test. These steps, currently involving pressure filtration through a 0.45 um filter, can be difficult and time consuming for certain waste types. EPA expects that these problems will be avoided in the new procedure. In addition, because the new procedure has been developed to address the leaching of organic compounds as well as inorganics, the new procedure is designed to prevent loss of the volatile compounds through the use of a zero head space extractor. Finally, other minor problems in the EP protocoal, such as accounting for the loss of waste materials to the sidewalls of sample containers, have been corrected in the new procedure.

Athough the TCLP was developed to model the codisposal of an industrial waste in a municipal waste landfill, EPA believes that the predicted degree of contaminant migration could reasonably occur during the course of most waste management, including the RCRA Subtitle C hazardous waste land disposal situation. This applies to the leaching of both organics and inorganics.

Since leaching results from the percolation of rainwater through the land disposal area, the leaching medium is almost always primarily aqueous in nature. As the rainwater precolates through the waste, it naturally picks up contaminants from the waste. However, the leaching medium is still primarily aqueous. As was demonstrated by the leaching experiments conducted during development of the TCLP (Refs. 46 and 47), as well as other research (Ref. 22), minor changes to primarily aqueous media do not generally result in significant differences in the degree of leaching of organic compounds. For inorganics, where the degree of leaching is most affected by pH conditions, the acidity afforded by the TCLP leaching medium accounts for the possibility that wastes could be subjected to mild acidic conditions which could occur in RCRA Subtitle C land disposal environments.

Of course, wastes do have the potential to be subjected to more aggressive leaching conditions that might be better modeled through the use of strong inorganic acids or perhaps certain types of solvents. However, the Agency finds it difficult to support the use of these more aggressive leaching media, primarily because it would be difficult to support a reasonable worst-case mismanagement scenario for use of these media. This is particularly significant for the RCRA Subtitle C hazardous waste land disposal situation since early in this program, EPA is restricting the disposal of solvent and acidic wastes in RCRA Subtitle C hazardous waste management land disposal facilities.

In addition, it appears that small amounts of some solvents may not affect leaching significantly. The TCLP was developed from a field-model lysimeter experiment which generated a municipal waste leachate (MWL). The leaching media for the TCLP (acetate buffer) was selected primarily because it was an adequate model for the MWL. The MWL, in addition to containing carboxylic acids and higher molecular weight organic compounds, also contained toluene, a common industrial solvent, in the range of 1 to 2 parts per million. It also contained other common industrial chemicals, such as benzene, however, at lower concentrations. The presence of these compounds in the MWL did not appear to affect the leaching of organic compounds to a significant degree.

Another consideration in the Agency's decision to propose the use of the TCLP in the restrictions program is the time constraints of the program. It took EPA approximately 4 years to develop and evaluate the TCLP. Congress, in directing EPA to identify treatment standards for wastes banned from land disposal, provided strict time limits under which regulations must be promulgated. If EPA were to develop a new leaching test for the land disposal restrictions program, the congressionally mandated timelines established for these decisions could not be met.

The protocol for the TCLP is set forth in Appendix I. In addition, detailed information on the development and evaluation of the TCLP will be presented in the Organic Toxicity Characteristic proposed rule, to be published in the **Federal Register** in the near future.

2. Testing and Recordkeeping

Under the framework being proposed today, determination of whether a waste or treatment residue requires further treatment prior to land disposal generally depends on whether the concentration of constituents in the waste, or in an extract from the waste (using the prescribed leach procedure), exceeds the applicable regulatory thresholds. Because this determination is critical to the proposed scheme, EPA is proposing to impose waste testing/analysis requirements.

The Agency first considered who should bear the responsibility for testing: the generator, the owner/operator of the treatment facility and/or the owner/operator of the land disposal facility.

The Agency considered three possible approaches. The first option would require that testing be conducted by the generator, the treater, and the ultimate disposer of the waste. The second option would require testing at the treatment facility and disposal facility (when they are separate facilities). The third option requires testing at only the disposal facility.

In the first option, the generator would be required to test the wastes before sending them off-site. As a result, the generator would know to send waste for treatment if it exceeded the regulatory threshold or for disposal if the concentration of constituents in the waste were less than or equal to the regulatory thresholds. The test would include only measurement of those constituents listed in Table CCWE of the regulation (§ 268.42). The generator initially would have to test the waste and establish the concentrations for the constituents in Table CCWE. Testing would be repeated when the process or inputs changed or the generator expected that the constituents in the waste stream may be different. Following treatment, the treater would be required to test the treated waste. Finally, the disposal facility would have to verify that the waste met the treatment standards by testing the shipment, possibly doing a modified waste analysis of the constituents of concern. If one or more processes occurred at the same site (e.g., the generator also treated the waste prior to sending residues off-site for disposal, or the generator shipped the waste off-site to one location for both treatment and disposal), testing would be required only once at each location. Thus, for example, a generator who also treats his waste would be required to test the waste only after treatment (i.e., before it is sent off-site for disposal). However the disposal site also would be required to test the waste prior to ultimate disposal. If generation, treatment, and disposal all occur at the same site, testing would be required only once prior to disposal.

The Agency believes there are several advantages to this approach. EPA believes that generators who know what is in their wastes will send their wastes to the proper place—either to the treatment facility or to the disposal facility. The testing information from the generator also provides valuable information for the treater. With the testing data, the treater will then be able to target the amount, method, and characteristics of treatment necessary for the waste in question. Requiring treaters to test wastes before shipping them for disposal assures accountability since they will know whether the applicable treatment standards have been met. Finally, by requiring the disposal facilities to verify the constituent content of the wastes before disposal, they can assure themselves and the Agency that only wastes that have met the treatment standards will be or have been land disposed.

A second option would require testing at the off-site treater and separate off-site disposal facility, but not at the generator. Under this approach, the treater would have to test wastes or treatment residues after treatment to show the disposal facility that they have met the treatment standards. The disposal facility would then verify, by testing, that the wastes met the treatment standards before land disposal. Where the disposal facility and treatment facility are a combined operation, the test would take place only once, before land disposal.

The third option would require testing at the disposal site, thereby assuring that wastes placed in the disposal units do not exceed the regulatory thresholds. Under this approach, the disposal facility must either conduct an analysis of the waste or obtain an analysis of the waste from the generator or treater. Similarly, the owner or operator of a land disposal facility could arrange for the generator or treatment facility to supply all or part of the required testing data. However, if the generator or treater did not supply the testing data and the land disposal facility owner or operator chose to accept the waste, the owner or operator would be responsible for conducting the required testing.

While options two and three do not require testing by the generator, they do not relieve the generator of his responsibilities under 40 CFR 262.20 to designate a facility (on the manifest) which is permitted to handle his waste when he sends his waste off-site for management. Thus, a generator must know whether he must treat his waste prior to disposal. However, rather than specifically requiring the generator to conduct testing, the Agency would allow determination of whether wastes meet the regulatory thresholds to be based on either testing or knowledge of the characteristics of the waste. Accordingly, a generator could determine that his waste requires treatment based solely on his knowledge of the waste without conducting and keeping records of the test results. This approach is directly analogous to the generator's responsibility to determine whether his waste is "identified" by any of the hazardous characteristics included in Subpart C of 40 CFR Part 261. This determination may be made by either testing the waste or by the application of knowledge of the waste in light of the materials or the processes used in its generation (40 CFR 262.11). Thus, although generators are held responsible for determining whether their wastes are hazardous, they are not specifically required to perform testing (or to keep records) to make this determination.

After evaluation of these alternatives, EPA is proposing the third option whereby the disposer would be held responsible for testing the wastes. The Agency believes that this approach would produce the desired result—an assurance that the wastes placed in land disposal facilities have met the applicable standards. It is flexible, does not require redundant testing, fits into the current regulatory scheme for the waste analysis plan and requires the testing to take place where the liability for disposal exists—at the land disposal facility. In addition, many disposal facilities already will have laboratory capabilities because of the existing waste analysis requirements.

To implement the proposed approach the Agency has included a reference to the requirements of Part 268 in the general waste analysis requirements in § 264.13 (a)(1) and (b)(6), for permitted facilities, and in § 265.13 (a)(1) and (b)(6), for facilities in interim status. Consistent with the current approach to waste analysis requirements in Parts 264 and 265, the Agency also has added the specific waste analysis requirements resulting from the restrictions program that must be incorporated into the general waste analysis, as a separate section in Part 268. Lastly, the Agency has revised the operating record requirements in §§ 264.73 and 265.73 to indicate that waste analyses conducted pursuant to this requirement be recorded and maintained in the facility's operating record.

In those cases where the applicable treatment standards are expressed as a concentration in a waste or an extract from a waste, the waste analysis requirements being proposed in Part 268 mandate that actual testing of the waste be conducted. (Frequency and sampling procedures are specified in §§ 264.13 and 265.13). Where the applicable treatment standard for the waste is specified as a method of treatment, testing to determine compliance is not applicable. In such cases, a certification by the generator or treatment facility owner or operator is sufficient to demonstrate compliance. The Agency requests comments on the proposed approach, as well as the alternative approaches discussed.

3. Facilities Operating Under an RCRA Permit

Land disposal and all other facilities which have been issued RCRA permits prior to the enactment of the HSWA must comply with certain requirements of the HSWA even though those requirements are not specifically referenced in the permit conditions. The Agency anticipates proposing in separate rulemaking, an amendment to § 270.4 to indicate that facilities with RCRA permits are subject not only to the conditions written into the permit, but also must comply with all applicable requirements of the HSWA (including implementing regulations) which would otherwise go into effect by statute.

Since the land disposal restrictions do go into effect by statute, permitted facilities would be required to comply with all applicable land disposal regulations when they become effective, even if the regulations are not referenced in the permit.

In order to facilitate implementation of the land disposal restrictions program, EPA is considering modifying the RCRA permitting regulations to make it easier for permitted treatment facilities to accept new waste streams not covered by their permit. For example, incinerator permits may specifiy the waste codes and volumes of waste which the unit is permitted to incinerate. Alternatively, the permit may be written to allow the incineration of broader categories of wastes if the unit's previous trial burn (or data in lieu of a trial burn) demonstrates the applicable Destruction and Removal Efficiency (DRE) on a Principal Organic Hazardous Constituent (POHC) or compound more difficult to incinerate than those wastes. Presently when waste codes are specifically listed in a RCRA permit, the permit must be modified to include any additional waste codes handled at the permitted unit. When waste codes are not specifically listed in a RCRA incinerator permit, a waste may be incinerated at a permitted unit if it is less difficult to incinerate than the POHC for which performance data are available, and all other conditions of the permit (e.g., minimum heating value of the waste) are met. If the permitted unit had demonstrated the applicable DRE on a POHC less difficult to burn or had not demonstrated the applicable DRE, another trial burn is necessary, and the permit would need to be modified.

In order to provide flexibility in meeting the capacity demands that will result from the restrictions program in as timely a manner as possible, EPA is considering allowing the treatment of restricted wastes (except for wastes containing dioxins) at permitted units without requiring the units to add waste codes through the permit modification process. This change would not allow new treatment processes or units to be added without a permit modification but would provide flexibility to permitted units to expand the types of waste they treat. Dioxin-containing waste (F020 through F023 and F026 through F028) may be treated only at units which have been certified specifically to manage those wastes.

Another alternative is to require any permitted treatment unit to modify its permit before treating any restricted wastes not covered by its permit. These permit modifications currently must be processed under § 270.41 (major modifications). Alternatively, EPA could revise the Part 270 regulations to simplify the modification process by allowing the incorporation of restricted wastes at permitted treatment facilities as a modification processed under the § 270.42 (minor modifications) procedure. EPA invites comment on these possible alternatives.

E. Determination of Alternative Capacity and Ban Effective Dates

RCRA section 3004(h)(2) states that the Agency may grant a variance of up to 2 years from the statutory ban effective date if adequate alternative treatment, recovery, or disposal capacity which protects human health and the environment is not available. Congress, however, intends for the land disposal restrictions to "go into effect immediately upon promulgation whenever and wherever possible." (S. Rep. No. 98–284, 98th Cong., 1st sess. 19 (1983)) The legislative history also states that "the Agency should expend every effort to assure that unsafe practices are terminated as quickly as possible." Therefore, "extensions based on capacity shortfalls should be infrequently granted. Given consistent regulatory and economic incentives, adequate capacity will be quickly developed." (S. Rep. No. 98–284, 98th Cong., 1st sess. 19 (1983)) The proposed procedures for extensions appear at § 268.4. EPA will consider several factors when calculating alternative capacity and when determining the length of any variance from the ban effective dates mandated by RCRA. These factors are discussed below.

1. Ban Effective Dates

EPA will develop estimates of treatment capacity needed versus capacity available to determine if current capacity of alternative treatment, recovery, and disposal technologies is sufficient to manage restricted wastes. These estimates will be developed from currently available data on capacity requirements and technology capacity. EPA also will use interpretations of existing data if EPA determines that existing capacity data are insufficient. If capacity is available, the ban will go into effect immediately. If capacity is not available, then the Agency will have to determine when additional, or new capacity, will become available, so that the length of a variance can be established. Establishment of the ban effective date will not be affected by the processing of petitions under RCRA section 3004 (d), (e), and (g). The interaction between the variance to the ban effective date and the case-by-case extension under section 3004(h)(3) is discussed later in this unit.

2. Regional and National Capacity

The Agency will make a national determination of both the quantity of banned waste generated and the capacity of alternative treatment, recovery, and disposal technologies. If national capacity is insufficient to treat all of the banned waste, in most cases the Agency will extend the effective date of the ban. If national capacity is sufficient, the ban will become effective immediately, even if, for instance, the only capacity for a waste generated in California, is located in Ohio.

This approach is consistent with congressional intent. The Senate legislative history provides that "the available capacity determination is to be done on a national basis." (S. Rep. No. 98–284, 98th Cong., 1st sess. 19 (1983)) That is, the effective date of the ban for a given waste should not vary from region to region because one region has sufficient alternative capacity and another does not. If cheaper land disposal is banned in only a portion of the country, it is likely that waste will be transported outside of that region and land disposed elsewhere. This would have the effect of discouraging the use of treatment in those regions in which it is available and land disposal is banned. As the Senate history points out, those regions of the country in which land disposal is permitted might become the "dumping ground" for wastes generated in regions where land disposal is banned. (S. Rep. No. 98–284, 98th Cong., 1st sess. 19 (1983).)

The legislative history recognizes that the nationwide approach to capacity determinations "might necessitate the transportation of wastes to treatment facilities over significant distances," but notes that "this kind of waste transportation is occurring today." It predicts the development of "inexpensive 'milk run' style collection services . . . to meet regional demands." S. Rep. No. 98–284, 98th Cong., 1st sess. 19 (1983)). In light of this legislative history, EPA believes that the need to transport wastes should not be the basis for extending the effective dates of the ban.

The Agency recognizes that there are some disadvantages to making a nationwide determination of capacity. Even though capacity may exist in some regions of the country, if nationwide capacity is insufficient, all of the wastes subject to the restrictions could continue to be land disposed. Thus, existing treatment capacity may not be utilized. Industries located in regions where treatment is not readily available may incur higher transportation costs when capacity exists elsewhere. The Agency solicits comment on alternative approaches to determining capacity consistent with congressional intent.

3. The Nationwide Variance and the Case-by-Case Extension

In cases where EPA has not granted a nationwide variance, it is not precluded from granting case-by-case effective date extensions. For instance, if alternative capacity exists to manage most of the waste to be banned, the Agency might choose not to grant a nationwide variance, even though alternative capacity appears to be lacking slightly. In these cases, it is more desirable to grant case-by-case extensions (as described in Unit III.F) to specific applicants who lack alternative capacity than to allow everyone, even those for whom alternatives are available, to continue to land dispose of their wastes. This approach is consistent with congressional intent to ban land disposal at the earliest possible time. In these circumstances, the Agency will specify in the proposed rulemaking that the ban will be effective immediately upon promulgation and the basis for this determination. Generators who cannot find alternative capacity for their wastes can apply for case-by-case extensions.

For the same reasons, EPA may grant a variance of less than 2 years, even though some facilities may require more time to be completed. These facilities could be completed under a case-by-case extension, if all applicable criteria are met, without allowing continued land disposal nationwide.

It is possible that some generators may produce wastes in such small quantities that no commercial treatment or other waste management facility is willing to accept this waste. Unique wastes may also exist that cannot be treated by the technologies or to the levels achievable for most other wastes. For these reasons, a case-by-case extension may be granted to allow facilities generating such wastes to provide alternative capacity or develop appropriate treatment methods.

If the Agency proposes an immediate ban effective date, it may receive applications for case-by-case extensions before the final rule is promulgated (see Unit III). Before promulgation of the final ban effective date, EPA will consider information provided by case-by-case extension applications as well as other comments submitted during the public comment period. As a result of this information, EPA may choose to grant a nationwide variance in the final rule.

However, after EPA promulgates a nationwide ban effective date, this date is, as a practical matter, unlikely to be amended based on applications for or issuances of case-by-case extensions, or any other information available that may indicate that nationwide capacity is insufficient. The Agency considered the possibility of changing the decision not to grant a nationwide variance if, after the ban became effective, it received evidence that capacity was not adequate. EPA also considered whether it should shorten a variance based on new information showing that nationwide capacity is adequate. The Agency believes that any change to the ban effective date would require a lengthy rulemaking that could not be completed in significantly less than 2 years. Since the maximum variance allowed by the statute is 2 years after the statutory effective date, a change to the ban effective date probably would not be practical.

4. Determination of Capacity Requirements by Waste Treatability Group

In general, EPA will develop treatment standards for waste groups derived from the physical/chemical characteristcs of the banned wastes (see Unit III.B). EPA will also determine the quantities of wastes that require specific treatment or recovery methods by waste treatability group. For instance, to remove dilute solvents from aqueous wastes, treatment processes such as air and steam stripping are required. However, solvent-contaminated sludges require incineration. Concentrated solvent liquids may be either recovered (e.g., by distillation or solvent extraction), reused (e.g., as a fuel substitute), or incinerated. These treatability groups will enable EPA to compare required capacity (capacity demand) with available capacity (capacity supply). Throughout this unit, the use of the word "waste" refers to the individual waste group on which the capacity determination will be based.

Currently, the major source of data for most waste capacity requirements is the Office of Solid Waste's Regulatory Impact Analysis (OSW RIA) Mail Survey of hazardous waste management activities during 1981 (Ref. 116). Information concerning dioxin waste quantities, however, was obtained in a separate effort (Ref. 67). In most other cases, the quantities of wastes land disposed reported in the Survey will be grouped according to the description of their characteristics also provided in the survey responses. In addition, EPA will consider other increases in capacity demand generated by emergency and remedial responses. EPA also will include, to the extent possible, the impact of other final rulemakings, such as the regulation of small quantity generators, that have occurred since EPA's capacity data were collected.

Under section 3005(j)(11)(B) of RCRA, certain treatment surface impoundments are exempted from the land disposal restrictions. Waste currently placed in exempted surface impoundments does not require alternative capacity. Therefore, the Agency is not including the quantity of waste placed in these units annually in its calculation of capacity requirements. Treatment residuals that under section 3005(j)(11)(B) must be removed from exempted surface impoundments do require alternative capacity and will be considered in the analysis.

EPA may set different ban effective dates for different waste groups depending upon the capacity available to handle each waste group. It will be possible, for example, to have one effective date for sludges that require incineration and another effective date for recoverable liquids within the same waste code based on the availability of incinerator and recovery processes, respectively. This approach is consistent with congressional intent that prohibitions become effective immediately whenever possible.

In some cases, the same technology will apply to several waste groups that must be regulated in the same rulemaking. For instance, incineration is the applicable technology for both sludges and solids that contain high concentrations of solvents (i.e., organic sludges and solids) and sludges and solids that contain lower levels of solvents (i.e., inorganic sludges and solids). However, total capacity for incinerators may be insufficient to treat both of these groups of wastes.

One option is to extend the ban effective date for both organic sludges and solids that require incineration and inorganic sludges and solids that contain lesser solvent concentrations and that require this incineration. However, available incinerator capacity would not be utilized under this approach, since all of these wastes could continue to be land disposed during a variance. This approach maybe viewed as inconsistent with the intent of Congress to ban wastes as soon as possible.

The Agency believes that a better approach is to subdivide the waste groups and utilize all available treatment capacity on specific subgroups in order to implement bans as quickly as possible. Under this approach, as much waste as possible would be banned immediately. One option under consideration is to prioritize the wastes to be banned by considering relative toxicity, as represented by concentration. Thus, in the example given above, the ban on land disposal of organic sludges and solids containing solvents would be effective immediately and a variance granted for inorganic sludges and solids containing solvents. EPA solicits comment on this method of prioritizing treatment capacity among different hazardous wastes.

5. Definition of Available Capacity

The Agency will consider both current on-line facilities and planned facilities that will be completed by the ban effective date, as available capacity. On-line facilities are facilities that have been approved to operate and accept pertinent wastes under current regulations by applicable Federal, State, and local agencies. Facilities operating under RCRA interim status meet these criteria, and therefore will be included in the capacity determination. Current facilities are facilities that are on-line at the time of the capacity analysis. These facilities include both off-site and on-site facilities, as well as stationary and mobile facilities. Planned facilities are facilities that are projected, under development, or under construction. Planned facilities include both new commercial and on-site treatment, recovery, or disposal facilities. They also include planned capacity additions or expansions to current facilities undertaken by the owner/operator to accommodate increased demands or because the existing process is used to its total capacity.

The planned facility or capacity expansion will be considered available if it is EPA's judgment that, by the time the ban goes into effect, the capacity will be on-line. In order to predict if the capacity will be on-line in time, EPA will consider the time the facility will require to be completed, including reasonable estimates of time to site, to obtain permits, to construct, and to test. In most cases, EPA will consider the capacity of planned facilities only if all permits required for construction have been approved and if there is sufficient additional evidence of intent to build, such as contracts issued for construction.

As explained in Unit III.E.4, EPA will account for treatment surface impoundments exempted from the land disposal restrictions under RCRA section 3005(j)(11)(B) by not including in the calculation of capacity demand, wastes currently placed in such units. Because it has no information to the contrary, EPA is assuming that all exempted surface impoundments that are currently on-line are used to capacity. Thus, for the purpose of this proposal, these units will not be considered available, unused capacity. Any new or planned treatment surface impoundments will be considered alternative treatment capacity if they will be on-line by the pertinent ban effective date, and if they will meet the requirements of RCRA section 3005(j)(11)(B).

6. Definition of Alternative Treatment Capacity

RCRA section 3004(h)(2) states that a variance from the effective date of a land disposal ban "shall be established on the basis of the earliest date on which adequate alternative treatment, recovery, or disposal capacity which protects human health and the environment will be available."

Available treatment technologies (i.e., those found to present less risks than land disposal) that can achieve the screening concentration levels established by EPA are, by definition, protective of human health and the environment. Such treatment technologies will be considered in determining whether adequate alternative treatment capacity exists. If the capacity of these protective treatment technologies, coupled with protective disposal and recovery capacity, is insufficient to accommodate the banned waste, EPA will exercise its discretionary authority not to extend the effective date if the capacity of the protective technologies, together with the capacity of technologies that meet technology-based section 3004(m) standards, is adequate to address the restricted wastes. As discussed in Unit III. B, EPA believes that this approach is fully consistent with congressional intent.

Treatment methods that are not identified as BDAT for the waste group being considered also will be included in the capacity determination, as long as EPA judges that the method can achieve the treatment standards for some of the wastes in question and will pose less risk than land disposal. These methods are still available to treat such hazardous waste. EPA believes that this approach is consistent with the congressional intent to ban hazardous wastes from land disposal at the earliest possible date, as discussed earlier.

7. Definition of Alternative Recovery and Disposal Capacity

In general, the Agency will consider the capacity of all on-line recovery and disposal facilities that are protective of human health and the environment in assessing available capacity. Planned facilities, including expansion of existing facilities, also will be considered where appropriate. On-line facilities are defined as those facilities that have received approval from applicable State, local, and Federal agencies to operate a recovery or disposal facility for the waste in question or for a similar waste.

However, alternative land disposal methods (e.g., deep well injection) will not be considered as available capacity for banned waste unless EPA has determined that such methods of disposal are protective for the waste in question. This question will arise frequently in the context of assessing underground injection as alternative capacity. RCRA section 3004(f) allows the Agency until August 1988 to study the disposal by deep well injection of solvents, dioxins, and California List wastes and to promulgate any necessary regulations banning these wastes from deep well injection. This deadline occurs after the mandated deadlines for ban decisions concerning disposal of these wastes by other land disposal methods. For wastes scheduled for later banning, the Agency will make decisions to ban from deep well injection concurrently with decisions to ban from other land disposal methods. Accordingly, in evaluating the capacity of alternative protective disposal methods for these wastes prior to a decsion under section 3004(f), EPA will not consider underground injection to be available disposal capacity, or since the Agency will not have determined whether the injection of such wastes is protective.

EPA is considering recycling methods in the comparative risk assessment (see Unit III.C), and recycling methods that EPA judges are riskier than land disposal methods will not be considered available capacity. Those recycling methods not evaluated in the comparative risk assessment, such as use of waste as fuel, are either currently regulated, or will be regulated under other Agency regulatory efforts. EPA believes this will assure that these technologies are less risky than land disposal.

In the past, many recycling facilities were not subject to regulation under RCRA. Recent modifications to the 40 CFR 261.2 regulations defining a solid waste, published in the **Federal Register** of January 4, 1984, (50 FR 617), will bring many recycling facilities under RCRA regulatory control. Because most of EPA data were obtained prior to this change, and because available data pertain to RCRA-regulated facilities alone, information about recycling facilities is incomplete. EPA is actively collecting data concerning the applicability and capacity of existing recycling facilities, and solicits comment and information concerning these facilities.

8. Calculation of Capacity

EPA will calculate the annual unused or surplus capacity of alternative treatment, recovery, and disposal facilities that are used nationwide to manage wastes restricted from land disposal. This nationwide capacity (capacity supply) will then be compared with quantities of banned waste generated annually nationwide (capacity demand).

Surplus capacity will be expressed as throughput capacity. Since data on unused throughput may be difficult to obtain in some instances, EPA may need to use other available information, such as the difference between practical maximum design capacity and the capacity currently utilized, to calculate capacity. Practical maximum design capacity may need to be estimated from theoretical maximum design capacity. Frequently, treatment and recovery technologies consist of a series of unit processes. Treatment systems for specific constituents will be considered as a whole when determining capacity. However, it is possible for more than one treatment system to be present at one location.

In this rulemaking, capacity estimates will be based on the OSW RIA Mail Survey. However, the Agency is currently developing a new survey of commercial and private treatment facilities. EPA will use the results of this survey when they become available to calculate capacity.

As discussed earlier, EPA will consider both current surplus capacity and planned capacity when calculating surplus capacity.

a. *Current surplus capacity.* Current surplus capacity is defined as present capacity which is not being utilized. Surplus capacity can be any of the following:

(i) Commercially available.

(ii) Private and can be used to process additional waste produced by the owner.

(iii) Private and the owner will be willing and able to accept wastes from other generators.

EPA will assume that commercial facilities are willing to accept wastes that they are capable of treating. In cases where commercial capacity is inadequate, EPA will consider the likelihood that available private capacity not needed to process additional waste produced by the owner will be converted to commercial capacity, and will try to estimate the volume of wastes generated by others that private facilities are willing to accept. In some cases, the Agency's calculation of commercial capacity already includes the surplus capacity located at private facilities that accept some waste commercially. EPA solicits comment from owners of private facilities as to whether they will accept wastes commercially in the future and whether they will use their current surplus capacity to treat their own banned wastes.

b. *Planned capacity.* If EPA finds that current capacity is insufficient for a particular waste, it will evaluate the potential for the development of planned facilities and capacity by the statutory ban effective date. Planned capacity will also be considered in determining the length of a variance, if necessary (see Unit III.E.9). EPA will also consider planned capacity of emerging treatment technologies (as defined in Unit III.B) if treatment standards are based on these technologies or if these technologies can be expected to achieve health-based levels. Planned facilities and capacity will be considered available only if EPA determines that, by the time the ban goes into effect, the facility will (1) be on-line, and (2) meet the screening level (or a technology based treatment standard if no demonstrated technology meets the screening level.)

9. Time to Develop Capacity and Length of Variance

According to RCRA section 3004(h)(2), if the Agency determines that sufficient capacity currently exists, or if the necessary additional capacity can be developed by the time the mandated ban date for each waste (e.g., November 1986 for dioxin and solvent wastes), the ban will go into effect on that date. If not, a variance of up to 2 years may be granted at the same time that the final rule is promulgated.

The length of the variance will depend on the time required to provide alternative capacity that meets the criteria described above. To determine the time needed to develop additional capacity, EPA will consider several factors, including the time required to finance, site, permit, design, construct, obtain equipment, and test (Ref. 64). The approach to determining if emerging facilities will be available for the purpose of setting treatment standards will also apply to capacity determinations. If EPA judges that cost to develop a new technology or to retrofit or expand an on-line facility is prohibitively high, it may determine that further development will not occur, and that capacity will not be available on time. Whether costs are prohibitively high will be a case-by-case determination.

The Agency has considered whether amendment to §270.72 is necessary to allow the treatment processs expansions, additions, or alterations that will result as hazardous waste management facilities adjust to today's regulatory proposal. It appears that most expansions of treatment capacity in response to land disposal restrictions can be made without changing any provisions of § 270.72. Comments are requested on this conclusion by the Agency.

F. Case-by-Case Extensions

1. Introduction

According to RCRA section 3004(h)(3), any person who generates or manages a hazardous waste restricted from land disposal may submit an application to the Administrator for an extension of the effective date of the restriction. The statute provides that the applicant must demonstrate that he has entered into a binding contract to construct or otherwise provide alternative treatment, recovery (recycling), or disposal capacity that protects human health and the environment. The applicant must also demonstrate that, due to circumstances beyond his control, such alternative capacity cannot reasonably be made available by the applicable effective date.

The legislative history provides that EPA should use the case-by-case extension "sparingly and only in cases of extraordinary nature." (S. Rep. No. 98-284, 98th Cong., 1st sess. 19 (1983)). The legislative history further states that "a generating industry" should not "be allowed to continue to have its wastes disposed of in an otherwise prohibited manner solely by binding itself to using a facility which has not been constructed" and that "when an 'alternative technology' facility is operating at less than maximum capacity, the Administrator should determine that alternative capacity is available whether or not an individual company applying for an extension is constructing its own alternative facility." (S. Rep. No. 98-284, 98th Cong., 1st sess. 19 (1983)). According to the legislative history, "in such cases the company should be required to use the available alternative capacity until such time as its own capacity has been constructed and permitted."

During an extension, a successful applicant is exempted from the land disposal restrictions, including the conditional prohibition on storage under § 268.50. However, if he chooses to dispose of his waste in a surface impoundment or landfill, he must comply with minimum technological requirements under § 268.4(i).

The proposed criteria for obtaining a case-by-case extension as required under § 268.4 are described below.

2. Receipt of Application

Both generators and treatment, storage, and disposal (TSD) facility owners or operators are eligible to apply for a case-by-case extension, and they may apply independently or together. RCRA section 3004(h)(3) authorizes the Agency to grant the extensions to any person who can make the demonstration described below. In order for generators and TSD facilities applying for the extension to have a continuous means to dispose of their wastes if alternative capacity is not available, they must be able to obtain an extension that will become effective on the same date as the land disposal ban. Therefore, should the Agency propose an immediate ban effective date (i.e., no variance under section 3004(h)(2)), it will accept applications for case-by-case extensions as soon as the proposed rule is published.

Applications should be submitted at least 6 months before the ban effective date to provide a reasonable opportunity for EPA to process them before the ban becomes effective. For example, extension applications for all bans proposed today become effective November 1986 should be submitted by May 1986. The Agency will accept applications after this deadline, but it may not be able to process them by the ban effective date.

If the Agency proposes and promulgates a variance pursuant to section 3004(h)(2), applicants for a case-by-case extension will be able to make use of the duration of the variance (variances can be granted for up to 2 years) to develop the case-by-case extension request. Note that such a request may be granted only if sufficient capacity has not developed during the variance period established under section 3004(h)(2).

Once the effective date of a land disposal restriction decision has passed, EPA will entertain requests for a case-by-case extension under certain limited conditions. First, EPA could elect to make a restriction immediately effective (i.e., not grant a variance under section 3004(h)(2)) even though it determines that nationwide capacity does not exist. It is not expected that the Agency will invoke this option frequently. However, there may be situations in which the shortfall in capacity is minor, and the Agency may determine that the most environmentally protective approach is to grant case-by-case extensions to a few applicants rather than grant a national variance to all generators and disposers of the waste in question. In such a case, applicants may need to apply for a case-by-case extension after the restrictions have become effective.

Second, there may be situations in which necessary capacity has not developed by the end of the variance period granted under section 3004(h)(2). Although in such a case an applicant will often have had time to develop a case-by-case extension application, there may be some cases in which such an application is tendered after the variance period has ended and the restriction has taken effect.

Lastly, capacity that was available when the ban became effective may become unavailable. For instance, a major commercial treatment facility may stop operating, which could result in insufficient national capacity for its former clients.

In the above and similar cases, EPA will entertain requests for case-by-case extensions after the effective date of a restriction decision. However, as noted earlier, consideration of such requests is subject to certain conditions. First, submission of an application for case-by-case extension will not affect the applicability of a restriction decision to the waste in question unless and until an extension is granted.

In addition, EPA is proposing to impose a limit on the period of time after a restriction effective data during which a case-by-case extension will considered. EPA believes that Congress intended the variance and extension provisions of section 3004(h) to encourage the development of safe alternatives to land disposal. Since 48 months (i.e., the maximum 2-year variance under section 3004(h)(2) plus the maximum 2-year case-by-case extension under section 3004(h)(3)) is the longest delay in implementing the restrictions that Congress appeared to contemplate, EPA believes that it is appropriate to adopt this timeframe as an outside limit for the consideration of extension requests. The timeframe during which the Agency will allow extensions to occur, therefore, will be 48 months after the ban effective dates if no variance is granted. Should EPA grant a variance to the ban effective date, this 48 months will decrease by the duration of the variance. For instance, if a 2-year variance is granted, all extensions must terminate 2-years from the ban effective date. As a practical matter, this means that the duration of the extensions (starting with a maximum extension of 1 year with a 1-year renewal) will become shorter as more time elapses between the scheduled effective date and the date of the extension application. No extensions would be granted to exceed the statutory maximum of 2 years.

3. Length of the Case-by-Case Extension

Section 3004(h)(3) specifies that the Agency may grant the first extension for up to 1 year. However, an extension of less than 1 year will be granted if, in EPA's judgment, less than 1 year is required to provide the needed capacity. If the development of capacity will take over 1 year, the Agency will consider a time period of over 1 year for planning purposes. However, in order to comply with section 3004(h)(3), the extension must be officially renewed after the end of the first year.

The length of the initial extension will depend on the time required to provide capacity. The applicant must submit a proposed schedule for obtaining required operating permits and for completing his facility under § 268.4(a)(5). EPA will compare this schedule with available information concerning the time to complete the type of facility in question. The schedule will also include interim milestones, where appropriate, which represent significant events that need to be accomplished. This information will allow EPA to evaluate a successful applicant's progress toward developing capacity. The renewal of the extension for all or part of the second year will be contingent upon demonstating a good-faith effort to meet the completion schedule (see Unit III.F.8).

4. Demonstrations Included in Applications

a. *Demonstration that alternative capacity is unavailable.* The applicant will have to provide evidence that sufficient capacity for alternative treatment, recovery, or disposal technologies does not exist for the waste under § 268.4(a)(3). The application must include the quantity of waste for which capacity is lacking and sufficient information on the characteristics of the waste to determine which alternative treatment, recovery and disposal technologies apply. If the applicant is stating that his waste cannot be treated by available treatment methods, he must submit information, such as descriptions of interfering waste characteristics and waste treatment data, that support this claim.

To show capacity is unavailable, the applicant must demonstrate that he has made a good-faith effort to locate and contract with appropriate treatment, recovery, and disposal facilities nationwide, but that no facility will accept his waste. Documentation of the latter may include copies of correspondence with commercial facilities. Resources are available to assist applicants in locating applicable waste management facilities. EPA's Hazardous Waste Treatment Directory (Volume II, 1985) lists commercial treatment and recycling facilities and provides addresses, phone numbers, and information on services provided and wastes accepted. The EPA Directory also provides lists of State contacts and professional and trade organizations which may be helpful in identifying pertinent facilities. Several other commercial directories are also published. EPA will use the information from these directories and other sources to determine if the applicant has made a good-faith effort to investigate all possible sources of capacity.

b. *Demonstration that sufficient capacity is being provided.* The Agency will require under § 268.4(a)(4) that the applicant provide sufficient information (e.g., waste quantities and design data) to demonstrate that, after the extension, sufficient alternative capacity will exist for the waste that is the subject of the application. EPA does not believe that an extension should be granted if the applicant is not providing full capacity for the waste. The applicant may also demonstrate that he is changing his manufacturing process so as to eliminate the waste generated or to decrease its volume. In cases where a waste cannot be treated by existing methods, elimination of the waste may include efforts to change waste characteristics through process modifications to allow treatment. If waste minimization is occurring, either the entire quantity of waste which would be subject to the extension must be addressed through this practice, or any waste not eliminated must be tied to specific treatment capacity.

c. *Demonstration that lack of capacity is "beyond the control" of the applicant.* According to the statute, applicants for a case-by-case extension will have to demonstrate that the reasons they cannot provide capacity by the effective date of the ban were beyond their control. For instance, if permitting or other licensing delays are the reason why the applicant cannot develop capacity, the applicant must show that he submitted the permit and other licensing applications in a timely fashion, but that the permits were not awarded in time to provide capacity by the date of the ban. The applicant may also show that, through no fault of his own, the development of capacity was stalled by problems concerning, but not limited to the following: design, testing, construction, financing, equipment, or supplies.

d. *Demonstration of binding contractual commitment.* An applicant must show a binding contractual commitment to provide alternative capacity under § 268.4(a)(1). The applicant must contract directly with the person or organization that is to provide alternative treatment, recovery, or disposal capacity. The contract should stipulate that a penalty be assessed by the applicant's contractor if the contract is canceled. The size of this penalty will have to be sufficiently large to discourage strongly applicants who have no intention of providing capacity. EPA solicits comment on the determination of the size of a penalty for cancellation that should be required.

e. *Waste management and capacity during extension.* The application must describe the way in which the subject waste will be managed during an extension under § 268.4(a)(6). This showing must include the location of all off-site waste management facilities. This information is needed to identify the States affected by the extension. The applicant must certify that any surface impoundment or landfill in which the waste is managed during the extension meets the minimum technological requirements referenced in § 268.4(i). This provision does not allow waste subject to an extension to be managed in surface impoundments or landfills exempt from double liner requirements under RCRA section 3005(j) or managed in any existing portion that does not meet the new technical requirements referenced in § 268.4(i). All facilities in which the waste is managed must meet all applicable RCRA requirements.

The applicant must also demonstrate under § 268.4(a) (6) that sufficient capacity will exist during the extension to store, dispose, or otherwise manage the waste. The Agency, having limited resources for the review of applications, must assure that these resources are used to process applications where the applicant has already arranged for waste management during an extension. This will eliminate the need to reconsult with affected States (see Unit III.F.5 below) due to changes in an applicant's plans.

f. *Certification of application*. All applicants must certify, under penalty of law, that all of the information provided to the Agency is accurate under § 268.4(b).

5. Consultation With Affected States

Based on the information provided on management of a waste during an extension, the Agency will notify and consult with appropriate agencies in all States it judges may be affected by a specific extension. This action is required by section 3004(h)(3) of RCRA.

6. Notice of Initial Determination

The Agency will notify the applicant of its initial determination as to approval or denial of the case-by-case extension. Initial determination of each case-by-case extension will be published in the **Federal Register** and comment solicited on these determinations.

7. Granting of Extension Approval

If EPA grants an extension of the ban effective date based on an assessment of all of the information provided by applicants and by others during the comment period, it will provide the successful applicant with a written notice of the extension. This notice will describe the manufacturing process(es) that are the source(s) of the waste subject to the extension, the volume of such wastes, the disposal facilities in which the waste will be managed during the extension period.

Because waste identical to waste granted an extension is otherwise prohibited from land disposal when it is generated by someone other than the applicant, it is important that the site of land disposal of the waste granted an extension be documented. The Agency is requiring under § 268.4(e) that the successful applicant retain the approval notice in his operating record during the period of the extension and for at least 3 years after the extension expires. In addition, the applicant must provide a copy of the notice to any land disposal facility identified in the approval notice before to the first shipment of waste granted an extension is sent to the facility.

The owner or operator of the land disposal facility must also retain a copy of the notice in his operating record during the period of the extension and for at least 3 years thereafter.

8. Progress Reports and Revoking the Extension

The Agency will monitor the progress achieved by the successful applicant in meeting the completion schedule submitted in the application. The applicant must submit progress reports at intervals designated by EPA under § 268.4(h). Such reports must describe the overall progress made toward obtaining required permits and constructing or otherwise providing alternative treatment, recovery or disposal capacity. The report must also identify any event which may cause or has caused a delay in the development of capacity, and summarize the steps taken to mitigate the delay. EPA can revoke the extension at any time if the successful applicant does not make a goodfaith effort to meet the completion schedule.

The recipient of an extension must also notify the Agency as soon as he has knowledge of any changes in the conditions certified in the extension application. Such changes include any proposed change in the site of treatment or land disposal, and any significant proposed change (e.g., volume or characteristics) to the waste subject to the extension. Any such planned modifications to the conditions may subject the applicant to a re-evaluation of his extension, and possible revocation.

G. Proposed Procedures To Evaluate Petitions Demonstrating Land Disposal To Be Protective Of Human Health and the Environment

1. Introduction

As noted in Unit II.A, a hazardous waste referred to by section 3004 (d), (e), or (g) is banned from land disposal unless EPA determines that one or more methods of land disposal of such waste is protective of human health and the environment. The Administrator is authorized to find that land disposal of a particular waste will be protective of human health and the environment if an interested person demonstrates, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the land disposal unit or injection zone for as long as the wastes remain hazardous (42 U.S.C. 6924, RCRA section 3004 ((d)(1), (e)(1), and (g)(5)). This demonstration is made in the form of a petition to the EPA Regional Administrator or authorized State program director. A petition may be submitted by any interested person, including any generator of a hazardous waste or any owner or operator of a land disposal unit (as defined in RCRA section 3004(k)). A petition may be submitted to the Agency at any time prior to the effective date of the ban, or at any time after the ban becomes effective.

The statutory requirement for an application by an interested person is intended to place the burden on the applicant to prove that a specified waste can be contained safely in a particular type of disposal unit or injection zone. The nature of the facility and the waste must assure that migration of hazardous constituents will not occur while the wastes still retain their hazardous characteristics and present a potential threat to human health and the environment. This demonstration can be made either for a particular facility by an individual applicant, or for a class of facilities with like natural hydrogeologic conditions. The Agency believes, however, that an adequate petition demonstration for a class of facilities with like natural hydrogeologic conditions may be technically complicated depending on site- and waste-specific characteristics. The Agency requests comments on the feasibility of such a demonstration and is interested in specific examples of classes of facilities that are in like natural hydrogeologic conditions.

If the Agency grants a petiton, the subject waste may be managed in that land disposal unit as long as the unit is in compliance with all applicable requirements. The granting of a petition does not relieve the owner or operator of the land disposal unit from any obligation to comply with applicable technical standards (e.g., the requirements to install a double liner system in the case of certain landfills and surface impoundments).

The standard to be applied in determining whether a petition will be granted is whether there has been a demonstration, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous.

The Agency interprets this statutory standard to mean that a variance can be granted only in cases where it is shown that any migration that does occur from the disposal unit will be at concentrations that do not pose a threat to human health or the environment. This interpretation is supported by the statutory language itself and by the legislative history. The statute provides that there will be "no migration of hazardous constituents . . . for as long as the wastes remain hazardous" thus, implying that some migration would be allowed as long as the standard set by the latter phrase is not violated. The legislative history sheds some light on the intended construction of these terms. It notes that "[t]he administrator is required to find that the nature of the facility and the waste will assure that migration of the wastes will not occur while the wastes still retain their hazardous characteristics in such a way that would present any threat to human health and the environment" (Senate Report No. 98-284 at page 15). Accordingly, a petition could be granted if it is shown that the hazardous constituents that migrate beyond the unit are at concentration levels that would not pose a threat to human health and the environment. The approach outlined today is founded upon this interpretation.

The Agency believes that, ultimately, petition review is properly a function of the permit review process, and should, therefore, be the responsibility of the permit writer in authorized States, or the regional EPA office (RO) for other States not fully authorized to manage a RCRA Subtitle C program. However, EPA headquarters may be involved in petition review to resolve any significant policy or technical issues that may arise in a manner that ensures consistency across all States and regions. Responsibility will eventually be delegated to authorized States at such time that each State has received final authorization, and has an acceptable petition review program in place. In addition, EPA headquarters or the ROs will be responsible for issuing a notice for publication in the Federal Register with an explanation of the basis for determining that a method of land disposal is protective of human health and the environment, as required by section 3004(i). Where individual States are authorized for petition review, a notice will be published in a manner that constitutes legal notice under State law.

If a permit has not already been issued, the Agency believes that the petition review will normally be undertaken in the context of the full technical review of the Part B permit application, since disposal unit, waste, and site information critical for petition review is, to a large extent, the same or consistent with permit application information requirements. The Agency believes that parallel review of a permit application and a petition application is the most efficient use of Agency resources and will ensure complete and consistent review of all information regarding the disposal unit and its operations. The Agency has not, however, decided if petition approval should be contingent upon formal permit issuance. The Agency requests comments on an approach that would allow approval of a petition to a facility operation under interim status, and on an alternative approach that would make petition review contingent upon permit issuance including the opportunity for public participation. In addition, the Agency requests comment on the extent of public notice and opportunity for public comment to be provided prior to final decision on a petition.

As a matter of policy, the Agency is proposing that the receipt of a petition by the Agency or authorized State is not considered to be a basis for delaying the effective date of any prohibition on land disposal of a specific waste. The Agency expects that the preparation of a petition, and adequate review, are processes that are likely to consume a number of months. During this period of time, the petition applicant will be required to comply with all restrictions on land disposal, once the effective date of such restrictions has been reached.

However, the statute allows an extension of the ban effective date if it is shown, *inter alia*, that the applicant for the extension has contracted to provide alternate treatment, recovery or disposal capacity (including land disposal capacity) that is protective of human health and the environment (Section 3004(h)(3)). The Agency solicits comment on whether a contract to dispose of waste in a unit for which a petition decision is pending constitutes a contract to provide protective disposal capacity. Must a favorable decision have been reached on the petition before the subject unit is considered protective, or may the unit subject to the pending petition be deemed protective before the petition decision is made?

The Agency will make every effort to review petitions in as timely a manner as possible. The Agency will establish a protocol for reviewing and evaluating petitions. The protocol will be designed to identify clearly deficient petitions as early as possible so as to conserve the resources of the petitioner and the Agency. This will be accomplished by early meetings with petitioners. The protocol will be as specific as possible in order to alert the prospective petitioner as to the nature and scope of the data and analysis requirements, rather than continuously requiring additional data submittals or analyses through notices of deficiency. The most important aspect of the protocol will be in defining the types of data and analyses needed for a petition demonstration. The Agency believes that it is clearly in the best interests of the regulated community and the Agency to devote the Agency's limited resources to the review and evaluation of well-documented petitions, rather than devoting those resources to reviewing and rejecting numerous non-meritorious petitions.

The evaluation of land disposal petitions could be a complex task involving substantial data collection and analyses. The intention of the Agency in developing the protocol is to minimize the effort and resources required for a petition demonstration. A site-specific methodology can, by virtue of its specificity, be expensive and time consuming to implement when assessing the risks presented by land disposal of hazardous waste. The Agency is developing a protocol with a tiered approach to the risk assessment process required in the petition demonstration in order to expedite the decisionmaking process.

The first tier of the protocol starts with a set of critical screening factors that would direct a potential petitioner to the appropriate level of sophistication for the demonstration. It has also been designed to suggest which petitions should be rejected outright. An example of an outright rejection criterion would be the failure to submit an analysis documenting the validity of a fate and transport model, other than the unmodified version of the Screening/Treatment Standard models, to be used in evaluating the site- and waste-specific scenario. Failure to meet these critical factors may be cause for an outright rejection of a petition.

Tier one may also include screening factors that identify sites for which the Agency does not believe that the Screening Level Standard models, or similar simplified models, are appropriate. If a petition concerns a site without these characteristics, the Agency will accept petitions based on simplified models such as the Screening/Treatment Standard models. The Agency will refer to this as a "tier two" demonstration. If a site has characteristics that indicate that a tier-two demonstration will not be appropriately conservative, then a more complex "tier three" demonstration will be required for a successful petition. The Agency would like commenters to identify characteristics that would make the Tier 2 demonstration inappropriate. The Agency will consider requiring that petitions for such sites be based on demonstrations with more complex fate and transport models appropriate to the tier-three level of sophistication.

In the second tier, a petitioner could base the demonstration on the results of inputting site-specific data in the models used to develop screening levels. The petitioner would be required to use site-specific data or conservative assumptions in lieu of all data points included in the monte carlo analysis used to establish screening levels. The petitioner will also have the option of using other simple fate and transport models as they are appropriate to the site- and waste-specific scenario.

A simplified model is one that accounts for only the most important physical phenomena. It is important to understand that the use of simplified models will only be acceptable if assumptions that account for phenomena not modeled or not taken into account are reasonably conservative. The uncertainty of the representativeness of a simple model has to be tempered with sufficiently conservative assumptions to ensure that the model has sufficient validity to be used in the petition decision. The petitioner must satisfactorily demonstrate the validity of alternative simplified models for the site and waste considered in the petition.

The central goal of the second tier is to usually allow the petitioner, with minimal effort, to determine whether concentrations of the hazardous constituents in the waste leachate will not result in concentrations that exceed the established health and environmental standards at the point or points of potential exposure. (The term "point(s) of potential exposure" will be defined later in this section.) Thus, the second tier centers on the fate and transport of the hazardous constituents from the disposal unit to the point(s) of potential exposure. If the petitioner can demonstrate that the established screening and environmental based standards are not exceeded at the point or points of potential exposure, he will not be required to perform any analysis of the existing or future population that may be in proximity of the site.

There may be situations where waste constituent concentrations are in excess of the Screening/Treatment Standards, but because of unique site-specific factors (such as where exposure can be demonstrated not to occur), land disposal may still be protective of human health and the environment. In this event, using appropriate data, the petitioner may be able to omit the fate and transport analysis.

Petitioners who fail at the second-tier level of analysis have the option of moving onto the third tier of the protocol, which involves more detailed site analysis and the use of more sophisticated fate and transport models to demonstrate that a hazardous constituent of a waste will not exceed health based standards at the point or point(s) of exposure. The use of more sophisticated models will naturally require collection and use of more site-specific data and a greater effort for the analysis. The main goal of using more sophisticated models is to reduce the uncertainty of the results, and, therefore, allow the use of more realistic assumptions, computational algorithms, or actual data in the place of conservative assumptions. If the petitioner can demonstrate that the established screening and environmental based standards will not be exceeded using a more sophisticated third-tier site-specific analysis, the petitioner will not be required to perform any analysis of future or existing population in proximity of the site.

The petitioner will also have the option to use any other data or analyses in conjunction with fate and transport analyses to show that, in the event of an exceedance of the screening and environmental standards, concentrations at the point or points of potential exposure will still not endanger human health and the environment. Using an approach that does not rely strictly on fate and transport modeling may result in a considerably greater effort on the part of the petitioner, and also for the Agency when reviewing the petition. If the petitioner plans to make such a demonstration, he will be required to consult with the Agency to establish the nature and scope of such a demonstration prior to submittal.

The amount of resources committed to the development and review of a demonstration in the third-tier would increase significantly, depending on site- and waste-specific factors, as compared to a second-tier demonstration. To the extent possible, the Agency will provide guidance to the petitioner as to what level of effort, in terms of data collection and/or analysis, will be needed to support such a petition.

The Agency is preparing a guidance document that will provide a detailed description of the protocol. The document is entitled "Land Disposal Ban Variance Guidance Manual." When the draft guidance document is completed, a notice of availability of the guidance will be published in the **Federal Register.**

As an alternative to the proposed approach, the Agency is considering limiting the eligibility of interested persons to petition the Agency to those generators of banned wastes for which no acceptable treatment is available. Where acceptable treatment exists and is available, the generator of a banned waste would be required to treat the waste to meet the section 3004(m) standards. The Agency believes that support for this position may be found in the statement of congressional policy that "reliance on land disposal should be minimized or eliminated", and that "land disposal . . . should be the least favored method for managing hazardous wastes" (section 1002(b)(7)). The statute further points out that Congress seeks to protect human health and the environment and conserve natural resources by "minimizing the generation of hazardous waste and the land disposal of hazardous waste by encouraging process substitution, materials recovery, properly conducted recycling and reuse, and treatment." (Section 1003(a)(6)) Therefore, the Agency is considering a requirement that all banned wastes be treated wherever adequate treatment technology is available. A drawback to this alternative approach is that it would force waste managers to treat their waste even when they can demonstrate that continued land disposal at their respective site would not endanger human health and the environment. The Agency is requesting comments on this alternative approach, and the corresponding limitation on the eligibility of an interested person to petition the Agency to remove a ban on the land disposal of an untreated hazardous waste.

2. Performance Standard

a. *"(N)o migration . . . for as long as the wastes remain hazardous."* Under today's proposal, as noted above, the performance standard of "no migration . . . for as long as the wastes remain hazardous" can be met if the petitioner can demonstrate that, by the time the constituent reaches a point of potential human exposure, or a sensitive environment, it will be at a concentration level that does not threaten human health or the environment. (See unit III.D.6, for discussion of environmental effects.) It should be noted that this determination of non-hazardousness is generally not equivalent to a delisting determination. (See discussion at units III.D 2.b.(2) and III.D.2.c.) In order to make this demonstration, the petitioner may have to show that, as a result of the natural chemical and physical processes at the site, the hazardous constituents are immobilized, diluted, or degraded between the disposal unit and the point or points of potential exposure such that human health and the environment at any point of potential exposure is protected. In addition to the fate and transport element of the demonstration, the petitioner may have to incorporate an analysis of future and existing population in proximity of the site, and, in the case of an exceedance of the established RfD or a departure from 10^{-6} for a risk-specific dose, a demonstration that human health and the environment are protected.

b. *Point of potential exposure.* The point or points of potential human exposure will be determined on a case-by-case basis by the petitioner. There are several alternative approaches to defining the points. In addition, the points of potential exposure may differ depending upon whether migration via air, surface water, or ground water is being considered. The following discussion focuses primarily on migration of hazardous constituents in ground water and surface water, and only in regard to human exposure.

One possible approach is to define the point of exposure as the point at which the closest drinking water well (or surface water used for drinking water purposes) is located. This approach would ensure that any migrating hazardous constituents are at acceptable concentration levels by the time they reach the closest existing user. However, this approach does not control for the possible location of additional drinking water wells (or surface water uses) closer to the unit at some future time. Since the statutory standard appears to call for protection of human health over the long term, this approach does not seem to be acceptable.

A second approach, which is being proposed by the Agency is to designate as the exposure point the closest point or points at which a use of surface or ground water for human consumption could be located. Under this approach, the petitioner would identify an area extending from the limit of the disposal unit over which he or she can ensure long-term control of water resources. The petitioner would demonstrate that the controls in place would prevent human exposure to hazardous constituents in the ground or surface water within this area. The point or points of potential exposure would then be designated at the edge of this area of effective control, and the petitioner would be able to make use of the attenuative capacity of the surface or subsurface area between the edge of the disposal unit and the outer edge of the area of effective control in developing acceptable concentration levels. For this approach to be acceptable, the controls must be in place for as long as the hazardous constituents within the area of effective control remain at concentrations hazardous to anyone potentially exposed to such constituents. If the petitioner is unable to establish an area of effective control beyond the disposal unit, the point of potential human exposure would be presumed to be at the edge of the disposal unit.

The Agency is interested in comment on the kinds of controls that should be considered. Under the law of most States, is it possible to include a provision in a deed that will ensure that all subsequent owners are bound to observe the use controls imposed by the original owner? Would it be acceptable, or preferable, to require that use be limited through local zoning law? What about State controls?

The Agency is also requesting comment on a third approach for designating ground water exposure points. Under this approach, the potential exposure point would be assumed to be at the edge of the waste management boundary, unless the petitioner demonstrates that site-specific factors justify selection of a different point. Petitioners requesting an alternative point as the potential exposure point would be required to demonstrate that ground water use between the waste management boundary and the requested exposure point is highly unlikely. This approach is similar to the approach described previously. The principal difference is that this approach would allow consideration of non-legal parameters that influence ground water use, in addition to legally enforceable restrictions, when designating potential exposure points.

Examples of site-specific factors the Agency might consider include:

(1) Existing local ground water uses;

(2) Site proximity to existing ground water users;

(3) Expected persistence of ground water contaminants; and

(4) Likelihood of future ground water use, considering:

a. Background aquifer quality;

b. Potential aquifer yield;

c. Institutional controls on ground water withdrawal;

d. Availability of public drinking water distribution systems; and

e. Current and expected land use of adjacent properties.

Comments are requested on this alternative approach to designating potential exposure points. Interested parties are also invited to submit, for consideration, additional site-specific parameters that could be used to evaluate the likelihood of future ground water use and their views on any of the specific factors given above.

Another approach would be to consider the point of exposure to be the property boundary. However, EPA has rejected the proposition that RCRA's jurisdiction is limited to dangers occurring outside hazardous waste management facilities. (See for example, 45 FR 33184.) Accordingly, EPA does not propose to presume that the property boundary is the point of exposure, but will require that the petitioner justify the appropriate boundary based on a demonstration of effective control.

The Agency is considering similar options for defining the point of potential exposure to airborne hazardous constituents. The analysis of available options is complicated by the fact that it is much more difficult to control exposure to airborne constituents. The Agency would like to consider an approach, analogous to that outlined previously, under which the point of potential exposure would be coterminous with the area in which an owner or operator could ensure that there would be no exposure to hazardous constituents at unacceptable levels. However, the Agency believes that such an approach would, in fact, provide the owner or operator with little of the intended flexibility. Because it is difficult to limit exposure to airborne constituents, EPA expects that, in some cases, the point of potential exposure would be at the limits of the disposal unit. In other cases, however, the point of potential exposure could be established at the limits of a waste management area that is surrounded by security fences, controlled access gates, and warning signs. The petitioner must be able to demonstrate that such security measures are effective in preventing access by local residents or any employees that are not protected from airborne contaminants. EPA is requesting comments on whether other points of potential exposure to airborne emissions may be justified.

In determining potential exposure to airborne hazardous constituents, EPA does not propose to limit its examination to constituents posing harm when inhaled. Thus, in identifying the point of potential exposure, EPA might consider a situation in which airborne inorganic particulates are deposited in the soil in concentration that present a threat to human health through direct exposure (e.g., ingestion) or through contamination of underlying drinking water or adjacent surface water. EPA might also consider a situation in which the surface migration of volatile constituents causes harm to human health as a result of accumulation in buildings or other physical structures.

c. "*. . .[T]o a reasonable degree of certainty. . .*". The degree of certainty ascribed to the elements of the petition demonstration will be largely controlled by the waste- and site-specific factors and the analytical limitations of the methods employed to characterize those factors. The petition demonstration is a risk-based process that provides for a risk assessment of the waste- and site-specific scenario and the opportunity for exercising risk management decisions on a site-specific level.

The Agency will balance the importance of each element of a demonstration and its respective degree of uncertainty, while making a risk management decision on a petition. The major elements of the petition demonstration are:

(1) Exposure potential using fate and transport analyses.

(2) Existing and future populations surrounding a site.

(3) Toxicological data specific to the constituents at a site.

(4) Leachate concentration of hazardous constituents.

The Agency believes that sources of uncertainty for each element cannot be eliminated but can be reduced to a reasonable degree. The Agency further believes that it would not be possible to quantify a reasonable degree of certainty for all permutations of site-specific factors that are likely to occur in the petition process. The Agency also considers that the major sources of uncertainty are probably from those elements of the demonstration that relate to long-term predictions and are, by their nature, not quantifiable.

Although statistical analysis can be an appropriate technique for evaluating the quality of the technical data and for estimating the probability of the occurence of a significant series of events that influence potential migration, the Agency believes that the "reasonable degree of certainty" concept cannot be defined by a statistical procedure.

The Agency has, therefore, chosen to prescribe certain methods to be used by the petitioner to ensure reasonably high quality data and analyses, and, thereby, reduce uncertainty to a reasonable degree, rather than specifying that a statistical test be applied to the entire demonstration. The prescribed methods involve setting data quality objectives for data collection, analysis, and prediction. The testing and analysis techniques should be selected by the petitioner and approved by the Agency as appropriate for the site- and waste-specific scenario; i.e., the techniques should reasonably accurately measure appropriate waste properties, characterize atmospheric and hydrogeologic conditions in the field, reasonably determine waste and site interactions affecting the ultimate fate of the waste, and predict the most severe, long-term effects on the air and water resources resulting from the disposal of the subject waste. If the petitioner has made a reasonable effort to assemble high quality data and analyses, the Agency will consider the petition results to represent a "reasonable degree of certainty."

The protocol the Agency is developing for evaluating petition demonstrations will address the issue of certainty in a manner appropriate to the tiered approach discussed above. In essence, the tiered approach is designed to handle waste- and site-specific scenarios according to the degree of certainty that critical elements can be analyzed, and according to their importance in making a risk management decision. The second tier would be for waste and site scenarios where a greater degree of uncertainty would be acceptable given a generally favorable waste- and site-specific scenario. For waste- and site-specific scenarios where conditions appear to be marginal, a higher degree of certainty for the critical elements will be required.

An integral feature of the petition will be the development of quality control (QC) procedures tailored to the site- and waste-specific scenario. These procedures will be specified by the petitioner in a quality control plan and reviewed and approved by the Agency prior to submission of a petition to the Agency. For tier-two level petition demonstrations QA/QC requirements will be necessary only for the data used in the demonstration and for any fate and transport analysis that does not use the unaltered Screening/Treatment Standard models. For the tier-two level, sufficiently conservative assumptions may replace the need for QA/QC requirements that would normally be required for actual site-specific data used in the analysis.

For tier-three petition demonstrations, the Agency may perform a quality assurance (QA) audit of the petitioner's data collection and analytical procedures, on-site testing and measurement procedures, and computer modeling and statistical analysis procedures. The quality assurance audit may include review of laboratory methods, including duplicate analysis by an independent laboratory, site visits prior to and during on-site field sampling, independent air, ground-and surface-water monitoring, and independent modeling and testing of the computer code and modeling assumptions. The Agency believes that emphasis on the procedures used by the petitioner to collect and evaluate data and to perform simulation modeling is most critical in reducing uncertainty.

The Agency has chosen to require strict adherence to the quality control procedures as agreed upon by the Agency and petitioner as the most effective means of ensuring that the entire petition meets the reasonable degree of certainty test. A guidance manual will be available to aid the petitioner in meeting the QA/QC requirements. The Agency is seeking comments on the use of QA/QC procedures as described above, and on alternative approaches that should be considered. In light of the tiered approach to the petition demonstration process, the Agency will use a pre-petition conference with the Agency or State staff to discuss the general approach to be taken by the petitioner, and to agree upon the basic elements of the quality control plan and the petition itself, if the tier-three level of sophistication is required. If any data or information brought to light during this conference casts serious doubt on the likely success of the petition, the Agency or State staff will advise the petitioner not to proceed with the demonstration.

d. *Pathways of Migration.* In demonstrating that there will be no migration of hazardous constituents for as long as the wastes remain hazardous, the petitioner should account for the potential migration of hazardous constituents in all possible pathways, including but not limited to air, surface water, and ground water. Nothing in the statutory language or legislative history suggests that Congress intended a more limited demonstration. Accordingly, the Agency proposes that in order to demonstrate that a method of land disposal is protective of human health and the environment, the petitioner must provide an accounting of the ultimate fate of the hazardous constituents. The petitioner, therefore, may have to demonstrate that the hazardous constituent mass is degraded, diluted, or immobilized, and not merely transferred from one environmental medium to another. During the degration process, some hazardous constituents break down to form new hazardous constituents (*i.e.*, other constituents on Appendix VIII). If the degradation process produces additional hazardous constituents, EPA proposes to require that the applicant demonstrate that such degradation products also will not migrate to the point of exposure in concentrations that harm human health and the environment. Because of state-of-the-art limitations on the ability to detect the presence of many degradation byproducts that are not listed as hazardous constituents, the Agency does not propose to require such a demonstration for these constituents even though such constituents may theoretically have an effect on human health or the environment.

e. *Time Frames.* The statutory language prohibiting the migration of constituents "for as long as the waste remains hazardous" suggests not only a substantive standard (i.e., no migration in hazardous concentrations) but a time component as well. EPA interpret this provision to require the applicant to demonstrate that the hazardous constituents will not exceed acceptable concentration levels at all points of potential exposure as long as the constituents retain the potential to harm human health or the environment. In practical terms, this means that EPA will not only assess the potential for migration in unacceptable concentrations during the active life of the facility, but will also assess the migration potential for what may be an extensive period of time after closure.

The length of the assessment period may vary depending upon the pathway of migration. For example, the exposure posed by airborne constituents may be relatively short-lived if volatilization occurs only during the active life of the unit. On the other hand, the exposure due to volatilization may be long term if, for example, constituents migrate through the subsurface and accumulate in buildings. The Agency believes that the time period to be covered by the demonstration can reasonably be determined by modeling contaminant migration in the air, ground water, and surface water. As long as the model results indicate that there is a possibility that the maximum allowable concentration of any hazardous constituent could be exceeded at any points of potential exposure, a complete demonstration has not been made. When the model results indicate that concentrations have reached a level that does not exceed the maximum allowable level, and have begun an irrevocable decline at all points of potential exposure, then the demonstration has considered a sufficient period of time. In addition, the Agency believes that the petitioner should make a reasonable estimate of the maximum quantity of the subject waste to be placed in the disposal unit over the entire life of the unit, rather than assume an infinite source of hazardous constituents.

f. *Consideration of Artificial Barriers.* The legislative history provides that in making a petition demonstration, "the applicant must sustain the burden of . . . [demonstrating no migration as long as the wastes remain hazardous] . . . without the use of artificial barriers such as liners." It goes on to note that "[a]rtificial barriers cannot provide the assurances necessary to meet the standard." (S. Rep. No. 98–284 at page 15.) EPA interprets the above-cited language to reflect congressional intent to foreclose EPA from granting a petition on the assumption that the "no migration" standard has been met because a liner is in place. In light of the fact that all liners eventually leak, such an assumption would clearly fail to provide the "assurances" that Congress is seeking. EPA does not believe that Congress intended to preclude a more realistic consideration of liner performance in assessing when and if migration might be expected to occur. Indeed, one could argue that, in some cases by failing to consider the effect of existing containment mechanisms on constituent migration, EPA would increase the uncertainty of the petition analysis, thereby failing to achieve those "assurances" that Congress is seeking. If EPA were to disregard the effect of existing containment mechanisms altogether, the Agency would be obligated to make numerous additional assumptions about the migration of constituents in a hypothetical setting rather than under existing conditions. In addition, it makes little sense to allow generic consideration of liner effectiveness in identifying screening levels at which wastes may be land disposed under section 3004(m) (see discussion at Unit III. A.l.b.), but to preclude a much more accurate, site-specific consideration of liner performance in the petition process.

Thus, the Agency believes that some reasonable projection of failure rates for liners to the extent that liners or other engineered systems may be appropriate in some petition demonstations. However, it is expected that consideration of liners will be critical to the outcome of petition deliberations only in limited cases. At the tier-two or three levels of sophistication, the petitioner may rely on sufficiently conservative assumptions as to the efficacy of liners or other engineered systems, or, may employ specific engineered component performance data. In the event of a petitioner using specific performance data, the Agency will require that appropriate QA/QC procedures are employed to obtain such data.

A petitioner may be able to demonstrate that waste will be transformed to a non-hazardous or less hazardous state while the containment mechanism is still effective, so that upon a breach of the system there would be no migration of hazardous constituents in unacceptable concentrations. In such a case, consideration of the liner would have a direct bearing on the petition decision. However, because the land disposal restrictions program is aimed at preventing long-term as well as short-term harm to human health and the environment, a demonstration that harmful migration would merely be delayed due to the existence of a liner would not be the basis for granting a petition.

EPA solicits comment on appropriate assumptions to be made concerning liner failure. What factors should be considered in assessing when the liner will fail? To what extent are these factors site-specific? Are there any generic assumptions about liner failure that could and should be drawn? What other artificial barriers, if any, should be considered in the petition process? What is an acceptable level of certainty that could realistically be obtained in an analysis of the performance of man-made systems?

g. *Environmental Effects.* In addition to demonstrating that there will be no harmful effects on human health, the petitioner is required to demonstrate that there are no harmful effects on any aquatic biota, wildlife, estuaries, vegetation, or protected lands. This demonstration may be met purely on the basis of fate and transport analysis that shows that concentrations of hazardous constituents would be at or below the established levels that are protective of the environment at the point or points of exposure. The Agency proposes that, at a minimum, the following types of species or environmentally sensitive areas be considered in any petition demonstration: endangered or threatened species and their habitats, wetlands, wilderness areas, wildlife refuges, coastal areas, and any other areas of potential ecological or economic significance. The Agency is proposing to require that the petitioner demonstrate that there will be no significant effect on any such species or sensitive areas by demonstrating that there will be no exposure of hazardous constituents to the species or environment of concern or that whatever exposure may occur will have no significant effect. Additionally, the Agency proposes to require that the petitioner demonstrate that ambient surface water concentrations or hazardous constituents for which a fresh-water, aquatic-life criterion has been established will not be exceeded. Where no such aquatic-life criteria exist, it may be necessary that the petitioner estimate the likely effects on the appropriate test species (e.g., fathead minnows of daphnia) by reference to similar chemicals for which aquatic toxicity data do exist. The petitioner may determine the significance of exposure by the use of qualitative structure activity relationships, and infer the likely effects on indigenous aquatic species in surface water affected by the disposal unit. The petitioner may seek the opinion of a qualified aquatic biologist to support any such inferences.

The Agency requests comments on the type of information necessary to demonstate no harmful effects on endangered species or sensitive ecosystems. What environmental factors should be considered? What level of exposure of specific hazardous constituents may be harmful to protected species or ecosystems, such as wetlands or wildlife refuges?

h. "*[H]azardous constituents.*" The statute provides that there shall be no migration of hazardous constituents from the unit for as long as the wastes remain hazardous. The term "hazardous constituent" is defined by EPA's existing regulations to encompass all constituents identified in Appendix VIII of 40 CFR Part 261. It is presumed that Congress was aware of the meaning given to this term by the Agency and intended that the term be given like construction in the context of the petition demonstration.

The Agency will require that the petitioner perform an analysis of the subject waste for those Appendix VIII chemical constituents that are reasonably expected to be present, to determine whether the screening concentration level was met for each constituent. The petitioner could certify, however, that certain Appendix VIII constituents are not present in the waste, due to the fact that raw materials containing such chemicals are not used in the manufacturing process that produced the waste. It would be incumbent on the petitioner, however, to notify the Agency promptly that, due to a change in the manufacturing process, chemical constituents that were previously certified as not being present are now expected to be found in the waste.

The screening level models establish leachate concentration levels for all Appendix VIII constituents that are generally considered to be protective of human health and the environment. The petitioner should demonstrate that the petition performance standard is met for those Appendix VIII constituents that did not meet the screening concentration levels. Under the proposed approach, it is not necessary to demonstrate that the petition performance standard is met for other Appendix VIII constituents that already meet the screening/treatment standards. As noted in Unit III. G.2.d, EPA believes that Congress intended the petition demonstration to extend to all media. Accordingly, the Agency is proposing to require that the petitioner consider any hazardous constituents that did not meet the screening concentration levels in examining surface water, ground water, soil, and air pathways of migration.

The Agency seeks comments on any reasonable approach for limiting the number of hazardous constituents that would require consideration in any petition demonstration. The petitioner may use a method for identifying indicator chemicals in the waste whose chemical and physical characteristics are similar to other chemicals in the waste. The ultimate fate of these indicator chemicals may be used to determine the ultimate fate of other chemicals, rather than analyze each chemical constituent separately, provided that the indicator selection approach is scientifically valid. One method for identifying indicator chemicals is described in the *Draft Superfund Public Health Evaluation Manual,* dated October 1, 1985. The Agency seeks comments on the applicability of this method, and on any scientific research that would support the use of specified indicator chemicals.

Since the statute sets a series of effective dates for restricting wastes from land disposal that extend to May, 1990, it is conceivable that a particular waste may contain some hazardous constituents for which a screening/treatment standard has been established at an early effective date (e.g., November, 1986) and other hazardous constituents that will be subject to separate screening/treatment standards at a later restriction deadline (e.g., May, 1990). When this situation arises, the Agency may choose one of several alternative approaches.

The first approach would only require the petitioner to demonstrate that the performance standard is met for those Appendix VIII constituents that did not meet the screening/treatment standards that are currently in effect. Other Appendix VIII constituents for which no screening/treatment standard was currently in effect, due to the later effective dates established in the statute or in the schedule promulgated under section 3004(g), would not be considered by the petitioner until the effective dates for those constituents are reached. At that time, assuming that the petition was approved for the constituents having an earlier effective date, the waste may be restricted again, due to the presence of other hazardous constituents. The petitioner would, therefore, be required to re-submit the petition and demonstrate that the performance standard is met for any additional Appendix VIII constituents that did not meet the established screening/treatment standards.

Another approach would require the petitioner to demonstrate that the performance standard is met for any additional Appendix VIII constituents for which no screening/treatment standards have been established, in addition to demonstrating that the performance standard is met for those Appendix VIII constituents that did not meet the established screening treatment standards. Under this approach, the petitioner may be required to include in his petition demonstration additional constituents that may eventually meet the screening/treatment standards. But if the petition is approved, the waste can be managed in the land disposal unit without interruption at some later date due to the need to re-submit the entire petition for approval.

A third approach would not require the petitioner to demonstrate that the performance standard is met for any additional Appendix VIII constituents, but would allow the petitioner to do so at his or her option.

The Agency is seeking comments on each of the above approaches. The Agency would prefer to select an approach that minimizes the burden on the petitioner and on the Agency but, at the same time, leads to unambiguous decisions regarding the land disposal of previously restricted hazardous wastes. Comments are requested on how well each of the above approaches meets these stated goals.

In the case of certain characteristic wastes (i.e., wastes that are hazardous due to ignitability, corrosivity, or reactivity) with which no additional hazardous constituents are associated, a concentration level is not a valid criterion for determining whether the performance standard has been met. Therefore, the petitioner is required to demonstrate that the waste has undergone chemical or physical changes, such that when the waste eventually migrates it no longer exhibits the characteristics that originally caused the wastes to be classified as hazardous, at the point(s) of potential exposure. This demonstration, in effect, would result in the declassification of the waste as hazardous, as defined at 40 CFR 261.3. The petitioner would also be required to demonstrate that no additional hazardous constituents were present in the original wastes, or that such hazardous constituents do not result in a violation of the standard as described previously.

i. "*[D]isposal unit or injection zone*". The statute requires that there be a showing of "no migration . . . from the disposal unit or injection zone for as long as the wastes remain hazardous". The legislative history makes clear that the term "injection zone" is to be defined as prescribed in existing EPA regulations at 40 CFR 146.3 (S. Rep. No. 98–284 at page 16). Thus, the term refers to a geological formation and is not to be construed in terms of surface property ownership (S. Rep. No. 98–284 at page 15). The term "disposal unit" is not expressly defined in the statute or legislative history applicable to section 3004 (d), (e), and (g)(5). However, it is presumed that Congress is aware of the usage given to this term by EPA (see e.g., 47 FR 32289), and intended that the term be given like meaning in the context of these sections. Indeed, in legislative history addressing another section of the new law, the House Committee on Energy and Commerce explicitly provides that the term "unit" be defined as consistent with the Agency's existing use of the term and "as further defined by EPA in the future" (H. Rep. Report No. 98–198, Part 1, at page 60). Unless there is an expressed indication of contrary congressional intent, a term is given consistent meaning throughout a statute. Accordingly, for purposes of the petition process, the term "unit" will be defined with reference to the agency's present use of the term. Thus, a unit is defined as a "contiguous area of land on or in which waste is placed, or, the largest area in which there is a significant likelihood of mixing waste constituents in the same area." Thus the unit would include the area contained within the engineered components and any excavated areas of the surface or subsurface that support the engineered components. An individual surface impoundment, waste pile, or land treatment unit is a "unit" for purposes of this discussion. In the case of landfills that are designed as a series of separately lined trenches, each individual trench is a separate unit. For the purpose of the land disposal restrictions program, the Agency also proposes to characterize salt dome formations, salt bed formations and underground mines and caves as units.

The petitioner must identify the boundary of any unit or units that may be involved in the management of the banned waste that is the subject of the petition. This boundary becomes the compliance point, for the purpose of demonstrating that human health and the environment will be protected. In the absence of an acceptable demonstration of effective long-term control of an area beyond the boundary of the disposal unit, this boundary is also the point of potential human exposure.

3. Applicability of the Performance Standard

a. *Landfills, surface impoundments, and waste piles.* Land disposal units that are located at the land's surface, contain such engineered components as a liner system and a leachate collection and removal system, and are often closed by constructing a cover system, include landfills, surface impoundments, and waste piles. Due to their similar characteristics, these types of units will be expected to make similar types of petition demonstrations. For the purpose of making this demonstration, the limits of the disposal unit are established at the edge of the liner or excavated liner foundation at all landfills, surface impoundments, and waste piles; at the open face of an active landfill cell; at the surface of an active surface impoundment; at the surface of an active waste pile; and at the surface of the cover of a closed landfill cell, surface impoundment, or waste pile.

b. *Land treatment units.* Land treatment units do not typically have liners or leachate collection and removal systems. For the purpose of this demonstration, therefore, the limits of the disposal unit are the lateral and vertical extents of the treatment zone, as established in the permit in compliance with 40 CFR 264.271(b). With regard to air emissions, the surface of the treatment zone is considered to be the limits of the disposal unit.

The Agency believes that much of the waste and site testing, analyses of degradation, and immobilization of constituents, that is already required for a land treatment permit should satisfy the testing and analysis requirements of a petition demonstration. Rather than requiring duplication of these tests, the Agency would allow the use of the same testing and analytical results for the permit application and a petition demonstration, as long as the requirements of both are met. For a petition demonstration, this would include the air and surface water pathways and a consideration of the likely long-term effects of migration (i.e., beyond the operating period of the land treatment unit). If the petitioner failed to provide the minimum information required under 40 CFR Part 270 relevant to the land treatment demonstration, the petition would be subject to rejection.

c. *Underground injection wells.* The approach for petitioning for removing a ban on underground injection of hazardous waste will be discussed in a separate Notice of Proposed Rulemaking to be published in the **Federal Register**, regarding a separate rulemaking on hazardous wastes that are managed in underground injection wells (section 3004(f) and 3004(g)).

d. *Other methods of land disposal.* In addition to the above methods of land disposal, section 3004(k) defines land disposal as including any salt dome formation, salt bed formation, underground mine, or cave. Other types of waste management practices (e.g., open detonation units) may also be included in the section 3004(k) definition of land disposal. (See Unit I.C.1.) Currently, the Agency has no specific guidelines for demonstrating no migration with respect to these or other forms of land disposal. A petitioner may attempt to demonstrate no migration of hazardous constituents in unacceptable concentrations by applying the general concepts discussed in this proposed rulemaking in a reasonably defensible manner. The Agency will review such petitions in a manner consistent with any other petitions received. Specific criteria for determining whether the petition standard will be achieved would be developed on a case-by-case basis.

The Agency is seeking comments on the applicability of the performance standard to each of the types of land disposal discussed in this unit.

Specifically, the Agency seeks comments on the comprehensiveness and consistency of its approach to determining that the petition standard is achieved with each of the various methods of land disposal.

4. Demonstration Components

a. *Waste analysis.* The petitioner should perform appropriate tests of the subject waste to characterize fully the waste's chemical and physical characteristics. Sampling of the waste for testing and analysis must be frequent enough to account for the variations over time of the waste's characteristics. Appropriate sampling frequencies and techniques and acceptable statistical procedures should be developed on a case-by-case basis, in consultation with the Agency. The petition demonstration will, therefore, be based upon a waste with particular chemical and physical characteristics, with the corresponding degrees of variation. If the Agency approves a petition demonstration, such approval will apply strictly to a waste with these particular characteristics. If, over time, a particular waste stream changes substantially so that it no longer exhibits the particular chemical and physical characteristics originally specified in the petition, the petitioner must notify the Agency or authorized State of the change, and the demonstration must be resubmitted and reevaluated. Until such reevaluation occurs, the waste is not permitted to be placed in the land disposal unit.

The Agency may require periodic monitoring and analysis of the waste to determine if significant changes in the waste characteristics have occurred. Alternatively, the Agency may require that the petitioner notify the Agency whenever a change in the waste characteristics has occurred or is expected to have occurred, rather than regular monitoring, analysis, and reporting requirements. The Agency is considering various means of assuring that the waste characteristics have not changed dramatically over time, thereby invalidating the petition demonstration, and is seeking comments on the most effective approach.

In addition to information on waste characteristics, the petitioner must estimate volumes of the subject waste to be disposed, on a yearly basis, for as long as the land disposal unit is capable of accepting wastes, since the volume of waste ultimately disposed is a crucial factor in the petition demonstration. The petitioner can rely upon historical data and estimate changes in volume in the future, based on industrial activity or advances in technology. The Agency will accept a reasonable projection of waste volume but will review, following the approval of any petition demonstration, information on actual volumes of the subject waste accepted at the disposal unit during the course of site inspections. If actual volumes exceed the projected volumes so as to call into question the results of the petition demonstration previously approved, the Agency will reevaluate the demonstration and may require that the petition be resubmitted. If there is no valid basis for projecting the annual volumes of the subject waste to be disposed throughout the active life of the disposal unit, the petitioner should assume that the total volume is equal to the design capacity of the disposal unit, and that the annual volume is constant over the expected life of the disposal unit.

b. *Human Exposure and Risk Assessment.* There are documented scientific research data available to verify that certain organic constituents are degraded to their harmless components due to such processes as photolysis in the atmosphere, and hydrolysis and biodegradation in the subsurface. Inorganic and non-degradable organic constituents can be immobilized due to chemical or physical adsorption to soil particles in the subsurface, and can be diluted due to the dispersive effects of air movement and ground water and surface water flow. The petitioner, depending on the waste- and site-specific scenario, may have to demonstrate that the degradation, dilution, and immobilization processes are effective for the subject waste, under the environmental conditions as they exist at the disposal unit site.

Concentration levels at the point or points of potential exposure that are protective of human health must be determined for noncarcinogenic constituents and for carcinogenic constituents of the subject waste. The sophistication of the analysis to show the degree of exposure will depend upon the site- and waste-specific scenario.

The Agency is proposing that the Reference Dose (RfD) (See Unit III.A regarding the establishment of screening/treatment standards) be adopted as the screening level for noncarcinogens and that a screening level concentration based on a risk-specific dose be adopted for carcinogens. Because certain site-specific factors may impact the degree to which an RfD could be acceptably exceeded and may impact the selection of the risk-specific dose, the petitioner may be required to perform an analysis of the size of the potentially exposed population, both current and future, and various other factors related to the assessment and management of risk. The results of this analysis would be used to determine a level that is protective of human health and the environment. (See Unit III.A.1.b, for a more detailed discussion of the screening levels.) The petitioner must demonstrate that hazardous constituents will not migrate from a disposal unit in concentrations that will cause an RfD or risk-specific dose to be exceeded at any point of potential human exposure. In order to determine whether an unacceptable concentration of hazardous constituents will exist at the edge of the disposal unit, the petitioner must calculate the maximum concentration in the air, ground water, surface water, and soil, and compare it with the RfD or risk-specific dose at the point of potential exposure, taking into consideration the attenuation derived from natural processes such as photolysis, hydrolysis, biodegradation, and adsorption in the subsurface, surface, and atmosphere, and, in some cases, taking into consideration the size and nature of the potentially exposed population. Again, the sophistication and scope of the analysis of these critical elements will depend upon the waste- and site-specific scenario.

For noncarcinogenic contaminants, predicted concentration levels at or below the RfD will be considered protective of human health. Concentration levels above the RfD may also be considered protective if the petitioner can demonstrate that such concentrations are not expected to cause adverse health effects. Such a demonstration by the petitioner, and its subsequent review and evaluation, will require the exercise of considerable professional judgment by qualified toxicologists. The petition process will only address unique site-specific factors that justify exceeding an established RfD. Challenges to the established RfD that are not based on site-specific factors must be reviewed using established Agency protocol.

The Agency proposes to use the following criteria for determining whether or not a petitioner may exceed the established RfD for a noncarcinogenic constituent:

(A) Exposure Criteria

(i) Other potential or actual sources of exposure to the same or similar constituents;

(ii) The level and type of uncertainty inherent in the models used to predict potential exposure to the surrounding population;

(iii) The nature of the potentially exposed population.

(B) Toxicological Criteria

(i) The slope or slopes of the dose-response curves for the health effects attributable to a threshold constituent;

(ii) The frequency and magnitude of potential exposure to a threshold constituent.

The Agency expects that the petitioner will meet with the petition reviewer (EPA or the authorized State) during the pre-petition conference to discuss the specific demonstration necessary to support a concentration in excess of the established RfD, and to discuss the above criteria that will be used in reviewing the demonstration.

In determining a level for any carcinogenic constituents that will not present a threat to human health, the Agency will consider the following criteria:

(A) Exposure Criteria

(i) Other potential or actual sources of exposure to the same or similar constituents;

(ii) The level and type of uncertainty inherent in the models used to predict potential exposure to the surrounding population;

(iii) The potential current and future risk to individuals from the activities of the disposal unit;

(iv) The size and nature of the potentially exposed population.

(B) Toxicological Criterion

(i) The level and type of uncertainty inherent in the data used to estimate health risk.

Consistent with decisions that the Agency has made in the past, the maximum exposed individual (MEI) risk level for each petition will be set to correspond to a statistical lifetime risk in the range of 10^{-4} to 10^{-7} using 10^{-6} as a point of departure. This is equivalent to preventing the person most exposed to the hazardous constituent of concern from having more than a 1 in 10,000 to a 1 in 10,000,000 chance of developing cancer. Within the range of 10^{-4} to 10^{-7}, the actual level chosen for each petition will depend upon the analysis provided by the petitioner on the size of the aggregate potentially exposed population, considering the period of time that the wastes remain hazardous.

The Agency will thoroughly evaluate the strength of the evidence of carcinogenicity, the basis of the petitioner's exposure assessment, and other site-specific factors that may affect aggregate risk. Where the evidence of carcinogenicity is weak, where extremely conservative exposure assumptions have been made, and where the predicted exposure assessment has been completed with a high degree of confidence, the Agency would probably not require a reduction in risk beyond the higher end of the range (i.e., 10^{-4} to 10^{-5}). In other cases where the aggregate exposed population is relatively large, the evidence of carcinogenicity is strong, or the predicted exposure assessment is relatively uncertain, the Agency would not allow an MEI risk level greater than 10^{-6} or 10^{-7}. With a larger population being exposed, there is a greater chance that an unacceptable number of incidents of cancer would actually occur in the population. With a larger population the Agency would be more likely to adopt a more conservative risk level, taking into account other factors, such as the assumptions used in the models that estimate risk levels, since an incorrect decision would have more severe consequences.

In addition to using population as a factor in determining how conservative the Agency may be in granting petitions, the Agency will also consider future events/processes such as earthquakes, floods etc., as they may modify exposure. Exposure scenarios are likely to change over time with major differences occurring when the unit is operating compared to the post closure care period. Thus, the Agency will require the consideration of events and processes that are potentially capable of modifying exposure.

Where these events and processes and their effects are identified with a reasonable degree of certainty, the Agency may be able to be more flexible in making risk management decisions regarding petitions. If these events or processes cannot be identified with a reasonable degree of certainty the Agency will tend to take a more conservative approach to making risk management decisions.

The Agency believes that this approach provides flexibility to approve or deny petitions based on the magnitude of potential current or future human health effects. Rather than establish a single MEI risk level to be applied to all petitions, the proposed approach allows the petitioner to include all factors relevant to potential risk to be examined in a local, site-specific context, where the best decision can be made.

Although this approach involves a fairly sophisticated analysis by the petitioner and extensive review by the petition reviewer, the Agency believes that such site-specific decisions must be made on the basis of a thorough analysis of the effects on the local population. The Agency intends to reject petitions where the probability of expected cancer incidence from the continued land disposal of a banned waste would be significant. Where it can be demonstrated, to a reasonable degree of certainty, that continued land disposal is a safe management practice, the Agency will approve the petition.

The Agency is considering an alternative approach for including total population in the decision to approve or deny a petition. This alternative approach would involve an analysis of the effects on the MEI using the same criteria (i.e., the risk-specific dose and the RfD) used for setting the screening concentration levels, rather than allowing a site-specific determination based on the factors previously discussed. The analysis of the potential aggregate exposed population would not be used to determine how much of an excess concentration above the RfD is allowable or to set an MEI risk level.

The alternative approach would, however, allow population information to be used to determine the acceptable level of certainty to be attained by the petitioner in all data and analyses included in the overall demonstration. To meet the "reasonable degree of certainty" test required by the statute, the Agency is requiring that the petitioner prepare a comprehensive quality control plan setting out data quality objectives to be achieved in all waste and environmental testing and measurements, and in modeling analyses. Under this alternative approach, the Agency would allow less stringent quality control procedures and, therefore, a higher degree of uncertainty, where the current and expected future population size is relatively small, since the consequences of an incorrect decision would be less severe than in an area where population size is relatively large. Less stringent quality control procedures would reduce the intensity of the data requirements, reduce the thoroughness of the analysis, and reduce the degree to which laboratory data and model results must be validated by comparison to field test data. Where population size is relatively large, the quality control procedures would become more stringent to reduce the degree of uncertainty.

The critical feature of this approach is allowing the size of the potentially exposed population to have a direct impact on the petition demonstration, in terms of the level of effort required on the part of the petitioner and the likelihood of the petition being approved, without compromising on the level of risk to which any individual may be subjected. The petitioner would still be responsible for determining the effect on the MEI, using the same human health criteria used in determining the nationally applicable screening concentration levels. Population information would be used to set the acceptable level of certainty to be attained in the complete development of the petition demonstration.

The Agency requests comments on the proposed approach and on the alternative approach. The Agency has some concern that requiring any population analysis may result in delays in preparing and reviewing petitions, due to the effect involved in collecting and analyzing information pertaining to various aspects of population analysis. Therefore, the Agency also requests comments on an approach that would not require any population analysis. Under such an approach, the decision on any petition would be based on the predicted effects on the MEI, although the petitioner could supply information on aggregate population effects, at his discretion.

c. *Site characterization.* The petitioner must perform a characterization of the site of the disposal unit to establish actual field conditions in the atmosphere, at the surface, and in the subsurface. The depth and scope of the characterization will depend on the waste- and site-specific scenario. Much of the information may already have been collected and analyzed to fulfill the other information requirements of Part 264, Part 270, or applicable State or local requirements. Site-specific data may be among the most important factors in the petition analysis, since the ultimate fate of any hazardous constituents of the subject waste is determined by the natural assimilative processes affecting degradation and immobilization. The Agency, therefore, believes that accuracy and precision in the measurement and analysis of all environmental parameters are extremely crucial to a successful petition demonstration. The Agency will provide guidance to the petitioner on the types of data that must be presented and the required analyses. Test methods to be used, frequency and types of sampling and analysis, and data quality objectives must be submitted to the Agency in a quality control plan. The amount of data and the extensiveness of the analysis will be determined on a case-by-case basis, depending on the complexity and nature of the entire demonstration. At a minimum, however, the petitioner is expected to provide all information that is relevant to the demonstration from the Part B permit application (40 CFR Part 270). Failure to provide the relevant minimum information required for establishing the Subpart F ground water monitoring program would constitute justification for rejection of the petition. As additional site characterization information requirements are included in Part 270, related to other environmental media such as air and surface water, this additional information will also be required of the petitioner.

d. *Evaluation of performance of engineered systems.* The petitioner should consider the design, operation, maintenance, and expected performance of the engineered systems of the disposal unit to the extent that such systems affect the quantity, or quality of the hazardous constituents that may be released into the environment. The petitioner should have prepared and analyzed most of the required information in conjunction with preparing a RCRA Part B permit application. The petitioner may use this permit information as a starting point for estimating the eventual failure mechanisms and resulting release of hazardous constituents.

The petitioner may be able to demonstrate that the hazardous constituents undergo chemical or physical transformation processes within the disposal unit prior to failure of any liner, cover, or other engineered components so that the hazardous constituents that migrate from the unit are not at hazardous concentrations, or so that the material that eventually migrates into the atmosphere or subsurface no longer contains any hazardous constituents or any other characteristics that may have caused the waste to be hazardous. In doing so, however, the petitioner would be required to identify specific chemical and physical processes (e.g., biodegradation and hydrolysis) that result in a permanent transformation of the waste well in advance of the end of the expected performance life of the engineered components. Appropriate testing is required to demonstrate that the specified chemical and physical processes will occur, and that any reaction byproducts that may also be hazardous are identified and quantified. Because little technical data are available on the actual degradation and immobilization of hazardous wastes, or on the long-term performance of engineered components, the Agency will evaluate such a demonstration by using conservative assumptions regarding the performance of the engineered systems and the accuracy and precision of the analytical methods used in the demonstration.

5. Request for Comments

The Agency is seeking comments on the types of waste and site situations that are most likely to meet the performance standard, and is seeking data on the various technical aspects of such a demonstration. Specifically, the Agency is interested in information on:

a. What types of wastes may meet the standard by rapid degradation or immobilization in a land disposal unit environment?

b. What natural processes in the atmosphere, surface and subsurface provide long-term control of certain waste constitutents? Can results of field testing, and laboratory studies applicable to field situations, with specific wastes be made available to the Agency?

Other comments are sought on various technical matters related to the petition demonstration. Specifically, comments are requested on:

a. Specific transformation and immobilization rate data for hazardous constituents under specific environmental conditions;

b. use of a dispersivity factor in ground water transport models and models for other media;

c. Criteria for evaluating the effect of engineered components on the ultimate fate of hazardous constituents;

d. Criteria for evaluating the consequences of floods, earthquakes, or other natural and potentially significant phenomena;

f. Criteria for model validation.

H. Restrictions on the Storage of Waste That is Prohibited From Land Disposal

Pursuant to section 3004(j) of RCRA, any waste that is prohibited from one or more methods of land disposal is also prohibited from storage, unless the storage is solely to accumulate sufficient quantities of the waste to allow for proper recovery; treatment, or disposal. The Agency does not interpret this provision as applying to wastes that have been treated in accordance with treatment standards under section 3004(m), because under the language of section 3004(m)(2) such wastes are not prohibited from land disposal. In addition, the Agency does not interpret this provision as applying to wastes and units that have been the subject of a successful petition demonstration. However, such wastes may be stored only in a unit that is covered by a RCRA permit or, is under interim status, and is covered by the petition.

Since the statutory restrictions on land disposal under subsections 3004 (d), (e) and (g) apply to placement in land-based units incuding land-based units identified as storage units (e.g., storage surface impoundments and waste piles), the Agency interprets the term storage, as used in section 3004(j), to go beyond the restrictions in subsections 3004 (d), (e) and (g). Therefore, the Agency interprets section 3005(j) to apply to storage that does not constitute land disposal such as storage in tanks and containers.

The legislative history indicates that Congress' concern in enacting this provision was to foreclose the possibility of using long-term storage as a means of avoiding a land disposal prohibition. (S. Rep. No. 98-284, 98th Cong., 1st Sess. 18 (1983).) However, in making the restriction conditional, Congress did recognize that some amount of legitimate storage is necessary prior to final management.

EPA is proposing, under § 268.50, that generators be allowed to accumulate prohibited wastes on-site for up to 90 days. EPA has already determined that this is an appropriate period of time to allow generators to accumulate wastes on-site without a permit prior to further management (40 CFR 262.34). This period was selected because the Agency felt that it would allow a reasonable period for accumulation prior to further management without interfering with a generator's production processes, and because the Agency determined that most wastes were removed from the site of generation within 90 days, as published in the **Federal Register** of February 26, 1980 (45 FR 12730) and January 11, 1982 (47 FR 1248).

The Agency also interprets the statutory accumulation times of 180 or 270 days for small quantity generators [12] (section 3001(d)(6)) as representing the allowable time period for small quantity generators to accumulate a dufficient quantity of wastes to facilitate proper treatment, recovery, or disposal. The legislative history accompanying the small quntity generator provision states that "the longer storage period . . . will allow the [small quantity] generator to consolidate wastes into large loads for shipment off the premises." (S. Rep. No. 98-284, 98th Cong., 1st Sess. 10 (1983).) EPA believes that Congress, in light of the quntities of wastes generated by small quantity generators and the fact that many of them are small businesses, recognized the need for a longer accumulation time.

The Agency has codified these time periods for generators in todays' proposed rules by referencing § 262.34. This was done based on the assumption that the longer time frames for accumulation by small quantity generators will be promulgated as an amendment to § 262.34 when the rules proposed for small quantity generators are issued as final. If this is not the case, then the reference will be change accordingly.

While the Agency believes that these time periods provide a reasonable accumulation time for most generators, it is concerned that a longer time may, in some cases, be necessary to accumulate sufficient quantities to facilitate proper recovery, treatment, or disposal. The Agency solicits comments on the appropriate time limits for storage of prohibited wastes by generators to accumulate sufficient quantities to facilitate proper recovery, treatment, or disposal. Specifically, are the existing accumulation times sufficient or should procedures be developed for allowing longer periods on a case-by-case basis?

The Agency does not interpret the statutory restriction on the storage of prohibited wastes as overriding the satellite accumulation rule contained in 40 CFR 262.34(c). That rule allows generators to accumulate up to 55 gallons of hazardous waste or 1 quart of acutely hazardous waste in a container, at or near the point of generation, without a permit, interim status, or compliance with the 90-day accumulation rule. The purpose of satellite accumulation is to allow the accumulation of certain quantities necessary to facilitate transportation, further treatment, or disposal and, thus, such accumulation falls under the section 3004(j) exemption.

The Agency believes that transporters should be allowed to hold prohibited wastes at transfer facilities for some minimum period of time to allow for activities incidental to normal transporter practices. These activities may include the consolidation of wastes into larger units or the transfer of wastes to different vehicles for redirecting or rerouting. The Agency is proposing, under § 268.50, that transporters be allowed to hold such wastes for up to 10 days.

The Agency realizes that due to operational difficulties, repairs and maintenance at treatment, storage, and disposal facilities, it may be necessary for a treatment or recovery process to shut down temporarily. In addition, back-ups may occur at treatment or recovery facilities while wastes are being held for treatment or recovery. The Agency does not believe that it was Congress' intent to ban storage for short periods due to these occurrences.

The Agency does not, however, have data on the frequency of such occurrences of their usual duration and is therefore unable to quantify these time periods. The Agency is proposing 90 days as the maximum time limit on permissible storage at waste management facilities under § 268.50 and is seeking comments as to whether or not this duration is appropriate.

Another approach to the storage restriction for both generators and owners or operators of waste management facilities is not to specify a time limit but rather to incorporate the statutory language directly into the regulation. Because no specific limit would be specified, this approach would be difficult to enforce and and would fail to provide the regulated community with a clear indication of its responsibilities.

The Agency interprets the statute as not applying the restriction on storage of prohibited wastes to successful petitioners under section 3004 (d), (e), and (g) and successful applicants for a case-bay-case extension. The applicant or petitioner must, however, store his waste according to the applicable requirements of 40 CFR Parts 262, 264, and 265. However, the Agency does interpret this provision as prohibiting storage (other than storage necessary to generate sufficient quantities to facilitate proper treatment, recovery, or disposal) pending the Agency's determination on a petition submitted under section 3004 (d), (e), or (g). In addition, the Agency believes that this provision does prohibit such storage of a waste after the effective date of a ban pending an Agency determination on an application for a case-by-case effective date extension.

IV. Unit-Specific Considerations

Land treatment and deep well injection are significantly different from other methods of land disposal of hazardous waste from both technical and regulatory perspectives. The Agency believes that the unique aspects of these technologies should be considered in developing regulations for these land disposal methods under section 3004 (d), (e), (f), and (g) of RCRA.

This unit of the preamble summarizes briefly the unique technical and regulatory aspects of land treatment, outlines the Agency's thinking to date on how to address this method of land disposal, and solicits comments and

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[12] See the proposed rule for small quantity generators published in the Federal Register of August 1, 1985 (50 FR 31278) for an explanation of the applicability of these accumulation times.

information that would be useful in fulfilling the relevant statutory requirements.

The Agency will address disposal of hazardous waste into deep injection wells at a later date in accordance with the deadlines established in section 3004 (f) and (g) of RCRA. Therefore, under § 268.1 hazardous waste disposal in injection wells is exempted from the regulations being proposed today.

A. Land Treatment

1. Introduction

Under section 3004(k) of RCRA, land disposal of hazardous waste is defined to include ". . . any placement of such hazardous waste in a . . . land treatment facility. . . ." As a result, the Agency must make land disposal prohibition determinations for land treatment of hazardous wastes in accordance with the requirements and schedules of section 3004 (d), (e), and (g).

The Agency intends to fulfill these statutory requirements for land treatment facilities by developing, if possible, a back calculation model and database specifically for land treatment. However, due to the difficulties involved in characterizing the complexity and variability of land treatment and the very limited availability of critical data (e.g., biodegradation rates), it is not possible for the Agency to develop, review, and approve a back calculation model and database specifically for land treatment within the deadlines established under section 3004(e). In view of the desirability of developing a land treatment-specific model and database, and the current inadequacy of time and data, the Agency proposes the following approach to address land treatment of hazardous wastes under section 3004 (d), (e), and (g).

a. The Agency will continue to develop a land treatment-specific back calculation model and database.

b. To meet statutory deadlines that occur before the land treatment-specific back calculation model and database are available, screening concentrations for land treatment will be the same as screening concentrations for other types of land disposal units.

c. If and when an appropriate and adequate land treatment-specific back calculation model and database can be developed, the Agency will use them to establish subsequent land treatment screening concentration determinations.

d. If and when an appropriate and adequate land treatment-specific back calculation model and database can be developed, the Agency will review screening concentrations for land treatment made previously, using the generic land disposal model, and may make appropriate modifications based on the land treatment-specific back calculation model and data base.

2. Background

Land treatment of hazardous waste involves the application of waste on the soil surface or incorporation of waste into the upper layers of the soil (zone of incorporation) in order to degrade, transform, or immobilize hazardous constituents present in the waste. As such, land treatment is both a treatment and a disposal operation.

Because land treatment depends upon the dynamic physical, chemical, and biological procedures occurring in the treatment zone for success, it is especially important that the units be carefully operated to maintain optimum degradation and immobilization of hazardous constituents, and prevent environmental contamination. Development of a treatment program both allows and demands detailed consideration of a large number of factors, including:

a. Waste characteristics.

b. Treatment zone characteristics.

c. Climatic conditions.

d. Operating procedures.

The Agency has established standards for owners and operators of hazardous waste land treatment units under 40 CFR Part 264 Subpart M, and 40 CFR Part 265, Subpart M, respectively. Many of the regulatory requirements for hazardous waste land treatment (HWLT) units are similar to those for other surface land disposal units (e.g., requirements regarding: Control of run-on and runoff, waste analysis, recordkeeping, ground water monitoring, control of wind dispersal of particulate matter). However, there are also significant differences in regulatory requirements for HWLT units that the Agency believes should be considered in developing and implementing the land treatment restrictions program.

One of the most basic differences is that land treatment facilities are not required to have a liner or a cap as are other surface land disposal units such as landfills. Neither caps nor liners are requird for land treatment units because they would lead to conditions that would reduce microbial degradation of hazardous constituents and thus, would be counterproductive. Similarly, HWLT units are not required to have a leachate collection and removal system as is required for landfills and waste piles.

While land treatment facilities are not required to have caps or liners, they are subject to a variety of stringent regulatory requirements that are not applied to any other type of land disposal units. Among the more important land treatment-specific requirements are:

(i) Limitations on the types of waste that may be treated at HWLT units (§§ 264.271(a)(1) and 264.272(a)).

(ii) Specification of operating practices necessary to maximize the success of degradation, transformation, and immobilization processes in the treatment zone (§ 264.271(a)(2)).

(iii) Unsaturated zone monitoring requirements including soil monitoring and soil pore liquid monitoring (§§ 264.271(a)(3) and 264.278).

(iv) Treatment zone limitations (i.e., maximum depth of 1.5 meters from the initial soil surface, and more than 1 meter above the seasonal high water table (§ 264.271(c)).

(v) Land treatment demonstration (§ 264.272).

(vi) Modification of unit operating practices if results of the unsaturated zone monitoring program indicate a statistically significant increase in hazardous constituents below the treatment zone (§ 264.278(g)).

(vii) Expanded recordkeeping requirements including waste application dates and rates (§ 264.279).

(viii) Requirement to continue, during the closure and postclosure phases, all operations necessary to maximize degradation, transformations, or immobilization of hazardous constituents within the treatment zone (§ 264.280).

3. Proposed Approach for Land Treatment

The Agency believes that, in view of the many unique aspects of land treatment, it may not be desirable to make land treatment restriction decisions using the same back calculation models and data base to be used for the other land disposal options. The Agency, therefore, is developing a model that will represent the chemical, physical, and biological interactions between hazardous waste and soil in the treatment zone. The Agency then intends to integrate this treatment zone model with the back calculation models for air, surface water, and ground water that will be used for the other land disposal options, which are described in Unit III.A of this preamble. The integrated model will be modified, as necessary, to make it representative of land treatment units (e.g., the factors representing caps and liners will be eliminated). The integrated model will be used to establish health-based concentrations for land treatment operations.

The Agency realizes that it will be very difficult to develop a land treatment model and database due to the complex interactions between wastes and the treatment zone/saturated zone, and the interdependence of input parameters, For example, the biodegradation rate for a given hazardous constituent may vary greatly, depending upon a large number of factors, including: Waste constituent structure, presence of other waste constituents, waste loading rate, degree of waste and soil mixing, and soil characteristics. In turn, many of these factors may depend upon other factors and/or vary greatly.

The Agency believes that the complex interdependence and interactions of these variables, coupled with the current limited knowledge of ranges and distributions of values of some critical input parameters (e.g., biodegradation rates) will make the modeling effort very difficult at best. Although the Agency intends to continue developing the land treatment back calculation model and database, it recognizes the possibility that the ultimate conclusion of the development effort may be that development of an adequate, representative model or database is not feasible and that any special consideration of land treatment should be made on a site-specific basis through the petition process. The Agency will not be prepared to make a decision on the feasibility of developing the land treatment model and database until considerably more information is made available by ongoing research efforts and data requests.

The Agency is concerned that even under the most optimistic scenario (i.e., the Agency can successfully develop a representative land treatment model and database), it is quite likely that a land treatment-specific model and database will not be available in time to make prohibition determinations for solvents and dioxins within the 24-months statutory deadline established under section 3004(e) of RCRA. In such an event the Agency proposes to apply the screening concentration established for other types of land disposal units to land treatment operations. When the land treatment-specific model and database become available, the Agency will make necessary modifications, if any, to the screening concentrations for land treatment. The Agency believes that this is the most reasonable approach for several reasons. First, it will allow the Agency to develop the necessary model and database while meeting all of the statutory deadlines. Second, the Agency believes that use of the screening concentrations calculated for other types of units will be protective of human health and the environment pending development of land treatment screening concentrations; the Agency believes that the screening concentrations for land treatment will be higher than those established for landfills. Third, the Agency believes that the impact on industry of temporarily using the expectedly more stringent landfill screening concentration will be minimal, because little if any of the listed solvent- or dioxin-containing wastes identified in section 3004(e) are land treated.

4. Request for Comments and Information

EPA solicits comments on all aspects of its approach to HWLT and requests information that may be useful in implementing the Agency's proposed plans.

Issues on which EPA would like to receive comments include:

a. Is a "generic" land treatment model appropriate for making restriction decisions on land treatment of hazardous waste? Or is land treatment so dependent on waste characteristics, site characteristics, and facility operating practices that development of a representative model is not feasible?

b. If a generic land treatment model is used, how should the Agency address variability in waste characteristics, site characteristics and facility operating practices?

c. Are critical data (e.g., biodegradation rates for hazardous constituents) adequate and available for making restriction decisions using a land treatment model?

d. What timeframe should be used for the analysis? Should the analysis be limited to the active closure and post-closure phases of operation, or should it extend beyond the post-closure phase?

The Agency also requests data and other additional information that would be useful in making land treatment determinations, including:

(i) Chemical and physical characteristics of wastes at land treatment facilities (e.g., physical form, types and concentrations of chemical constituents, RCRA identification codes, waste volume).

(ii) Information on land treatment design and operating measures (e.g., methods, rates and timing of waste application, pH adjustment, nutrient addition, use of tilling).

(iii) Biodegradation rates for hazardous wastes and hazardous constituents.

(iv) Site characteristics (e.g., soil characteristics, topography, climate).

V. Proposed Treatment Standards for Hazardous Wastes Containing Solvents

A. Background

1. Summary of Congressional Mandate—Land Disposal Restrictions of Solvents

According to the provisions in the 1984 Amendments to RCRA, effective 24 months after the date of enactment, further land disposal of solvents is prohibited unless the EPA determines that such prohibition is not required in order to protect human health and the environment. If the Agency fails to meet this deadline, these wastes will be banned automatically from further land disposal. Solvents are presumed banned unless the Agency sets treatment levels or persons generating these wastes successfully demonstrate that "no migration" will occur from the disposal unit.

The statute specifically addresses the list of spent solvents in 40 CFR 261.31—EPA Hazardous Waste Nos. F001, F002, F003, F004, and F005. However, the Agency also is including the corresponding solvents listed in 40 CFR 261.33 (e) and (f) (i.e., P022, U002, U031, U037, U052, U057, U070, U080, U112, U117, U121, U140, U154, U159, U161, U169, U196, U210, U211, U220, U226, U228, and U239). The list of hazardous wastes identified as "P and U wastes" applies to the unused portion of commercial chemical products, off-specification commercial chemical products, manufacturing intermediates and spill residues which are intended for disposal. Since these wastes pose hazards identical to the corresponding spent solvents (listed in F001 through F005), the Agency believes that Congress also intended to prohibit further land disposal of these wastes within the 24-month timeframe.

The Agency in today's action is proposing treatment standards for the following spent solvents and commercial chemical products, off-specification commercial chemical products, manufacturing intermediates, and spill residues:

F001—The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F002—The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, and trichlorofluoromethane; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F001, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F003—The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing solely the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F004—The following spent non-halogenated solvents: cresols and cresylic acid, and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F005—The following non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

P022—carbon disulfide
U002—acetone
U031—n butyl alcohol
U037—chlorobenzene
U052—cresols and cresylic acid
U057—cyclohexanone
U070—o-dichlorobenzene
U080—methylene chloride
U112—ethyl acetate
U117—ethyl ether
U121—trichlorofluoromethane
U140—isobutanol
U154—methanol
U159—methyl ethyl ketone
U161—methyl isobutyl ketone
U169—nitrobenzene
U196—pyridine
U210—tetrachloroethylene
U211—carbon tetrachloride
U220—toluene
U226—1,1,1-trichloroethane
U228—trichloroethylene
U239—xylene

The legislative history to the 1984 Amendments to RCRA indicates that a waste may be restricted from land disposal not only on the basis of hazards posed by its inherent toxicity, but also becuase of its ability to degrade clay and synthetic liners and to mobilize relatively non-mobile hazardous constituents, when co-disposed with other hazardous waste (S. Rept. No. 98-284, 98th Cong., 1st Sess. 14 (1983)). Since solvents exhibit these characteristics, the Agency has considered these overriding factors in developing treatment standards for solvents.

The Agency is proposing in today's action to set screening levels for the individual solvents listed for "toxicity" (i.e., F001, F002, F004, F005, and the corresponding P and U wastes). The Agency is also prospoing a liner protection threshold which is derived for the lowest concentration at which solvents are known to degrade liners. In cases where screening levels for the individual solvents exceed the liner protection threshold, the Agency will specify the liner protection threshold in lieu of the screening level. Thus, the liner protection threshold serves as a "safety cap" where screening levels are not stringent enough to assure that solvents will not breech liners during the operating life of the facility.

The Agency also is proposing the liner protection threshold in lieu of a screening level for ignitable solvents (F003). These solvents were listed as hazardous wastes solely becuase they exhibit the characteristic of ignitability ("toxicity" was not a basis for listing). Therefore, the Agency was not evaluated toxicological data for these solvents.

EPA has determined that a number of technologies are applicable to the treatment/recovery of solvent wastes, including biological degradation, steam stripping, carbon absorption, distillation, incineration, and fuel substitution. The Agency is proposing to identify "best demonstrated available" technologies for each solvent waste based upon the wastes' physical form, the specific solvent constituents they contain, and the concentrations at which such constituents are present. For all solvent wastes subject to today's proposed rulemaking, best demonstrated treatment technologies are identified that are capable of achieving the screening levels for the applicable solvent constituents they contain. Furthermore, although final evaluations have not yet been completed, preliminary results indicate that these best demonstrated treatment technologies do not pose total risks to human health and the environment greater than those posed in the direct land disposal of most categories of the solvent wastes subject to today's proposed rulemaking.

Accordingly, EPA is proposing the screening or liner protection thresholds as the section 3004(m) treatment standards for each applicable solvent constituent contained in the solvent wastes subject to today's proposed rulemaking, capping off the required technology performance levels at these protective levels.

EPA is proposing to establish immediate effective dates for all but three of the categories of solvent wastes subject to today's proposed rulemaking: Solvent-water mixtures (wastewaters) containing less than 1 percent (10,000 ppm) of total organic constituents and less than 1 percent (10,000 ppm) of total solids; inorganic sludges and solids containing less than 1 percent (10,000 ppm) total organic constitutents; solvent-contaminated soils. The Agency is proposing 2-year national variances for these solvent wastes upon a determination that the capacities of alternative treatment technologies capable of achieving the treatment standards for these wastes (wastewater treatment units and incinerators), in conjunction with the capacities of alternative recovery and disposal technologies, are insufficient to accommodate the quantities of these solvent wastes currently managed in land disposal units.

2. Description of the Solvent Listings

On May 19, 1980, (45 FR 33119), the Agency listed 27 commonly used organic solvents as hazardous wastes when spent or discarded. The solvents were listed as Hazardous Waste Nos. F001, F002, F003, F004, and F005. The listed solvents consist of certain spent halogenated and non-halogenated solvents, and still bottoms from the recovery of these solvents. A solvent is considered "spent" when it has been used and is no longer fit for use without being regenerated, reclaimed, or otherwise reprocessed. Manufacturing process wastes containing these solvents are not covered under the listing.

When the Agency promulgated the solvent listings, a major regulatory loophole was created by the manner in which the listing were originally structured—that is, only the pure form of the solvents or technical grade were covered by the listing. Therefore, the Agency amended the listing to include mixtures containing a total of 10 percent or more (by volume) of one or more of the listed solvents, as published in the Federal Register of December 31, 1985 (50 FR 53315).

The Agency also listed as hazardous waste certain commercial chemical products, manufacturing chemical intermediates or off-specification commercial chemical products (under 40 CFR 261.33(e) and (f)). Commercial chemical products and manufacturing chemical intermediates are defined as chemical substances which are manufactured or formulated for commercial or manufacturing use, and which consist of the commercially pure grade of the chemical, any technical grades of the chemical that are produced or marketed, and all formulations in which the chemical is the sole active ingredient. Section 261.33 also lists as hazardous wastes off-specification variants and the residues and debris from the cleanup of spills of these chemicals. Finally, certain containers that have held these chemicals also are hazardous wastes under §261.7.

B. Physical and Chemical Characteristics of Solvents

Large volumes of solvents are used in a variety of industries because of their inherent ability to dissolve and mobilize other constituents. For example, solvents are used in dry cleaning, vapor degreasing, and cold cleaning of metals and parts; extraction of oils and waxes; in solvent drying; and dye manufacturing. Solvents also are used as extractants, diluents, and chemical intermediates. When land disposed, the ability of solvents to dissolve and mobilize other constituents may cause adverse effects such as degradation of liners, mobilization of co-disposed wastes, air emissions, and ground water contamination. The characteristics of solvents can be quantified using physical and chemical parameters such as solubility, vapor pressure and liquid density. In addition, biodegradation, bioaccumulation, oxidation, hydrolysis, and photodegradation indicate whether solvents are likely to persist in the environment once they have migrated from the land disposal unit. Two of these parameters, solubility and vapor pressure, are discussed in today's action. The other parameters are addressed in the Background Document for solvents to support this proposed rule (Ref. 4).

1. Solubility

Solubility is a measure of the mass of a substance that has disssolved in or become miscible with water at a given temperature and pressure. When applies to solvents, this measure may be used as an indication of which solvents are more likely to enter into the aqueous phase and how fast they would enter that phase. Solvents that possess high solubility values will enter into the aqueous phase more readily than solvents with low solubility values. Hence, solubility may be used to indicate the potential of a solvent to migrate into and remain with the ground water beneath a land disposal facility (Ref. 95).

In general, many of the halogenated solvents are less soluble than the non-halogenated solvents. Solvents, such as chlorobenzene, carbon tetrachloride, tetrachloroethylene, and o-dichlorobenzene have low solubilities, while non-halogenated solvents, such as pyridine, methyl ethyl ketone, and isobutanol have very high solubilities (Ref. 95). Despite their low solubilities, halogenated solvents have been found in ground water, well water, and surface water. Anderson and Jones (Ref. 15) reported that both halogenated and non-halogenated solvents were found as contaminants in drinking water wells and in surface water. A study of 50 industrial waste land disposal sites demonstrated that in 80 percent of the sites, ground water was contaminated with halogenated organics (Ref. 33).

2. Vapor Pressure

Vapor pressure is the pressure which is exerted by a gas at equilibrium with its solid and liquid states at a given temperature. A solvent's vapor pressure may be used as an indication of its volatility. The higher the vapor pressure, the greater the tendency of a solvent to volatilize. Solvents with high vapor pressures may present a substantial risk from air emissions when placed in open disposal areas, i.e., surface impoundments and land treatment (Ref. 100). Coupled with low solubilities, these solvents readily volatilize. For example, solvents with high vapor pressures and low solubilities, such as trichlorofluoromethane, carbon disulfide, 1,1,2-tricholoro-1,2,2-trifluoroethane, and carbon tetrachloride, are more likely to volatilize into the atmosphere rather than remain in the disposal unit.

C. Characterization of Solvent Wastes

1. Solvent Waste Characteristics

Spend solvents typically are sludges, wastewaters, and liquids. Residues from treatment of these wastes consists of still bottoms, incinerator ash, wastewaters, and, in some cases, stabilized or solidified wastes. The majority of spent solvent wates, however, are liquids or sludges. Of the listed spent solvent wastes disposed in 1981, the greatest quantities were inorganic liquids, organic liquids, and inorganic sludges (Ref. 41).

Spent solvent wastes may vary in composition. For example, these wastes may contain contaminants, such as chemicals, inorganic materials, organic materials, sorbents, dirt, ash, metals, and water. In addition the waste's actual solvent content varies from waste to waste. Liquid solvent waste can contain up to 90 percent of the original solvent. A solvent sludge waste may contain between 10 and 50 percent of the original solvent. Incineration ash, on the other hand, generally contains solvents only in the parts per billion range.

Solvents listed under 40 CFR 261.33(e) and (f) are the unused portions of commercial chemical products, manufacturing chemical intermediates, or off-specification commercial chemical products that are intended to be discarded. These wastes may be liquids or solids. Certain containers or inner liners removed from a container that has been used to hold a commercial chemical product or manufacturing chemical intermediate and any residue or contaminated soil, water, or other debris resulting from the cleanup of a spill also are covered by the listing.

2. Quantity of Solvents Currently Land Disposed

Approximately 3.1 billion gallons of spent solvent waste were generated in 1981 (Ref. 9). This includes the solvents covered in today's proposal. The following quantities were land disposed in 1981:

[In millions of gallons]

Activity	Volume
Large quantity generators:	
Land disposed	[1] 1,202
Landfill	32
Surface impoundment	[2] 1,169
Waste piles	0.743
Land application	0.001
Small quantity generators: Land disposed	7.6

[1] Excluding deepwell injection:

[2] Including treatment and storage surface impoundments.

Although EPA has promulgated regulations restricting disposal of liquids in landfills, these regulations do not have a significant impact on the quantities of solvents being land disposed. The majority of spent solvents destined for land disposal typically have been solids or sludges. Moreover, liquid solvent wastes are typically disposed of in surface impoundments and, therefore, are not subject to the prohibition for liquid wastes in landfills.

D. EPA Concerns With the Land Disposal of Solvents

1. Adverse Health Effects

When EPA promulgated the first phase of the hazardous waste regulations in 1981, solvents were listed because of their inherent toxicity (and ignitability). Many of these solvents are known carcinogens, teratogens, mutagens, or neurotoxins. Others are associated with acute and chronic adverse health effects such as kidney, liver and lung damage (Refs. 100 and 111). Since solvents are mobile and persist in the environment, the Agency is concerned that, when land disposed, these solvents may readily migrate to ground water. In addition, since some solvents are highly volatile, the Agency is also concerned that toxic vapors from these waste may result in human health hazards during handling and land disposal.

2. Solvent/Liner Interactions

Currently available information indicates that exposure to dilute aqueous solutions of solvents could result in deterioration of flexible membrane liners. Diluted solvents appear to have little effect on compacted soil liners in short-term exposure tests. There is not, however, sufficient information available to predict the effect on soil liners from long-term exposure to dilute solutions. Additional research is needed not only on possible long-term effects of dilute solutions, but also on mechanisms by which concentrated solvent phases may be generated in landfills or surface impoundments.

a. *Interactions between solvents and flexible membrane liners (FMLs).* There are a variety of mechanisms by which solvents can interact with FMLs. In general, most FMLs will adsorb solvents, which can result in swelling and decreased physical strength in the liner material (Ref. 54). Additionally, solvents can leach plasticizers out of certain types of FMLs, causing the liner material to shrink and become brittle (Ref. 56).

One possible mechanism by which solvents may interact with synthetic liners involves the solubility parameter theory. This theory was developed originally for predicting the behavior of simple liquids in solution. Recently, however, the solubility parameter theory has been extended to the behavior of complex liquids in solution, the behavior of liquid mixtures, and the behavior of polymers (such as those found in synthetic liners). The basic assumption behind the theory is that any given molecule will be attracted to any other molecule provided that they exhibit similar physical and chemical factors, such as cohesive energy density, hydrogen bonding and polar bonding. The physical and chemical factors of a liquid or polymer are analyzed and weighted to determine the total solubility parameter. The total solubility parameters for liquid mixtures or solutions is determined by adding up the individual parameters for each component, weighted by their volume fraction in solution. Thus, the solubility parameter for a dilute solvent solution equals the parameter for that solvent (weighted by its volume in the solution) and for water (weighted by its volume in the solution) (Ref. 90).

Liquids, solutions or polymers with like solubility parameters will be attracted to one another. Thus, wastes with total solubility parameters similar to those of a polymer used to fabricate an FML may adsorb into the liner causing the liner to dissolve or swell and, therefore, potentially fail.

Barton and Burrell (Refs. 20, 21, and 31) provide comprehensive tabulations of solubility parameters for common solvents and polymers. Almost all individual solvents contained in F001 through F005 and the polymers used to fabricate FMLs fall within a solubility parameter range of 7.4 to 10.7 cal/cm^3 (Refs. 56 and 95). Consequently, when these polymers come into contact with waste liquids containing solvents or solvent mixtures, at any concentration, swelling or dissolution of the polymer is likely to occur.

Haxo (Ref. 53) indicated that swelling of an FML is associated with deterioration in the FMLs' physical properties (i.e., loss of mechanical strength, softening, increased permeability, tendency to creep, etc.). In a recent study, Haxo et al. (Ref. 56) examined the swelling of 12 FMLs submerged in a series of nine pure solvents with different solubility parameters (6.8 to 14.5). All the FMLs showed significant swelling after exposure to most of the solvents. It should be noted that, even without showing much swelling, FML properties, such as tear resistance, puncture resistance, gain in permeability, tensile strength, and propensity to undergo stress-cracking, can be affected by solvents (Ref. 56).

There are few data available on the impact of dilute solvents on the physical properties of FMLs. However, in one study, 12 FMLs were exposed for 500 days to a dilute aqueous solution of a solvent (Ref. 55). The data indicated that even very low concentrations of solvents may deteriorate FMLs.

A study conducted by the Federal Environmental Agency of Germany (Ref. 18) tested 13 solvents, both in their dilute and pure form, against 14 FMLs of various types and thicknesses. Two of the test solvents, xylene and toluene, permeated through the FMLs at faster rates than would be expected. A solution of 200 ppm xylene mixed in water permeated through a high density polyethylene liner sample at a rate of 1.6 $gm/m^2/day$, while a solution of 500 ppm toluene permeated through a high density polyethylene liner sample at a rate of 2.0 $gm/m^2/day$. These rates are only 10 to 50 times lower than the rates of the pure solvents (Ref. 18).

Solvents are also known to diffuse through FMLs. Lord et al. (Ref. 71) reported that benzene diffused through ethylene propylene diene rubber, polyvinyl chloride, and chlorinated polyethylene at the rate of 2×10^{-6}, 1.3×10^{-6}, and 6×10^{-7} cm^2/sec, respectively. Diffusion coefficients of this magnitude would allow benzene to pass through a 30 mil sheet of these materials in about 2 years if the initial concentration was as little as 100 ppm.

There are no data available on the effect of solvent mixtures on FMLs. In addition, these mixed solvent effects cannot always be predicted on the basis of solubility parameters (Ref. 95). There are cases where a polymer that was insoluble in individual solvents was quite soluble when these solvents were mixed (Ref. 74).

Solvent wastes are often complex mixtures of solvents. Several FML experts have suggested that no single FML is likely to be resistant to the complete range of solvents (Refs. 53 and 96). Complex mixtures of solvents will, therefore, increase the probability that at least one component of the solvent mixture will adversely affect the physical properties of an FML.

b. *Interactions between solvents and compacted soil liners.* Several studies have shown that concentrated solvents with properties similar to those in F001 through F005 can greatly increase the permeability of clay soils (Refs. 89 and 122), clay minerals (Refs. 30 and 72), and compacted soil liners (Refs. 14, 15, 28, and 45). More recent studies have indicated that it is primarily the low dielectric constant of these concentrated solvents which is associated with the permeability increases (Refs. 29 and 75). The high dielectric constant of water causes the expanded clay minerals to swell and disperse. In the context of a compacted soil liner, clay mineral swelling and dispersal tends to decrease the effective diameter of soil pores, and thereby decrease permeability of the liner. If subsequently exposed to solvents with dielectric constants of less than 50, the clay minerals will tend to flocculate (Ref. 29). When the clay minerals in a soil liner flocculate, the soil liner will begin to shrink, crack, and exhibit large increases in permeability. All of the solvents in F001 through F005 have dielectric constants of 36 or less (Refs. 14, 57, and 95). Consequently, if any of these undiluted solvents is placed in soil-lined land disposal facilities, the permeability of the soil liner may be greatly increased.

The effect of aqueous solutions containing solvents on the permeability of soil liners has been shown to be related to the concentration of the solvents. Brown and Thomas (Ref. 29) found that the permeability of soil liners increased when the concentration of solvent in water was sufficient to decrease the dielectric constant of the solution below 50 (the dielectric constant of water equals 78.5). For the solvents in F001 through F005, there would need to be a solvent concentration in water of at least several percent before the mixture would have a dielectric constant of less than 50. However, few of the solvents in F001 through F005 are soluble in water at concentrations greater than a few percent. These solvents will separate from water and form a concentrated solvent phase. Therefore, an aqueous solution containing F001 through F005 solvents may yield a concentrated solvent which may adversely affect a soil liner provided that the solution has a dielectric constant less than 50.

The ability for concentrated solvents to migrate rapidly through clay soils and compacted soil liners has been verified in field-scale studies using solvent wastes (Ref. 27) and at hazardous waste disposal facilities where solvents have been disposed (Ref. 50). Dilute solutions of solvents appear to have little effect on soil liners in short-term tests (Ref. 37). Brown et al., (Ref. 28) tested the effect of 100, 75, 50, 25, 12.5, and 2 percent acetone diluted with water on a compacted micaceous soil. The results showed an increase in permeability of the soil when the acetone concentration in the solution was greater than 50 percent; however, the dilute solutions of less than 50 percent acetone showed no increase in permeability of the soil. Brown theorized that at the low acetone concentrations the solution may have caused dispersion and swelling of the clay which would be more likely to lead to a decrease in permeability rather than an increase. The higher concentration of acetone, however, may have caused flocculation and shrinkage of the clay resulting in an increase in permeability. Although this study showed little adverse effects from a low concentration solvent on a soil liner, it is possible that in the long-term the solvent eventually may cause an increase in permeability. Overall, little is known about the long-term effects of dilute solvents on the permeability of soil liners.

Several mechanisms have been suggested by which concentrated solvent phases may be generated after a solvent-bearing waste has been placed in a landfill, as follows:

i. Waste solids may biodegrade, losing the ability to retain solvents (Ref. 17).

ii. Solvents may be displaced or washed from waste solids or sorbents by water percolating through the landfill (Ref. 14).

iii. Waste solids may release solvents in response to gravitational forces (Ref. 17).

iv. Solvents may be squeezed out as waste solids consolidate due to overburden pressures (Ref. 17).

v. Solvents may be separated from water due to decreases in their solubility inducted by changes in the temperature and/or ionic strength of the aqueous solution.

vi. Solvents may volitalize from water and condense elsewhere, forming more concentrated solutions.

vii. Percolation of solvent-water mixtures through waste solids may tend to concentrate one phase through either molecular sieving or preferential adsorption.

There are many methods used in organic chemistry to separate liquid phases. Additional research is needed to determine the extent to which these methods and the mechanisms discussed above may result in the formation of concentrated solvent phases in landfills or surface impoundments which may pose deleterious effects on liner systems. With the information that is currently available, it is not possible to determine the effect of long-term exposure to dilute solutions of solvents on soil liners.

3. Mobilization of Other Hazardous Constituents

Solvents are used in commerce primarily for their ability to dissolve or disperse (mobilize) other substances. For example, studies conducted on PCB-contaminated soils demonstrated that more than 95 percent of the PCBs were extracted from these soils using acetone as a solvent (Ref. 92). Since solvents are known to degrade and in some cases, permeate both synthetic and clay liners, the Agency is concerned that solvents may readily facilitate migration of other non-mobile or relatively immobile hazardous constituents from the land disposal unit.

A recent study conducted by the Agency supports its claim that solvents may increase the mobility of other compounds (Ref. 43). The study demonstrates that wastes containing aromatic solvents and chlorinated solvents, as well as surfactants, generally increase the mobility of compounds adsorbed onto a synthetic waste. Wastes such as electroplating waste, American Petroleum Institute separator sludge, lime-stabilized waste and an unstabilized sludge were used in the study. However, due to the complexity and diversity of these wastes some chromatographic interferences and reproducibility problems occurred. (The wastes contained high concentrations of a variety of solvents.) The Agency therefore is contemplating doing further research and applying synthetic waste using a standard leaching solution with single solvents or binary mixtures of common organic solvents added at low levels. Such a protocol will assure homogeneity and allow for stability testing. Information from the study could then be used to assess better and possibly predict the mobilizing power of common organic solvents at low levels.

Although these data clearly indicate that solvents may mobilize other hazardous constituents present in land disposal units, the Agency believes that the treatment standards (i.e., the health-based thresholds and liner protection threshold) are below concentrations which may elicit this effect. For example, the Agency has found that in a field-model lysimeter test conducted during development of the TCLP, the presence of toluene in the range of 1 to 2 parts per million (i.e., the level of the liner protection threshold) did not appear to affect significantly the leaching of organic compounds (see Unit III.D). Since the treatment standard for the individual solvents does not exceed 2 ppm, the Agency believes that the data indicate that solvents at this concentration will not increase the leachability of relatively non-mobile constituents. Moreover, since toluene is a "strong" solvent, it can reasonably be expected that solvents with equal or lesser solubility also will not affect leachability of other constituents.

In light of the limited data available on mobilization power of solvents, in particular, whether solvents present in concentrations at or below the liner protection threshold will mobilize other constituents, the Agency is initiating further studies. When additional data becomes available, the Agency will re-evaluate the liner protection threshold. In the interim, however, the Agency is requesting comments and data on this issue.

4. Volatilization of Solvents From Land Disposal Sites

Many solvents are highly volatile. As such, these solvents are likely to escape into the atmosphere. In particular, solvents with high vapor pressure and low solubilities (such as chlorofluorocarbons, carbon disulfide and carbon tetrachloride) will volatilize rather than remain in the disposal unit. The Agency is concerned that these toxic solvents when airborne may pose adverse effects to humans and animals. Also, certain solvents such as chlorofluorocarbons are known to pose environmental harm (i.e., depletion of the ozone layer).

The California Air Resources Board (ARB) conducted a study designed to measure the escape of volatile organics from land disposal areas. The study showed that high levels of hydrocarbons were being emitted from major hazardous waste disposal sites. The levels detected, in some cases, were several orders of magnitude higher than the National Ambient Air Quality Standard for hydrocarbon emissions. From the results of the study, ARB concluded that current land disposal practices do not adequately prevent the air emissions of certain organic compounds, but instead allow substantial emissions of these compounds (Ref. 4).

The Agency believes that the treatment standards proposed in today's action will substantially reduce air emissions due to the land disposal solvent wastes. However, as discussed earlier, the Agency is developing a back calculation procedure to assess the effects of air emissions. The Agency's plans for that procedure, as well as that procedure's effect on the treatment standards being proposed today, are discussed in Unit III.A.4.

5. Contamination of Soil and Ground Water Solvent

Contamination of soil and ground water has occurred at several landfill sites. In Wilsonville, Illinois, a hazardous waste landfill was found to be leaking. Concentrations of halogenated organics as high as 36 percent were found in monitoring wells 9 feet from the site (Ref. 93).

These data clearly demonstrate that solvents may migrate from landfills to surrounding soils and ground water where they may cause harm to humans and the environment.

E. Screening Levels/Liner Protection Threshold

Since solvents are known to degrade clay and synthetic liners and to mobilize other hazardous constituents when co-disposed with hazardous wastes, the Agency cannot be assured that screening levels, based on toxicity concerns are protective of human health and the environment. Therefore, the Agency has developed a liner protection threshold which takes into account the effects of solvents on liners.

1. Applicability of Screening Levels

The Agency has derived screening levels for the solvents listed on the basis of toxicity using the ground water back calculation model. In calculating these levels, the Agency used the apportioned RfD for noncarcinogens, or MCL or RSD (10^{-6}) for carcinogens as the starting point.

The Agency has developed the following health-based thresholds for constituents in solvents wastes in the following Table 10:

TABLE 10—HEALTH-BASED THRESHOLDS

Solvent	Waste code (F,P&U)	Reference dose (mg/1)	Percent fractionated to water	Fractionated reference dose	Hydrolysis (constant/hr.)	Log K_{ow}	Screening level (mg/1)
Acetone	F003, U002	*	*	*	None	−0.24	*
n-Butyl Alcohol	F003, U031	*	*	*	None	[f]0.88	*
Carbon Disulfide	F005, P022	3.85	25	1.0	>10y[d]	[f]2.16	22.0
Carbon Tetrachloride	F001, U211	[b]0.005			>7000y[e]	2.96	0.1
Chlorobenzene	F002, U037	0.95	10	0.1	<1E-5[d]	2.87	2.0
Cresols (p, m, o) **	F004, U052	[f]1.8	40	[f]0.7	None	2.15	15.0
Cyclohexanone	F003, U057	0.015	*	*	None	[f]0.81	*
ortho-Dichlorobenzene	F002, U070	3.15	10	0.3	<E-4[d]	3.58	6.5
Ethyl Acetate	F003, U112	*	*	*	4.0E-1[c]; 396[d]	0.66; [f]0.73	*
Ethyl Benzene	F003	*	*	*	None	3.36	*
Ethyl Ether	F003, U117	*	*	*	None	0.71	*
Isobutanol	F005, U140	11.0	25	2.75	None	0.74	60.0
Methanol	F003, U154	*	*	*	None	−0.75	*
Methylene Chloride	F001, F002, U080	[a]0.056			1.1E-8[e]	1.26	1.2
Methyl Ethyl Ketone	F005, U159	1.6	25	0.4	None	0.30	8.8
Methyl Isobutyl Ketone	F003, U161	*	*	*	None	1.25	*
Nitrobenzene	F004, U169	0.016	25	0.004	None	1.90	0.09
Pyridine	F005, U196	0.075	40	0.03	None	0.68	0.7
Tetrachloroethylene	F001, F002, U210	[a]6.6 x 10^{-4}			None	3.03	0.015
Toluene	F005, U220	10.0	10	1.0	None	2.82	22.0
1,1,1-Trichloroethane	F001, F002, U226	[b]0.2			267D[e]	2.50	1,300.0.
1,1,2-Trichloro-1,2,2-Trifluoroethane	F002	950.0	10	95.0	>10y[d]	3.10	[g]320.0
Trichloroethylene	F001, F002, U228	[b]0.005			None	2.28	0.1
Trichlorofluoromethane	F002, U121	12.2	25	3.0	>7000y[d]	2.52	66.0
Xylene	F003, U239	*		*	None	[f]3.15	*

* F003 Ignitable only solvents.

** Data not available at present time for Cresylic Acid

[a] Risk Specific Dose at 10^{-6} (not fractionated)

[b] Proposed Maximum Contaminant Level (not fractionated)

[c] Acid Hydrolysis.

[d] Base Hydrolysis.

[e] Neutral Hydrolysis.

[f] Data Undergoing Verification.

[g] Based on surface water screening procedure.

2. Derivation of the Liner Protection Threshold

As described earlier, several studies demonstrate that solvents degrade FMLs. Although the data does not show effects of dilute solvent concentrations on soil liners, the Agency believes that these low concentrations may likewise degrade liners given a longer exposure time (liner compatibility tests generally are conducted for only a few months to a year). Moreover, waste/liner compatibility tests of incoming solvent wastes do not take into account possible waste-to-waste interactions within the disposal facility. These interactions may allow a previously compatible solvent to combine with other solvents (or other chemicals) and result in a mixture which can degrade soil liners. Thus, in developing a liner protection threshold, the Agency relied on a liner compatibility study which demonstrates increased permeability of an FML exposed over a period of 30 days to a dilute solution containing 0.02 percent (200 ppm) xylene and water (Ref. 18). The Agency believes that the data represent the lowest concentration at which solvents are known to degrade FMLs. The Agency applied the 200 ppm level as the starting point in calculating the liner protection threshold. However, lower concentrations of solvents may likewise affect liners given sufficient exposure time. For example, concentrated solvent phases may be generated from these dilute solutions as a result of volatilization and condensation, or solvents may be generated from these dilute solutions may be squeezed out of solution due to pressure within the disposal facility. In addition, factors such as interactions with co-disposed wastes, effects of solvent mixtures, and liner type (i.e., high density polyethylene (HDPE), polyvinyl chloride (PVC), ethylene propylene rubber (EPDM), chlorinated polyethylene (PEC), ethylene copolymer asphalt (ECB)) may also effect permeability. Additional research is needed to determine the extent to which dilute solutions of solvents and solvent mixtures may affect liners over the long term.

In light of these uncertainties and data gaps, the Agency derived the liner protection threshold by dividing the 200 ppm starting point by an uncertainty factor of 100. The choice of this factor is based on extrapolation from short-term exposure (30 days) to the actual operating life of the facility combined with the factors described earlier. The calculated liner protection threshold is 2 ppm.

The Agency is soliciting comments on the derivation of the liner protection threshold. The Agency also is seeking data on solvent/liner interactions. In particular, EPA is interested in data which demonstrate the effects of dilute solutions and solvent mixtures on FMLs.

3. Applicability of the Liner Protection Threshold

a. *Toxic solvents.* Screening levels are intended to identify levels at which land disposal is protective based on a consideration of the toxic effects of constituents. However, the Agency is concerned not only with the toxic effects of solvents but also, as discussed above, their effects on liners. Therefore, the Agency is specifying the liner protection threshold in lieu of a screening level where the screening level for an individual solvent may not be stringent enough to protect liners during the operating life of the facility (i.e., the screening levels exceeds the liner protection threshold).

The liner protection threshold overrides the screening levels for the following toxic solvents:

	Screening level	Liner protection threshold
Carbon disulfide	22.0	2.0
O-cresol	15.0	2.0
P-cresol	15.0	2.0
M-cresol	15.0	2.0
Ortho-dichlorobenzene	6.5	2.0
Isobutanol	60.0	2.0
Methyl ethyl ketone	8.8	2.0
Toluene	22.0	2.0
1,1,1-trichloroethane	1,300.0	2.0
1,1,2-trichloro-1,2,2-trifluoroethane	320.0	2.0
Trichlorofluoromethane	66.0	2.0

The Agency is requesting comments on all aspects of today's proposal for the solvents land disposal restriction. In particular, it is requesting data on the effects of dilute solvent solutions and mixtures on clay and synthetic liners and also data on the ability of solvents to mobilize other hazardous waste. In addition, the Agency is requesting comments on the liner protection threshold determination.

b. *Ignitable solvents (F003).* The F003 solvents were listed solely because they exhibit the characteristic of ignitability. Therefore, they are not included in either Appendix VII or VIII.

At this time, the Agency is evaluating data which indicate that these solvents may be toxic. The results of this evaluation are expected in early February 1986. If these data support listing these solvents as "toxic" wastes, the Agency will add these solvents to both Appendices VII and VIII, amend the listings to include these solvents in the list of ignitable/toxic solvents (F005), and establish screening levels for these wastes. Since it is unlikely that these tasks can be completed within the timeframe established for this rulemaking, the Agency is proposing, in the interim, to establish the liner protection threshold as the treatment standard for ignitable solvents. Once screening levels are developed for these solvents the Agency will re-evaluate these levels.

Data from delisting petitions addressed in the solvents restrictions Background Document (Ref. 4) show that treated waste or waste which naturally meets the 2 ppm threshold will no longer exhibit the characteristic of ignitability. Several liner compatibility studies show effects on FMLs caused by ignitable solvents such as acetone, xylene, methanol and ethyl acetate. For example, effects were seen at concentrations of 5.0, 0.02, 5.0, and 5.0 percent respectively (Ref. 18). These solvents have solubility parameters similar to those of the polymers used to fabricate FMLs and, therefore, are more likely to cause liners to swell or dissolve. Thus, the Agency believes that specifying the liner protection threshold as the treatment standard for ignitable solvents is appropriate and feasible. The Agency is proposing 2 ppm as the treatment standard for the following ignitable solvents:

Xylene
Acetone
Ethyl acetate
Ethyl benzene
Ethyl ether
Methyl isobutyl ketone
N-butyl alcohol
Cyclohexanone
Methanol

F. Analysis of Treatment Technologies for Solvents and Determination of BDAT

In order to set treatment standards for solvent wastes subject to this proposed rulemaking, the Agency must evaluate the ability of treatment technologies to remove, destroy, or immobilize the hazardous constituents that these wastes contain (see Unit II for an explanation of setting treatment standards). Based on its study of applicable treatment methods, EPA determines the best demonstrated achievable technology (or technologies) for hazardous wastes, and the performance of these technologies (see Unit III.C for a discussion of the procedures to determine BDAT). This unit summarizes the analysis of treatment technologies pertinent to solvent wastes. The Background Document for solvents to support this proposed rule (Ref. 4) gives a detailed description of this analysis.

1. Applicable Treatment Technologies

The Agency has evaluated many treatment and recovery technologies for their ability to remove, destroy, or immobilize solvent constituents present in hazardous wastes. Recovery or recycling methods (e.g., reclamation and reuse) are included in this analysis because these technologies also remove or destroy hazardous constituents present in hazardous wastes. Treatment and recycling technologies potentially applicable to solvent wastes fall into three general categories: Separation/removal techniques such as evaporation, air stripping, steam stripping, distillation, carbon adsorption, and resin adsorption; destruction techniques such as incineration, use as a fuel substitute, chemical oxidation and reduction, biological treatment, and wet air oxidation; and immobilization techniques such as encapulation and chemical fixation/solidification. These technologies are described below.

Separation/removal techniques are particularly applicable to many solvent wastes primarily because of the inherent volatile nature of many solvents. Since solvents are usually more volatile than the other constituents of the waste, they can often be removed by simple static evaporation or by passing air over or through the waste, a process called air stripping. Vapor pressure or volatility of organics increases as the temperature increases; therefore, the application of heat or steam, such as the use of steam stripping, can be used to increase the rate, and often efficiency, of separation and to remove solvents of relatively lower volatility. Distillation processes are also used to reclaim spent solvents based on the relative volatility of their organic constituents. In conclusion, the performance of these separation and removal methods for different solvents will vary because of the inherent differences in vapor pressures of the individual solvents.

Solvents separated through steam stripping or distillation are typically recovered by condensation. Carbon adsorption is often used to capture less concentrated organic emissions from air stripping. Steam stripped solvents may require further treatment via distillation to purify enough for reuse. Distillation generates both a reclaimed solvent, which is reused, and a sludge, which normally requires further treatment by the destruction methods addressed below.

Carbon and resin adsorption are also separation/removal techniques used primarily for aqueous wastes. The solvent constituents are removed by physical and/or chemical attraction on the surface of macro- and micro-pores of the adsorbents as the waste is passed through it. Solvents which have lower water solubility or higher molecular weight will generally be adsorbed more efficiently than those of high water solubility or low molecular weight. The spent carbon or resin can be regenerated, producing a more concentrated solvent waste, or subjected to the destruction methods described below.

Destruction techniques involve the processes of oxidation and reduction, which break the chemical bonds within the solvent molecules to produce smaller molecules and fewer hazardous compounds such as carbon dioxide, water, and hydrogen chloride. These techniques are applicable to all organic compounds.

Incineration is the most efficient and rapid oxidation and destruction techniques currently available. The oxidation reaction occurs at elevated temperatures, in the gaseous state, and with highly efficient mixing. These conditions are the most highly favorable, both kinetically and thermodynamically, which currently exist for oxidation. Several other technologies, such as wet air oxidation, incorporate variations on these favorable conditions by either using even higher temperatures, higher pressures, or more efficient mixing.

Chemical oxidation and reduction techniques generally involve the addition of chemical reagents (i.e., oxidants and reductants) to the waste, at or near ambient temperature and pressures. Typical reagents include chlorine, chlorine dioxide, hypochlorite, ozone, hydrogen peroxide, potassium permanganate, sodium bisulfite, sodium borohydride, and sodium or potassium metal. While these reactions can be quite efficient, they occur at much lower reaction rates compared to oxidation rates of incineration and are more sensitive to interferences and competing reactions. Data indicate that these rates can often be improved by application of low energy through ultraviolet irradiation, by addition of inorganic catalysts, and by use of efficient mixing devices. The oxidation techniques are primarily applicable to aqueous waste because of the ease with which the reagents can be added and mixed. The reduction techniques which involve the addition of sodium or potassium metal are designed for non-aqueous wastes because of their reactivity with water and are designed to strip halogens off of the halogenated solvents. These reagents are dangerously reactive and have limited application.

Biological treatment accomplishes destruction via chemical oxidation and reduction within the cell walls of various biota such as bacteria, virus, fungi, and other microbes. Theoretically, all of the solvent constituents can be biodegraded, but many constituents are toxic to the organisms at even low levels. All constituents must be present below toxic concentrations if biodegradation is to occur. While biological reactions can be quite efficient for some wastewaters and hazardous constituents, they generally require more lengthy reaction and contact time than nonbiological reactions. The biota are generally quite sensitive to concentrations of other toxic constituents (e.g., metals such as arsenic and cadmium). The processes also require maintenance of nutrient levels, and removal of spent biomass. It is necessary to develop the specific biomass necessary for degradation through an acclimation process.

Immobilization techniques have been demonstrated on a limited number of wastes and have yet to be verified as practically applicable to all solvent constituents. Theoretically, any organic molecule (and, therefore, any solvent) can be entrapped in an inorganic or organic matrix and immobilized. This is the concept of microencapsulation. However, sufficient amounts of reagents must be present in order to surround the molecule completely. Data also indicate that there may exist a limit on the total organic content, not just the solvent content, which can be microencapsulated or chemically fixed in a solid inorganic matrix. The choice of an organic matrix for microencapsulation must consider the solubility of the matrix in the solvent being encapsulated.

All of the aforementioned technologies appear to have some applicability to solvent wastes. In the following unit, EPA discusses the extent of this applicability for the technologies that are demonstrated.

2. Demonstrated Treatment Technologies

The Agency evaluated data on the use of the treatment technologies described above to treat solvent-containing waste codes F001 through F005 as well as P- and U-listed solvent wastes. Solvent wastes fall into two general treatability groups: (1) solvent-water mixtures (i.e., wastewaters) or other liquids containing solvents that are amenable to separation/removal techniques (e.g., steam stripping, carbon adsorption, distillation); and (2) liquids, sludges, and solids containing solvents that are not amenable to these methods. Solvent wastes from which the solvent constituents cannot be separated or removed usually require complete destruction, using technologies such as incineration and fuel substitution.

Often, EPA was not able to determine if the available data pertaining to the treatment of solvents referred to the treatment of RCRA hazardous wastes, or waste streams that merely contained the constituents of concern. Therefore, EPA also studied data documenting treatment of any waste containing the solvent constituents addressed by this proposal (i.e., Appendix VII constituents of concern for F001 through F005 wastes). Where data were lacking for certain constituents, EPA evaluated treatment data for similar compounds.

EPA believes that the solvent waste for which it has treatment data is similar to solvent waste which is currently land disposed. Therefore, available treatment data should apply to most, if not all, wastes subject to this proposed rule. EPA recognizes that there may be land disposed wastes whose treatment is not represented by available treatment data. The Agency requests data describing any such wastes, including the waste characteristics that would affect their treatability. These data also should include data documenting the actual treatability of the wastes.

EPA studies available data from full-scale, pilot-scale, and sometimes bench-scale treatment facilities to determine if the data demonstrated the treatment of wastes that adequately represent the treatability waste groups given above. EPA has identified the existence of full-scale, pilot-scale, and bench-scale facilities that demonstrate the general applicability of the following technologies for the treatment of solvent wastes: biological degradation, steam stripping, air stripping, carbon adsorption, distillation, incineration, and use as a fuel substitute (i.e., in industrial boilers and furnaces). The data, which are summarized below, show that all of the solvent wastes and constituents subject to this rule can be treated by one or more of these technologies. Accordingly, EPA determines that such technologies meet the "demonstrated" component of the BDAT standard.

The Agency has determined that the following potentially applicable technologies have not yet been sufficiently demonstrated on the solvent wastes and constituents of concern: resin adsorption, chemical oxidation, wet air oxidation, chemical reduction, encapsulation, and chemical fixation/solidification. While the Agency believes these technologies are theoretically applicable to many of the solvents constituents, the lack of adequate full-scale, pilot-scale, or bench-scale data for the treatment of the solvents of concern precludes these technologies from consideration in EPA's evaluation of BDAT. The Agency recognizes that the data on the use of technologies to treat solvent wastes are in a constant state of flux as these and other technologies are being developed and tested, and as facilities are being built. EPA believes, however, that the data available on the use of the technologies listed above to treat a representative sample of solvent wastes is insufficient to show that these technologies are demonstrated. The Agency solicits comments and data on the use of these technologies for treating solvent wastes, including paired influent and effluent values and air emissions data. This information will assist EPA in determining whether such technologies could form the basis of BDAT standards in the final rule.

a. *Steam and air stripping.* The use of steam stripping to remove solvents is a widely recognized manufacturing process and waste treatment technology for separation of dilute solvents from water. Steam stripping is demonstrated on wastes containing concentrations of solvents as high as several thousand milligrams per liter. The organic chemicals industry and the pesticides industry use full-scale steam stripping facilities to remove solvents from wastewaters. Steam stripping is also used full-scale and pilot-scale to remove solvents from contaminated ground water. Recent data indicate that there are at least 27 industrial steam stripping units, both commercial and private. Air stripping is commonly used full-scale and pilot-scale to remove solvent contaminants from ground water, as well as a pretreatment to biological degradation. Waste concentrations amenable to air stripping are typically less than 100 mg/l.

Based on available treatment data, EPA believes that steam and air stripping are especially applicable to the following solvents addressed in this rulemaking: chlorobenzene, ethylbenzene, methylene chloride, toluene, 1,1,1-trichloroethane, and trichloroethylene. Steam and air stripping have also been applied less successfully to other solvent constituents, such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and nitrobenzene, which are moderately or slightly volatile. Furthermore, based on their volatility, EPA believes that steam stripping is potentially applicable to eight more solvents; carbon disulfide, carbon tetrachloride, chlorobenzene, 1,2-dichlorobenzene, tetrachloroethylene, 1,1,1-trichloro-1,2,2-trifluoroethane, trichlorofluoromethane, and xylene.

b. *Carbon adsorption.* Activated carbon adsorption also is a widely recognized technology for the removal of organic compounds from wastewaters. Carbon adsorption is normally used to treat wastewaters containing less than a few hundred milligrams per liter of total organic constituents, although it has been used to treat up to 6,500 mg/l of cresols. EPA has identified approximately 50 commercial facilities with full-scale carbon adsorption units. Carbon adsorption has been demonstrated to various degrees of effectiveness for most of the solvent constituents that are the subject of this rule. Data from full-scale facilities have shown that carbon adsorption is particularly effective for removing cresols, nitrobenzene, and toluene from wastewaters. EPA concludes that carbon adsorption is a demonstrated technology for the treatment of solvent wastes and constituents.

c. *Distillation.* EPA estimates that there are at least 43 full-scale commercial solvent recyclers using some form of distillation for at least 149 million gallons per year of solvents listed as F001 through F005. In addition, data indicate that there are over 4,000 on-site solvent recyclers. Data are somewhat limited on these facilities because of their partial and previous exclusion from regulation under RCRA (see Unit III.B). Also, approximately 18 million gallons of solvents produced by small quantity generators are recycled, principally by distillation. Data show that the following solvent constituents have been reclaimed by distillation: acetone, n-butyl alcohol, carbon disulfide, carbon tetrachloride, chlorobenzene, cyclohexanone, 1,2-dichlorobenzene, ethyl acetate, ethylbenzene, isobutanol, methyl isobutyl ketone, methanol, methylene chloride, tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, and trichlorofluoromethane. Based on this information, EPA finds that distillation is a demonstrated technology for the treatment of certain solvent wastes (i.e., those with high enough organic and low enough solids content). As explained earlier, in most cases, further treatment of the distillation still bottoms is required.

d. *Biological degradation.* Biological degradation is practiced extensively in the organic chemicals, pharmaceuticals, and related industries for the removal of soluble organic compounds from wastewaters. A considerable body of literature exists documenting the biodegradation of soluble organic compounds via biological treatment. The range of concentrations of individual solvents in wastewaters that are amendable to biological treatment depends on the toxicity of the compound to microbes. The degree of toxicity depends, in part, on the acclimation achieved by the microorganisms. The levels of highly toxic solvents may not be able to exceed 10 mg/l, whereas other solvents can be present at over 100 mg/l.

Plants sampled to develop the effluent guidelines for the organic chemicals and plastics and synthetic fibers industries demonstrate the use of biological treatment, most often activated sludge, to treat carbon tetrachloride, chlorobenzene, 1,2-dichlorobenzene, ethylbenzene, methylene chloride, nitrobenzene, tetrachloroethylene, toluene, and trichloroethylene. EPA has determined that biological treatment is also demonstrated on the following constituents based on solubility: acetone, n-butyl alcohol, carbon disulfide, cresols, cyclohexanone, ethyl acetate, ethyl ether, isobutanol, methanol, methyl ethyl ketone, and methyl isobutyl ketone, and pyridine.

e. *Incineration.* The Agency estimates that there are currently at least 330 individual incineration units (both commercial and private) burning a minimum of 317 million gallons of materials containing solvents per year. The wastes burned include wastewaters containing as little as 0.01 percent (100 mg/l) solvents, liquids, and sludges containing 60 percent (600,000 mg/l) or more solvents, and primarily inorganic sludges and solids, such as soils contaminated with low levels of solvents. Almost any waste containing solvents can be incinerated, even those with low heat value, by blending with waste of higher heat value or by co-injecting the waste with fuels.

The majority of the incinerated hazardous waste is listed as ignitable waste containing primarily the solvents listed for F003 or F005 wastes. The data indicate that one or more incinerators burned all solvent constituents listed under F001 through F005. EPA data show that ignitable solvent constituents appear frequently in fuel for incinerators. Based on this information, EPA believes that the incineration of all solvent constituents is demonstrated.

f. *Fuel substitution.* According to an EPA survey of wastes burned as fuel in 1983, 1,400 industrial boilers burned hazardous wastes (Ref. 124). In addition, a large volume of the hazardous wastes burned in these devices contained chlorinated and nonchlorinated solvent constituents. Data indicate that all of the solvent constituents listed in F001 and F005 wastes have been present in hazardous wastes burned as fuel substitutes. However, because of their high chlorine content, and resulting corrosivity, most F001 and F002 waste must be blended with other solvents or fuel prior to burning.

The Agency conducted field tests on 11 full-scale industrial boilers and 9 industrial furnaces (Ref. 105). The test facilities represented a wide variety of boiler and furnace types and sizes burning a variety of hazardous wastes with a variety of auxiliary fuels. The hazardous wastes burned ranged from methanol and toluene wastes with a heating value similar to No. 6 fuel oil (and which was spiked with chlorinated organics for test purposes) to methyl acetate waste with a heating value of less than half that of No. 6 fuel oil (and which was also spiked with chlorinated organics for test purposes). The results of the tests showed that industrial boilers and furnaces can destory to 99.99 percent destruction and removal efficiency organic compounds considered difficult to burn, including 1,1,1-trichloroethane, carbon tetrachloride, chlorobenzene, trichloroethylene, and tetrachloroethylene. Also destroyed were organic compounds that burn more easily, such as benzene, toluene, xylene, and nitrobenzene. In additional EPA tests of boilers, fuel oil was spiked with selected organic compounds, including chloroform, 1,1,1-trichloroethane, trichloroethylene, and trichlorobenzene (Ref. 106). Accordingly, EPA believes that data demonstrate the use as fuel of the solvent wastes of sufficient heat value and all solvent constituents addressed in this proposed rule.

The Agency is currently developing regulations that will govern the use of hazardous waste as fuel. These standards are likely to control hydrogen chloride emissions. (The Agency already controls these emissions for incinerators.) To meet the emission standard, owner/operators could limit the chlorine levels in the waste or rely on emission control equipment, such as scrubbers. EPA believes that most industrial furnaces, and some boilers, will be able to meet these standards when burning hazardous solvent wastes as fuel.

3. Available Treatment Technologies

a. *Proprietary processes.* The Agency has determined that none of the demonstrated treatment technologies for the separation/removal or destruction of Appendix VII solvent constituents in F001 through F005 wastes are considered proprietary processes. Therefore, no technologies need to be excluded from consideration in establishing treatment standards based on their proprietary nature.

The Agency recognizes that proprietary treatment processes may also exist for which it has no data. The Agency solicits comments on specific proprietary treatment processes for solvent-bearing wastes, their performance for each solvent constituent, and their specific applicability to F001 through F005 solvent wastes and constituents.

b. *Analysis of relative risks.* The Agency evaluated 20 representative solvent waste streams and 10 treatment and recycling unit processes to determine if alternative treatment and recycling methods pose greater risks than land disposal methods. The results of this evaluation are summarized here. More detailed information on this analysis is given in the Background Document to the Comparative Risk Assessment (Ref. 1). Although final evaluations have not yet been completed, preliminary results indicate that the best demonstrated treatment technologies for solvents do not pose total risks to human health and the environment greater than those posed in the direct land disposal of most categories of the solvent wastes subject to today's proposed rulemaking. Detailed analyses are underway, however, to evaluate risks posed by the treatment of certain categories of solvent waste streams in steam strippers and incinerators. Since greater risks may be posed by these technologies only for a small subset of the solvent wastes subject to today's proposed rulemaking, EPA is continuing to classify both of these technologies as available treatment technologies for purposes of establishing the section 3004(m) treatment standards until the results of the detailed analyses are available. If this analysis indicates that these technologies are riskier than land disposal and this determination would change the treatment standard for these wastes, a supplemental proposal to this rulemaking will be issued. The waste streams and technologies chosen for this analysis are summarized below and are described in more detail in the Background Document to the Comparative Risk Assessment (Ref. 1). The methodology used to perform the comparative risk assessment is explained in Unit III.C.

The waste streams chosen for the analysis are derived from waste streams already characterized in the RCRA Risk-

Cost Analysis (WET) Model database (Ref. 118). In general, the wastes represent wastewaters, concentrated organic liquids, and organic sludges containing various concentrations of hazardous constituents. Wastes that contain only solvents, as well as those that contain both solvent and metal constituents, are represented.

The waste streams containing only solvent constituents range in concentration from 0.5 percent (5,000 mg/1) to 80 percent (800,000 mg/1), a range EPA judges to be representative of the solvent concentration in listed hazardous wastes. Because not all solvent constituents of concern could be modeled, EPA chose the constituents based on the frequenty of their occurrence in F001, F002, F003, F004, and F005 wastes codes. Also, the quality of toxicity data available for each constituent influenced the choice of constituents. In order to simplify the analysis, the waste streams contain either halogenated solvent constituents (e.g., 1,1,1-trichloroethane, carbon tetrachloride, methyl chloride, chloroform) or nonhalogenated compounds (e.g., benzene, toluene, m-xylene).

The waste streams containing both solvent and metal constituents are either wastewaters containing as little as .012 percent (120 mg/1) solvents and 0.1 percent (1,000 mg/1) metals or concentrated streams containing as much as 60 percent (600,000 mg/1) solvents and 6 percent (60,000 mg/1) metals. EPA believes that this range represents the range of concentrations present in RCRA-listed hazardous wastes that also contain solvent constituents. The metals chosen for the analysis are the following: lead. mercury, thallium, choromium (VI), cadmium, and arsenic. These metals correspond to those in the California List.

For the purposes of this evaluation, numerous treatment and recycling unit processes were combined to form treatment trains. These sequences represent treatment trains that EPA judges will meet the treatment standards ultimately established. All demonstrated technologies are represented, as well as those that do not meet EPA's criteria for demonstrated, but may be able to meet the treatment standards for some wastes. The unit processes evaluated for the solvent constituents include steam stripping, distillation, carbon adsorption, and incineration. EPA has not yet completed the evaluation of biological degradation and air stripping. To the extent that the results of the comparative risk assessment for these technologies would affect the treatment standards proposed today, a supplemental proposal to this rulemaking will be issued.

Treatment systems for treating solvent wastes that also contain metals often incorporate unit processes to remove the metal constituents. In order to assess the total risk associated with the treatment of solvent wastes containing metals, the treatment trains modeled and evaluated for these waste streams include the following: chromium reduction, chemical precipitation, sludge drying beds, vacuum filtration, centrifugation, and lime fixation.

Both surface impoundments and landfills were used to simulate the land disposal. Liquid waste streams were presumed to be land disposed in surface impoundments and sludges and solids were presumed to be landfilled.

4. Determination of BDAT and Achievable Concentrations

The Agency evaluated performance data for the five processes that are demonstrated treatment/recycling technologies for the treatment of hazardous wastes containing solvents: Steam stripping, carbon adsorption, biological degradation, distillation, incineration, and fuel substitution. EPA found that BDAT for solvent wastes and constituents amenable to separation/removal techniques is either steam stripping, carbon adsorption, biological treatment, or some combination of these processes. BDAT for solvent wastes not amenable to separation/removal methods is either incineration or fuel substitution.

The best performance achieved by BDAT for each solvent constituent addressed today is given in the following Table 11:

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TABLE 11--PERFORMANCE ACHIEVED BY BDAT (MG/L)

Constituent	Screening Level	Steam Stripping	Carbon Adsorption	Biological Treatment[1]	Combination	Fuel Substitution/ Incineration
Acetone	2.0			<0.050[2]		<0.050[2]
n-Butyl alcohol	2.0			<0.100[2]		<0.100[2]
Carbon disulfide	2.0					<0.010[2]
Carbon tetrachloride	0.1			<0.010		<0.010
Chlorobenzene	2.0			0.292	0.062[3]	<0.020
Cresols	2.0		0.62	<0.100[2]		<0.100
Cyclohexanone	2.0			<0.100[2]		<0.100[2]
1,2-Dichlorobenzene	2.0			0.302	0.053[3]	<0.010[2]
Ethyl acetate	2.0			<0.100[2]		<0.100[2]
Ethylbenzene	2.0	0.200		<0.010		<0.010[2]
Ethyl ether	2.0			<0.100[2]		<0.100[2]
Isobutanol	2.0			<0.050[2]		<0.050[2]
Methanol	2.0			<0.100[2]		<0.100[2]
Methylene chloride	1.2	0.109		0.011		<0.010
Methyl ethyl ketone	2.0			<0.050[2]		<0.050
Methyl isobutyl ketone	2.0			<0.010[2]		<0.010[2]
Nitrobenzene	0.09		0.027	<0.010	0.026[3]	<0.010[2]
Pyridine	0.7			<0.500[2]		<0.500[2]
Tetrachloroethylene	0.015			<0.010		<0.010
Toluene	2.0	0.036	0.016	0.066	0.230[3]	<0.010
1,1,1-Trichloroethane	2.0	0.457				<0.010
1,1,2-Trichloro-1,2,2-trifluoroethane	2.0	0.457[2]				<0.010[2]
Trichloroethylene	0.1	0.019		0.011		<0.010
Trichlorofluoromethane	2.0	0.457[2]				<0.010[2]
Xylene	2.0				<0.005[4]	<0.010[2]

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Footnotes

[1] Includes activated sludge, trickling filters, and aerated lagoons.

[2] Estimated value.

[3] Activated sludge followed by granular activated carbon.

[4] Granular activated carbon followed by steam stripping.

The screening concentration levels or liner protection thresholds discussed in Unit V.E. are also listed. As explained in Unit III.B, whenever BDAT achieves the screening or liner protection concentrations, treatment is substantial. Because BDAT for solvent wastes achieves these concentrations for each solvent constituent, BDAT for solvents is substantial treatment in all cases. The basis for determining BDAT concentrations is discussed in this unit. In Unit V.G the Agency discusses the comparison of the performance of BDAT to the screening concentration levels established in Unit V.E.

It is important to note that, although destruction techniques such as incineration and fuel substitution are capable of completely destroying solvent wastes and constituents, many solvent constituents present in wastewaters cannot be completely removed by separation/removal processes. Therefore, BDAT levels achievable for these constituents in wastewater are higher than those achieved by incineration or fuel substitution. The Agency believes that the more concentrated solvent wastes will be destroyed by incineration or fuel substitution because wastewater treatment of these wastes is impractical. Thus, it is unnecessary for the Agency to establish different performance categories for wastes amenable to incineration versus wastewater treatment to assure that BDAT is used. In the case of solvents, both technologies meet the screening or liner protection levels described in Unit V.E, as discussed below.

a. *Analysis of performance data.* EPA is aware of numerous reports in the technical literature as to the solvent concentrations achieved by the demonstrated technologies identified previously. These concentrations show a wide variation in performance. EPA believes that this is explained by the fact that solvent separation technologies are designed to achieve specific efficiencies for the projected influent loading. Therefore, the performance of solvents treatment is controlled by the design and operation of the treatment system, i.e., rate of heat transfer for steam stripping, amount of activated carbon per volume of wastewater, and detention time and aeration rate for biological treatment.

As a result, EPA does not intend to pool all available performance data, regardless of design, in developing treatment standards. Instead, EPA intends to review the available performance data and determine the concentration achievable by a "reasonable" design and operation for such equipment. EPA's test for reasonable will be whether a given constituent concentration is achievable by systems the Agency judges to be comparable to the "best" systems now in use, even if no data currently exist to document the treatment of a solvent constituent to this concentration using the "best" system. EPA will not consider as reasonable unusually repetitious treatment systems or the use of other designs or operation that are inconsistent with standard engineering practice. EPA solicits comment on the actual designs of demonstrated technologies necessary to achieve the BDAT levels identified in Table 11 and the reasonableness of providing treatment systems that meet these design specifications.

Furthermore, EPA did not include effluent data for the treatment of wastes that contains solvent concentrations less than the health-based or liner effects thresholds. EPA believes that the inclusion of such data would skew the results towards an unreasonably low performance number.

Performance data for those technologies determined to be demonstrated are summarized in this unit. All specific technical data are available in the Background Document for solvents to support this proposed rule (Ref. 4).

b. *Steam (and air) stripping.* According to available data, steam stripping achieves lower effluent concentrations for solvent wastes containing higher concentrations of solvent constituents than does air stripping. EPA concludes that steam stripping, and not air stripping, is BDAT for certain wastewaters containing solvents. As stated previously, steam stripping has been applied in wastewaters containing up to several thousand milligrams per liter of solvent constituents.

Data on steam stripping of solvent constituents is available for many of the solvent constituents addressed in this proposal. Because EPA believes that the performance of steam stripping is design- and operation-limited, it chose to evaluate data for the performance of only optimally designed and operated steam stripping devices. Based on data from these types of units, steam stripping is BDAT for five solvent constituents of concern: ethylbenzene, methylene chloride, toluene, 1,1,1-trichloroethane, and trichloroethylene.

Henry's Law Constants, which take into account vapor pressure and water solubility, are an excellent theoretical indicator of the ease with which chemical compounds can be stripped. Compounds with Henry's Law Constants greater then 10^{-3} are generally considered highly volatile. Based on their Henry's Law Constants, eight additional solvents are highly volatile. (Henry's Law Constants can be found in Refs. 4, 76, and 117.) These constituents are the following: carbon disulfide, carbon tetrachloride, chlorobenzene, 1,2-dichlorobenzene, tetrachloroethylene, 1,1,2-trichloro-1,2,2-trifluoroethane, trichlorofluoromethane, and xylene. Their high volatility indicates that steam stripping is potentially BDAT for these solvents.

Because no other treatment data are available for the two most volatile solvents, 1,1,2-trichloro-1,2,2,-trifluoroethane and trichlorofluoromethane, EPA is estimating that these solvents can be steam stripped to at least the level that can be achieved for 1,1,1-trichloroethane, or 0.457 mg/1. The Henry's Law Constant for 1,1,2-trichloro-1,2,2,-trifluoroethane is two orders of magnitude larger than that of 1,1,1-trichloroethane; the Henry's Law Constant for trichlorofluoromethane is one order of magnitude larger. Because these solvents are far more volatile than 1,1,1-trichloroethane, EPA believes that at the very least the performance given above can be achieved. In the final rule, EPA also may decide to extrapolate steam stripping performance for the other volatile solvents. EPA requests influent and effluent stripping data on these solvents, as well as design and operational information on the steam stripping units used to treat them.

Several other constituents with Henry's Law Constants ranging from 8.7×10^{-4} to 1×10^{-5} are reported to be moderately volatile: ethyl ether, ethyl acetate, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, nitrobenzene, and isobutanol. Solvent constituents that are slightly volative (Henry's Law Constant between 7.0×10^{-6} and 9.5×10^{-7}) include n-butyl alcohol, acetone, cresols, and methanol. Pyridine is reported to be nonvolatile. Conceivably, given high temperatures and long retention times, the moderately and slightly volatile constituents can be steam stripped to low levels. However, EPA has little or no data showing that steam stripping alone achieves the lowest levels possible for these constituents.

Based on available data and chemical properties (i.e., vapor pressure and water solubility) the Agency believes that steam stripping is potentially applicable to wastewaters contaminated with any of the F001 through F005 solvent constituents for which steam stripping is indicated in Table 11. The low levels (i.e., levels approaching detection limits) for these solvents achieved by steam stripping indicates that steam stripping is BDAT for these solvents. EPA recognizes that there may be other constituents present which may preclude application of this technology and solicits comments on such constituents, as well as paired influent and effluent data for steam stripping of solvents. The Agency requests comment on the design characteristics necessary to achieve these concentrations for wastes listed under F001 through F005 waste codes.

c. *Carbon adsorption.* Data on carbon adsorption indicate that all solvent constituents for F001 through F005 wastes are adsorbed to some extent. Carbon adsorption produces exceptionally low concentration (approaching detection limits) for only three solvent constituents: cresols, nitrobenzene, and toluene. These concentrations for these, which were achieved in full-scale carbon adsorption units, are given in Table 11.

As with steam strippers, carbon adsorption units need to be specifically designed and operated to achieve adequate removal of solvents based on the influent concentration and other constituents present in the waste treated. The Agency recognizes that carbon adsorption is particularly sensitive these variables, and that even with pretreatment, this technology may not be applicable or the specified levels achieved on specific waste matrices that would demand an excessively large amount of carbon. EPA solicits comments on such variables and solicits paired influent and effluent data for the removal of solvents by activated carbon.

d. *Biological treatment.* As discussed earlier, data on biological treatment demonstrated that it can be applied to all solvent constituents when they are present at levels in wastewater that are nontoxic to acclimated microorganisms. Table 11 indicates the solvents for which performance data are available from well-operated biological treatment systems. These constituents are the following: carbon tetrachloride, chlorobenzene, 1,2-dichlorobenzene, ethylbenzene, methylene chloride, nitrobenzene, tetrachloroethylene, toluene, and trichloroethylene. The biological treatment methods used include activated sludge, trickling filters, and aerated lagoons. Because the levels achieved shown in Table 11 are very low (approaching detection), biological treatment is BDAT for these solvents.

EPA also believes that very soluble compounds can be removed to their detection limits, even though performance data are not available for these compounds. These constituents are the following: acetone, n-butyl alcohol, cresols, cyclohexanone, ethyl acetate, ethyl ether, isobutanol, methanol, methyl ethyl ketone, methyl isobutyl ketone, and pyridine. As noted earlier, a great deal of literature exists to support EPA's contention that the compounds listed above are highly biodegradable, include bench- and pilot-scale data for some constituents. EPA believes that biological treatment is BDAT for these solvents. However, because data, particularly from full-scale systems, have not been identified, EPA encourages comment that provides paired data showing influent and effluent data for biological treatment of these constituents, as well as resulting concentrations of constituents in the sludge. EPA also invites comment on the loading rates and detention times necessary to remove these and other constituents to their detection levels in properly operated biological treatment units, and the rate at which air or oxygen are added during treatment.

e. *Combinations of wastewater treatment technologies.* There are at least three general combinations of demonstrated technologies that also are used to treat solvent wastes. Steam stripping can be used prior to biological treatment to reduce relatively high solvent concentrations that would inhibit biological activity. Activated carbon can also be used following biological treatment for solvents to reduce the carbon capacity required to achieve the desired performance. Lastly, all three technologies can be used in the same treatment system.

As shown in Table 11, available data indicate that activated sludge followed by granular activated carbon is BDAT because of the low levels achieved for four solvent constituents: chlorobenzene, 1,2-dichlorobenzene, nitrobenzene, and toluene. Granular activated carbon followed by steam stripping is BDAT for xylene. The Agency solicits additional data pertaining to the performance of these or other technology combinations. EPA solicits paired data on the performance achieved by these systems and the design characteristics appropriate for the combined system.

f. *Distillation.* Distillation is a method to separate a solvent or solvents from other organic constituent of a waste, including other solvents. It is also used to purify a solvent by separating the solvent from contaminents (e.g., water). Distillation is normally used to reclaim solvents from wastes containing high concentrations of solvents and low levels of solids, usually leaving behind a sludge (still bottom). Data indicate that the residual ranges from 9 to 44 percent of the volume of the waste prior to distillation, with an average residual volume of approximately 15 percent. This residual sometimes contains even higher concentrations of solvents than the original waste.

EPA believes that distillation can be considered a waste concentration and/or volume reduction step in a treatment train which includes destruction of the still bottoms. However, based on available information, distillation alone does not appear to achieve low levels of solvents in the waste residual, and therefore is not considered BDAT for any solvent waste. EPA requests data on the performance of distillation, including the concentration of solvents (and metals) in the influent, still bottoms, and reclaimed solvent. Information on the percent solids present in the still bottoms is also requested.

g. *Incineration.* Incineration is demonstrated on all solvent constituents listed in F001 through F005 waste. Incineration has been performed on liquids, sludges, and solids, most of which are not amenable to wastewater treatment. Incineration has achieved 99.99 percent destruction and removal efficiencies in the air emissions for all solvents. However, in this rulemaking, EPA is concerned with the wastes and residuals going to land disposal, such as the incinerator ash and the scrubber water. Data are available characterizing scrubber water from four full-scale incinerators, and ash from three of these incinerators, operating at 99.99 percent DRE for air emissions during test burns (Ref. 77). The feed for these incinerators contained nine of the solvent constituents subject to this proposed rule, including difficult to incinerate chlorinated solvents. In most cases, the solvent constituents were not detected in the scrubber water or the ash. Based on this information, the Agency believes that the scrubber water and ash from an incinerator achieving the 99.99 percent DRE for air emissions will not contain detectable levels of any of the solvent constituents addressed in this proposal. Incineration is therefore DBAT for incinerable solvent wastes. Performance based on both actual data and EPA estimates is given in Table 11.

EPA is currently gathering more data on the presence of hazardous constituents in incinerator ash and scrubber water. EPA solicits additional paired data on the concentration of solvent constituents in incinerator feed, influent and effluent scrubber water, and fly and bottom ash to compare to these data.

Solvents containing metals may result in ash residuals that require additional treatment to immobilize the metal constituents, and in scrubber water that must be treated to remove metals. Treatment standards for some metals will be addressed in a later rulemaking.

h. *Fuel substitution.* Use of these solvents as a fuel substitute is essentially identical to incineration of these wastes. Industrial boilers and furnaces, such as cement and lime kilns, burn solvent wastes directly as fuel or indirectly by blending it with auxiliary fuel. As discussed earlier, halogenated solvent constituents, although the most difficult to burn, can be destroyed in industrial boilers and furnaces to achieve 99.99 percent DRE in the air emissions from these devices (Ref. 105). Therefore, EPA believes that, like incinerators, industrial boilers and furnaces which are capable of meeting 99.99 percent DRE will not produce residuals with detectable levels of the solvents addressed in this rule. EPA concludes that use of solvent wastes as fuel is BDAT for solvent wastes recycled in this way.

Some existing data indicate that certain types of industrial furnaces (e.g., aggregate kilns) do not combust waste as well as other types of devices that utilize solvent waste as fuel. It is unclear if the residuals from these devices will achieve the low levels of solvents in their residuals that are achieved by incinerators. EPA solicits paired data on the concentration of solvent constituents in hazardous wastes used as fuel in industrial boilers and furnaces, and the levels of these constituents in residual scrubber water, fly ash, and bottom ash from these devices.

i. *Request for comment.* The Agency solicits comments and data which pertain specifically to the performance of destruction, removal, or immobilization methods for solvent constituents listed in F001 through F005 wastes. The Agency solicits this type of data for any of the demonstrated technologies, as well as any of the technologies previously identified as potentially applicable to solvent wastes. In order to assess treatment performance properly, these data should include waste codes, physical/chemical form of the waste, initial concentrations, all residual concentrations (i.e., air, water discharges) and leachability of solid residuals, as well as design and operating parameters for the technology.

G. Comparison of BDAT and Screening Levels

The following Table 13 gives the technology-based levels, the screening or liner protection thresholds, and the treatment standards for each solvent constituent of F001 through F005 wastes:

TABLE 13.—COMPARISON OF SCREENING AND LINER PROTECTION THRESHOLDS WITH TECHNOLOGY-BASED LEVELS AND THE TREATMENT STANDARDS (MG/L)

Constituent	Screening/Liner protection threshold	Technology-based level	Treatment standard
Acetone	2.0	[1] <0.050	2.0
n-Butyl alcohol	2.0	[1] <0.100	2.0
Carbon disulfide	2.0	[1] <0.010	2.0
Carbon tetrachloride	0.1	<0.010	0.1
Chlorobenzene	2.0	<0.062	2.0
Cresols	2.0	[1] <0.100	2.0
Cyclohexanone	2.0	[1] <0.100	2.0
1,2-Dichlorobenzene	2.0	0.053	2.0
Ethyl acetate	2.0	[1] <0.100	2.0
Ethylbenzene	2.0	<0.010	2.0
Ethyl ether	2.0	[1] <0.100	2.0
Isobutanol	2.0	[1] <0.050	2.0
Methanol	2.0	[1] <0.100	2.0
Methylene chloride	1.2	<0.011	1.2
Methyl ethyl ketone	2.0	[1] <0.050	2.0
Methyl isobutyl ketone	2.0	[1] <0.100	2.0
Nitrobenzene	0.09	<0.010	0.09
Pyridine	0.7	[1] <0.500	0.7
Tetrachloroethylene	0.015	<0.010	0.015
Toluene	2.0	0.016	2.0
1,1,1-Trichloroethane	2.0	0.457	2.0
1,1,2-Trichloro-1,2,2-trifluoroethane	2.0	[1] 0.457	2.0
Trichloroethylene	0.1	<0.019	0.1
Trichlorofluoromethane	2.0	[1] 0.457	
Xylene	2.0	<0.005	2.0

[1] Estimated value.

As explained in Unit II, whenever BDAT can achieve the screening or liner protection threshold, this threshold becomes the treatment standard. EPA believes that BDAT can achieve the screening or liner protection threshold in all cases.

As noted earlier, the levels achievable using BDAT for solvent constituents in wastewater are often higher than those achieved by incineration or fuel substitution. EPA believes that it is unnecessary for the Agency to establish different performance categories for wastes amenable to incineration rather than wastewater treatment to assure that BDAT is used. Therefore, Table 13 gives the BDAT levels achieved by wastewater treatment. Because even these levels are better than the screening or liner protection levels, the differences between wastewater treatment performance and thermal destruction performance is unimportant. Also, the levels achieved by the best wastewater treatment method for each constituent is listed. However, all of the BDAT levels listed in Table 11 achieve the screening or liner protection levels.

Although EPA prefers to use performance data (rather than theoretical levels) as the basis for BDAT levels, in some cases EPA believes it is appropriate to use an estimated value for treatment performance. These cases are indicated in Table 13. The rationale for choosing either the actual data or the theoretical levels is given in Unit V.F. The Agency solicits treatment data to support these theoretical levels, or to demonstrate that different treatment levels are achievable.

H. Determination of Alternative Treatment and Recycling Capacity for Solvents and Effective Dates

As explained in Unit III.E, EPA may extend the effective date of land disposal restrictions if, on a nationwide basis, there is insufficient alternative treatment, recovery, or disposal capacity that protects human health and the environment. In order to determine whether the effective date of the solvents restrictions should be extended, EPA has examined the alternative capacity requirements for solvent hazardous wastes that are currently land disposed, by estimating the quantity of this waste that will be directed to specific types of alternative treatment, recovery (recycling), and disposal technologies. This quantity is then compared to available capacity of alternative technologies.

As discussed in Unit III.E, EPA is not considering deep well injection as alternative disposal capacity in this proposed rulemaking. Also, no ocean-disposal permit currently applies to any solvent waste subject to today's proposed rulemaking. Accordingly, the Agency concludes that, for the purpose of this proposal, no alternative disposal methods, and thus capacity, exists for these solvent wastes. Therefore, all alternative capacity consists of treatment and recycling capacity. The analysis of the demand for and availability of alternative treatment and recycling capacity for solvent waste is given below.

1. Summary of Volumes of Wastes Land Disposed Annually

EPA estimated the quantity of hazardous waste listed under F001 through F005 waste codes and the corresponding P and U waste codes that is currently land disposed annually. The estimates are based primarily on the data provided by the OSW RIA Mail Survey of hazardous waste management activities in 1981 (Ref. 116). The analysis of the Survey data is summarized in this unit. A more detailed assessment is given in the Background Document for solvents to support this proposed rule (Ref. 4).

Because concentration data are not provided by the Survey, EPA is assuming that all hazardous waste identified as F001, F002, F003, F004, or F005 or the corresponding P and U waste codes in the Survey exceeds the treatment standards proposed today and that this waste will be banned from land disposal.

EPA estimates that approximately 214 million gallons of the total quantity of solvent waste per year that is land disposed will require alternative treatment or recycling capacity. Of this total, the Agency estimates that 185 million gallons (86.4 percent) are solvent-water mixtures (i.e., aqueous wastes), 14.7 million gallons (6.9 percent) are organic liquids, 7.3 million gallons (3.5 percent) are organic sludges or solids, and 6.7 million gallons (3.2 percent) are inorganic sludges or solids.

EPA does not know which surface impoundments will meet the requirements of RCRA section 3005(j)(11)(A) and (B), thus allowing their continued use for treatment. (See Unit I.C for a discussion of the exemption for treatment in surface impoundments.) In the calculations to determine the total quantity of waste requiring alternative capacity, EPA has assumed that surface impoundments accounting for 80 percent of the volume of solvent-water mixtures treated in surface impoundments will continue to operate under this exemption. This assumption is consistent with the economic impact assessment prepared in support of this rule and is based primarily on the economic feasibility of meeting the section 3005(j)(11)(A) and (B) requirements (Ref. 9).

For the purposes of this proposed rulemaking, the Agency is also assuming that solvent wastes described as organic liquids contain greater than 1 percent total organic content by weight, and those described as solvent-water mixtures contain less than 1 percent. The basis for this assumption are data for three facilities with large-volume aqueous waste streams which account for 94 percent of the total volume of solvent-water mixtures treated or disposed of in surface impoundments annually. These waste streams are characterized as greater than 99 percent water and less than 1 percent total solvents. Because there is no standard method for the determination of total solvent content, EPA is assuming that these waste streams contain few additional organic constituents, and that their total organic content is also less than 1 percent. Total organic content can be measured by the test for total organic carbon (TOC) (see 40 CFR 136.3).

EPA is also assuming in this rule that wastes characterized as solvent-water mixtures contain less than 1 percent total solids and those described as sludges contain greater than 1 percent total solids.

2. Required Treatment and Recycling Capacity

In order to determine the treatment and recycling capacity required to address the volumes of wastes given above, these wastes must be assigned to treatment and recycling methods. EPA can then compare this demand for treatment and recycling capacity to the available unused capacity of these alternative methods to land disposal.

The Agency recognizes that the actual application of a technology to a specific solvent waste is highly dependent upon waste characteristics such as the content of solvents, halogens, metals, water, and the heat value as fuel. As noted above, the concentration data for solvent wastes currently land disposed are limited. However, EPA can use the available data describing land disposed waste to approximate the most likely alternative treatment and recycling technologies for all wastes in a waste group. The rationale for assigning specific types of solvent wastes to one of these alternative technologies is summarized below. For more information, see the Background Document for solvents to support this proposed rule (Ref. 4).

a. *Solvent-water mixtures.* As given in Unit V.H.1, liquids containing solvents and water comprise 185 million gallons (86.4 percent) of all solvent wastes currently land disposed each year. Almost all of these wastes (99.9 percent) are handled in surface impoundments. As stated earlier, EPA estimates that aqueous mixtures contain less than 1 percent total organics and less than 1 percent total solids.

The low organic content and high water content of these wastes result in a waste with little or no heat value. EPA has evaluated data which indicate that some solvent-water mixtures with as low as 0.01 percent total solvent content have been incinerated, but incineration of these wastes requires a great deal of blending with wastes of higher heat content. The Agency believes it is unlikely that relatively dilute solvent-water mixtures will require incineration capacity. For the same reasons, this waste is not amenable to use as a fuel substitute. Also, distillation, the most common means of reclaiming solvents, generally requires concentrations of at least 10 percent solvents. Based on this information, EPA is estimating that none of the 185 million gallons of solvent-water mixtures that are currently land disposed and that require alternative capacity will be used as a fuel substitute, incinerated, or sent to solvent reclamation.

Accordingly, the Agency is assuming that the entire 185 million gallons of solvent-water mixtures land disposed annually require some form of wastewater treatment technologies applicable to dilute waste. Wastewater treatment technologies identified in Unit V.F include biological degradation, chemical oxidation, steam stripping, and carbon/resin adsorption. As discussed in Unit V.F, biological degradation, steam stripping, and carbon adsorption are demonstrated on many solvent wastes, and the treatment standards given in Unit V.G are based on these methods. In addition, chemical oxidation and resin adsorption, although not demonstrated for a wide variety of solvents, are capable of achieving the treatment standards for some solvent wastes.

Solvent-water mixtures may be treated by many different combinations of wastewater treatment technologies sequenced in various process trains taking place in tanks. The choice of treatments will depend on specific waste characteristics and economic factors, and EPA data are currently insufficient to determine precisely the volumes of wastes that would require any specific wastewater treatment. Because EPA currently lacks these data, it is unable to determine the future capacity needs for specific wastewater treatment methods. For the purpose of determining capacity needs in this proposal, it is necessary for EPA to group solvent-water mixtures of less than 1 percent total organics into one treatability group of wastes, all of which require some form of wastewater treatment. So that EPA may better define capacity needs by technology, it requests information on the treatment technologies that generators will choose to replace land disposal of solvent-water mixtures, and the factors that will influence this decision.

b. *Organic liquids.* As described in Unit V.H.1, EPA estimates that currently 14.7 million gallons of organic liquids are land disposed each year, and that these wastes contain greater than 1 percent total organic constituents. In addition, 5.9 million gallons of wastes generated by small quantity generators (SQGs) are organic liquids and will compete for alternative capacity with currently land disposed organic liquids. EPA believes that the organic liquids produced by SQGs are similar to the organic liquids currently land disposed. Therefore, a total of 20.6 million gallons of organic liquids require alternative capacity. EPA estimates that 10.9 million gallons of organic liquids contain principally halogenated organic constituents and 9.7 million gallons contain nonhalogenated organics.

Because of their higher organic content (greater than 1 percent), EPA estimates that all organic liquids are amenable to incineration, although some of these wastes may require blending with wastes of higher heat value. As discussed in Unit V.F, EPA believes that incineration can meet the treatment standards given in Unit V.G for solvent wastes.

EPA also believes that some of these organic liquids can be reclaimed by distillation or used as fuel substitutes. Distillation is a volume reduction or concentration step in a treatment process which also must include destruction of the distillation still bottoms, either by incineration or fuel substitution, in order to meet the treatment standards. EPA estimates that currently at least 428 million gallons of spent solvents are reclaimed by distillation each year.

As Unit V.F. explains, fuel substitution is equivalent to incineration in its ability to destroy solvent wastes. Hazardous wastes containing solvents are often used as fuel substitutes. Approximately 159 million gallons of wastes containing solvent constituents found in F001, F002, F003, F004, and F005 wastes are currently burned as fuel. The Agency believes that spent solvents, even those containing high concentrations of metals, can be safely burned in industrial furnaces, and some boilers, if these facilities meet regulations that EPA is now developing. However, these new regulations may influence the quantity and characteristics of hazardous wastes currently used as fuel. Because the Agency is uncertain to what extent solvents will be used as fuel under the new requirements, to determine capacity requirements, EPA is assuming that no solvent wastes banned from land disposal will be directed to fuel substitution.

The data indicate that organic liquid waste containing halogenated solvents are equally likely to be distilled as incinerated. Data also show that organic liquids containing nonhalogenated solvents are not as frequently distilled for reuse as are halogenated solvents. In general, the resale value of halogenated solvents is higher than that of nonhalogenated solvents. Therefore, in order to estimate the total quantity of organic liquid waste that is amenable to each alternative technology, EPA assumes that approximately half (when considering rounding of decimals) of all halogenated organic liquids will be incinerated and about half will be distilled. EPA is also assuming that two-thirds of nonhalogenated organic liquids will be incinerated and one-third distilled.

Based on this analysis, the organic liquids that will be incinerated annually include 5.5 million gallons of halogenated solvents and 6.5 million gallons of nonhalogenated solvents, for a total of 12.0 million gallons of organic liquids. The organic liquids that will be distilled each year include 5.4 million gallons of halogenated solvents and 3.2 million gallons of nonhalogenated solvents, for a total of 8.9 million gallons.[13] The Agency recognizes that these are only estimates and requests information and comment that support these or alternative estimates.

c. *Organic sludges and solids.* As stated in Unit V.H.l, EPA estimates that 7.3 million gallons of organic sludges and solids currently are land disposed per year. These sludges and solids contain greater than 1 percent total organics and greater than 1 percent total solids. In addition, 1.9 million gallons of wastes generated by small quantity generators are organic sludges and will compete for alternative capacity with currently land disposed organic sludges. Also, 1.2 million gallons of still bottoms will be generated by distillation of the organic liquids discussed in the previous unit. Therefore, a total of 10.4 million gallons of organic sludges and solids require alternative capacity. Of this quantity, EPA is assuming that 7.2 million gallons of organic sludges and solids contain primarily halogenated organic constituents and 3.2 million gallons contain nonhalogenated constituents.

Organic sludges and solids are amenable to both incineration and use as a fuel substitute. Blending of still bottoms for use as a fuel in industrial boilers or furnaces is recognized as a common disposal method for these wastes and is widely practiced. As stated before, EPA is confident that many industrial furnaces, and some boilers, can burn spent solvents, even those containing high concentrations of metals, when using control technologies required to meet the new rules that the Agency is currently developing. However, for the reasons given in the previous unit, EPA is assuming that no wastes banned from land disposal will be used as fuel substitutes. EPA is assuming that all of the organic sludges and solids, 3.2 million gallons of nonhalogenated and 7.2 million gallons of halogenated organic solvents, will be incinerated. Therefore, a total 10.4 million gallons of organic sludges and solids require incineration capacity.

d. *Inorganic sludges and solids.* As given in Unit V.H.1, 6.7 million gallons of inorganic sludges and solids are currently land disposed. These wastes consist of (1) soils contaminated with solvents, and (2) sludges and solids containing less than 1 percent total organics and greater than 1 percent total solids. Although EPA estimates that soils contain between 1 percent and 7 percent organics, EPA believes that those surveyed in the RIA Mail Survey considered any soil contaminated with solvents as an inorganic solid.

EPA estimates that these inorganic sludges and solids contain concentrations of solvents too low to allow these wastes to be distilled or reused as fuel. The Agency has determined that the only treatment option for the 6.7 million gallons of inorganic sludges and solids contaminated with solvents is destruction by incineration. Although the concentration of this waste is too low to incinerate alone, it can be co-fired with waste of higher heat value. A potential secondary option for treatment of these wastes is encapsulation by chemical fixation or solidification processes. However, the Agency has too little information on the applicability of encapsulation to solvent wastes to estimate the quantities of wastes that might be treated by this technique.

e. *CERCLA wastes.* Estimating capacity demands of CERCLA waste is difficult for several reasons. First, few data are available to describe CERCLA waste in sufficient detail to determine its treatability. Secondly, the Agency has no way of predicting whether wastes removed from future site

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[13] EPA estimates that 1.2 million gallons of still bottoms will be generated by distilling this waste. Capacity for treating still bottoms is considered under organic sludges and solids.

cleanups will be similar in type and quantity to wastes removed in the past. Lastely, EPA must determine the quantity of CERCLA waste that represents an increase in the demand for capacity over current treatment and recycling practices for CERCLA waste. Such an increase may result from the land disposal restrictions. However, the Agency's recent policy emphasizing the use of alternatives to land disposal for CERCLA wastes may assert a greater demand on capacity. Capacity demand also depends heavily on the number of CERCLA actions and the extent of each cleanup.

Because of the problems that this analysis entails, EPA has not yet completed its estimates of the future alternative capacity demands presented by CERCLA waste. The results of this evaluation will be included in the final rule. For the purposes of this proposal, however, EPA is assuming that the alternative capacity (e.g., incineration) required by CERCLA wastes will remain at its current rate of use.

f. *Summary of capacity needs.* In the previous units, the Agency estimated that the quantity of solvent wastes requiring wastewater treatment is 185 million gallons. Wastewater treatment will be performed by a variety of treatment methods (e.g., biological degradation, steam stripping, or carbon adsorption) occurring in tanks. The quantity of solvent wastes requiring incinerator capacity annually is 22.4 million gallons of organic liquids, sludges, and solids and 6.7 million gallons of inorganic sludges and solids, for a total of 29.1 million gallons. The volume of waste requiring distillation capacity each year is 8.8 million gallons of halogenated and nonhalogenated organic liquids. The following Table 14 summarizes these quantitites:

TABLE 14.—ANNUAL TREATMENT AND RECOVERY CAPACITY DEMAND BY TECHNOLOGY

[Million gallons per year]

	Wastewater Treatment	Incineration	Distillation
Solvent-Waster Mixtures	185		
Halogenated Organic Liquids		5.5	5.4
Nonhalogenated Organic Liquids		6.5	3.2
Halogenated Organic Sludges and Solids		7.2	
Nonhalogenated Organic Sludges and Solids		3.2	
Inorganic Sludges and Solids		6.7	
Total	185	29.1	8.8

3. Unused Capacity of Treatment and Recycling Facilities

In the previous units, EPA estimated that solvent wastes restricted from land disposal as a result of these proposed rules will be directed to incineration and wastewater treatment methods that can achieve the treatment standards given in Unit V.G. Some solvent wastes will also be directed to recycling methods for solvent wastes including distillation and the use of waste as fuel. In this unit EPA estimates the unused capacity that is currently available, or will soon be available, to treat or recycle solvent wastes by these methods.

As explained in Unit III.E, private treatment, recycling, and disposal capacity will be considered in two circumstances: (1) if a private owner or operator plans to accept banned waste commercially when the ban becomes effective; or (2) when a private owner or operator has excess capacity to manage his own banned waste. At this time EPA does not have information on the extent to which these circumstances will occur. The Agency plans to conduct a treatment, storage, and disposal facility (TSDF) survey in the near future which it hopes will provide data on the availability of private capacity to manage hazardous wastes that are banned from land disposal. However, for the purposes of this proposed rulemaking, the determinations of the capacity to treat and recycle solvent wastes will be based solely on unused commercial capacity. EPA requests comment and information on the availability of private treatment and recycling capacity to manage the solvent wastes addressed today. The Agency will consider the capacity of private treatment and recycling facilities if the required information becomes available before the final rule is promulgated.

a. *Capacity of wastewater treatment facilities.* As discussed in Unit V.F., BDAT wastewater treatment methods for solvent-water mixtures are biological degradation, steam stripping, and carbon adsorption. In addition, other technologies, such as resin adsorption, although not BDAT, may be capable of meeting the treatment standards for some wastes (see Unit V.G.). All of the treatment methods are referred to as tank treatment under the RCRA TSDF regulations.

The OSW RIA Mail Survey (Ref. 116) is currently EPA's only source of information concerning the unused capacity at tank treatment facilities. The Survey provides information on tank capacity at both commercial and private facilities treating F001 through F005 solvent wastes, although the data at wastewater treatment facilities exempted from RCRA requirements are somewhat limited. As discussed above, EPA will consider only commercial wastewater treatment capacity in this proposed rulemaking.

The Survey data provided little information on specific treatment methods. Therefore, EPA estimated the total unused tank capacity at commercial facilities that treat solvents. This unused capacity is approximately 112 million gallons. This quantity represents the difference between planned design capacity (full capacity) of approximately 170 million gallons per year and used capacity of approximately 58 million gallons per year.

Because treatment facilities seldom operate at full capacity, the estimate of 112 million gallons is probably high. In addition, these commercial facilities treat other hazardous wastes, and EPA is not able to determine the portion of the 112 million gallons of unused capacity that is available to treat solvent wastes. In conclusion, the tank capacity dedicated to treat solvent wastes at commercial facilities is less than 112 million gallons.

b. *Capacity of incinerators and distillation.* EPA estimates that unused commercial incineration capacity is less than 25.6 million gallons per year. This calculation is based on the maximum design capacity of on-line commercial incinerators and a utilization rate of 80 percent (see Ref. 4). The Agency believes that this capacity is the maximum capacity available to incinerate solvent wastes. It requests comments on the utilization rate of 80 percent reported by several incinerator owner/operators. As discussed earlier, EPA has insufficient data to estimate the additional quantity of solvent liquid wastes that will be incinerated privately in the future. EPA requests data to help determine these quantities. In addition, several companies have proposed to build new rotary kiln incinerators that would operate commercially. However, at this time, construction has not begun on any of these facilities. Therefore, the Agency is unable to project when these incinerators will be completed, and capacity that they would provide cannot be considered for this proposed rulemaking. The final rule will consider the capacity of these facilities if such information becomes available.

As stated earlier, distillation of spent solvents is widely practiced. EPA estimates that unused commercial capacity for distillation totals 225 million gallons per year. EPA believes that a large number of distillation facilities is operated privately. EPA does not know the extent to which these facilities will accept waste commercially or be able to reclaim solvents from additional waste of their own. The Agency solicits comment and information in this area.

4. Comparison of Treatment and Recovery Demand with Unused Capacity

A summary of EPA's estimates of quantities of solvent wastes requiring treatment and recovery and the unused commercial capacity per technology is presented in the following Table 15:

TABLE 15.—COMPARISON OF ALTERNATIVE TREATMENT AND RECOVERY DEMAND WITH UNUSED CAPACITY

TABLE 15.—COMPARISON OF ALTERNATIVE TREATMENT AND RECOVERY DEMAND WITH UNUSED CAPACITY

[Million gallons per year]

Treatment or recovery technology	Waste quantity requiring alternative capacity	Unused capacity	Capacity shortfall
Wastewater treatment	185	<112	>73
Incineration:			
Organic liquids, sludges and solids	22.4	<25.6	0
Inorganic sludges and solids	6.7	(1)	6.7
Distillation	8.6	225	0

[1] EPA is assuming that none of the <25.6 million gallons per year of incineration capacity is available to treat inorganic sludges and solids.

The Agency believes that based on the analysis of these data, sufficient unused commercial recovery capacity exists for all solvent wastes that will be distilled. Commercial incinerator capacity is insufficient to treat all solvent wastes requiring incineration. As explained in Unit III.E, when capacity is insufficient to treat all of the wastes groups requiring the same technology, EPA will attempt to utilize all of the available capacity by banning the more toxic or concentrated waste first. In this case, if inorganic sludges and solids (which are soils or contain less than 1 percent total organics) are excluded, incinerator capacity is adequate to handle the wastes containing the greater concentrations of solvents (and total organics). Furthermore, EPA believes that the estimated incinerator capacity represents maximum capacity, and that the actual difference between incinerator capacity and the capacity required by organic liquids, sludges, and solids is insignificant. Therefore, the Agency concludes that a shortfall in incinerator capacity exists for inorganic sludges and solids. Current estimates of commercial wastewater treatment capacity also show a significant shortfall for treating the estimated 185 million gallons of solvent-water mixtures containing less than 1 percent (10,000 ppm) that are currently land disposed each year.

EPA is aware of recent news reports citing possible closure of existing commercial incineration capacity and relatively high current utilization rates. The Agency solicits comment on the extent to which available capacity has changed since EPA's most recent data collections.

5. Time Required To Develop Alternative Capacity

Because capacity is insufficient for solvent water mixtures and inorganic sludges and solids, the Agency has estimated the time to provide wastewater treatment and incinerator capacity, respectively, to treat these wastes. EPA has conducted an in-depth study of the time required to provide facilities to treat hazardous wastes (Ref. 64).

All new incinerators and some tank treatment facilities require RCRA permits to manage hazardous wastes. The EPA study found that processing time for RCRA permits for treatment tanks, storage facilities, and incinerators currently averages approximately 14 months, with a range of 4 months to 4 years. EPA believes that some new facilities that treat solvent-water mixtures in tanks will not require RCRA permits because they will fall under the regulatory permitting exemption for wastewater treatment tanks at 40 CFR 264.1(g)(6).

The permitting time that may be required by new treatment facilities includes permits under the National Pollutant Discharge Elimination System. Many facilities that need to build wastewater treatment facilities to meet the land disposal restrictions will already have NPDES permit limits established for the wastes that are currently treated in surface impoundments. EPA does not require that these NPDES-permitted facilities obtain approval to change their treatment process unless effluent concentrations or discharge rates change (delegated States may have different requirements). Most incinerators will generate scrubber water, which will require treatment and subsequent discharge under NPDES. According to EPA's study, the EPA and delegated States currently require 6 months to 1 year to process discharge permits under the NPDES.

In addition to permitting, the EPA study found that a facility designed for steam stripping or carbon adsorption, two common methods of treating solvent wastewaters, will require 1 to 3 years (on average) to solicit and review bids, finance, design, construct, and test, depending on the size of the facility. For instance, a 1,200 gallons per day (GPD) steam stripping facility will require from stet to one and a half years to complete these steps, whereas a 4,800 GPD unit will take as long as 3 years. Various types of incinerators take approximately 3 to 5 years to complete the necessary steps (e.g., financing, design, construction, and testing), depending on size and other factors.

In summary, EPA data show that in some cases a minimum of 1 year (i.e., for facilities that already have necessary permits or are exempt from RCRA permitting) is required to provide wastewater treatment capacity for solvent-water mixtures, although in other cases 2 to 3 years are required. EPA is unable, however, to determine to what extent less than 2 years are needed to provide wastewater treatment capacity. Therefore, the Agency believes that 2 years is the best estimate of the time to provide wastewater treatment capacity. It appears unlikely that additional incinerator capacity can be developed within 2 years, since the total time required to provide an incinerator averages 4 to 6 years.

6. Effective Date for Land Disposal Restrictions

Based on the Agency's determination of available alternative capacity and the time to provide additional treatment capacity, the Agency believes that a full 2 years are required to provide sufficient tank treatment capacity for solvent-water mixtures. These wastes are defined as aqueous wastes containing less than 1 percent (10,000 ppm) of total organic constituents and less than 1 percent total solids. In addition, insufficient incinerator capacity exists to treat inorganic sludges and solids. These wastes consist of (1) soils, and (2) sludges and solids which contain less than 1 percent total organic carbon and greater than 1 percent total solids.

Therefore, EPA is proposing to grant a 2-year variance to the effective date of the land disposal restrictions for these two categories of waste. Under this proposal, the treatment standards discussed in Unit V.G. will become effective November 8, 1988. Owner/operators who cannot complete their facilities by this date can apply for a case-by-case extension described in Unit III.F.

EPA requests comments on a 1-year variance, and a corresponding effective date of November 8, 1987. Some facilities probably could be completed before this date, and those owner/operators who could not complete their facilities could apply for a case-by-case extension. If EPA granted a 1-year variance, however, the Agency probably would receive far more applications for extensions, and more resources would be required to process these applications.

7. Acceptance of Applications for Case-by-Case Extensions

The Agency believes that applications for case-by-case extensions will require at least 6 months to process. Therefore, EPA recommends that applications be submitted as soon as possible in order to prevent a lapse in the period of time during which the applicant may land dispose and store his waste.

VI. Proposed Treatment Standards for Dioxin-Containing Wastes

A. Introduction

1. Summary of Congressional Mandate—Land Disposal Restrictions of Dioxin-Containing Hazardous Wastes

According to section 3004(e) of RCRA, effective 24 months after the date of enactment, further land disposal of certain dioxin-containing wastes is prohibited unless EPA determines that such prohibition is not necessary in order to protect human health and the environment (42 U.S.C. 6924(e)). If the Agency fails to meet this deadline, these wastes will be banned automatically from further land disposal as of November 8, 1986. Section 3004(e) addresses the dioxin-containing EPA Hazardous Wastes, EPA Hazardous Wastes Nos. F020, F021, F022, and F023 as referred to in EPA's proposed rule published in the **Federal Register** of April 4, 1983 (48 FR 14514). EPA issued the dioxin listing as a final rule on January 14, 1985 (50 FR 1978) and modified the numbering of the new listing, without making substantive changes to the constituents covered. The final listing specifically identifies dioxin-containing wastes of F020, F021, F022, F023, F026, F027, and F028. The listing describes an interim regulatory regime with respect to land disposal, pending further evaluation under the land disposal restrictions program which explores whether dioxin-containing wastes should be restricted from land disposal.

In light of the congressional mandate, EPA is proposing in today's action to regulate further land disposal of the following dioxin-containing hazardous wastes: EPA Hazardous Waste Nos. F020, F021, F022, F023, F026, and F027. F028 is a treatment residual from incineration or thermal treatment of dioxin-containing soil to six 9s DRE and therefore is not addressed in this proposal. The Agency is proposing to establish screening levels for the constituents of concern in the listed dioxin-containing hazardous wastes using the modeling approach described earlier. These constituent levels which are determined to be protective of human health and the environment represent maximum allowable concentrations for individual constituents in extracts (leachates) of dioxin-containing hazardous wastes which are determined to be protective of human health and the environment.

2. Description of the Dioxin-Containing Hazardous Waste Listing [14]

The dioxin listing designated certain wastes containing the tetra-, penta-, and hexachlorinated dioxins and diabenzofurans and certain chlorinated phenols as acute hazardous wastes (50 FR 1978). This rulemaking also specified certain management standards for these wastes.These wastes are listed as acute hazardous wastes (except F028: residual from six 9s DRE for incineration of dioxin-contaminated soils, which is listed as toxic) because they contain tetra-, penta-, and hexachlorinated dibenzo-p-dioxins and dibenzofurans. In addition, these wastes contain tri-, tetra- and pentachlorophenols and their derivatives. The dioxin-containing waste listing is as follows:

F020—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production and manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri-, or tetrachlorophenol or of intermediates used to produce their pesticide derivatives. (This listing does not include wastes from production of hexachlorophene from highly purified 2,4,5-trichlorophenol.)

F021—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediates, or component in a formulating process) of pentachlorophenol, or of intermediates used to produce its derivatives.

F022—Wastes (except wastewater and spent carbon from hydrogen chloride (purification) from the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzenes under alkaline conditions.

F023—Wastes (except wastewater and spent carbon from hydrogen chloride (purification) from the production of materials on equipment previously used for the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri-, and tetrachlorophenols. (This listing does not include wastes from equipment used only for the production or use of hexachlorophene made from highly purified 2,4,5,-trichlorophenol.)

F026—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the manufacturing use (as a reactant, chemical intermediate, or component in a formulation process) of tetra-, penta-, or hexachloro-benzenes under alkaline conditions.

F027—Discarded unused formulations containing tri-, tetra-, or pentachlorophenols, or compounds derived from these chlorophenols. (This listing does not include formulations containing hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component).

F028—Residues resulting from incineration or thermal treatment of soil contaminated with EPA Hazardous Wastes Nos. F020, F021, F022, F023, F026, and F027.

The wastes covered by the listing include reactor residues, still bottoms, brines, spent filter aids, spent carbon from product purification, and sludges from wastewater treatment. Also included are residues from managing (i.e., treating or storing, or disposing) of any of these wastes. Soils contaminated with these wastes are also regulated since soils contaminated by spills of listed hazardous wastes are defined as hazardous wastes (50 FR 28713, July 15, 1985). In addition, residues in containers that contain any of the listed wastes are covered unless the container has been triple-rinsed with a solvent capable of removing the waste or the container has been cleaned by an alternative method

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[14] The following acronyms and definitions are used: PCDDs—all isomers of all chlorinated dibenzo-p-dioxins. CDFs—all isomers of all chlorinated dibenzofurans. CDFs—and CDFs—all isomers of tetra-, penta-, and hexachlorodibenzo-p-dioxins and-dibenzofurans, respectively. TCDDs and TCDFs—all isomers of the tetrachlorodibenzo-p-dioxins and-dibenzofurans, respectively. TCDD and TCDF—the respective 2, 3,7,8-isomers. The prefixes Tr, T, Pe, and Hx denote the tri-, tetra-, penta-, and hexachlorodioxin and -dibenzofuran congeners, respectively.

shown to achieve equivalent removal (See 40 CFR 261.7(b)(3)).[15]

3. Summary of Regulations Affecting Land Disposal of Dioxin-Containing Wastes

In the dioxin listing rule, EPA also specified additional management standards relating to land disposal of these wastes. Specifically, the Agency prohibited the management of the listed dioxin-containing wastes at interim status land disposal facilities and required land disposal facilities intending to manage these wastes to submit a waste management plan to address the additional design and operating measures over and above those in Part 264 which the facility intends to adopt in order to prevent migration of the waste or waste constituents. (There are exceptions for interim status surface impoundments holding wastewater treatment sludges that are created in the impoundments as part of the plant's wastewater treatment system and interim status waste piles that meet the requirements of § 264.250(c).) The plan is to be submitted by the owner or operator of the disposal facility as part of the Part 264 permit application and should address the following factors:

a. The volume, physical, and chemical characteristics of the wastes, including their potential to migrate through soil, to volatilize or otherwise excape into the atmosphere.

b. The attenuative properties of underlying and surrounding soils and other materials.

c. The mobilizing properties of other materials co-disposed with these wastes.

d. The effectiveness of additional treatment, design, or monitoring techniques.

The Agency believes that such a waste management plan will help provide assurance that these wastes are properly managed in a land disposal situation.

The exception for management at surface impoundments in which wastewater treatment sludges are generated was based on pragmatic as well as environmental considerations. If the Agency banned all interim status impoundments from managing these wastes, facilities generating wastewater treatment sludges in impoundments would have to halt the manufacturing process and obtain a permit for new capacity before they could manage these wastes. The Agency determined that the short-term management of these sludges in interim status impoundments could be protective, since the sludges will absorb the CCDs and CDFs and since other potentially mobilizing organics will be present in the wastes at low concentrations due to dilution and biological treatment. In the case of interim status waste piles meeting the requirements of § 264.250(c), the Agency determined that such waste presents a minimal and acceptable risk because the pile is inside a structure that provides protection from precipitation, run-on, and wind dispersal, does not generate leachate, and does not contain free liquids.

4. Quantity of Dioxin-Containing Waste Generated

Approximately 14.7 million pounds (6,650 metric tons) of dioxin-containing wastes are presently covered by the dioxin listing rule (Ref. 67). These wastes are primarily associated with the past production and manufacturing use of tri- and tetra-chlorophenol and current manufacturing uses of pentachlorophenol. These quantities are estimates and will be revised as more information becomes available. The recent dioxin listing rule will provide the Agency, through its reporting requirements, with the universe of facilities that generate, transport, treat, store, and dispose of dioxin-containing wastes and the amounts generated and managed (40 CFR 262.41, 264.75, and 265.75). For the purpose of this proposal, however, the Agency is relying on available data presented above. (Additional information on quantity estimates of dioxin-containing wastes can be found in the public docket for this proposal (Ref. 67).

The Agency is investigating through its Superfund program and the "Dioxin Strategy" (Ref. 103) the extent of dioxin contamination in the U.S. When these investigations are complete, EPA will be able to determine more accurately the total volume of contaminated soil covered by the rule. In the interim, an assessment of the extent of dioxin-contaminated soil can be made by assessing estimates made in the State of Missouri. Indications are that an estimated 1.1 billion pounds (500,000 metric tons) of dioxin-contaminated soil exist in Missouri with an estimated 350 million pounds (160,000 metric tons) of soil at Times Beach alone (Ref. 67). For purposes of this proposed rulemaking, the Agency is assuming that 1.1 billion pounds of dioxin-contaminated soil exist in the country, until the results of other EPA studies can be evaluated.

5. EPA Concerns With Land Disposal of Dioxin-Containing Wastes

The constituents of concern in these wastes are CDDs, CDFs, tri-, tetra-, and pentachlorophenols, and chlorophenoxy derivatives of these chlorophenols. CDDs and CDFs are among the most potent toxic substances known. TCDD and a mixture of two H_x CDDs are among the most potent animal carcinogens tested. These substances are also potential human carcinogens. TCDD has also been shown to be teratogenic, fetotoxic and embryotoxic at very low doses. Many CDDs and CDFs are acute toxicants at the ug/kg/day dose rate and, even at these very low concentrations, are inducers of the liver's enzyme system (Ref. 103a).

CDDs and CDFs are persistent in the environment. Bio-degradation and hydrolysis decay mechanisms are not likely to be significant. Additionally, several of the constituents of concern can accumulate in the food chain. The estimated bio-accumulation factor (BCF) for TCDD is approximately 5,000 to 8,000 and structure activity considerations make it reasonable to assume that the BCF for other CDDs and CDFs is similar. These are some of the highest BCFs known. The calculated BCF for the chlorophenols ranges from 290 for 2,4,5–TCP to 610 for 2,4,6–TCP. Thus, if these constituents migrate from these wastes, even in extremely low concentrations, they can accumulate in biological organisms at much higher levels.

Investigations have documented the extreme immobility of TCDD in most soils and its low solubility in water. Given their physiochemical similarities, the other CDDs and CDFs are expected to be immobile in soils and water insoluble. However, these constituents are likely to be more mobile in situations where they are co-disposed with solubilizing solvents or in situations in which soil binding sites are exhausted. A recent study determined that chloro-organic contaminants in wastes, other than TCDD, may be more significant than soil properties in controlling solubility and movement of TCDD in contaminated soil, once the absorptive capacity of the natural organic compounds (i.e., humic acids) has been exhausted (Ref. 63). However, CDDs and CDFs are not expected to leach to ground water and percolate through soils if proper precautions are taken to prevent co-disposal with solubilizing solvents.

In addition, the waste management plan helps provide assurance as far as is practically possible that contamination of air and surface water as a result of

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[15] If the container is cleaned, the container is considered empty and no longer subject to the regulation. However, the rinsate that is generated is an acute hazardous waste and, thus, subject to regulation (45 FR 78528, November 25, 1980).

windblown dust, water runoff, erosion or flooding of waste disposal sites will minimize human health hazards as well as environmental contamination during handling and disposal.

6. Contamination of Soil, Ground Water, and Streams

Contamination of soil, ground water, and streams from the constituents of concern in dioxin-containing wastes has occurred at several uncontrolled sites. Most of the damage incidents described below focused on environmental pollution by TCDDs. However, it is reasonable to assume that TCDDs are a marker substance for the CDDs and CDFs. Hazardous wastes, including organic solvents and wastes from the production of chlorophenols, were disposed at the Hyde Park landfill near Niagara Falls, New York, from 1953 to 1975. The landfill is estimated to contain about 120 kg of TCDD. A breach in the landfill contaminated a stream, which runs past the landfill, with organic residues, including TCDD at an average concentration of 70 ppb. At the Love Canal landfill in Niagara Falls, New York, wastes containing CDDs and chlorophenols were disposed from 1942 to 1953. Numerous natural drainage features and three storm sewers underlie the area. TCDDs and chlorophenols have migrated into the environment, resulting in contamination of soil and sediment at a considerable distance from the dump site. Environmental contamination has also occurred at a facility in Jacksonville, Arkansas, where 2,4,5–TCP/2,4,5–T/2,4–D were produced. Several thousand drums of toluene still bottoms were improperly disposed. The drums corroded over the years and their contents contaminated soil, sediments of two nearby streams, and fish and aquatic life with TCDD.

While these damage incidents and others (Ref. 103a) demonstrate that the toxic constituents in dioxin-containing wastes can migrate from the waste, that they persist in the environment, and can become part of the food chain, thereby posing a threat to human health when disposed in an uncontrolled manner, they are not representative of what is likely to occur under current regulations. The management requirements specified in the dioxin listing rule are designed to ensure as far as practically possible that these wastes are properly managed in a land disposal situation. However, these requirements alone may not ensure that land disposal is protective of human health and the environment for as long as these wastes remain hazardous.

B. Screening Levels For The Constituents of Concern in the Listed Dioxin-Containing Wastes

In today's action, the Agency is proposing to establish screening constituent levels for the dioxin-containing hazardous wastes, EPA Hazardous Waste Nos. F020, F021, F022, F023, F026, and F027, using the modeling approach described in Unit III.A. The chemical-specific inputs to the model are included in the following Table 16:

TABLE 16

Constituent	Reference dose (mg/1)	Proposed TEF	Percent apportioned to water	Health-based reference	Hydrolysis rate	Screening level
2,3,7,8-TCDD	[1]2×10^{-10}	1	100	2×10^{-10} mg/1	0	4×10^{-9} mg/1
Other TCDDs		0.01	100	2×10^{-8} mg/1	0	$4\times10\times^{7}$mg/1
2,3,7,8-PeCDDs		0.5	100	4×10^{-10} mg/1	0	8×10^{-9} mg/1
Other PeCDDs		0.005	100	4×10^{-8} mg/1	0	8×10^{-7} mg/1
2,3,7,8–H×CDDs		0.04	100	5×10^{-9} mg/1	0	1×10^{-7} mg/1
Other H×CDDs		0.0004	100	5×10^{-7} mg/1	0	1×10^{-5} mg/1
2,3,7,8–TCDFs		0.1	100	2×10^{-9} mg/1	0	4×10^{-8} mg/1
Other TCDFs		0.001	100	2×10^{-7} mg/1	0	4×10^{-6} mg/1
2,3,7,8=PeCDFs		0.1	100	2×10^{-9} mg/1	0	4×10^{-8} mg/1
Other PeCDFs		0.001	100	2×10^{-7} mg/1	0	4×10^{-6} mg/1
2,3,7,8–H×CDFs		0.01	100	2×10^{-8} mg/1	0	4×10^{-7} mg/1
Other H×CDFs		0.0001	100	2×10^{-6} mg/1	0	4×10^{-5} mg/1
2,4,5-Trichlorophenol	3.5		10	0.35 mg/1	0	8 mg/1
2,4,6-Trichlorophenol	0.0018		100	0.0018 mg/1	0	0.04 mg/1
2,3,4,6-Tetrachlorophenol	0.35		25	0.09 mg/1	0	2 mg/1
Pentachlorophenol	1.05		25	0.25 mg/1	0	2 mg/1

[1] Reference Dose (Risk specific dose)=$(10^{-6}/q_{1}^{*})$ × (body weight) / (daily water intake)=$(10^{-6}/1.56\times10^{5}$ mg/kg/day$^{-1})$ × (70 kg) / (2 1/day)=2×10^{-10} mg/1.

[2] Derived from the surface water screening procedure.

Note.—In the absence of insomer specific analytical data, it should be assumed that all isomers are 2,3,7,8 substituted.

The reference dose for each of the CDDs and CDFs (the starting point of the back calculation procedure) are based on an evaluation procedure developed by the Agency's Chlorinated Dioxins Work Group to assess the toxicity of these constituents (Ref. 111a). In this procedure, toxicity factors for the CDDs and CDFs are based on an evaluation of the potency of the various CDD and CDF isomers and congeners in a range of systemic and biochemical effects. Data from experiments on cancer induction, reproductive effects and biochemical effects were used for this purpose. These data were normalized to the potency of 2,3,7,8-TCDD, the most toxic congener. Table 16 lists the toxicities (Toxicity Equivalent Factor, TEF) of CDDs and CDFs relative to 2,3,7,8-TCDD and the health-based reference for each of the constituents of concern in the listed dioxin-containing wastes. The health-based references (Table 16, column 4) were derived by applying the TEFs to the 10^{-6} risk specific dose for 2,3,7,8, TCDD. The proposed screening levels (Table 16, column 7) were derived by applying the ground water model attenuation factor to the health-based reference point, except in the case of pentachlorophenol, where the application of the surface water model attenuation factor results in a more stringent screening level. These values represent the maximum concentration of each constituent in extracts of these wastes that are acceptable for land disposal.

C. Analysis of Treatment Technologies for Dioxin-Containing Wastes and Determination of BDAT

1. Applicable Treatment Technologies

The Agency, with the promulgation of the dioxin listing rule, has established specific management standards for dioxin-containing wastes. With respect to treatment, the Agency has established standards for incineration and certain thermal treatment. The dioxin listing rule states that incinerators burning the listed CDD/CDF-containing wastes must achieve a destruction and removal efficiency of six 9s in addition to the other standards contained in § 264.340 (Subpart O). The rule specifies that the six 9s DRE will be measured on a surrogate Principal Organic Hazardous

Constituent that is more difficult to incinerate than the particular CDDs or CDFs contained in the waste.

The Agency uses heats of combustion (HC) as its incinerability hierarchy: the lower a compound's heat of combustion, the more difficult it is to incinerate. For example, using the heats of combustion hierarchy, the incinerability of a waste containing HxCDD would be tested using a POHC with a heat of combustion less than 2.81 kcal/gm, perhaps, 1,1,1-trichloroethane (HC=1.99 kcal/gm) (50 FR 1992, January 14, 1985) in order to determine if a six 9s DRE was met. If an incinerator proved a six 9s DRE on pentachlorophenol, which has a heat of combustion of 2.09 kcal/gm, it could incinerate all the CDDs and CDFs, covered by the dioxin listing rule, since the CDD/CDF compound most difficult to decompose (incinerate) is HxCDD.

The Agency acknowledges in the dioxin listing rule that there are presently a number of emerging thermal treatment technologies that may be applicable for the treatment of dioxin-containing wastes in order to render them non-hazardous (or at least, less hazardous). Some of these technologies are now thought to be practicable, while some are in the pilot stage, and pilot-scale field experiments need to be performed; others are still in early research and development. In the absence of RCRA permit standards, such treatment units would not be allowed. This would stifle and discourage the development of new treatment alternatives and the development of innovative technologies for the treatment of these very toxic wastes. The Agency feels that such an outcome is undesirable. As a result, the dioxin listing rule allows for interim status thermal treatment units to treat the dioxin-containing wastes if it has been certified that the units meet the applicable performance standards in § 264.343 (including six 9s DRE for POHCs).

The dioxin listing rule impose certain restrictions on the treatment of dioxin-containing wastes. Only those facilities meeting the performance standards for incineration or thermal treatment, (i.e., six 9s DRE) can manage these wastes. Units which meet these specified performance standards for incineration and thermal treatment will be considered applicable treatment for dioxin-containing wastes.

Much research is currently being conducted to develop and evaluate treatment technologies applicable to dioxin-containing wastes. Listed below are treatment technologies that are in one of three stages of consideration: existing technologies being evaluated; technologies being actively researched; and technologies in the conceptual or development phase (Ref. 8).

a. Technologies under evaluation:
i. Mobile incineration.
ii. High temperature, fluid-wall, advanced electric reactor.
iii. Infrared heating.
iv. UV photolysis.
v. Underground surface mines as repositories for dioxincontaminated soils.
vi. Thermal desorption of 2,3,7,8-TCDD from contaminated soils.
vii. White rot fungus *(Phanerochaete chrysosporium)*.

b. Current research:
i. Sorption/desorption of 2,3,7,8–TCDD in contaminated soils.
ii. Mobility of 2,3,7,8–TCDD from soils in water, methanol, methanol and toluene liquid system.
iii. Bioavilability research.
iv. In-situ stabilization techniques.

c. Technologies in conceptual or developmental Phase:
i. In-situ vitrification.
ii. Recirculating fluidized bed.
iii. Fluidized bed.
iv. Chemically modified clays.
v. Catalytic UV-ozone.
vi. Supercritical water.
vii. At-sea incineration.

Few data currently exist, however, on the performance of these technologies on all types of dioxin wastes. The Agency is continuing to gather data and information on these and other emerging technologies in order to evaluate their future potential as an applicable treatment technology.

2. Demonstrated Technologies for Dioxin-Containing Wastes

Incineration is the only technology which has been fully demonstrated for treating dioxin-containing wastes. A field demonstration of EPA's Mobile Incineration System (MIS) was recently conducted on dioxin-containing wastes (F020, F022, F023, F026, and F027) at the Denney Farm Site in McDowell, Missouri. This full-scale demonstration was conducted in accordance with the incineration performance standards specified in the dioxin listing rule, i.e. six 9s DRE.

During the field demonstration at the Denney Farm Site, various dioxin-containing solids, liquids and soils were incinerated. They included: CDD–/CDF-contaminated soil, activated carbon, drum remnants, miscellaneous trash, asphaltic material, mixed solvents and process wastes. The data indicate that this full-scale mobile incineration unit, operating at six 9s DRE is capable of treating dioxin-containing wastes and constituents subject to this rule.

Accordingly, EPA determines that units meeting the performance standards of the dioxin listing rule (six 9s DRE) also meet the "demonstrated" component of the BDAT standard.

Another type of incinerator which meets the "demonstrated" component of the BDAT standard, are those units burning polychlorinated biphenyls. These incinerators are required to operate under conditions that result in six 9s destruction (40 CFR 761.70). Similar DREs are expected to be achievable for CDDs and CDFs in these units, since PCBs and CDDs and CDFs have similar degrees of incinerability (heats of combustion). Consistent destruction of PCBs to six 9s DRE has been demonstrated full-scale at a number of facilities (e.g., those of SCA, Incorporated in Chicago, Illinois; Rollins Environmental Services, in Deer Park, Texas; the facilities operated by Energy Systems Company in El Dorado, Arkansas; and by the General Electric Corporation in Waterford, New York).

The Agency has determined that incinerators operating in accordance with the performance standards specified in 40 CFR 761.70 for PCB wastes, namely six 9s destruction, also meet the "demonstrated" component of the BDAT standard.

3. Analysis of Relative Risk

EPA has evaluated the potential risks posed by incineration of a dioxin-containing waste compared to the potential risks posed by land disposal of the same waste in a landfill. The Agency determined that for the selected waste, incineration posed a lower potential risk than land disposal. The waste selected for the analysis was an off-specification pesticide product with 0.6 ppm TCDD equivalents. Incineration is modeled because it is the only demonstrated treatment method for dioxincontaining wastes. The Agency believes that the risks presented by potential land disposal and incineration of the selected dioxin-containing waste are adequately simulated in the modeling procedure. As better data become available characterizing additional dioxin-containing wastes, the Agency will include this information and expand its evaluation.

4. Determination of BDAT

Currently, the only sufficently demonstrated treatment technology for dioxin-containing wastes is incineration. Incineration to six 9s DRE achieves lower concentrations of CDDs and CDFs in the treatment residuals than incineration to four 9s DRE (current standard for all RCRA hazardous wastes except dioxin-containing wastes). The efficiency of incineration of dioxin-containing wastes has been demonstrated full-scale by the successful dioxin burn at six 9s DRE in the EPA Mobile Incineration System at the Denney Farm Site in McDowell, Missouri and the incineration of PCB wastes at six 9s destruction at a number of facilities. Data have recently been collected on incineration residues that were generated during the field demonstration of the MIS (50 FR 23721, June 5, 1985). These residues included the process wastewater, the rotary kiln ash, the filter media generated from a cleanable high efficiency air filter (CHEAF) particulate scrubber, and other solids removed from the wastewater.[16] Analytical data on the organic constituents in the incineration residues from six 9s DRE showed no detectable levels of CDDs/CDFs in the filtered scrubber water, kiln ash, or CHEAF residue by routine analytical methods. Although no detectable levels of CDDs and CDFs were found in the residuals from the MIS trial burn, the actual concentrations of CDDs and CDFs in these residues are likely to be much less than the maximum possible concentrations projected from detection limits. Most of the analyses were performed in accordance with the methods specified in SW-846 (Ref. 120a). However, these methods, developed for routine use, are not designed to achieve extremely low detection limits. When a research analytical method was applied to the ash, a fifty-fold reduction in the detection limit was achieved. Preliminary results using this method show that the ash residues are likely to contain no more than 4 ppt of TCDD equivalents (i.e., a fiftieth of the maximum concentration projected from detection limits). With respect to the aqueous waste, the estimated maximum concentration of CDDs and CDFs (6 ppt, based on detection limits), in the wastewater, probably overestimates the concentration by a factor of 50. Thus, a more realistic estimate for the concentrations of CDDs and CDFs in the wastewater would be about 0.1 ppt.

The data from the MIS burn show that residues resulting from the incineration of CDDs and CDFs at six 9s DRE contain these toxicants at concentrations about five to seven orders of magnitude less than those in the starting material. Thus, solid residues resulting from incineration at six 9s DRE of dioxin-containing wastes containing 10 ppm TCDD may be expected to contain less than .1 ppb TCDD.[17] As stated in the delisting petition for the MIS (50 FR 23721, June 5, 1985), it is the Agency's usual practice to use the detection limit as the possible upper level exposure limit for purposes of hazard evaluation when a constituent is not detected. For example, the detection limits for the TCDDs in wastewater was reported at 0.88 to 3.9 ppt. Therefore, TCDDs could be present in the filtered scrubber water in concentrations up to 3.9 ppt.

Because CDDs and CDFs are of similar incinerability (heats of combustion) to PCBs, it is reasonable to expect that incineration of these constituents at similar initial waste concentrations would result in similar residual concentrations to PCBs. Data are available on PCB and CDD/CDF concentrations in treatment residuals from several incinerators burning industrial chlorinated wastes, PCB wastes, and dioxin-containing wastes (Ref. 103a). These data demonstrate that an incinerator operating at six 9s DRE can achieve extremely low concentrations of CDDs, CDFs, and PCBs in the treatment residuals. According to these data, incinerator scrubber water from the treatment of chlorinated industrial wastes, contain less than 0.001 ppb of various CDD congeners. Also, PCB incineration at six 9s DRE results in residual concentrations 0.01 to 0.2 ppb of PCB in the ash to 0.01 to 50 ppb PCBs in other residuals.

The Agency has evaluated performance data for the incineration of dioxin-containing wastes at six 9s DRE. This treatment is the only "demonstrated" technology for these wastes. The Agency has concluded that incineration to six 9s DRE substantially dimishes the toxicity of dioxin wastes subject to this rule, and minimizes short-term and long-term threats to human health and the environment from those wastes that may remain after treatment. As previously discussed in Unit III B., EPA considers treatment methods to be substantial if they result in nondetectable levels of hazardous constituents of concern in residuals. Therefore, best demonstrated achievable technology for treating dioxin-containing wastes subject to the land disposal restrictions consists of incineration to six 9s DRE.

D. Comparison of BDAT and Screening Levels and Establishment of Treatment Standards

1. Comparison of BDAT and Screening Levels

The Agency has determined that the only sufficiently demonstrated technology for the treatment of dioxin-containing wastes is incineration. However, the agency cannot exclusively state that incineration to six 9s DRE will achieve the screening levels for the CDDs and CDFs because these levels are below those which can be detected using standard EPA methods. The detection limit for the CDDs and CDFs in waste extracts analyzed, using method 8280 specified in SW-846, is 1.0 ppb (Ref. 120a). Current analytical data indicate that residual concentrations for the CDDs and CDFs from the incineration of dioxin-containing wastes will be far below that detectable by standard EPA analytical methods (50 FR 23721, June 5, 1985). Therefore, the Agency is using the detection limit to establish the treatment standard under proposed § 268.42.

2. Treatment Standard for Dioxin-Containing Wastes

Under today's proposal, wastes identified by the hazardous waste listings as F020, F021, F022, F023, F026, and F027, must be treated to a level below the detection limit if there are any detectable levels of the CDDs and CDFs in the extracts of the wastes prior to their being disposed in a RCRA Subtitle C land disposal facility.[18]. However, wastes exceeding the detection limit can only be treated in accordance with the criteria for incineration as specified under 40 CFR Parts 264.343 and 265.352 in the dioxin listing rule. The Agency believes that such treatment in combination with the management requirements specified in the dioxin

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[16] The other solids include particulates collected from the secondary combustion chamber and sludge which is collected from the air pollution control equipment sumps and from the clarifier on the process waterpurge stream threatment system. The carbon filters are not included in the other solids category and hence are not a subject of this notice.

[17] Concentrations of CDDs and CDFs in the residue equals the amount in the waste feed times the fraction remaining $= 10$ mg/kg $\times 10^6$ ng/mg $\times$ (10^{-7} to 10^{-5} reduction) $= 1$ to 100 ng/kg $= 1$ to 100 ppt. This estimate assumes that the net formation of CDDs and CDFs in the course of incineration is negligible. This assumption is warranted because the conditions necessary to ensure six 9s DRE are presumably consistent with conditions to minimize the formation of products of incomplete combustion.

[18] Revisions to RCRA method 8280 specified in SW-846 may result in a lowering of the current detection limit. For example, if the method is revised and the detection limit is lowered from the current limit of 1.0 ppb to 1.0 ppt, this new detection limit will become the level at which wastes will be banned from land disposal.

listing rule will help provide assurance that these wastes are properly managed in a land disposal situation. The generator also has the option of treating dioxin-containing wastes by incineration to six 9s DRE rather than first conducting the extraction procedure.

The Agency acknowledges in the dioxin listing rule that there are presently a number of emerging thermal treatment technologies that may be used to treat dioxin-containing wastes in order to render them non-hazardous (or at least, less hazardous). Although these units have not yet been demonstrated for all dioxin waste matrices or at full-scale, for purposes of this proposal, thermal treatment units certified as meeting the applicable performance standards in 40 CFR 264.383 (including six 9s DRE for POHCs in the waste) may also be used as a treatment method under RCRA section 3004(m).

E. Determination of Alternative Capacity and Ban Effective Dates

1. Required Alternative Capacity for Dioxin-Containing Wastes

As discussed in Unit VI.A.5, the actual volume of wastes subject to the dioxin rule are still being evaluated and revised by the Agency. It is believed, however, that the quantity of wastes currently being generated that will be subject to the dioxin rule amounts to 3 million pounds (1,350 metric tons) (Ref. 67). It is more difficult to assess the quantities of waste that have been stored over the years or those subject to remedial or cleanup activities (including contaminated soils), that fall under this rule. The Agency believes that the latter will create a larger demand on capacity than the currently generated wastes. As mentioned earlier, the Agency is continuing to evaluate the universe of these wastes and will in the future be better able to present actual volumes. The Agency requests information and data in this area to assist it with its efforts.

2. Treatment Disposal and Recovery Capacity Currently Available

Currently, there is no disposal or recovery capacity for dioxin-containing wastes. In addition, no incinerator or other thermal treatment facility has been approved by the Agency to treat dioxin-containing wastes. Although several certification petitions have been received by the Agency, no incineration or thermal treatment units have been certified/permitted as required under the dioxin listing rule.

Interim status incinerators that have been approved under TSCA to burn PCBs are a type of incinerator for which the owner/operator may wish to apply for certification. As pointed out earlier, PCB incinerators are a logical choice to burn these wastes because they are required to meet the same performance standard (six 9s DRE) required under the dioxin listing rule, and PCBs in some cases, are more difficult to incinerate than CDDs and CDFs. There are currently three commercial incinerators approved under TSCA to burn PCBs. In addition to these units, several other incinerators under development may be available (contingent on certification) for treating CDD/CDF-containing waste. However, the Agency has no indication whether or when any of these, or any other facility will be certified to treat dioxin-containing wastes.

The Agency has full confidence in the safeguards provided by the required management standards. EPA is committed to move rapidly to assure that approved capacity is available to properly manage the listed dioxin-containing wastes. Agency efforts in this area include identification of facilities that could properly manage dioxin wastes, and encouraging owners and operators to apply for the necessary Federal, State, and local permits. The EPA regional offices will work closely with these facilties to expedite their applications with the Federal, State and local governments.

It is difficult to predict accurately, however, when facilities will be on-line. At the present time, however, no facilities have been approved to dispose, recover or thermally treat dioxin-containing wastes, and for purposes of this proposed rule, there is currently no capacity available to meet the treatment standards.

3. Time to Develop Capacity

The Agency anticipates that certifications to burn dioxin-containing waste will be issued in the near future. It is difficult to predict, however, when these certifications will occur. A review of past permitting actions indicates that the length of time needed to obtain a permit to operate a major hazardous waste treatment facility can take as long as 2 to 3 years. While the Agency believes that certification of existing incinerators should not take as long as permitting new facilities, no data exist from which to determine the most likely time period for this certification to occur.

4. Land Disposal Restriction Effective Date

Section 3004(h)(2) indicates that EPA need not establish the effective date of the land disposal restrictions immediately, but can set the effective date on the earliest date on which adequate alternative treatment, recovery, or disposal capacity will be available. In this case, as has been discussed in Unit VI.E.2, alternative capacity is not currently available due to the lack of treatment facilities certified to destroy dioxin wastes. Although it is not clear how long it will take for a facility to obtain certification, EPA estimates that the process can take as long as 2 to 3 years. Accordingly, EPA is proposing to grant the maximum 2-year variance allowed under section 3004(h)(2). If a 2-year variance is granted, the effective date for the land disposal restriction decisions affecting hazardous waste listings F020, F021, F022, F023, F026 or F027 would be November 18, 1988. In the interim, facilities will be required to manage these wastes in accordance with the requirements of the dioxin listing rule.

EPA will reconsider this effective date and will specify an earlier date if, prior to final rulemaking, one or more facilities that meet the treatment method specified in Unit VI.C.5 are certified by EPA, and if the unused capacity of these facilities is sufficient to destroy the quantity of dioxin wastes that are subject to the land disposal restrictions. Upon reconsideration, the Agency may choose to grant a shorter variance (e.g., 1 year) or to make the ban effective immediately upon final promulgation.

F. Request for Comments

The Agency requests public comment on all aspects of the approach outlined in today's proposal. However, public comment is especially requested with respect to establishing incineration to six 9s DRE as the treatment standard if any detectable levels of CDDs or CDFs are found in extracts of the listed dioxin-containing wastes. Also, the Agency solicits comment on the use of method 8280 specified in SW-846 (Ref. 120a). for determining if any dioxins are present in extracts of dioxin-containing wastes and requests information on other appropriate methods which could be used for the same purpose.

VII. California List

As stated earlier, effective 32 months after the date of enactment, further land disposal of the California List constituents is prohibited unless EPA determines that such prohibition is not required to protect human health and the environment (see Unit I.B.2 of today's action). If the Agency fails to meet this deadline, the wastes will be banned automatically from further land disposal at the levels specified in the statute.

Congress incorporated the California List into the provisions of the HSWA primarily because the State of California had conducted studies and initiated rulemaking which demonstrate that waste containing these constituents at the designated concentrations may be harmful to humans and the environment. (S. Rep. No. 98-284, 98th Congress, 1st Sess. 17 (1983).) Congress' intent in specifying threshold levels for these constituents was to avoid time-consuming litigation over the selection of appropriate levels (H.R. Rep. No. 98-198, 98th Congress, 1st Sess. 35(1983).) The Agency is authorized to establish less stringent levels based on BDAT if BDAT cannot achieve the levels specified in the statute (or a more stringent level that EPA may establish). The Agency also may authorize land disposal of the specified constituents at concentrations that are less stringent than the level prescribed in the statute if it is demonstrated through a petition under section 3004(d) that less stringent levels will be protective of human health and the environment at a particular site.

The Act also provides EPA the flexibility to substitute more stringent levels, where necessary to protect human health and the environment under section 3004(d)(2). The Agency, does not interpret this provision as imposing an affirmative duty on the Agency to initiate studies to determine whether the statutory levels are protective.

Although there is no affirmative duty to do so, the Agency is re-evaluating the California list constituent levels. EPA is considering using the ground water back calculation model to evaluate liquid waste containing California list metals. The MINTEQ component of the model will account for variables such as speciation of metals and dilution and dispersion in ground water. The halogenated organic compounds (HOCs) category is more comprehensive and, therefore, more difficult to evaluate than the other California List categories. Because of the diversity inherent in this group of constituents (i.e., it includes compounds which exhibit a wide range of toxicological, chemical, and physical properties), and the lack of data on individual HOCs, the Agency is unable to use the ground water model which is constituent-specific in its evaluation. Moreover, since HOCs are the only category for which Congress specified both liquid and solid wastes for prohibition, the Agency must identify a practical test method for determining the content of these constituents in solid hazardous waste. Therefore, the Agency is soliciting comment on how to evaluate the specified level for HOCs. If the Agency cannot resolve the difficulties with evaluating HOCs, it may not re-examine the statutory levels.

The Agency anticipates proposing treatment standards for the California List constituents in approximately 6 months.

VIII. Relationship of the Part 268 Land Disposal Restrictions Provisions To Other Statutory and Regulatory Requirements

A. Relationship to Other Statutory Ban Provisions

The 1984 Amendments to RCRA include several other provisions that ban or restrict specific practices. These provisions include: conditional restrictions on the placement of hazardous wastes in salt dome formations, salt bed formations, and underground mines and caves (section 3004(b)); restrictions on the disposal of bulk and containerized liquid wastes in landfills (section 3004(c)); a ban on the use of dioxin-contaminated materials and other hazardous wastes (except for wastes identified solely on the basis of ignitability) for dust suppression or other road treatment (section 3004(l)); and a ban on underground injection of hazardous waste into or above a formation which contains an underground source of drinking water within one-quarter mile of the well used for the injection (section 7010(a)). Based on the specific statutory language in section 3004 (b) and (c), determinations by the Administrator under section 3004 (d), (e), or (g) do not supersede the statutory restrictions on placement of hazardous wastes in salt dome and salt bed formations and underground mines and caves or the statutory restrictions on liquids in landfills contained in section 3004(c)(1). The language of section 3004(m)(2) also indicates that compliance with the section 3004(m) treatment standards exempts wastes only from prohibitions promulgated under section 3004 (d), (e), (f), or (g). Thus, compliance with section 3004(m) does not provide an exemption from restrictions on salt domes, salt bed formations, and underground mines and caves (section 3004(b)), or liquids in landfills (section 3004(c)). Likewise, the Agency interprets the statutory ban on use of hazardous wastes for dust suppression or road treatment and the ban on certain injection of hazardous waste as overriding any Agency decisions under section 3004 (d), (e), (g), or (m).

B. Relationship To Hazardous Waste Identification Regulations

In 40 CFR 260.22, procedures are identified for the submission of petitions to amend 40 CFR Part 261 to exclude a waste produced at a particular facility from regulation as a hazardous waste (i.e., to delist the waste). The Agency recently amended these procedures in response to additional requirements imposed by HSWA (50 FR 28702, July 15, 1985). Standards promulgated under section 3004(m) are not an Agency determination of the appropriate levels for delisting. A delisting determination is based on a finding that the waste need not be subject to regulatory control under Subtitle C of RCRA, but rather that the waste can be safely managed in a Subtitle D facility. This is a different determination than the Agency must make an establishing treatment standards. Treatment standards based on health-based thresholds assure protection of human health and the environment when waste is managed in a Subtitle C facility. Treatment standards based on technology-based levels assure that the mobility or toxicity of the waste has been substantially reduced.

The Agency will shortly propose a new characteristic for identifying wastes as hazardous—the Organic Toxicity Characteristic. Under this characteristic, wastes will be determined to be hazardous if the concentration of hazardous constituents in an extract from the waste exceeds specified levels. The approach being used to determine the appropriate levels of regulatory control in the Organic Toxicity Characteristic is similar to the approach being used by the Agency is establishing health-based thresholds. In developing regulatory levels for the Organic Toxicity Characteristic, the Agency will use a back calculation procedure using fate and transport equations in much the same way as the Agency is establishing health-based thresholds. However, the scenario being modeled for purposes of establishing regulatory levels for the Organic Toxicity Characteristic represents a Subtitle D, non-hazardous waste facility. Wastes containing constituents at concentrations below the regulatory levels for the characteristic can be safely managed at a facility that does not meet the engineering standards required for Subtitle C facilities and thus will not be identified as hazardous wastes. In those cases where the section 3004(m) treatment standard is expressed as a leach concentration, the Agency is proposing to use the same leach procedure used in the Organic Toxicity Characteristic to determine whether a waste complies with this standard.

C. Relationship To 40 CFR Parts 264 and 265 Standards

Compliance with the section 3004(m) treatment standards does not relieve owners and operators of their responsibility to comply with other applicable requirements such as the requirement to install liners and leachate removal systems, to conduct ground water monitoring and corrective action, and to comply with closure and post-closure requirements and financial responsibility requirements. In addition, owners and operators are not relieved of the responsibility to comply with existing or future applicable location standards.

IX. State Authority

A. Applicability of Rules in Authorized States

Under section 3006 of RCRA, EPA may authorize qualified States to administer and enforce the RCRA program within the State. See 40 CFR Part 271 for the standards and requirements for authorization. Following authorization, EPA retains enforcement authority under sections 3008, 3013 and 7003 of RCRA, although authorized States have primary enforcement responsibility.

Prior to the Hazardous and Solid Waste Amendments of 1984 remending RCRA, a State with final authorization administered its hazardous waste program entirely in lieu of the Federal program. The Federal requirements no longer applied in the authorized State, and EPA could not issue permits for any facilities in the State which the State was authorized to permit. When new, more stringent Federal requirements were promulgated or enacted, the State was obligated to enact equivalent authority within specified timeframes. New Federal requirements did not take effect in an authorized State until the State adopted the requirements as State law.

In contrast, under newly enacted section 3006(g) of RCRA, 42 U.S.C. 6926(g), new requirements and prohibitions imposed by the HSWA take effect in authorized States at the same time that they take effect in nonauthorized States. EPA is directed to carry out these requirements and prohibitions in authorized States, including the issuance of permits, until the State is granted authorization to do so. While States must still adopt HSWA-related provisions as State law to retain final authorization, the HSWA applies in authorized States in the interim.

Today's proposed rule would be added to Table 1 in § 271.1(j) which identifies the Federal program requirements that are promulgated pursuant to HSWA. The Agency believes that it is extremely important to specify clearly which EPA regulations implement HSWA since these requirements are immediately effective in authorized States. States may apply for either interim or final authorization for the HSWA provisions identified in Table 1 as discussed in the following unit of this preamble.

B. Effect on State Authorizations

Today's action proposes standards that would be effective in all States since the requirements are imposed pursuant to section 3004 (d) through (k), and (m) of HSWA, 42 U.S.C. 6924. Thus, EPA will implement the standards in nonauthorized States and in authorized States until they revise their programs to adopt these rules and the revision is approved by EPA.

A State may apply to receive either interim or final authorization under section 3006(g)(2) or 3006(b), respectively, on the basis of requirements that are substantially equivalent or equivalent to EPA's. The procedures and schedule for State program revisions under section 3006(b) are described in 40 CFR 271.21 (see 49 FR 21678, May 22, 1984). The same procedures should be followed for section 3006(g)(2).

Applying § 271.21(e)(2), States that have final authorization must revise their programs within a year of promulgation of EPA's regulations if only regulatory changes are necessary, or within 2 years of promulgation if statutory changes are necessary. These deadlines can be extended in exceptional cases (40 CFR 271.21(e)(3)).

States with authorized RCRA programs may have requirements similar to those in today's proposed rule. These State regulations have not been assessed against the Federal regulations being proposed today to determine whether they meet the tests for authorization. Thus, a State is not authorized to carry out these requirements in lieu of EPA until the State program revision is approved. As a result, the standards in today's proposed rule will apply in all States, including States with existing standards similar to those in today's action. States with existing standards may continue to administer and enforce their standards as a matter of State law. In implementing the Federal program, EPA will work with States under cooperative agreements to minimize duplication of effort. In many cases, EPA will be able to defer to the States in their efforts to implement their programs, rather than take separate actions under Federal authority.

States that submit official applications for final authorization less than 12 months after promulgation of EPA's regulations may receive approval without including standards equivalent to those promulgated. However, once authorized, a State must revise its program to include standards substantially equivalent or equivalent to EPA's within the time periods discussed above.

C. State Implementation

There are four unique aspects of EPA actions under today's proposal which affect State implementation and the impact of State actions on regulated parties:

1. Under section 268, Subpart C, EPA's imposition of nationwide disposal bans for all generators and disposers of certain types of hazardous wastes.

2. Under § 268.41, EPA's granting of a national variance extension for all generators and disposers for up to 2 years, due to insufficient alternative national capacity.

3. Under § 268.4, EPA's granting of case-by-case extensions to the nationwide bans for 1 year (renewable for an additional year) for specific applicants who lack adequate capacity.

4. Under § 268.5, EPA's granting of petitions of specific duration to dispose of certain hazardous waste in a particular unit or units where it can be demonstrated that there will be no migration of hazardous constituents for as long as the waste remains hazardous.

Regarding item 1, in order to retain authorization, States must adopt any national ban which EPA imposes under RCRA. As provided in section 3009 of RCRA, State requirements can be no less stringent than those of the Federal program.

Extending the imposition of a nationwide ban (i.e., items b and 3 above) is the sole responsibility of the Administrator of EPA and cannot be delegated to the States. Because RCRA section 3004(h)(3) refers to the Administrator taking action specifically after consulting with the affected States, it is clear that the statute intends that these actions be reserved for the Administrator, not States. Further, the actions are to be taken on the basis of national concerns which only the Administrator would be in the position to be aware of and evaluate.

On the other hand, under item 4 above, States which have the authority to impose bans may be authorized under section 3006 to grant petitions for exemptions from bans. This is because the statutory language differs and because decisions on petitions do not require the same type of national perspective as the decisions to ban waste or grant extensions discussed above. In accordance with section 3004(i), EPA will issue for publication in the **Federal Register** notices of authorized States' decision on petitions.

Notwithstanding any of the above EPA actions, States are free to impose their own disposal bans. Such bans may be imposed by States because State programs are permitted to be more stringent or broader in scope than the Federal program. (See section 3009 of RCRA and 40 CFR 271.1(i).) Where States impose bans of their own which contravene an EPA action such as a variance, extension or granting of a petition, the more stringent State ban would govern and the EPA action would be without meaning in the State.

EPA will issue additional guidance on State authorization regarding the above issues.

X. Implementation of the Part 268 Land Disposal Restrictions Program

The requirements of the HSWA and the resulting proposed regulations under 40 CFR Part 268 pertaining to land disposal restrictions, when combined with existing hazardous waste management requirements, will make the management of restricted wastes (i.e., those wastes listed in Part 268 Subpart C) more complex than the current management of hazardous wastes. In most cases several options will be available for the management of restricted wastes. In order to provide direction to generators and treatment and/or disposal facilities, EPA has prepared guidance which outlines the proposed Part 268 regulatory requirements with which waste handlers will have to comply. The following guidance provides references to applicable Parts 264 and 265 requirements as well as proposed Part 268 requirements for implementation of the various waste management options. The waste management options provided under Part 268 for the treatment and disposal of restricted wastes are dependent both upon the type of waste and the concentrations of hazardous constituents in the waste. The following steps are offered as guidance in determining the appropriate waste management procedures to refer to in Table 17 at the end of this unit.

Step 1. Determine whether the hazardous waste is listed in Part 268 Subpart C. If not, the hazardous waste is not a restricted waste and is not subject to the land disposal restrictions under Part 268.

Step 2. If the waste is listed in Part 268 Subpart C, determine whether the waste contains any hazardous constituents with concentrations at or exceeding the levels listed in Table CCWE under § 268.42. (See Procedure 1 below.) If none of the applicable concentration levels are met or exceeded, the hazardous waste may be land disposed without further restriction under Part 268. (See Procedure 6 below.)

Step 3. If the waste contains hazardous constituents with the concentration of any constituent at or exceeding a level listed in Table CCWE, the waste is subject to Part 268 land disposal restrictions. If a treatment technology is specified for the waste under § 268.40(a), that identified technology (see Procedure 2a below) or an equivalent treatment method (see Procedure 2b below) must be used to treat the waste. If a treatment technology is not specified under § 268.40(a), any appropriate treatment method may be used to reduce hazardous constituent concentration levels to levels below any level listed in Table CCWE of § 268.42. The exceptions to Step 3 (applying the required treatment standards of Part 268 Subpart D) are as follows:

a. *Case-by-case extension.* An application for an extension to an effective date (see Procedure 3 below) due to a shortage of treatment capacity nationwide may be submitted to the Administrator which if approved, would allow continued land disposal of a specific waste for up to two 1-year periods.

b. *Petition.* Approval of a petition (see Procedure 4 below) would allow continued land disposal of a specific waste in a specific unit provided the petitioner demonstrates such disposal is protective of human health and the environment.

c. *Treatment in a surface impoundment.* Wastes may be treated for up to 1 year in a surface impoundment meeting specified design and locational requirements. (See Procedure 5 below.)

Step 4. Restricted wastes which have been treated in accordance with Step 3 may be land disposed without further restriction under Part 268. (See Procedure 6 below.)

TABLE 17—LAND DISPOSAL RESTRICTION PROCEDURES

	Generator	RCRA TSD Facility Operating Under Interim Status	RCRA TSD Facility Operating Under a Permit
Procedure 1.—Analysis to Determine Constituent Concentrations in Waste or Waste Extract (40 CFR 268.6 and 268.40(b)).	The generator must determine, through either testing or knowledge of the waste, whether his waste meets the treatment standards under 40 CFR Part 268 Subpart D. If the hazardous constituents in the waste extract or waste do not exceed the concentrations listed in Table CCWE, the waste is not subject to further restriction under 40 CFR Part 268, although the generator must designate on the manifest a land disposal facility which is authorized to dispose of the waste (40 CFR 262.20).	The facility must either have documentation of tests conducted by the generator or test the waste to determine that such waste is in compliance with applicable treatment standards. The waste must be tested using the methods described in SW-846 or equivalent methods approved by the Administrator (40 CFR 268.6). The facility must record the result of this testing in its operating record (40 CFR 265.73).	The facility must either have documentation of tests conducted by the generator or test the waste to determine such waste is in compliance with applicable treatment standards. The waste must be tested using the methods described in SW-846 or equivalent method approved by the Administrator (40 CFR 268.6). The facility must record the result of this testing in its operating record (40 CFR 264.73).
	If the hazardous constituents in the waste extract or waste equal or exceed the treatment standards, the waste is subject to the land disposal restrictions and the generator must pursue one or more of the available options under 40 CFR Part 268 (case-by-case extension, petition, or treatment).	If the hazardous constituents in the waste extract or waste do not equal or exceed the 40 CFR Part 268 Subpart D treatment standards, the waste is not subject to further restriction under 40 CFR Part 268, although still a hazardous waste, and may be land disposed at a RCRA facility which has authority to manage the waste.	If the hazardous constituents in the waste extract or waste do not equal or exceed the 40 CFR Part 268 Subpart D treatment standards, the waste is not subject to further restriction under 40 CFR Part 268, although still a hazardous waste, and may be land disposed at a RCRA facility which has authority to manage the waste.
Procedure 2a.—Use of an Identified Technology to Treat a Restricted Waste (40 CFR 268.40(a)).	The generator must send its waste to a facility that has the ability to treat the restricted waste using the identified technology found under 40 CFR 268.41.	The treatment facility must be able to apply the identified technology designated for the restricted waste complying with any standards specified for that technology.	The treatment facility must be able to apply the identified technology designated for the restricted waste complying with the standards specified for that technology.
		The treatment facility must provide certification of proper treatment to the land disposal facility receiving the treatment residue.	The treatment facility must provide certification of proper treatment to the land disposal facility receiving the treatment residue.

TABLE 17—LAND DISPOSAL RESTRICTION PRICEDURES—Continued

	Generator	RCRA TSD Facility Operating Under Interim Status	RCRA TSD Facility Operating Under a Permit
		The treatment residue, after treatment by the required technology(ies), must be managed as a hazardous waste [1] but may be land disposed.	The treatment residue, after treatment by the required technology(ies), must be managed as a hazardous waste [1] but may be land disposed.
Procedure 2b.—Use of an Equivalent Treatment Method to Treat a Restricted Waste (40 CFR 268.40 (e)).	The generator must send its waste to a facility that has the ability to treat the restricted waste using an Equivalent Treatment Method approved by the Administrator.	The treatment facility must petition the Administrator for approval of an Equivalent Treatment Method in accordance with 40 CFR 268.41(b).	The treatment facility must petition the Administrator for approval of an Equivalent Treatment Method in accordance with 40 CFR 268.41(b).
		The treatment facility must provide certification of proper treatment to the land disposal facility receiving the treatment residue. The treatment residue, after treatment by the required technology(ies), must be managed as a hazardous waste [1] but may be land disposed.	The treatment facility must provide certification of proper treatment to the land disposal facility receiving the treatment residue. The treatment residue, after treatment by the required technology(ies), must be managed as a hazardous waste [1] but may be land disposed.
Procedure 3.—Case-by-Case Extensions of Effective Dates to Allow Continued Land Disposal of a Restricted Waste (40 CFR 268.4).	Generators seeking a case-by-case extension must apply to the Administrator. The extension does not become effective until a notice of approval is published in the FEDERAL REGISTER or the generator receives an approval notice from the Administrator. The generator must forward a copy of the approval notice to the land disposal facility receiving its waste before shipping the waste to the facility. The generator must retain the notice of approval in his records (40 CFR 262.40).	Land disposal facilities seeking a case-by-case extension must apply to the Administrator. The extension does not become effective until a notice of approval is published in the FEDERAL REGISTER or the disposal facility receives an approval notice from the Administrator. The facility must have a copy of the approval notice in its operating record and must keep an accounting of the waste disposed under the extension (40 CFR 265.73(b)(8)). This approval notice may be forwarded by the generator or obtained by the disposal facility directly.	Land disposal facilities seeking a case-by-case extension must apply to the Administrator. The extension does not become effective until notice of approval is published in the FEDERAL REGISTER or the disposal facility receives an approval notice from the Administrator. The facility must have a copy of the approval notice in its operating record and must keep an accounting of the waste disposed under the extension (40 CFR 264.73(b)(10)). The approval notice may be forwarded by the generator or obtained by the disposal facility directly.
Procedure 4.—Petitions to Allow Land Disposal of a Restricted Waste (40 CFR 268.5).	The generator should have evidence that the facility has an approved petition to land dispose of a specific restricted waste before shipping that waste to the facility for disposal. The generator, itself, may also file a petition or be a party to a petition with a treatment, storage, and disposal facility.	The facility must submit a petition to the Director [2] and receive a notice of approval before it can land dispose of a restricted waste. A copy of the approval notice must be kept on file in the operating record.	The facility must submit a petition to the Director [2] and receive a notice of approval before it can land dispose of a restricted waste. A copy of the approval notice must be kept on file in the operating record.
		The facility must have interim status (or an approved change under interim status) to manage the restricted waste and to operate the land disposal process. The facility must comply with all conditions of the approval.	The facility must have a permit which includes (or must modify its permit to include) the restricted waste codes to be managed and the land disposal process. The facility must (through permit conditions) comply with all conditions of the approval.
Procedure 5.—Treatment of Restricted Wastes in Certain Surface Impoundments (40 CFR 268.1(c)).	The generator must send its wastes to a treatment facility that has an impoundment that meets the minimum technological requirements, i.e., has been constructed with a double liner (with limited exceptions) and is in compliance with ground water monitoring requirements.	The facility must have Interim Status (or an approved change under Interim Status) to manage the restricted waste and operate the treatment process.	The facility must have a permit which includes (or must modify its permit to include) the restricted waste to be managed and the treatment process to be operated.
		The impoundment must meet the minimum technology requirements in accordance with 40 CFR 265.221 (a) through (e) and be in compliance with 40 CFR Part 265 Subpart F. The facility must analyze the contents of the impoundments annually in accordance with 40 CFR 268.1(e)(2). Impoundment residue that does not meet the standards found under 40 CFR 268.42 or 268.43 must be removed and managed as a restricted waste, but cannot be further treated in an impoundment. Residue that meets the standards found under 40 CFR 268 Subpart D can remain in the impoundment or can be otherwise land disposed. The residue must be managed as a hazardous waste.	The impoundment must meet the minimum technology requirements in accordance with 40 CFR 264.221 (a) through (e) and must be in compliance with 40 CFR Part 264 Subpart F. The facility must analyze the contents of the impoundments annually in accordance with 40 CFR 268.1(e)(2). Impoundment residue that does not meet the standards found under 40 CFR 268.42 or 268.43 must be removed and managed as a restricted waste, but cannot be further treated in an impoundment. Residue that meets the standards found under 40 CFR 268 Subpart D can remain in the impoundment or can be otherwise land disposed. The residue must be managed as a hazardous waste.
Procedure 6.—Land Disposal of Wastes that Meet 40 CFR Part 268 Subpart D Standards.	The generator must determine, through either testing or knowledge of his waste, that his waste meets the 40 CFR Part 268 Subpart D standards and is, therefore, no longer a restricted waste, before shipping the waste (with accompanying manifest) for land disposal to a facility with Interim Status or a RCRA permit.	The facility must have Interim Status (or an approved change under Interim Status) to manage the waste.	The facility must have a permit which allows (or must modify its permit to allow) management of the waste.
		The facility must have records and results of waste analysis performed (40 CFR 265.13 and 268.6), documenting in the operating record that the waste meets 40 CFR Part 268 Subpart D standards and may be land disposed without further treatment.	The facility must have records and results of waste analysis performed (40 CFR 265.13 and 268.6), documenting in the operating record that the waste meets 40 CFR Part 268 Subpart D standards and may be land disposed without further treatment

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[1] Unless the residue has been delisted (40 CFR 260.22) or the residue is the result of treating a waste that is hazardous solely because it exhibits one or more hazardous waste characteristics (40 CFR Part 261 Subpart C) and the residue no longer exhibits the characteristic(s).

[2] Director is as defined under 40 CFR 270.2.

XI. Regulatory Requirements

A. Executive Order 12291

Executive Order 12291 requires that the regulatory impact of potential Agency actions be evaluated during the development of regulations. Such an assessment consists of a description of the potential benefits and the potential costs of the rule, including any beneficial and any adverse effects which cannot be quantified in monetary terms.

In addition, Executive Order 12291 requires that regulatory agencies prepare a Regulatory Impact Analysis in connection with major rules. Major rules are defined as those likely to result in: (1) An annual effect on the economy of $100 million or more; (2) a major increase in costs or prices for consumers or individual industries; or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or international trade.

The Agency has performed an analysis of the proposed regulation to assess the economic impact of associated compliance costs. Based on this analysis, EPA has determined that the regulation of land disposal of solvents and dioxins will not constitute a major rule as defined by Executive Order 12291. The total annualized cost of restricting the land disposal of solvent and dioxin wastes will not exceed $100 million. However, EPA has prepared Regulatory Impact Analyses in support of this proposal, in recognition of the scope of the regulatory framework of which restrictions on land disposal of solvent and dioxin wastes are only a part, and of total costs of applying this regulatory framework to all land disposed wastes regulated under RCRA, which will exceed $100 million (and, therefore, would be a major rule).

Because of time contraints, the regulatory impact statement does not include a complete assessment of any potential shift of wastes (and associated risks) from land disposal to other media. The Agency is taking steps to more fully evaluate any potential shifts to the ocean, or surface water as a result of this decision rule to the extent that such shifts would be allowed by law, regulation, enforcement policy, or market place conditions. We solicit comment and data on anticipated shifts in waste treatment and disposal because of this rule, including comparative risk to human health and the environment.

The following discussion summarizes the methodology used in this analysis and the findings on which the conclusions above are based. More detailed information is available in the record and technical reports prepared in support of this rulemaking.

The remainder of Unit XI.A describes three analyses performed by EPA in support of today's proposed rule. Unit XI.A.1 describes the analysis of the economic impacts of restrictions on the disposal of fast-track solvent and dioxin wastes and on disposal of all RCRA wastes generically. Unit XI.A.2 details EPA's analysis of the environmental benefits attributable to this proposed rule. Finally, Unit XI.A.3 details EPA's assessment of the costs and cost savings resulting from petitions for variances from proposed restrictions on land disposal of all RCRA regulated wastes.

While these three analyses present independent results and methodologies specific to the objectives of each, they share a consistent analytical framework. The principal differences between the analyses lie in the level of detail (i.e., site-specific versus national) appropriate for conducting each. The specific assumptions, methodologies and results for each of these analyses are further detailed in the Regulatory Impact Analysis document and in the technical documents available in the docket supporting this proposed rule (Refs. 6, 7, 8 and 9).

1. Cost and Economic Impact Methodology

EPA has assessed the costs and potential economic impacts of this proposal. The proposed regulation will affect entities in a variety of four-digit Standard Industrial Classifications (SICs), including chemicals and allied products, petroleum products, and metals industries.

a. *Baseline population and practices.* The baseline population is the total number of hazardous waste generators and treatment, storage, and disposal facilities currently land disposing of RCRA regulated wastes either directly at the generation site or indirectly through the purchase of commercial land disposal services. This group's waste management practices are evaluated to identify correctly current costs of managing wastes and to assess incremental cost increases attributable to today's proposal.

This analysis represents the baseline population via a subset of respondents to the Office of Solid Waste's Regulatory Impact Analysis Mail Survey.[19] Waste quantities and management costs for plants responding to the RIA Mail Survey are scaled up to represent the national population by means of weighting factors developed within the Survey. EPA estimates that 895 facilities comprise the total national population currently land disposing of RCRA regulated wastes. Wastes are generated for disposal off-site, EPA estimates, by an additional 14,000 to 30,000 plants. Because the HSWA direct the Agency to lower the exemption for small quantity generators from 1,000 to 100 kilograms per month by March 31, 1986, SQGs generating between 100 and 1,000 kilograms of waste per month for off-site disposal are also included in the baseline population. The Agency estimates that SQGs add 25,636 plants to the baseline. Plant- and waste-specific data on this group are culled from OSW's Small Quantity Generator Survey.

Baseline management practices for these groups are characterized by adjusting waste management practices as of the 1981 Mail Survey to reflect compliance with the provisions of 40 CFR Part 264 and any other regulatory requirements which predate this proposal. In making this adjustment, the Agency assumes plants elect least-cost methods of compliance. This adjustment defines not only baseline management practices and costs associated with them, but also the number of waste streams in the baseline. For example, for 60 facilities, the costs of land disposing certain wastes are driven so high by regulations predating this proposal that other management modes are less expensive. EPA assumes that these facilities no longer land dispose of these wastes and that these wastes are no longer part of the base line population of waste streams which may be affected by any restrictions on land disposal.

For much of the population examined in this analysis, no aggregate models have been developed. Individual observations in the RIA Mail Survey have instead been treated as models, and weighted to represent the national population of wastes and management practices. In the analysis of SQGs, survey data provide a range of observations within each SIC from which a SIC-average plant can be modelled. For some dioxin wastes, individual plants are identified because they represent the majority generator of a particular waste type. For other dioxin wastes, typical plant characteristics are used to assess economic impacts.

b. *Development of costs.* The analysis detailed in this unit is based on cost estimates for surveyed plants representing the baseline population. Plants face several possible options if they may no longer land dispose of their wastes. EPA applies the same rationale in predicting plant choice among these options as it does in establishing the baseline population: firms are assumed to elect the least costly method of complying with the requirements of this proposal.

EPA developed baseline waste management cost using engineering costs models. Costs for disposal in surface impoundments assume compliance with section 3005(j) of RCRA, which requires surface impoundments to retrofit fully with double liners with leachate collection systems between liners subject to certain exemptions. This assumption

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[19] EPA conducted the RIA Mail Survey of hazardous waste generators and TSDFs to determine waste management practices in 1981. The survey included both generators of hazardous waste and facilities treating, storing, or disposing of wastes. Facilities that handled less than 1,000 kilograms of waste per month were not regulated in 1981 and thus are not included in the data. For more information see the "National Survey of Hazardous Waste Generators and Treatment, Storage and Disposal Facilities Regulated under RCRA in 1981" (Ref. 116).

could lead to an overestimate of baseline disposal costs, and, thus, to an underestimate of incremental costs for surface impoundments exempted from these requirements. Existing requirements under RCRA are also considered in developing costs for disposal in landfills and waste piles. Wastes amenable to similar types of treatment are grouped to identify economies of scale available through co-disposal and treatment.

Compliance waste management costs are derived by predicting the minimum-cost method of compliance with land disposal restrictions for each plant and calculating the increment between that and baseline disposal costs. As in the analysis of baseline costs, economies of scale in waste management are considered.

Shipping costs for wastes sent off-site for management are also considered. In the development of baseline waste management costs, the transportation distance assumed for off-site waste treatment and/or disposal is 100 miles. Most plants currently sending wastes off-site do so for disposal. Although the likely effect of restrictions will be to require treatment before and in addition to disposals, the Agency has assumed that off-site disposers ship no additional incremental distance as a result of the proposed regulations. In essence, EPA assumes that commercial facilities which currently dispose of the major portion of the wastes they receive can also treat this portion prior to disposal if necessary. EPA examined the sensitivity of results to this assumption and this analysis revealed that varying the assumption in travel distances, even by as much as a factor of eight, has a minor effect on results. This is because many plants which send wastes off-site send small amounts; thus, economies of scale reflected in per unit prices of waste disposal at large commercial facilities outweigh even a major increase in shipping costs. Although EPA found that varying transportation costs has a minor impact on the decision to ship off-site, in the Agency's analysis of petition costs, which is discussed in more detail in Unit XI.A.3 of this preamble, transportation costs were found to have a greater impact on a firm's decison to petition.

Costs of compliance include costs for pretreatment, of handling residuals and the value of byproducts of the various treatment technologies. For wastes to be distilled, for example, pretreatment may be necessary. Becasue of this, pretreatment costs have been added to those of distillation. In the case of incinerated wastes, costs of disposal of residual ash are added. And in the case of distilled solvents, when treatment generates saleable recovered products, the value of these products has been deducted from total costs of waste treatment.

EPA developed firm-specific compliance costs in two components which are weighted and then summed to estimate total national costs of the proposal. The first component of the total compliance cost is incurred annually for operation and maintenance (O&M) of alternative modes of waste treatment and disposal. The second component of the compliance cost is a capital cost, which is an initial outlay incurred for construction and depreciable assets. Capital costs are restated as annual values by adjusting them into equivalent yearly payments using a capital recovery factor calculated based on a real cost of capital of 7 percent. These annualized capital costs are then added to yearly O&M costs to derive an annual equivalent cost by which annual firm cash-flow may be reduced by the regulation.

c. *Economic impact analysis methodology.* Economic impacts are assessed in several steps. First, a general screening analysis compares plant-specific incremental costs to SIC-average financial information disaggregated by number of employees per plant. Two ratios are used to identify plants likely to experience adverse economic impacts. From the 1982 Census, values for cost of production and cash from operations are derived by a four-digit SIC for each of several employment size categories. A ratio of individual plant compliance costs to each of these values is taken, and a change of more than 5 percent is considered an economic impact. This analysis considers only pre-tax costs, because Census data are stated in before-tax terms.

Once SIC sectors experiencing adverse economic impacts are identified using the two screening ratios, more indepth financial analysis is performed to verify the results and focus more closely on affected firms. For the subset of firms which appear to incur sufficient economic impact to warrant more detailed analysis and for which such data are available, annualized plant-specific compliance costs are deducted from annual cash-flow values. Firm-specific financial data used in this analysis are derived from economic reporting services such as Robert Morris Associates or Dun & Bradstreet.

This cash-flow analysis can be misleading, however, since for some firms, cash-flow values reported for 1984 are negative. Clearly, this does not represent typical financial performance for these firms. Businesses may weather a year of poor cash-flow values, however, if they have a strong asset base and an expectation that financial conditions will improve. For these firms, therefore, EPA has conducted further analysis using alternative measures of economic size such as net income, assets and liabilities. This improves the assessment of the significance of the negative cash-flow values and of these firms' probable response to compliance costs.

d. *Small business impact analysis methodology.* In the small business impact analysis supporting this proposed rule, EPA has defined small business as firms employing fewer than 50 people. EPA has elected not to adopt the Small Business Administration's definition of small business, which is fewer than 500 employees for most SICs, because it would include the majority of plants in the regulated community. Using a threshold value which includes a majority of the total population obscures any differential impacts on smaller firms. The Agency considers a threshold value of fewer than 50 employees to be a more sensitive index of impacts on small businesses.

Economic impacts on small businesses are examined in two phases. First, the screening ratios, compliance cost to cash from operations and compliance cost to costs of production, are used across all sizes of firms in the analysis. The total small business population is then examined discretely to evaluate the percent of this total population exceeding the 5 percent threshold on either ratio. Then, EPA compares results of these ratios for the large firms in the total SIC to results for the subset considered small business. A substantial difference in the results of these ratios implies that average impacts for large firms differ markedly from average impacts for small firms within that population. These analyses allow EPA to evaluate whether or not a substantial number of small firms incur significant economic impact in complying with the proposal.

2. Costs and Economic Impacts

a. *Total national costs and economic impacts for all RCRA-regulated wastes.* In addition to proposing land disposal restrictions applicable to solvent and dioxin wastes, today's proposal details a framework which the Agency will apply to all RCRA-regulated wastes according to the congressionally mandated schedule. Because of the ultimately national impact of this regulation, EPA has treated this rulemaking as major, although on the basis of costs incurred by plants complying with restrictions on solvent and dioxin wastes it cannot be considered major. Further, in an attempt to assess the national economic impacts of the proposal, the Agency has evaluated the total costs of the regulation.

Total annualized costs of restricting land disposal of all RCRA-regulated wastes are estimated at $1.3 billion. These costs do not exclude taxes, which are merely transfers from one sector of the economy to another, and are stated in 1984 dollars. These costs may slightly understate total surface impoundment compliance costs to the extent that usable capacity in disposal impoundments must be wasted in switching to alternative disposal modes. The Agency will assess this possibility and revise cost estimates where appropriate. These costs are derived by weighting plant-specific compliance costs by the part of the total national population they represent, and then summing these weighted costs across all affected SICs. These weighting factors, however, cannot be used to scale up economic impacts to represent those likely to occur at the national level. The weighting factors are specific to individual waste streams, and were never intended to reflect firm economic context. For the purposes of the economic analysis, SICs must be unambiguously related to individual plants. Thus, all economic impacts are expressed in unweighted form.

Four SIC sectors account for approximately 70 percent of all land disposal restriction compliance costs. SIC 28, chemicals and allied products, alone accounts for 26 percent. Three other SICs also contribute significant amounts, although much less: SIC 29, petroleum refining, accounts for 14 percent, SIC 33, primary metals, accounts for 23 percent, and SIC 34, fabricated metal products, accounts for 6 percent.

Economic impacts have been assessed for both non-commercial and commercial facilities. Non-commercial facilities are those which generate and manage their own wastes, as distinct from facilities which accept fees in exchange for management and disposal of wastes generated by others. Of 413 unweighted non-commercial facilities nationally, 175 experience financial effects in excess of the 5 percent test on either compliance cost to cost of production or compliance cost to cash from operations or both. For some plants, such as those in the steel industry (SIC 33), compliance costs represent an added burden at a time when the industry as a whole is experiencing financial reversals. For other plants, costs simply represent a large increment over costs of unrestricted land disposal.

Of the 50 most significantly affected facilities, 80 percent belong to four industry groups. In SIC 28, chemicals and allied products, 23 facilities may experience severe impacts. In SIC 33, primary metals processing, 11 facilities are likely to be similarly affected. In SIC 29, petroleum refining, three facilities may incur economic impacts, and finally, in SIC 34, fabricated metal products, three facilities may be affected.

Commercial facilities are those which manage the wastes generated by other firms for a fee. For these facilities, economic impacts are impossible to assess directly due to the lack of any appropriate SIC from which to draw financial data. EPA's analysis therefore assumes that commercial facilities are able to pass the costs of regulatory compliance on to the purchasers of their services in the form of higher prices. The financial impact of this regulation is thus assumed to fall on consumers of commercial hazardous waste management services.

As a result of the restriction on land disposal of all RCRA-regulated wastes 53 commercial facilities incur incremental costs. Based on RIA Mail Survey data, the five SICs which send the majority of each facility's waste have been identified. Actual plants generating these wastes cannot be identified using RIA Mail Survey data. Therefore, EPA's analysis assumes that all wastes reported from a given SIC come from a single generator within that SIC. Ratios of the compliance costs for treating the total quantity of waste from a SIC to SIC-average values for cash from operations and to costs of production are taken for each industry sector which constitutes a primary source of waste for each of these 53 facilities. This procedure is likely to overstate significantly economic impacts among generating plants.

Significant economic impacts based on costs imposed by restrictions on land disposal are evinced by 110 SIC sectors. This represents nearly 60 percent of all waste-generating sectors which may have to pay increased waste management prices. Most significantly affected plants belong to four industry groups. In SIC 28, chemicals and allied products, 30 plants may experience severe impacts. In SIC 33, primary metals processing, 23 plants are also likely to be affected adversely. In SIC 29, petroleum refining, 16 plants may incur economic impacts, and in SIC 34, fabricated metals products, 15 plants may incur economic impacts.

More indepth financial analysis was then performed to verify the results of this impact analysis based on firm-specific financial data. For approximately 70 percent of the population of large quantity generators disposing on-site and commercial facilities (unweighted: 310 out of 466), these data are available. Ratio tests performed for these firms include compliance costs to cash-flow, compliance costs to net income, and compliance costs to total assets. Compliance costs used in this analysis are after-tax values, to preserve comparability with the after-tax financial data used.

In the three ratio tests, 27 plants exceed threshold values and are thus considered likely to be affected severely by costs imposed by this regulation. These plants represent 9 percent of the 310 for which financial data are available. This result differs significantly from results obtained using SIC-average financial data, and suggests that the general screening analysis may overstate economic impacts.

Total annualized national costs for the 25,636 small quantity generators of RCRA regulated wastes are $21.7 million. Based on engineering estimates of prices for off-site waste management services, costs for SQGs generating the maximum of 1,000 kg/mo of nothing but hazardous wastes would incur not more than $5,070 annually in incremental compliance costs. Economic ratios for typical plants in each 4-digit SIC sector represented in the SQG survey were examined, and in no case did the ratios exceed 0.6 percent. Thus, land disposal restrictions on RCRA-regulated wastes are not expected to cause economic impacts among generators of small quantities of wastes.

Changes in costs of waste treatment and disposal on a pergallon basis provide an additional measure of economic impact. Baseline management costs for waste land disposed by noncommercial facilities average $0.021, compliance costs average $0.46, and incremental costs average $0.25. Thus, baseline waste management costs have been increased by 120 percent. For wastes currently disposed of at commercial facilities, baseline costs average $0.69, compliance costs average $1.99, and incremental costs average $1.30. This represents a 190 percent increase in baseline management costs.

For wastes currently stored in surface impoundments at noncommercial facilities, baseline waste management costs average $0.0021 per gallon, compliance costs average $0.0096, and incremental costs average $0.0075. Thus, typical management costs are increased by approximately 360 percent. For commercial facilities, baseline costs average $0.0056, compliance costs average $0.0189, and incremental costs average $0.0133. Thus, typical management costs are increased by about 240 percent.

For wastes currently treated in surface impoundments at noncommercial facilities, baseline management costs average $0.0017 per gallon, compliance costs average $0.0051, and incremental costs average $0.0034. This represents a 200 percent increase in management costs. For commercial facilities, baseline management costs average $0.053, compliance costs average $0.0123 per gallon, and incremental costs average $0.0070 per gallon. Thus, typical management costs are increased by approximately 130 percent.

b. *Total costs and economic impacts for solvent wastes.* Total annualized compliance costs for plants currently generating and disposing of solvent wastes are $70.5 million. Although SQGs constitute 99 percent of this total population, they account for only 13 percent of the total costs.

Economic impacts have again been disaggregated into impacts on non-commercial and commercial facilities. Among non-commercial plants, only three incur compliance costs greater than 5 percent of costs of production. The most severely affected facility is in SIC 2999, which may incur a 9 percent increase in costs of production and a 52 percent reduction in cash from operations. Five other facilities incur reduction in cash from operations greater than 5 percent. These are in SIC 2865, in which two facilities may experience reductions in gross margin of 52 percent and 6 percent; SIC 2900, in which a facility may experience a 13 percent decline in cash from operations; SIC 2861, in which one firm's cash from operations may decline by 11 percent; and SIC 2819, in which a facility's cash from operations may drop by 26 percent.

Among commercial facilities—those which manage the wastes of other firms for a fee—direct impacts were impossible to assess due to the lack of financial data, even on an aggregate basis. Therefore, EPA's analysis has assumed that commercial facilities will be able to pass the increased costs of regulatory compliance on to their customers in the form of higher prices. The burden of this regulation is thus assumed to fall on consumers of commercial hazardous waste management services.

Fifteen commercial facilities incur incremental costs as a result of this regulation. Based on RIA Mail Survey data, the five industrial sectors which send the majority of each facility's waste have been identified. Ratios of the compliance costs to cash from operations and to costs of production are taken for each SIC which constitutes a primary sector of waste origin for one of these 15 facilities.

This analysis identifies 23 sectors as experiencing significant impacts. This represents over 30 percent of all solvent waste generating sectors. Of these, five include two or more severely affected firms. All plants identified as having significant impacts exceed the 5 percent criterion for the cash from operations ratio, and 10 plants exceed 5 percent in the cost of production ratio as well.

Among the most adversely affected plants are those in SIC 5500, which incur a 7.7 percent increase in costs of production and a 107 percent decrease in cash from operations. Plants in the primary metals processing industries also experience significant impacts: two in SIC 3300 and one in SIC 3341. Other affected sectors include SIC 34, fabricated metal products, and SIC 28, the chemical industry.

Total annualized costs for the 13,468 small quantity generators of solvent wastes are $9.5 million. Based on the estimated cost for off-site incineration, maximum incremental compliance costs for any individual SQG will not exceed $3,275 annually. Economic ratios were examined for typical SQGs in each SIC sector identified in EPA surveys as generating solvent wastes. In no instance did economic ratios exceed 0.6 percent. As a result, the Agency does not anticipate that this regulation will impose significant economic impacts on typical small quantity generators in any SIC sector.

c. *Total costs and economic impacts for dioxin wastes.* Total annualized compliance costs for all sources of dioxin wastes are $3.8 million. Costs for managing that portion of the estimated 1.1 billion pounds of existing dioxin-contaminated soil to which this regulation will apply are $7 million. Preliminary testing of dioxin-contaminated soils suggests that only 5 percent of the total quantity will require incineration, and the costs reflect this finding. Of these soils, EPA estimates 95 percent can continue to be landfilled, because they show no leachable dioxin.

Economic impacts appear most significant for plants in SIC 2869 as a result of the restriction on dioxin wastes. This sector manufactures industrial organic chemicals, with major products such as solvents, noncyclic organic, and polyhydric alcohols. Other affected sectors include 2879, in which one plant may close, and 5161, which may experience several plant closures. SIC 2879 includes plants manufacturing pesticides and agricultural chemicals for immediate household and farm use. SIC 5161 comprises distributors of acids, heavy chemicals, and industrial salts.

3. Cost Analysis of Petitions

a. *Introduction.* The Agency conducted a cost analysis to estimate the unit costs for a petition for a variance from the land disposal restriction; the national costs are based on the expected number of petitions to be submitted, and subsequently granted; and the savings that would accrue to petitioners receiving a variance.

This unit of the preamble is a summary of the cost analysis, documented in "Cost Analysis of Variances to Land Disposal Bans" (Ref. 7).

b. *Methodology.* EPA's analysis evaluated three issues: the contents and unit cost of a petition, considering various options for a petition demonstration; the number of petitions that are likely to be submitted; and the savings available to generators that choose to petition and are granted a variance.

To address these issues EPA used a simulation model that describes the options and outcomes for the regulated populations and estimated and compared the expected cost of the options. Using this framework, EPA simulated the response to a ban decision; whether to accept the ban and comply with treatment standards or to submit a petition. To complete the analysis the Agency conducted the following steps:

EPA first estimated the population of regulated facilities that may be affected by petitions for variances from land disposal bans. Existing data on generators that land dispose their wastes were obtained from the "National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Regulated Under RCRA in 1981" (Ref. 116).

For this analysis, the assumption was made that all wastes are banned from land disposal. It was also assumed that commercial facilities would encourage treatment, and thus generators that shipped their waste to these commercial facilities would not opt for applying for a variance. Therefore these generators were excluded from the population of candidates most likely to petition.

A sub-set of petition candidates for whom a variance from the ban is a feasible option was created. EPA predicted feasibility of applying for a variance by using the Liner Location Risk and Cost Analysis Model (LLM) to evaluate each candidate's ability to meet the performance standard that there would be negligible risk (defined as no greater risk than one in a million (10^{-6}) that a Maximum Exposed Individual would be affected) at designated compliance points. Because of the waste-specific nature of the ban decision, and the requirements for demonstrating for a variance, the analysis was on a facility/specific-waste stream basis.

EPA evaluated the feasibility of a variance from land disposal bans at three different compliance points. The broader standard defines the compliance point as the nearest receptor point, i.e., the closest ground water well. A more restrictive standard's compliance point is at the facility boundary. An even more stringent compliance point is at the waste management unit boundary. Those candidates with negligible risk (assumed to be $<10^{-6}$ to the most exposed individual) at the relevant compliance point for their specific facilities passed through the risk screen, and remained on the list of potential petition candidates.

Predictions were then made about the candidates' response to a ban on land disposal of their wastes. EPA defined their options as: (1) Accept the ban and comply with treatment standards or, (2) submit a petition. EPA estimated the cost to submit a petition and the cost to comply with the ban, either using on-site treatment or off-site (commercial) treatment. It was then assumed they would choose the option which minimized the expected value of the cost of responding to the ban. Facilities that had an incentive to petition, based on potential cost savings from preparing a petition instead of complying with the treatment standards required by the ban were then selected. EPA estimated the potential cost savings by comparing treatment costs with cost for preparing a petition. In comparing these estimates, consideration was given to (A) the cost of preparing a petition, (B) the costs of filing for a petition and still having to comply with treatment standards because a petition is denied, and (C) the probability that a petition would be granted.

Because the stream of these costs over time may be uneven, EPA converted this stream to its equivalent annual cost over the life of the facility using discounted cash flow analysis. This value represents the annual revenue required to cover the costs imposed or the annual savings realized by the provision, and provides a consistent basis for presenting and comparing costs of different provisions.

i. *Petition costs.* EPA considered the following components in the cost of preparing a petition: constituent identification, physical and chemical characterization of those constituents, and environment fate processes; hydrogeological evaluation, soil studies, aquifer characterization, and ground water usage; background water quality including background presence of constituents from the banned waste, other ground water parameters, and surface water monitoring; ground and surface water modeling; air exposure assessment including volatilization and dispersion models, monitoring for air releases, and collecting meteorologic data; identifying receptor populations including animals, humans, and plants; characterizing exposure to the receptor populations; and evaluating the human health and environmental effects of exposure.

EPA obtained estimates of the cost to prepare a petition from laboratories which regularly analyze waste streams; from firms familiar with hydrogeologic evaluation; and from professional judgment.

In estimating the cost to submit a petition several different interpretations of reasonable degrees of certainty in the petition demonstration were considered, because on a case-by-case basis, it would be difficult to predict how much additional effort would be required by each facility. For instance, since waste characterization is going to be required for the ban program it may not be necessary to put more effort into waste characterization in demonstrating for a petition, but this would also depend on a facility's present and past efforts to characterize their waste. The low estimate represents minimal additional data gathering, and minimal waste and site characterization beyond that which is already required of a regulated facility. The medium estimate represents some new data gathering and characterization of the waste and site, but does not require extensive validation of this data. The high cost estimate for a petition includes extensive field validation of various parameters and a very high level of certainty in the estimates made. In the analysis EPA estimated the number of petitions under all three scenarios.

ii. *Cost of complying with treatment standards.* In deciding whether to apply for a variance or use an alternative treatment, the facility owner or operator must consider the range of feasible treatments, their cost, both on- and off-site, and the cost of residual disposal. The owner or operator will compare these costs to the cost of continuing current disposal practices (assumed to be zero if a petition is granted). The Agency simplified the analysis by assuming that wastes treated on-site were disposed of on-site while wastes treated off-site were disposed of off-site. Unlike annualized petition costs which were assumed to be the same for all petitioners, annualized treatment costs were estimated separately for each of the sample candidates.

For most of the candidate facilities, the option exists to develop treatment capacity on-site. However, all candidates could elect to send their waste off-site for commercial treatment and disposal. The Agency assumed they would select the least-cost option.

EPA assumed that any treatments currently applied to wastes would not be adequate for compliance with the treatment standards under the ban. The Agency also assumed for the purpose of estimating costs that all landfills and surface impoundments were equipped with a double synthetic and clay liner, and a leachate collection system between the liners, as required for compliance in section 3005(O) of RCRA.

(A) *On-site costs.* EPA estimated on-site treatment costs for various waste streams using the WET Model, documented in the "RCRA Risk Cost Analysis Model, Phase III Report" (Ref. 118). Disposal costs were estimated using the cost model of "The Liner Location Risk and Cost Analysis Model" (Ref. 112).

The viable treatments and cost for on-site treatment of RCRA-regulated waste assumed to be banned were chosen from a list of 16 possible processes described in EPA's Risk-Cost Analysis Model/WET Model (Ref. 118). Appropriate treatments were chosen depending on which wastestreams were being handled. EPA assumed these processes would meet the treatment standards under the ban. Then the Agency estimated unit costs per metric ton assuming 20 years of throughput of a constant waste volume.

EPA estimated the cost of developing treatment capacity for the waste at the current site. The Agency excluded from the sample population candidate generators that currently ship waste off-side to commercial facilities or to facilities owned by States or municipalities.

On-site treatment costs were estimated for the remaining candidates' waste using the technology and cost information based on model plant data contained in the WET Model (Ref. 118). Generally, EPA assumed only a single treatment step and that the volume of waste currently disposed of was equal to the design capacity for the treatment facilities.

EPA estimated annualized costs for constructing and operating each technically feasible treatment plant for each candidate facility-waste combination. EPA then selected the least cost treatment for each candidate's waste type and volume.

Disposal costs were estimated based on the residual waste volumes calculated by the WET Model. The Facility Design Cost Model of the Liner Location Model (Ref. 112) allows the user to generate cost functions for a range of disposal unit sizes. From the functions, EPA predicted the incremental costs or savings from a change in volume brought about by treatment. EPA assumed for all on-site disposal scenarios that a landfill or surface impoundment contains only one waste.

(B) *Off-site costs.* For calculating the cost of sending waste off-site, EPA considered the cost of shipping the waste, the price of treating and disposing of it, and the savings from closing the existing on-site disposal unit. In considering off-site treatment, the price charged by commercial waste managers largely determines whether a decision maker can save money by sending waste off-site for treatment.

EPA estimated off-site treatment and disposal costs from a price survey of selected treatments at commercial facilities, "Review of Activities of Firms in the Commercial Waste Management Industry: 1983 Update" (Ref. 119). Transportation costs were obtained from existing models of hazardous waste transportation costs cited in the WET Model (Ref. 118). The total price for commercial treatment was estimated as the product of the unit price and the volume treated (which was available from the facility database).

EPA assumed that all residuals from treatment were disposed at the commercial facility. Using a flat rate of $200 per metric ton and multiplying this price by the residual volume gave the total price for landfilling the residual at a commercial facility.

In estimating off-site costs, transportation was an important factor in determining whether it would be more cost-effective to petition for a variance. In estimating transportation prices, distances between generators and commercial facilities were considered. EPA assumed that the waste would be shipped to the nearest commercial hazardous waste management facility and data from the 1981 OSW Survey and "Industrial and Hazardous Waste Management Firms 1985" (Ref. 116 and 61) was used to estimate these distances.

EPA obtained an estimate of the average capacity of trucks driving these distances, hauling hazardous waste from the WET model. The average capacity of stake trucks was 10.6 metric tons (MT) and 12 MT for tankers. Due to a lack of better information, EPA assumed that waste volumes greater than average shipment sizes were shipped in vehicles filled only to this average, while volumes less than the average were shipped in trucks containing only that lower volume. Therefore, smaller volume shipments resulted in higher costs per mile.

Annual transportation costs were estimated for each facility-waste combination.

iii. *Probability of being granted a variance.* After selecting the least-cost treatment option (on- or off-site), EPA compared the expected cost of petitioning and being granted a variance with the expected cost of complying with treatment standards. The results of this comparison formed the basis for the Agency's estimates of the number of petitions expected and the savings from use of the variance.

EPA assumed that a generator's decision whether or not to submit a petition would be driven by the expected value of the cost of various options. As a result, changes in the probability that a petition would be granted affected the estimated number of petitions submitted, the total cost, and the savings.

The range of probabilities that EPA used in the analysis (P=1, .5, and .1) represented factors that could not be quantified easily or were not well defined, which could still affect whether a variance was granted. For example, the probability could reflect the fact that even though a petitioner submitted information with a high degree of certainty and met the performance standard based on this information, the site could never be adequately characterized despite the best efforts made.

The probability, also represents the petitioner's perceptions of the chance that EPA would find the demonstration acceptable. The probability is most affected by guidance given to potential petitioners by EPA about the information required in petitions and the level of detail involved in petition review.

c. *Limitations of the analysis*—i. *Data limitations.* EPA had information on waste types, volumes, and site characteristics for 96 landfills and surface impoundments. EPA extrapolated this information to the regulated community. However, the sample facilities do not represent a statistically random sample of all landfills and surface impoundments and therefore, may not be truly representative of the regulated population.

The effect is that the analysis may have understated the total number of petitions and savings for at least two reasons. First, it did not consider petitions from generators whose waste is disposed of in waste piles, and/or by land application. Second, it excluded consideration of petitions for D001 wastes (ignitables).

Due to lack of information about the constituent composition of each facility's wastes and hydrogeologic parameters and models that EPA will use in making the ban decisions, the Agency assumed that all wastes in the sample population were banned. This may overestimate the number of petitions expected.

ii. *Analytical limitations.* In the course of the analysis EPA made several assumptions that affect the results. In determining the facilities that would pass a preliminary risk screen, EPA assumed a worst-case release scenario, where all landfills and surface impoundments were unlined. This assumption may underestimate the number of units where land disposal would present only a negligible risk.

By specifying that a generator will either petition or accept the ban, EPA assumed that although the ban regulations will impose additional costs on the regulated community, the increased costs will not affect the volume or type of wastes generated. This assumption ignores the possibility that generators will alter their production process to decrease volume and/or toxicity of their waste. For the short-term this assumption is reasonable, but over longer periods, such changes in processes are likely, but difficult to predict.

In looking at costs of on- and off-site treatment and disposal, and the costs of preparing a petition, EPA estimated the costs based on the volume of each individual waste. This approach ignored the generator's ability to take advantage of economies of scale in disposing and treating wastes. This led to an overestimate of the incremental unit costs for both treatment and disposal at candidate facilities. In general, that would result in fewer expected petitions. At the same time, since a petition will contain a great deal of information that is site-specific independent of the waste, the additional cost of preparing a second petition for a second waste would be much less than for the first. This would result in more petitions being submitted.

EPA also assumed for costing purposes that a facility owner/operator could submit one petition for a waste stream that contained multiple wastes, rather than a separate petition for each waste. If instead EPA had considered each waste separately, the number of petitions, and the associated costs would have increased substantially.

Finally, the functions that EPA used to estimate disposal costs were based on the volume of only one waste stream. Therefore, incremental costs of savings will be greater if the waste was one of several placed in the unit. This assumption resulted in an overestimate of both costs and savings at some disposal units. The savings were so large in some cases that they overwhelmed the incremental cost of treatment.

d. *Results.* EPA's approach gives an estimated fraction of petition candidates who find it less expensive to petition for a variance from the land disposal ban than to comply with the treatment standards imposed by the ban. EPA estimated the number of petitions, the petition costs, and the savings accruing to petitioners under several different scenarios. The scenarios were defined by different assumptions about the cost to prepare a petition, the performance standard for petitions, and the probability of receiving a petition once it is submitted. The following Table summarizes the results for each scenario:

TABLE 18.—RESULTS SUMMARY FACILITY BOUNDARY COMPLIANCE POINT

[Dollars in millions]

Probability	Annualized petition cost		
	Low $11,000	Medium $44,000	High $217,000
High probability:			
Population: Number of petitions	190	114	38
Total annualized costs	$2.1	$5.0	$8.2
Total annualized saving (Treatment-petition cost)	$59	$55	$42
Medium probability:			
Population: Number of petitions	133	76	38
Total annualized costs	$1.5	$3.3	$8.2
Total annualized saving (Treatment-petition cost)	$59	$54	$42
Low probability:			
Population: Number of petitions	76	38	11
Total annualized costs	$0.8	$1.7	$2.4
Total annualized saving (Treatment-petition cost)	$56	$48	$21
NEAREST WELL COMPLIANCE POINT			
High probability:			
Population: Number of petitions	361	247	95
Total annualized costs	$4.0	$10.9	$20.6
Total annualized saving (Treatment-petition cost)	$159	$150	$122
Medium probability:			
Population: Number of petitions	285	171	57
Total annualized costs	$3.1	$7.5	$12.4
Total annualized saving (Treatment-petition cost)	$159	$148	$120
Low Probability:			
Population: Number of petitions	171	57	38
Total annualized costs	$1.9	$2.5	$8.2
Total annualized saving (Treatment-petition cost)	$154	$132	$93

i. *Number of facilities where a variance is a feasible option.* The number of facilities where a variance was a feasible option depended on the compliance point. At the disposal unit as the compliance point, the variance was not a feasible option. The expected risks from exposure to those concentrations of leachate at the disposal unit edge were significant ($>10^{-6}$) for all waste characterized. Therefore, no petitions are expected for demonstrating safe levels of exposure at this compliance point.

Table 18 shows how the other two compliance points (the facility boundary and the nearest water well) affected the results. Different compliance points made a significant difference in the number of petitions. The more restrictive compliance point at the facility boundary cut the number of petitions by approximately one-half in every scenario.

At the waste facility boundary compliance point the variance was a feasible option since 494 facilities passed the risk screen (a risk of $<10^{-6}$). When the compliance point was designated as the nearest drinking water well, 722 facilities passed the risk screen, thereby making the variance a feasible option.

ii. *Costs to prepare a petition.* The estimated cost to prepare and submit a petition ranged from a present value of $170,000 to $3,220,000 with a medium estimate of $652,000. The annualized costs, assuming the petitioner could spread his costs over 20 years, ranged from $11,000 to $217,000 with a medium estimate of $44,000. The costs were assumed constant for all volumes and types of wastes. Changing petition costs from the low to the medium estimate reduced the number of petitions by 30 to 60 percent. Increasing petition costs from the medium to the high estimate further reduced the number of petitions by 50 to 70 percent.

The total annualized petition costs, ranged from $800,000 per year to $20.6 million per year, depending on the petition cost and the compliance point.

iii. *Savings to the petitioners.* The total annual savings ranged from $21 million to $159 million depending on unit petition costs, the probability of being granted a petition, and, most importantly, the compliance point.

Since petition costs do not vary with volume (and treatment costs do), there is a tendency for high volume generators to be more prevalent among the population of petitioners. These candidates, with a very high cost of compliance with treatment standards, dominated the estimated cost savings.

At the facility boundary the total savings ranged from $21 million to $59 million per year. At the nearest well compliance point the savings ranged from $93 million to $59 million per year.

4. Review of Supporting Documents and Request for Public Comments

a. *Review of supporting documents.* The primary source of information on current land disposal practices and industries affected by the proposed regulation is EPA's National Survey of Hazardous Waste Generators and Treatment, Storage and Disposal Facilities (Ref. 116). Waste stream characterization data and engineering costs of waste management are based on the Mail Survey, on reports by the Mitre Corporation, "The RCRA Risk-Cost Analysis Model," and an internal EPA memo titled "Final Reports on the Evaluation and Validation of Acceptance Daily Intake (ADIs) in Support of RCRA Ban Decisions" (Refs. 116, 78, 118, and 39). The survey of small quantity generators has been the major source of data on this group (Ref. 115). EPA's Office of Research and Development provided the report fundamental to the dioxins analysis, "Analysis of Technical Information to support RCRA Rules for Dioxins-Containing Waste Streams," July 1985 (Ref. 67).

For financial and value of shipment information for the general screening analysis, 1982 Census data were used. A primary source of firm-specific financial information is Dun & Bradstreet's "Business Information Reports." Secondary sources include data from

Robert Morris Associates and Dun & Bradstreet's "Industry Norms."

b. *Request for public comments.* EPA recognizes that due to constraints of time and data availability, this analysis has significant limitations. Specifically, EPA requests comment on the following:

i. EPA would like to refine the assumption that 100 percent of the costs imposed on commercial hazardous waste facilities can be passed through in the from of higher prices. The Agency requests any estimates of typical profit margins in the commercial hazardous waste industry, data on waste management fees, and on the percent price increase in waste management fees which may force substitution on generators.

ii. The Agency requests public comment and data on the feasibility of small business waste recycling, reclamation, or in-process reduction. In particular, EPA requests data from the solvent reclaiming industry and other reclaiming services applicable to RCRA-regulated wastes.

iii. The Agency's analysis asumes that all affected wastes are banned from land disposal. This assumption overstates the quantity of wastes banned from land disposal, and, hence, economic impact. EPA has made this assumption because severe time constraints imposed by the schedule legislated for this regulation prevented the incorporation of treatment standards. Given the relative restrictiveness of these standards, however, this overestimate may be minor. For the final rule, treatment standards will be applied to determine which waste streams will be covered under this regulation. EPA estimate of impacts will remain uncertain, however, because of the lack of data on waste composition and leachability of constituents. EPA requests any data on typical waste stream composition which could allow a better assessment of how treatment standards will constrain disposal and treatment options.

iv. EPA requests comments and data on alternative technologies or in-process waste reductions available.

This proposed rule was submitted to the Office of Management and Budget (OMB) for review, as required by Executive Order 12291.

B. Regulatory Flexibility Act

Under the Regulatory Flexibility Act, 5 U.S.C. 601 et seq., whenever an agency is required to issue for publication in the Federal Register any proposed or final rule, it must prepare and make available for public comment a Regulatory Flexibility Analysis which describes the impact of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions) unless the agency's administrator certifies that the rule will not have a significant economic impact on a substantial number of small entities.

The Agency has examined the proposed rule's potential impacts on small business and has concluded that this regulation will not have a significant impact on a substantial number of small entities.

This small business analysis excludes generators of large quantities of RCRA wastes, as it was not possible to determine the economic size of these firms (Ref. 6). The small business population examined here includes two groups: all noncommercial treatment, storage, and disposal facilities employing fewer than 50 persons, and all small quantity generators which are also small businesses. Of TSDFs, 244 are small businesses. Of these, 84 exceed the 5 percent ratio on costs of production or cash from operations or both. This represents 34 percent of the total small business population. Of all noncommercial facilities, 42 percent (175 out of 413) are predicted to experience economic impacts. Among larger businesses, 91 out of 169, or 54 percent, may experience economic impacts.

Of the total of 25,636 small quantity generators examined in this analysis, the vast majority (19,709 or 77 percent of the total population of SQGs) are also small businesses. None of the economic ratios examined for SQGs exceeded 1 percent on either costs of production or cash from operations. Thus, for the whole population of small businesses, economic impacts did not exceed 0.6 percent.

Accordingly, I hereby certify that this proposed rule will not have a significant impact on a substantial number of small entities. Therefore, this proposed rule does not require a Regulatory Flexibility Analysis.

C. Paperwork Reduction Act

The Paperwork Reduction Act of 1980, 44 U.S.C. 3501 et seq., requires that the information collection requirements of proposed and final rules be submitted to the Office of Management and Budget (OMB) for approval. This proposed rule would indirectly affect another information collection requirement that has been approved by OMB under the Paperwork Reduction Act. This affected requirement has been assigned the OMB Control Number 2050-0012. The appropriate changes to this requirement have been submitted to OMB for approval.

The information collection rquirements directly associated with today's proposed rule have been submitted for OMB approval. Submit comments on these requirements to the Office of Informtion and Regulatory Affairs, OMB, 730 Jackson Place, NW., Washington, D.C. 20503, marked: Attention: Desk Officer for EPA. The final rule will respond to any OMB or public comments on the information collection requirements.

XII. References

Background Documents

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XIII. List of Subjects in 40 CFR Parts 260, 261, 262, 264, 265, 268, 270, and 271

Administrative practice and procedure, Confidential business information, Environmental protection, Hazardous materials, Hazardous materials transportation, Hazardous waste, Imports, Indian lands, Insurance, Intergovernmental relations, Labeling, Packaging and containers, Penalties, Recycling, Reporting and recordkeeping requirements, Security measures, Surety bonds, Waste treatment and disposal, Water pollution control, Water supply.

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Lee M. Thomas,

Administrator.

Appendix I—Toxicity Characteristic Leaching Procedure (TCLP)

1.0 *Scope and Application*

1.1 The TCLP is designated to determine the mobility of both organic and inorganic contaminants present in liquid, solid, and multiphasic wastes.

1.2 If a total analysis of the waste demonstrates that individual contaminants are not present in the waste, or that they are present, but at such low concentrations that the appropriate regulatory thresholds could not possibly be exceeded, the TCLP need not to run.

2.0 *Summary of Method* (See Figure 1)

2.1 For wastes containing less than 0.5% solids, the waste, after filtration through a 0.6–0.8 um glass fiber filter, is defined as the TCLP extract.

2.2 For wastes containing greater than 0.5% solids, the liquid phase, if any, is separated from the solid phase and stored for later analysis. The particle size of the solid phase is reduced (if necessary), weighted, and extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. A special extractor vessel is used when testing for volatiles (See Table 1). Following extraction, the liquid extract is separated from the solid phase by 0.6–0.8 um glass fiber filter filtration.

2.3 If compatible (e.g., precipitate or multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract and these liquids are analyzed together. If incompatible the liquids are analyzed separately and the results are mathematically combined to yield a volume weighted average concentration.

3.0 *Interferences*

3.1 Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

4.0 *Apparatus and Materials*

4.1 Agitation Apparatus: An acceptable agitation apparatus is one which is capable of rotating the extraction vessel in an end over end fashion (See Figure 2) at 30 ± 2 rpm. Suitable devices known to EPA are identified in Table 2.

4.2 Extraction Vessel:

4.2.1 Zero-Headspace Extraction Vessel (ZHE). When the waste is being tested for mobility of any volatile contaminants (See Table 1), an extraction vessel which allows for liquid/solid separation within the device, and which effectively precludes headspace (as depicted in Figure 3), is used. This type of vessel allows for initial liquid/solid separation, extraction, and final extract filtration without having to open the vessel (See Section 4.3.1). These vessels shall have an internal volume of 500 to 600 ml and be equipped to accommodate a 90 mm filter. Suitable ZHE devices known as EPA are identified in Table 3. These devices contain viton O-rings which should be replaced frequently.

4.2.2 When the waste is being evaluated for other than volatile contaminants, an extraction vessel which does not preclude headspace (e.g., 2-liter bottle) is used. Suitable extraction vessels include bottles made from various materials, depending on the contaminants to be analyzed and the nature of the waste (See Section 4.3.3). These bottles are available from a number of laboratory suppliers. When this type of extraction vessel is used, the filtration device discussed in Section 4.3.2 is used for initial liquid/solid separation and final extract filtration.

4.3 Filtration Devices:

4.3.1 Zero-Headspace Extractor Vessel (See Figure 3): When the waste is being evaluated for volatiles, the zero headspace extraction vessel is used for filtration. The device shall be capable of supporting and keeping in place the glass fiber filter, and be able to withstand the pressure needed to accomplish separation (50 psi).

Note.—When it is suspected that the glass fiber filter has been ruptured, and in-line glass fiber filter may be used to filter the extract.

4.3.2 Filter Holder. When the waste is being evaluated for other than volatile compounds, a filter holder capable of supporting a glass fiber filter and able to withstand the pressure needed to accomplish separation is used. Suitable filter holders range from simple vacuum units to relatively complex systems capable of exerting pressure up to 50 psi and more. The type of filter holder used depends on the properties of the material to be filtered (See Section 4.3.3). These devices shall have a minimum internal volume of 300 ml and be equipped to accommodate a minimum filter size of 47 mm. Filter holders known to EPA to be suitable for use are shown in Table 4.

4.3.3 Materials of Construction. Extraction vessels and filtration devices shall be made of inert materials which will not leach or absorb waste components. Glass, polytetrafluoroethylene (PTFE), or type 316 stainless steel equipment may be used when evaluating the mobility of both organic and inorganic components. Devices made of high density polyethylene (HDPE), polypropylene, or polyvinyl chloride may be used when evaluating the mobility of metals.

4.4 Filters: Filters shall be made of borosilicate glass fiber, contain no binder materials, and have an effective pore size of 0.6–0.8 µm, or equivalent. Filters known to EPA to meet these specifications are identified in Table 5. Pre-filters must not be used. When evaluating the mobility of metals, filters shall be acid washed prior to use by rinsing with 1.0 N nitric acid followed by three consecutive rinses with deionized distilled water (minimum of 500 ml per rinse). Glass fiber filters are fragile and should be handled with care.

4.5 pH Meters: Any of the commonly available pH meters are acceptable.

4.6 ZHE extract collection devices: TEDLAR® bags or glass, stainless steel or PTFE gas tight syringes are used to collect the initial liquid phase and the final extract of the waste when using the ZHE device.

4.7 ZHE extraction fluid collection devices: Any device capable of transferring the extraction fluid into the ZHE without changing the nature of the extraction fluid is acceptable (e.g., a constant displacement pump, a gas tight syringe, pressure filtration unit (See Section 4.3.2), or another ZHE device).

4.8 Laboratory balance: Any laboratory balance accurate to within ± 0.01 grams may be used (all weight measurements are to be within ± 0.1 grams).

5.0 *Reagents*

5.1 Water: ASTM Type 1 deionized, carbon treated, decarbonized, filtered water (or equivalent water that is treated to remove volatile components) shall be used when evaluating wastes for volatile contaminants. Otherwise, ASTM Type 2 deionized distilled water (or equivalent) is used. These waters should be monitored periodically for impurities.

5.2 1.0 N Hydrochloric acid (HCl) made from ACS Reagent grade.

5.3 1.0 N Nitric acid (HNO_3) made from ACS Reagent grade.

5.4 1.0 N Sodium hydroxide (NaOH) made from ACS Reagent grade.

5.5 Glacial acetic acid (HOAc) made from ACS Reagent grade.

5.6 Extraction fluid:

5.6.1 Extraction fluid No. 1: This fluid is made by adding 5.7 ml glacial HOAc to 500 ml of the appropriate water (See Section 5.1), adding 64.3 ml of 1.0 N NaOH, and diluting to a volume of 1 liter. When correctly prepared, the pH of this fluid will be 4.93 ± 0.05.

5.6.2 Extraction fluid No. 2: This fluid is made by diluting 5.7 ml glacial HOAc with ASTM Type 2 water (See Section 5.1) to a volume of 1 liter. When correctly prepared the pH of this fluid will be 2.88 ± 0.05.

Note.—These extraction fluids shall be made up fresh daily. The pH should be checked prior to use to insure that they are made up accurately, and use these fluids should be monitored frequently for impurities.

5.7 Analytical standards shall be prepared according to the appropriate analytical method.

6.0 *Sample Collection, Preservation, and Handling*

6.1 All samples shall be collected using a sampling plan that addresses the considerations discussed in "Test Methods for Evaluating Solid Wastes" (SW–846).

6.2 Preservatives shall not be added to samples.

6.3 Samples can be refrigerated unless it results in irreversible physical changes to the waste.

6.4 When the waste is to be evaluated for volatile contaminants, care must be taken to insure that these are not lost. Samples shall be taken and stored in a manner which prevents the loss of volatile contaminants. If possible, any necessary particle size reduction should be conducted as the sample is being taken (See Step 8.5). Refer to SW–846 for additional sampling and storage requirements when volatiles are contaminants of concern.

6.5 TCLP extracts should be prepared for analysis and analyzed as soon as possible following extraction. If they need to be stored, even for a short period of time, storage shall be at 4°C and samples for volatiles analysis shall not be allowed to come into contact with the atmosphere (i.e., no headspace).

7.0 *Procedure When Volatiles Are Not Involved*

Although a minimum sample size of 100 grams is required, a larger sample size may be necessary, depending on the percent solids of the waste sample. Enough waste sample should be collected such that at least 75 grams of

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*TEDLAR is a registered trademark of DuPont.

the solid phase of the waste (as determined using glass fiber filter filtration), is extracted. This will insure that there is adequate extract for the required analyses (e.g., semivolatiles, metals, pesticides and herbicides).

The determination of which extraction fluid to use (See Step 7.12) may also be conducted at the start of this procedure. This determination shall be on the solid phase of the waste (as obtained using glass fiber filter filtration).

7.1 If the waste will obviously yield no free liquid when subjected to pressure filtration, weigh out a representative subsample of the waste (100 gram minimum) and proceed to Step 7.11.

7.2 If the sample is liquid or multiphasic, liquid/solid separation is required. This involves the filtration device discussed in Section 4.3.2, and is outlined in Steps 7.3 to 7.9.

7.3 Pre-weigh the filter and the container which will receive the filtrate.

7.4 Assemble filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure. Acid wash the filter if evaluating the mobility of metals (See Section 4.4).

7.5 Weigh out a representative subsample of the waste (100 gram minimum) and record weight.

7.6 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged prior to filtration.

7.7 Transfer the waste sample to the filter holder.

Note.—If waste material has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and subtract it from the sample weight determined in Step 7.5, to determine the weight of the waste sample which will be filtered.

Gradually apply vacuum or gentle pressure of 1–10 psi, until air or pressurizing gas moves through the filter. If this point is not reached under 10 psi, and if no additional liquid has passed through the filter in any 2 minute interval, slowly increase the pressure in 10-psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2 minute interval, proceed to the next 10 psi increment. When the pressurizing gas begins to move through the filter, or when liquid flow has ceased at 50 psi (i.e., does not result in any additional filtrate within any 2 minute period), filtration is stopped.

Note.—Instantaneous application of high pressure can degrade the glass fiber filter, and may cause premature plugging.

7.8 The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

Note.—Some wastes, such as oily wastes and some paint wastes, will obviously contain some material which appears to be a liquid—but even after applying vacuum or pressure filtration, as outlined in Step 7.7, this material may not filter. If this is the case, the material within the filtration device is defined as a solid, and is carried through the extraction as a solid.

7.9 Determine the weight of the liquid phase by subtracting the weight of the filtrate container (See Step 7.3) from the total weight of the filtrate-filled container. The liquid phase may now be either analyzed (See Step 7.15) or stored at 4° C until time of analysis. The weight of the solid phase of the waste sample is determined by subtracting the weight of the liquid phase from the weight of the total waste sample, as determined in Step 7.5 or 7.7. Record the weight of the liquid and solid phases.

Note.—If the weight of the solid phase of the waste is less than 75 grams, review Step 7.0

7.10 The sample will be handled differently from this point, depending on whether it contains more or less than 0.5% solids. If the sample obviously has greater than 0.5% solids go to Step 7.11. If it appears that the solid may comprise less than 0.5% of the total waste, the percent solids will be determined as follows:

7.10.1 Remove the solid phase and filter from the filtration apparatus.

7.10.2 Dry the filter and solid phase at 100±° C until two successive weighings yield the same value. Record final weight.

7.10.3 Calculate the percent solids as follows:

$$\frac{\text{weight of dry waste and filters} - \text{tared weight of filters}}{\text{initial weight of waste (Step 7.5 or 7.7)}} \times 100 = \text{percent solids}$$

7.10.4 If the solid comprises less than 0.5% of the waste, the solid is discarded and the liquid phase is defined as the TCLP extract. Proceed to Step 7.14.

7.10.5 If the solid is greater than or equal to 0.5% of the waste, return to Step 7.1, and begin the procedure with a new sample of waste. Do not extract the solid that has been dried.

Note.—This step is only used to determine whether the solid must be extracted, or whether it may be discarded unextracted. It is not used in calculating the amount of extraction fluid to use in extracting the waste, nor is the dried solid derived from this step subjected to extraction. A new sample will have to be prepared for extraction.

7.11 If the sample has more than 0.5% solids, it is now evaluated for particle size. If the solid material has a surface area per gram of material equal to or greater than 3.1 cm^2, or is capable of passing through a 9.5 mm (0.375 inch) standard sieve, proceed to Step 7.12. If the surface area is smaller or the particle size is larger than that described above, the solid material is prepared for extraction by crushing, cutting, or grinding the solid material to a surface area or particle size as described above. When surface area or particle size has been appropriately altered, proceed to Step 7.12.

7.12 This step describes the determination of the appropriate extracting fluid to use (See Sections 5.0 and 7.0).

7.12.1 Weigh out a small sub-sample of the solid phase of the waste, reduce the solid (if necessary) to a particle size of approximately 1 mm in diameter or less, and transfer a 5.0 gram portion to a 500 ml beaker or erlenmeyer flask.

7.12.2 And 96.5 ml distilled deionized water (ASTM Type 2), cover with watchglass, and stir vigorously for 5 minutes using a magnetic stirrer. Measure and record the pH. If the pH is $\leq$5.0, extraction fluid #1 is used. Proceed to Step 7.13.

7.12.3 If the pH from Step 7.12.2 is > 5.0, add 3.5 ml 1.0 N HCl, slurry for 30 seconds, cover with a watchglass, heat to 50°C, and hold for 10 minutes.

7.12.4 Let the solution cool to room temperature and record pH. If pH is $\leq$5.0, use extraction fluid #1. If the pH is > 5.0, extraction fluid #2 is used.

7.13 Calculate the weight of the remaining solid material by subtracting the weight of the sub-sample taken for Step 7.12, from the original amount of solid material, as obtained from Step 7.1 or 7.9. Transfer remaining solid material into the extractor vessel, including the filter used to separate the initial liquid from the solid phase.

Note.—If any of the solid phase remains adhered to the walls of the filter holder, or the container used to transfer the waste, its weight shall be determined, substracted from the weight of the solid phase of the waste, as determined above, and this weight is used in calculating the amount of extraction fluid to add into the extractor bottle.

Slowly add an amount of the appropriate extraction fluid (See Step 7.12), into the extractor bottle equal to 20 times the weight of the solid phase that has been placed into the extractor bottle. Close extractor bottle tightly, secure in rotary extractor device and rotate at 30±2 rpm for 18 hours. The temperature shall be maintained at 22±3°C during extraction period.

Note.—As agitation continues, pressure may build up within the extractor bottle (due to the evolution of gasses such as carbon dioxide). To relieve these pressures, the extractor bottle may be periodically opened and vented into a hood.

7.14 Following the 18 hour extraction, the material in the extractor vessel is separated into its component liquid and solid phases by filtering through a new glass fiber filter as outlined in Step 7.7. This new filter shall be acid washed (See § 4.4) if evaluating the mobility of metals.

7.15 The TCLP extract is now prepared as follows:

7.15.1 If the waste contained no initial liquid phase, the filtered liquid material obtained from Step 7.14 is defined as the TCLP extract. Proceed to Step 7.16.

7.15.2 If compatible (e.g., will not form precipitate or multiple phases), the filtered liquid resulting from Step 7.14 is combined with the initial liquid phase of the waste as obtained in Step 7.9. This combined liquid is defined as the TCLP extract. Proceed to Step 7.16.

7.15.3 If the initial liquid phase of the waste, as obtained from Step 7.9 is not or may be compatible with the filtered liquid resulting from Step 7.14, these liquids are not combined. These liquids are collectively defined as the TCLP extract, are analyzed separately, and the results are combined mathematically. Proceed to Step 7.16.

7.16 The TCLP extract will be prepared and analyzed according to the appropriate SW-846 analytical methods identified in Appendix III of 40 CFR 261. TCLP extracts to be analyzed for metals shall be acid digested. If the individual phases are to be analyzed separately, determine the volume of the individual phases (to 0.1 ml), conduct the appropriate analyses, and combine the results mathematically by using a simple weighted average:

$$\text{Final contaminant concentration} = \frac{(V_1)(C_1)+(V_2)(C_2)}{V_1+V_2}$$

where

V_1 = The volume of the first phase (1)

C_1 = The concentration of the contaminant of concern in the first phase (mg/1)

V_2 = The volume of the second phase (1)

C_2 = The concentration of the contaminant of concern in the second phase (mg/1)

7.17 The contaminant concentrations in the TCLP extract are compared to the thresholds identified in the appropriate regulations. Refer to Section 9 for quality assurance requirements.

8.0 *Procedure When Volatiles Are Involved*

The ZHE device has approximately a 500 ml internal capacity. Although a minimum sample size of 100 grams was required in the Section 7 procedure the ZHE can only accommodate a maximum 100 percent solids sample of 25 grams, due to the need to add an amount of extraction fluid equal to 20 times the weight of the solid phase. Step 8.4 provides the means by which to determine the approximate sample size for the ZHE device.

Although the following procedure allows for particle size reduction during the conduct of the procedure, this could result in the loss of volatile compounds. If possible, any necessary particle size reduction (See Step 8.5) should be conducted on the sample as it is being taken. Particle size reduction should only be conducted during the procedure if there is no other choice.

In carrying out the following steps, do not allow the waste to be exposed to the atmosphere for any more time than is absolutely necessary.

8.1 Pre-weigh the (evacuated) container which will receive the filtrate (See § 4.6), and set aside.

8.2 Place the ZHE piston within the body of the ZHE (it may be helpful to first moisten the piston O-rings slightly with extraction fluid). Secure the gas inlet/outlet flange (bottom flange) onto the ZHE body in accordance with the manufacturer's instructions. Secure the glass fiber filter between the support screens and set aside. Set liquid inlet/outlet flange (top flange) aside.

8.3 If the waste will obviously yield no free liquid when subjected to pressure filtration, weigh out a representative subsample of the waste (25 gram maximum—See Step 8.0), record weight, and proceed to Step 8.5.

8.4 This step provides the means by which to detemine the approximate sample size for the ZHE device. If the waste is liquid or multiphasic, follow the procedure outlined in Steps 7.2 to 7.9 (using the Section 7 filtration apparatus), and obtain the percent solids by dividing the weight of the solid phase of the waste by the original sample size used. If the waste obviously contains greater than 0.5% solids, go to Step 8.4.2. If it appears that the solid may comprise less than 0.5% of the waste, go to Step 8.4.1.

8.4.1 Determine the percent solids by using the procedure outlined in Step 7.10. If the waste contains less than 0.5% solids, weigh out a new 100 gram minimum representative sample, proceed to Step 8.7, and follow until the liquid phase of the waste is filtered using the ZHE device (Step 8.8). This liquid filtrate is defined as the TCLP extract, and is analyzed directly. If the waste contains greater than or equal to 0.5% solids, repeat Step 8.4. using a new 100 gram minimum sample, determine the percent solids, and proceed to Step 8.4.2.

8.4.2 If the sample is <25% solids, weigh out a new 100 gram minimum representative sample, and proceed to Step 8.5. If the sample is >25% solids, the maximum amount of sample the ZHE can accommodate is determined by dividing 25 grams by the percent solids obtained from Step 8.4. Weigh out a new representative sample of the determined size.

8.5 After a representative sample of the waste (sample size determined from Step 8.4) has been weighed out and recorded, the sample is now evaluated for particle size (See Step 8.0). If the solid material within the waste obviously has a surface area per gram of material equal to or greater than 3.1 cm2, or is capable of passing through a 9.5 mm (0.375 inch) standard sieve, proceed immediately to Step 8.6. If the surface area is smaller or the particle size is larger than that described above, the solid material which does not meet the above criteria is separated from the liquid phase by sieving (or equivalent means), and the solid is prepared for extraction by crushing, cutting, or grinding to a surface area or particle size as described above.

Note.—Wastes and appropriate equipment should be refrigerated, if possible, to 4° C prior to particle size reduction. Grinding and milling machinery which generates heat shall not be used for particle size reduction. If reduction of the solid phase of the waste is necessary, exposure of the waste to the atmosphere should be avoided to the extent possible.

When surface area or particle size has been appropriately altered, the solid is recombined with the rest of the waste.

8.6 Waste slurries need not be allowed to stand to permit the solid phase to settle. Wastes that settle slowly shall not be centrifuged prior to filtration.

8.7 Transfer the entire sample (liquid and solid phases) quickly to the ZHE. Secure the filter and support screens into the top flange of the device and secure the top flange to the ZHE body in accordance with the manufacturers instructions. Tighten all ZHE fittings and place the device in the vertical position (gas inlet/outlet flange on the bottom). Do not attach the extract collection device to the top plate.

Note.—If waste material has obviously adhered to the container used to transfer the sample to the ZHE, determine the weight of this residue and subtract it from the sample weight determined in Step 8.4, to determine the weight of the waste sample which will be filtered.

Attach a gas line to the gas inlet/outlet valve (bottom flange), and with the liquid inlet/outlet valve (top flange) open, begin applying gentle presssure of 1–10 psi (or more if necessary) to slowly force all headspace out of the ZHE device. At the first appearance of liquid from the liquid inlet/outlet valve, quickly close the valve and discontinue pressure.

8.8 Attach evacuated pre-weighed filtrate collection container to the liquid inlet/outlet valve and open valve. Begin applying gentle pressure of 1–10 psi to force the liquid phase into the filtrate collection container. If no additional liquid has passed thrugh the filter in any 2 minute interval, slowly increase the pressure in 10 psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if no additional liquid has passed through the filter in any 2 minute interval, proceed to the next 10 psi increment. When liquid flow has ceased such that continued pressure filtration at 50 psi does not result in any additional filtrate within any 2 minute period, filtration is stopped. Close the liquid inlet/outlet valve, discontinue pressure to the piston, and disconnect the filtrate collection container.

Note.—Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.

8.9 The material in the ZHE is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

Note.—Some wastes, such as oily wastes and some paint wastes, will obviously contain some material which appears to be a liquid—but even after applying pressure filtration, this material will not filter. If this is the case, the material within the filtration device is defined as a solid, and is carried through the TCLP extraction as a solid.

If the original waste contained less than 0.5% solids, (See Step 8.4) this filtrate is defined as the TCLP extract, and is analyzed directly—proceed to Step 8.13.

8.10 Determine the weight of the liquid phase by subtracting the weight of the filtrate container (See Step 8.1) from the total weight of the filtrate-filled container. The liquid phase may now be either analyzed (See Steps 8.13 and 8.14), or stored at 4° C until time of analysis. The weight of the solid phase of the waste sample is determined by subtracting the weight of the liquid phase from the weight of the total waste sample (See Step 8.4). Record the final weight of the liquid and solid phases.

8.11 The following details how to add the appropriate amount of extraction fluid to the solid material within the ZHE and agitation of the ZHE vessel. Extraction fluid #1 is used in all cases (See Section 5.6).

8.11.1 With the ZHE in the vertical position, attach a line from the extraction fluid reservoir to the liquid inlet/outlet valve. The line used shall contain fresh extraction fluid and should be preflushed with fluid to eliminate any air pockets in the line. Release gas pressure on the ZHE piston (from the gas inlet/outlet valve), open the liquid inlet/outlet valve, and begin transferring extraction fluid (by pumping or similar means) into the ZHE. Continue pumping extraction fluid into the ZHE until the amount of fluid introduced into the device equals 20 times the weight of the solid phase of the waste that is in the ZHE.

8.11.2 After the extraction fluid has been added, immediately close the liquid inlet/outlet valve, and disconnect the extraction fluid line. Check the ZHE to make sure that all valves are in their closed positions. Pick up the ZHE and physically rotate the device in an end-over-end fashion 2 or 3 times. Reposition the ZHE in the vertical position with the liquid inlet/outlet valve on top. Put 5–10 psi behind the piston (if necessary), and slowly open the liquid inlet/outlet valve to bleed out any headspace (into a hood) that may have been introduced due to the addition of extraction fluid. This bleeding shall be done quickly and shall be stopped at the first appearance of liquid from the valve. Re-pressurize the ZHE with 5–10 psi and check all ZHE fittings to insure that they are closed.

8.11.3 Place the ZHE in the rotary extractor apparatus (if it is not already there), and rotate the ZHE at 30 ± 2 rpm for 18 hours. The temperature shall be maintained at 22 ± 3° C during agitation.

8.12 Following the 18 hour extraction, check the pressure behind the ZHE piston by quickly opening and closing the gas inlet/outlet valve, and noting the escape of gas. If the pressure has not been maintained (i.e., no gas release observed), the device is leaking. Replace ZHE O-rings or other fittings, as necessary, and redo the extraction with a new sample of waste. If the pressure within the device has been maintained, the material in the extractor vessel is once again separated into its component liquid and solid phases. If the waste contained an initial liquid phase, the liquid may be filtered directly into the same filtrate collection container (i.e., TEDLER® bag, gas-type syringe) holding the initial liquid phase of the waste, unless doing so would create multiple phases, or unless there is not enough volume left within the filtrate collection container. A separate filtrate collection container must be used in these cases. Filter through the glass fiber filter, using the ZHE device as discussed in Step 8.8. All extract shall be filtered and collected if the extract is multi-phasic or if the waste contained an initial liquid phase.

Note.—If the glass fiber filter is not intact following agitation, the filtration device discussed in the NOTE in Section 4.3.1 may be used to filter the material within the ZHE.

8.13 If the waste contained no initial liquid phase, the filtered liquid material obtained from Step 8.12 is defined as the TCLP extract. If the waste contained an initial liquid phase, the filtered liquid material obtained from Step 8.12, and the initial liquid phase (Step 8.8) are collectively defined as the TCLP extract.

8.14 The TCLP extract will be prepared and analyzed according to the appropriate SW–846 analytical methods, as identified in Appendix III of 40 CFR 261. If the individual phases are to be analyzed separately, determine the volume of the individual phases (to 0.1 ml), conduct the appropriate analyses and combine the results mathematically by using a simple volume weighted average:

$$\text{Final contaminant concentration} = \frac{(V_1)(C_1) + (V_2)(C_2)}{V_1 + V_2}$$

where:

V_1 = The volume of the first phase (1)

C_1 = The concentration of the contaminant of concern in the first phase (mg/l)

V_2 = The volume of the second phase (1)

C_2 = The concentration of the contaminant of concern in the second phase (mg/l)

8.15 The contaminant concentrations in the TCLP extract are compared to the thresholds identified in the appropriate regulations. Refer to Section 9 for quality assurance requirements.

9.0 *Quality Assurance Requirements*

9.1 All data, including quality assurance data, should be maintained and available for reference or inspection.

9.2 A minimum of one blank for every 10 extractions that have been conducted in an extraction vessel shall be employed as a check to determine if any memory effects from the extraction equipment is occurring. One blank shall also be employed for every new batch of leaching fluid that is made up.

9.3 All quality control measures described in the appropriate analytical methods shall be followed.

9.4 The method of standard addition shall be employed for each waste type if: (1) Recovery of the compound from spiked splits of the TCLP extract is not between 50 and 150%, or (2) If the concentration of the constituent measured in the extract is within 20% of the appropriate regulatory threshold. If more than 1 extraction is being run on samples of the same waste, the method of standard addition need only be applied once and the percent recoveries applied to the remainder of the extractions.

9.5 TCLP extracts shall be analyzed within the following periods after generation: Volatiles—14 days, Semivolatiles—40 days, Mercury—28 days, and other Metals—180 days.

TABLE 1.—VOLATILE CONTAMINANTS

Compound	CASNO
Acrylonitrile	107-13-1
Benzene	71-43-2
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroform	67-66-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethylene	75-35-4
Isobutanol	78-83-1
Methylene chloride	75-09-2
Methyl ethly ketone	78-93-3
Pyridine	110-86-1
1,1,1,2,-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene	127-18-4
Toluene	108-88-3
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloreothylene	79-01-6
Vinyl chloride	75-01-4

TABLE 2.—SUITABLE ROTARY AGITATION APPARATUS [1]

Company	Location	Model
Associated Design and Manufacturing Company	Alexandria, Virginia (703) 549-5999	4-vessel device.
Lars Lande Manufacturing	Whitmore Lake, Michigan (313) 449-4116	10-vessel device.
		6-vessel device.
IRA Machine Shop and Laboratory	Santurce, Puerto Rico, (809) 752-4004	16-vessel device.
EPRI Extractor		6-vessel device.[2]

[1] Any device which rotates the extraction vessel in an end-over-end fashion at 30±2 rpm is acceptable.

[2] Although this device is suitable, it is not commercially made. It may also require retrofitting to accommodate ZHE devices.

TABLE 3.—SUITABLE ZERO-HEADSPACE EXTRACTOR VESSELS

Company	Location	Model No.
Associated Design and Manufacturing Company	Alexandria, Virginia, (703) 549-5999	3740-ZHB
Millipore Corporation	Bedford, Massachusetts, (800) 225-3384	SD1P581C5

TABLE 4.—SUITABLE FILTER HOLDERS [1]

Company	Location	Model	Size (millimeter)
Nuclepore Corporation	Pleasanton, California, (800) 882-7711	425910	142
		410400	47
Micro Filtration Systems	Dublin, California, (415) 828-6010	302400	142
Millipore Corporation	Bedford, Massachusetts, (800) 225-3384	YT30142HW	142
		XX1004700	47

[1] Any devide capable of separating the liquid from the solid phase of the waste is suitable, providing that it is chemically compatible with the waste and the constituents to be analyzed. Plastic devices (not listed above) may be used when only inorganic contaminants are of concern.

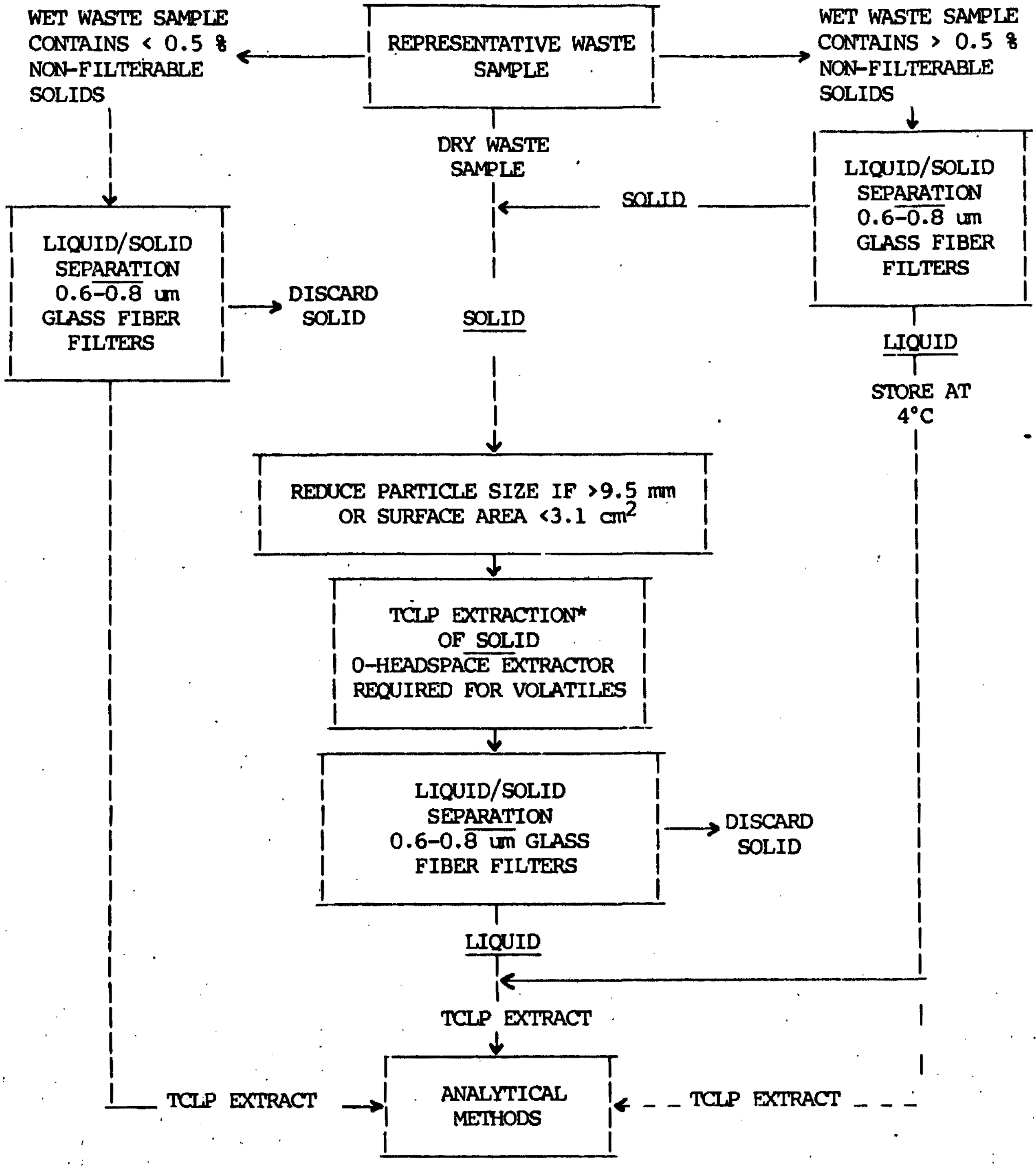
TABLE 5.—SUITABLE FILTER MEDIA

Company	Location	Model	Pore size [1]
Whatman Laboratory Products, Inc.	Clifton, New Jersey, (201) 773-5800	GFF	0.7

[1] Nominal pore size.

BILLING CODE 6560-50-M

FIGURE 1· TCLP Flowchart



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* The extraction fluid employed is a function of the alkalinity of the solid phase of the waste

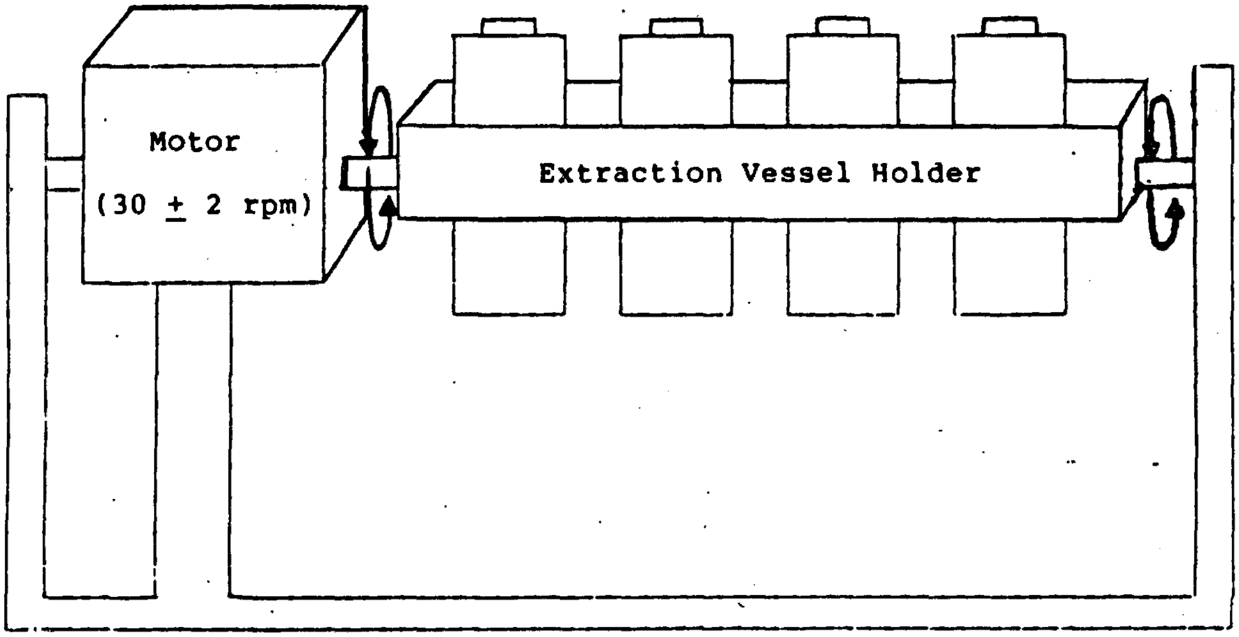

Figure 2: Rotary Agitation

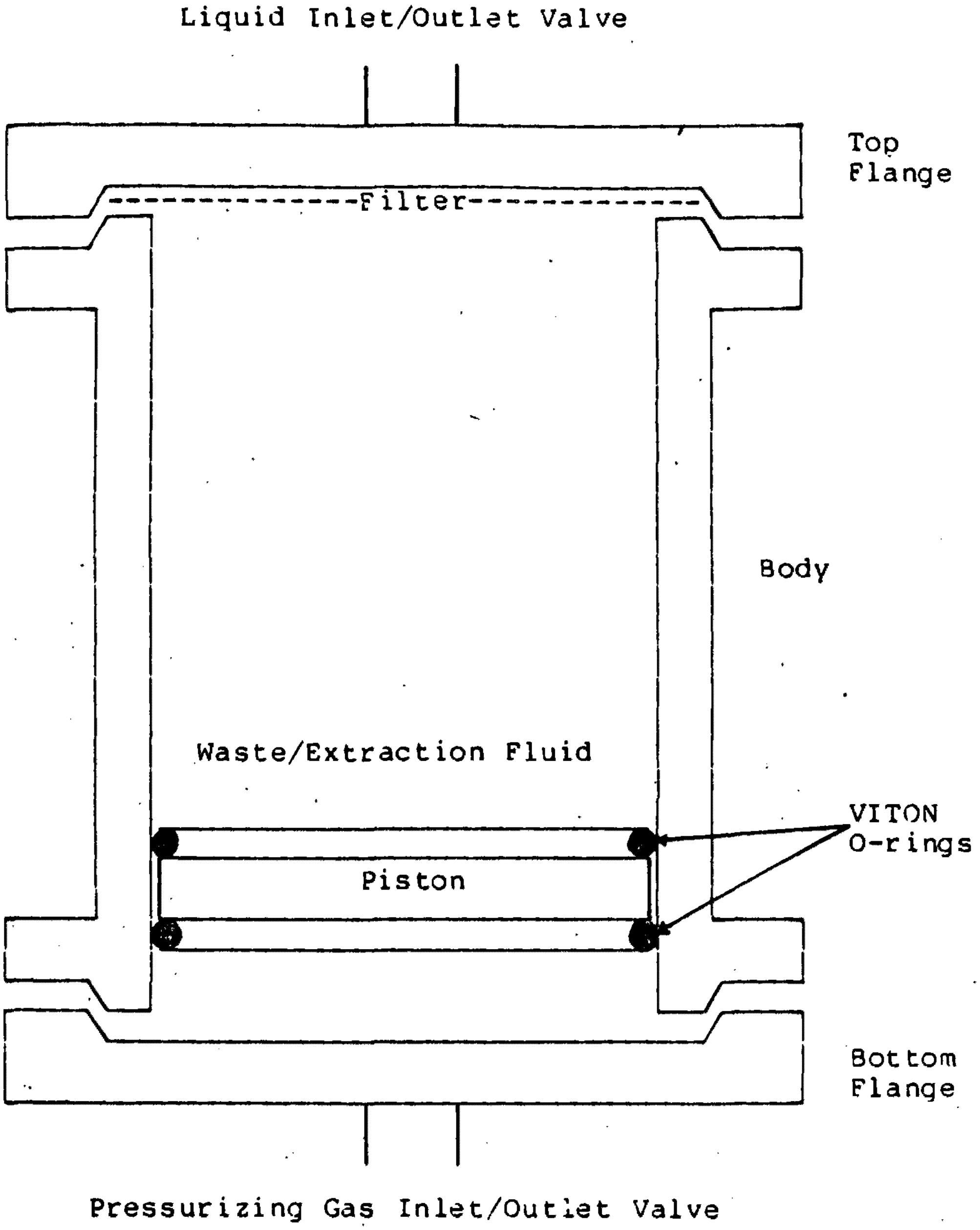

Figure 3: Zero-Headspace Extraction Vessel

BILLING CODE 6560-50-C

Therefore, it is proposed that Chapter I of Title 40 be amended as follows:

PART 260—HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL

I. In Part 260:

1. The authority citation for Part 260 is revised to read as follows:

Authority: Secs. 1006, 2002, 3001, through 3007, 3010, and 7004, Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6905, 6912, 6921 through 6927, 6930, and 6974).

§§ 260.1, 260.2, 260.3, 260.10, 260.20 [Amended]

2. By removing the Part number "265" and inserting in its place the Part number "268" in the following places:

(a) 40 CFR 260.1 (a) and (b) (1) through (4).

(b) 40 CFR 260.2 (a) and (b).

(c) 40 CFR 260.3 (introductory text).

(d) 40 CFR 260.10 (introductory text).

(e) 40 CFR 260.20(a).

3. In addition to the amendments set forth above, § 260.1 is amended by revising paragraph (b) (5) to read as follows:

§ 260.1 Purpose, scope, and applicability.

* * * * *

(b) * * *

(5) Section 260.21 establishes procedures for petitioning EPA to approve testing methods as equivalent to those prescribed in Part 261, 264, 265, or 268 of this chapter.

* * * * *

PART 261—IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

II. In Part 261:

1. The authority citation for Part 261 is revised to read as follows:

Authority: Secs. 1006, 2002(a), 3001, and 3002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6905, 6912(a), 6921, and 6922).

§§ 261.1, 261.4, 261.5, 261.7, 261.20, 261.30 [Amended]

2. By removing the Part number "265" and inserting in its place the Part number "268" in the following places:

(a) 40 CFR 261.1(a) introductory text and (a) (1);

(b) 40 CFR 261.4(c);

(c) 40 CFR 261.5 (b), (e), and (f);

(d) 40 CFR 261.7(a) (1) (ii), and (2) (ii);

(e) 40 CFR 261.20(b); and

(f) 40 CFR 261.30(c).

§ 261.4 [Amended]

3. In addition to the amendments set forth above, § 261.4 is amended by removing from paragraph (d) (1) the Part number "267" and inserting the Part number "268" in its place.

§ 261.6 [Amended]

4. By removing the Part number "266" and inserting in its place the Part number "268" in § 261.6(a) (3).

5. In addition to the amendment set forth above, § 261.6 is amended by revising paragraph (c) (1) to read as follows:

§ 261.6 Requirements for recyclable materials.

* * * * *

(c) (1) Owners or operators of facilities that store recyclable materials before they are recycled are regulated under all applicable provisions of Subparts A through L of Parts 264 and 265, and under Parts 124, 268, and 270 of this chapter and the notification requirements under section 3010 of RCRA, except as provided in paragraph (a) of this section. (The recycling process itself is exempt from regulation.)

* * * * *

PART 262—STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE

III. In Part 262:

1. The authority citation for Part 262 is revised to read as follows:

Authority: Secs. 1006, 2002, 3002, 3003, 3004, and 3005 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6905, 6912, 6922 through 6925).

Subpart A—General

2. In § 262.11, paragraph (d) is added to read as follows:

§ 262.11 Hazardous waste determination.

* * * * *

(d) If the waste is determined to be hazardous, the generator must refer to Parts 264, 265, and 268 of this chapter for possible exclusions or restrictions pertaining to management of his specific waste. The generator must either test the hazardous waste in accordance with § 268.6 or apply knowledge of the waste, in light of the materials or the processes used, to determine whether the waste must be managed in accordance with the land disposal restriction standards of Part 268 of this chapter.

Subpart D—Recordkeeping and Reporting

3. In § 262.40, paragraph (e) is added to read as follows:

§ 262.40 Recordkeeping.

* * * * *

(e) A generator must keep the notice of an extension to the effective date of any land disposal restriction granted pursuant to § 268.4 for a period of at least 3 years from expiration of the extension.

PART 264—STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES

IV. In Part 264:

1. The authority citation for Part 264 is revised to read as follows:

Authority: Secs. 1006, 2002(a), 3004, and 3005 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6905, 6912(a), 6924 and 6925).

Subpart B—General Facility Standards

2. In § 264.13, by revising paragraphs (a)(1) and (b)(6) and adding paragraph (b)(7) to read as follows:

§ 264.13 General waste analysis.

(a)(1) Before an owner or operator treats, stores, or disposes of any hazardous waste, he must obtain a detailed chemical and physical analysis of a representative sample of the waste. At a minimum, this analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with the requirements of this part or Part 268 of this chapter or with the conditions of a permit issued under Parts 124 and 270 of this chapter.

* * * * *

(b) * * *

(6) Where applicable, the methods which will be used to meet the additional waste analysis requirements for specific waste management methods as specified in §§ 264.17, 264.314, and 264.341 and § 268.6 of this chapter.

(7) for surface impoundments subject to the exemption from land disposal restrictions under § 268.1(e), the procedures and schedules for:

(i) The sampling of impoundment contents;

(ii) The analysis of test data; and,

(iii) The annual removal of residue which does not meet the standards of Part 268 Subpart D of this chapter.

* * * * *

Subpart E—Manifest System, Recordkeeping, and Reporting

3. In § 264.73, by revising paragraph (b)(3) and adding paragraph (b)(10) to read as follows:

§ 264.73 Operating record.

* * * * *

(b) * * *

(3) Records and results of waste analyses performed as specified in §§ 264.13, 264.17, 264.314, and 264.341, and §§ 268.1(e) and 268.6 of this chapter.

* * * * *

(10) Records of the quantities (and date of placement) for each shipment of hazardous waste placed in land disposal units under an extension to the effective date of any land disposal restriction granted pursuant to § 268.4 of this chapter or a petition pursuant to § 268.5 of this chapter and a copy of the extension or petition approval notice, as appropriate.

PART 265—INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

V. In Part 265:

1. The authority citation for Part 265 is revised to read as follows:

Authority: Secs. 1006, 2002(a), 3004, and 3005 of the Solid Waste Disposal Act, as amended (42 U.S.C. 6905, 6908, 6912(a), 6924, and 6925).

Subpart B—General Facility Standards

2. In § 265.13, paragraphs (a)(1) and (b)(6) are revised and paragraph (b)(7) is added to read as follows:

§ 265.13 General waste analysis.

(a)(1) Before an owner or operator treats, stores, or disposes of any hazardous waste, he must obtain a detailed chemical and physical analysis of a representative sample of the waste. At a minimum, this analysis must contain all the information which must be known to treat, store, or dispose of the waste in accordance with the requirements of this part and Part 268 of this chapter.

* * * * *

(b) * * *

(6) Where applicable, the methods which will be used to meet the additional waste analysis requirements for specific waste management methods as specified in §§ 265.193, 265.225, 265.252, 265.273, 265.314, 265.345, 265.375, and 265.402 and § 268.6 of this chapter.

(7) For surface impoundments subject to the exemption from land disposal restrictions under § 268.1(e) of this chapter, the procedures and schedule for:

(i) The sampling of impoundment contents;

(ii) The analysis of test data; and,

(iii) The annual removal of residue which does not meet the standards of Part 268 Subpart D of this chapter.

* * * * *

Subpart E—Manifest System, Recordkeeping, and Reporting

3. In § 265.73, paragraph (b)(3) is revised and paragraph (b)(8) is added to read as follows:

§ 265.73 Operating record.

* * * * *

(b) * * *

(3) Records and results of waste analysis and trial tests performed as specified in §§ 265.13, 265.193, 265.225, 265.252, 265.273, 265.314, 265.341, 265.375, and 265.402 and §§ 268.1(e) and 268.6 of this chapter.

* * * * *

(8) Records of the quantities (and date of placement) for each shipment of hazardous waste placed in land disposal units under an extension to the effective date of any land disposal restriction granted pursuant to § 268.4 of this chapter, or a petition pursuant to § 268.5 of this chapter, and a copy of the extension or petition approval notice as appropriate.

PART 268—LAND DISPOSAL RESTRICTIONS

VI. In Part 268, proposed in the **Federal Register** of May 31, 1985 (50 FR 23255):

1. The authority citation for proposed Part 268 is revised to read as follows:

Authority: Secs. 1006, 2002(a), 3001, and 3004 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6905, 6912(a), 6921, and 6924).

2. By adding Subpart A to proposed Part 268 to read as follows:

Subpart A—General

Subpart A—General

§ 268.1 Purpose, scope and applicability.

(a) This part identifies hazardous wastes that are restricted from land disposal and those limited circumstances under which an otherwise prohibited waste may continue to be land disposed.

(b) Except as specifically provided otherwise in this part or Part 261 of this chapter, the requirements of this part apply to persons who generate or transport hazardous waste and owners and operators of hazardous waste treatment, storage, and disposal facilities.

(c) The requirements of Subparts A, C, D and E of this part do not apply to the disposal of hazardous waste by underground injection.

(d) The requirements of this part apply to a person who generates, transports, treats, stores, or disposes of hazardous waste in a State which is authorized under Subpart A or B of Part 271 of this chapter if the State has not been authorized to carry out the requirements and prohibitions applicable to the generation, transport, treatment, storage, or disposal of hazardous waste which are imposed pursuant to the Hazardous and Solid Waste Amendments of 1984. The requirements and prohibitions that are applicable until a State receives authorization to carry them out include all Federal program requirements identified in § 271.1(j) of this chapter.

(e) The requirements of this part do not apply to persons placing hazardous wastes in a surface impoundment provided that:

(1) Treatment of such wastes occurs in the impoundment.

(2) The contents of the impoundment must be analyzed, through use of the test methods described in SW-846 and the residues of such treatment (including any liquid waste) that do not meet the treatment standards promulgated under Subpart D of this part, or are not delisted under § 260.22 of this chapter, must be removed at least annually and may not be placed in a surface impoundment for subsequent treatment. The procedures and schedule for (i) the sampling of impoundment contents, (ii) the analysis of test data, and (iii) the annual removal of residue which does not meet Subpart D treatment standards must be specified in the facility's waste analysis plan as required under §§ 264.13 or 265.13 of this chapter.

(3) The impoundment meets the desig requirements of § 264.221(c) or § 265.221(a) of this chapter, unless:

(i) Exempted pursuant to § 264.221 (d) or (e) of this chapter, or § 265.221 (c) or (d) of this chapter, or

(ii) Upon application of the owner or operator prior to November 8, 1986, the Administrator has granted a waiver of the requirements on the basis that the surface impoundment:

(A) Has at least one liner, for which there is no evidence that such liner is leaking;

(B) Is located more than one-quarter mile from an underground source of drinking water; and

(C) Is in compliance with the generally applicable ground water monitoring requirements for facilities with permits; or

(iii) Upon application of the owner or operator prior to November 8, 1986, the Administrator has granted a modification of the requirements on the basis of a demonstration that the surface impoundment is located, designed, and operated so as to assure that there will be no migration of any hazardous constituent into ground water or surface water at any future time.

(f) The requirements of this part do not apply to:

(1) Persons who have been granted a variance from a prohibition pursuant to § 268.5, with respect to those wastes and units covered by the variance; or,

(2) any land disposal of contaminated soil or debris resulting from a response action taken under section 102 or 106 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 or a corrective action required under Part 264 or 265 of this chapter until November 8, 1988.

(g) A generator or an owner or operator of a facility otherwise regulated by this part must comply with all applicable requirements of this chapter.

§ 268.2 Definitions applicable to this part.

(a) When used in this part the following terms have the meanings given below:

"Area of effective control" means an area where perpetual restrictions exist on the use of any air or water resources in a manner that would not be protective of human health and the environment. If this area extends beyond the waste management area, as defined at § 264.95(b) of this chapter, perpetual restrictions on the use of any air or water resources must be established by an act of the local or State legislature.

"Hazardous constitutent or constituents" means those constituents listed in Appendix VIII to Part 261 of this chapter.

"Land disposal" means placement in or on the land and includes, but is not limited to, placement in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, underground mine or cave, concrete vault or bunker intended for disposal purposes and placement in or on the land by means of open detonation. The term "land disposal" does not encompass ocean disposal.

(b) All other terms have the meanings given under §§ 260.10, 261.2, 261.3, or 270.2 of this chapter.

268.3 Dilution prohibited as a substitute for treatment.

No generator or owner or operator of a treatment, storage, or disposal facility shall in any way attempt to dilute a waste as a substitute for adequate treatment to achieve compliance with Subpart D of this part.

§ 268.4 Procedures for extensions to an effective date.

(a) Any person who generates, treats, stores, or disposes of a hazardous waste restricted (or proposed to be restricted) from land disposal pursuant to Subpart C of this part may submit an application to the Administrator for an extension to the effective date of any applicable restriction established under §§ 268.30, 268.31, or 268.40. The applicant must demonstrate the following:

(1) He has entered into a contract to construct or otherwise provide alternative treatment, recovery (recycling), or disposal capacity that protects human health and the environment. The contract must contain a penalty for cancellation that, in the Agency's judgment, is sufficient to discourage cancellation by the applicant.

(2) Due to circumstances beyond the applicant's control, such alternative capacity cannot reasonably be made available by the applicant by the applicable effective date.

(3) The applicant has made a good-faith effort to locate and contract with treatment, recovery, or disposal facilities nationwide to manage his waste in accordance with §§ 268.30 or 268.31.

(4) The capacity being constructed or otherwise provided by the applicant will be sufficient to manage all of the waste that is the subject of the application.

(5) The applicant has prepared and submitted to the Administrator a detailed schedule for obtaining required operating permits and construction or an outline of how and when alternative capacity will be provided.

(6) The applicant has arranged for adequate capactiy to manage his waste during an extension and has documented in the application the location of all sites at which the waste will be managed.

(7) Any waste managed in a surface impoundment or landfill during the extension period will meet the requirements of paragraph (i) (2) of this section.

(b) Any person signing an application described under paragraph (a) of this section shall make the following certification:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(c) On the basis of the information referred to in paragraph (a) of this section, after notice and opportunity for comment, and after consultation with appropriate State agencies in all affected States, the Administrator may grant an extension of up to 1 year from the effective date. The Administrator may renew this extension for up to 1 additional year upon the request of the applicant. In no event will an extension extend beyond 48 months from the applicable statutory effective date specified in section 3004(d), (e), or (g) of the Act (42 U.S.C. 6924(d), (e), or (g)).

(d) The length of any extension authorized in paragraph (c) of this section will be determined by the Administrator based on the time required to construct or obtain the type of capacity needed by the applicant as described in the completion schedule discussed in paragraph (a)(5) of this section.

(e) The Administrator will provide the successful applicant with written notice of the extension. This notice will describe the manufacturing process that is the source of the waste subject to the extension, the volume of such waste, the duration of the extension, and the name and the location of the facility designated in paragraph (a)(6) of this section to manage the waste during the period of the extension. The applicant must retain a copy of the notice during the period of the extension and for at least 3 years after the extension expires.

(f) The applicant must provide a copy of the notice to the facility designated in paragraph (a)(6) of this section. The notice must be provided to the designated facility prior to the first shipment of waste which is the subject of the extension. The owner or opreator of the facility shall retain a copy of the notice during the period of the extension and for at least 3 years after the extension expires.

(g) The successful applicant must immediately notify the Administrator as soon as he has knowledge of any changes in the conditions certified to in the application.

(h) The successful applicant must submit written progress reports at intervals designated by the Administrator. Such reports must describe the overall progress made toward constructing or otherwise providing alternative treatment, recovery or disposal capacity; must identify any event which may cause or has caused a delay in the development of the capacity; and must summarize the steps taken to mitigate the delay. The Administrator can revoke the extension at any time if the applicant does not demonstrate a good-faith effort to meet the schedule for completion, if the Agency denies or revokes any required permit, if conditions certified in the application change, or for any violation of this part.

(i) Whenever the Administrator establishes an extension to an effective date under this section, during the period for which such extension is in effect:

(1) The storage restrictions under § 268.50(a)(1) do not apply, and

(2) Such hazardous waste may be disposed of in a landfill or surface impoundment, only if:

(i) The landfill, if in interim status, meets the requirements of Subpart F of Part 265 and § 265.301 (a) through (e) of this chapter.

(ii) The landfill, if permitted, meets the requirements of Subpart F of Part 264 and § 264.301 (c) through (e) of this chapter.

(iii) The surface impoundment, if in interim status, meets the requirements of Subpart F of Part 265 and § 265.221 (a) through (e) of this chapter; or

(iv) The surface impoundment, if permitted, meets the requirements of Subpart F of Part 264 and § 264.221 (c) through (e) of this chapter.

§ 268.5 Petitions to allow land disposal of a waste prohibited under Subpart C of Part 268.

(a) Any person seeking a variance from a prohibition under Subpart C of this part for the disposal of a restricted hazardous waste in a particular unit or units must submit a petition to the Administrator demonstrating that any hazardous constituents of the waste are at levels that ensure, to a reasonable degree of certainty, that there will be no migration of any such hazardous constituents of the waste from the area of effective control into the air, ground water, surface water, or soil in concentrations that exceed the applicable screening level, or that result in adverse effects upon the environment.

(1) The Administrator will use the following criteria for determining whether the established screening levels may be exceeded for any threshold constituents:

(i) Exposure criteria:

(A) Other potential or actual sources of exposure to the same or similar constituents.

(B) The level and type of uncertainty inherent in the models used to predict potential exposure to the surrounding population.

(C) The nature of the potentially exposed population.

(ii) Toxicological criteria:

(A) The slope or slopes of dose response curves for the health effects attributable to a threshold constituent.

(B) The frequency and magnitude of potential exposure to a threshold constituent.

(2) The Administrator will use the following criteria for determining a health effects level for any non-threshold constituents:

(i) Exposure criteria:

(A) Other potential or actual sources of exposure to the same or similar constituents.

(B) The level and type of uncertainty inherent in the models used to predict potential exposure to the surrounding population.

(C) The potential current and future risk to individuals from the activities of the disposal unit.

(D) The size and nature of the potentially exposed population.

(ii) Toxicological criteria: the level and type of uncertainty inherent in the data used to estimate health risks.

(b) The demonstration referred to in paragraph (a) of this section must include an analysis of the total number of people that could potentially be exposed to any hazardous constituent of the specified waste for as long as the specified waste remains hazardous.

(c) The demonstration referred to in paragraph (a) of this section must include assurances that land disposal of the specified waste will not cause adverse effects on any aquatic biota, wildlife, vegetation, protected lands, or other areas of potential ecological or economic significance.

(d) The demonstration referred to in paragraphs (a), (b), and (c) of this section may include the following components:

(1) An identification of the specific waste and the specific unit for which the demonstration will be made.

(2) A waste analysis, using methods described in SW-846, where appropriate, or equivalent methods approved by the Administrator in accordance with § 260.21 of this chapter, to describe fully the chemical and physical characteristics of the subject waste, including the waste's toxicity, mobility, persistence, and propensity to bioaccumulate.

(3) An evaluation of the performance of the engineered components of the disposal unit.

(4) A comprehensive characterization of the disposal unit site and area of effective control, including an analysis of background air, soil, and water quality.

(5) Predictions of the ultimate fate of hazardous constituents in the air, soil, surface water, and ground water, at the point or points of potential human and environmental exposure.

(e) The demonstration referred to in paragraphs (a), (b), and (c) of this section must meet the following criteria:

(1) All waste and environmental sampling or test data must be accurate, and reproducible.

(2) All sampling, testing, and estimation techniques for chemical and physical properties of the waste and all environmental parameters must have been approved by the Administrator.

(3) Simulation models may need to be calibrated for the specific waste and site conditions, and verified for accuracy by comparison with actual measurements.

(4) A quality assurance and quality control plan that addresses all aspects of the demonstration must be approved by the Administrator.

(5) An analysis may need to be performed to identify and quantify any aspects of the demonstration that contribute significantly to uncertainty. This analysis must include an evaluation of the consequences of predictable future events, including, but not limited to earthquakes, floods, severe storm events, droughts, or other natural phenomena.

(f) Each petition must be submitted to the Administrator by certified mail.

(g) Each petition must include the following statement signed by the petitioner or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this petition and all attached documents, and that, based on my inquiry of those individuals immediately

> responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

(h) After receiving a petition, the Administrator may request any additional information that may reasonably be required to evaluate the demonstration.

(i) If approved, the petition will apply to land disposal of the specific restricted waste at the individual disposal unit described in the demonstration and will not apply to any other restricted waste at that disposal unit.

(j) The Administrator shall give public notice of the intent to approve or deny a petition and provide an opportunity for public comment. The Administrator shall give public notice of the final decision on a petition in the **Federal Register.**

(k)(1) The Administrator will provide written notice to the petitioner upon approval or denial of a petition. If approval is given, the notice will identify the land disposal unit, the wastes that may be disposed therein, the volume limit, and the duration of the approval.

(2) The petitioner shall retain the notice for the term of the approval as defined by paragraph (l) of this section.

(l) The term of an approved petition shall be no longer than the term of the RCRA permit if the disposal unit is operating under a RCRA permit, or up to a maximum of 10 years from the date of the notice provided under paragraph (k)(1) of this section if the unit is operating under interim status. In either case, the term of the approved petition shall expire upon the termination or denial of a RCRA permit, or upon the termination of interim status or when the volume limit specified in the petition is reached.

§ 268.8 Waste analysis.

(a) The owner or operator of any land disposal facility accepting any waste subject to restrictions under this part, must have records of either the treatment certification specified in paragraph (b) of this section or of sufficient waste analysis through testing of the waste for the constituents listed in Table CCWE in § 268.42 to determine whether the wastes are in compliance with the applicable treatment standards specified in Subpart D of this part. The waste must be tested using the methods described in SW–846 or equivalent methods approved by the Administrator in accordance with §§ 260.20 and 260.21 of this chapter.

(b) Where the applicable treatment standard for a waste is treatment by a specific technology (i.e., § 268.41(a)), the owner or operator of the treatment facility must submit a certification to the land disposal facility stating that the waste has been treated using the specified technology. The certification is subject to the following requirements:

(1) The certification must be signed by the treater or his authorized representative and must state the following:

> I certify under penalty of law that I have personally examined and am familiar with the treatment technology and operation of the treatment process used to support this certification and that, based on my inquiry of those individuals immediately responsible for obtaining this information, I believe that the treatment process has been operated and maintained properly so as to achieve the treatment standards of the specified technology without dilution of the prohibited waste. I am aware that there are significant penalties for submitting a false certification including the possibility of fine and imprisonment.

(2) The certification must be sent to the land disposal facility before the treated waste (including treatment residues) is shipped by the treater and must be kept on site for 3 years after the waste is placed in a land disposal unit at the facility.

§ 268.9 Incorporations by reference.

The following material is incorporated by reference and is available for inspection at the Office of the Federal Register Information Center, Rm. 8301, 1100 L St., NW., Washington, DC 20408. These incorporations by reference were approved by the Director of the Office of the Federal Register. The material is incorporated as it exists on the date of approval and a notice of any change in the material will be published in the **Federal Register.**

(a) "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW–846 (First Edition, 1980, as updated by Revision A (August 1980), B (July 1981), and C (February 1982) or Second Edition, 1982). The first edition of SW–846 is no longer in print. Revisions A and B are available from NTIS, 5285 Port Royal Road, Springfield, Virginia 22161. The second edition of SW–846 includes material from the first edition and Revisions A, B, and C in a reorganized format. It is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (202–783–3238), on a subscription basis, and future updates will automatically be mailed to the subscriber. The material is cited in the following sections of Part 268: §§ 268.1(e)(2), 268.5(c)(2), 268.6(a), and 268.42(a).

(b) [Reserved.]

3. By adding Subpart C to proposed Part 268 to read as follows:

Subpart C—Prohibitions on Land Disposal

Sec.

Subpart C—Prohibitions on Land Disposal

§ 268.30 Waste specific prohibitions—Group I.

(a) Effective November 8, 1986, the wastes listed in paragraph (b) of this section are prohibited from land disposal, except in an injection well, unless:

(1) The wastes are treated to meet the standards of Subpart D of this part, or

(2) The wastes are subject to a successful petition under § 268.5, or

(3) An extension has been granted under § 268.4.

(b) Prohibited are the following solvent containing wastes containing greater that 1 percent (by weight) total organic constituents, except for solvent contaminated soils:

F001—The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F002—The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, and trichlorofluoromethane; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F001, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F003—The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, solely the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and a total of 10 percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F004—The following spent non-halogenated solvents: cresols and cresylic acid and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F005—The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F004; and still bottoms from the recovery of these spent solvents and solvent mixtures.

P022—Carbon disulfide
U002—Acetone
U031—n-Butyl alochol
U037—Chlorobenzene
U052—Cresols and cresylic acid
U057—Cyclohexanone
U070—o-Dichlorobenzene
U080—Methylene chloride
U112—Ethyl acetate
U117—Ethyl ether
U121—Trichlorofluoromethane
U140—Isobutanol
U154—Methanol
U159—Methyl ethyl ketone
U161—Methyl isobutyl ketone
U169—Nitrobenzene
U196—Pyridine
U210—Tetrachloroethylene
U211—Carbon tetrachloride
U220—Toluene
U226—1,1,1-Trichloroethane
U228—Trichloroethylene
U239—Xylene.

§ 268.31 Waste specific prohibitions—Group II.

(a) Effective November 8, 1988, the wastes listed in paragraph (c) of this section are prohibited from land disposal, except in an injection well, unless:

(1) The wastes are treated to meet the standards of Subpart D of this part, or

(2) The Wastes are subject to a successful petition under § 268.5, or

(3) An extension has been granted under § 268.4.

(b) Between November 8, 1986, and November 8, 1988, wastes identified in paragraph (c) of this section may be disposed of in a landfill or surface impoundment only if the facility is in compliance with the minimum technological requirements of § 268.4 (i)(2).

(c) Prohibited are:

(1) The following solvent-containing wastes (containing less than 1 percent (by weight) total organic constituents) and solvent contaminated soils.

F001—The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F002—The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, and trichlorofluoromethane; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F001, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F003—The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing solely the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and a total of 10 percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F004—The following spent non-halogenated solvents: cresols and cresylic acid and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F005—The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

P022—Carbon disulfide
U002—Acetone
U031—n-Butyl alcohol
U037—Chlorobenzene
U052—Cresols and cresylic acid
U057—Cyclohexanone
U070—o-Dichlorobenzene
U080—Methylene chloride
U112—Ethyl acetate
U117—Ethyl ether
U121—Trichlorofluoromethane
U140—Isobutanol
U154—Methanol
U159—Methyl ethyl ketone
U161—Methyl isobutyl ketone
U169—Nitrobenzene
U196—Pyridine
U210—Tetrachloroethylene
U211—Carbon tetrachloride
U220—Toluene
U226—1,1,1-Trichloroethane
U228—Trichloroethylene
U239—Xylene

(2) The following dioxion-containing wastes:

F020—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production and manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri-, or tetrachlorophenol or of intermediates used to produce their pesticide derivatives. (This listing does not include wastes from the production of hexachlorophene from highly purified 2,4,5-trichlorophenol.)

F021—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediates, or component in a formulating process) of pentachlorophenol, or of intermediates used to produce its derivatives.

F022—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzenes under alkaline conditions.

F023—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri-, and tetrachlorophenols. (This listing does not include wastes from equipment used only for the production or use of hexachlorophene made from highly purified 2,4,5-trichlorophenol.)

F026—Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the manufacturing use (as a reactant, chemical intermediate, or component in a formulation process) of tetra-, penta-, or hexachlorobenzene under alkaline conditions.

F027—Discarded unused formulations containing tri-, tetra- or pentachlorophenol, or compounds derived from these chlorophenols. (This listing does not include formulations containing hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component.)

4. By adding Subpart D to proposed Part 268 to read as follows:

Subpart D—Treatment Standards

Sec.
268.40 Applicability of treatment standards.
268.41 Treatment standards expressed as a specified technology.
268.42 Treatment levels expressed as concentrations in waste extract.
268.43 Treatment standards expressed as waste concentrations. [Reserved]

Subpart D—Treatment Standards

§ 268.40 Applicability of treatment standards.

(a) Prior to land disposal, any waste for which an identified technology is specified as the treatment standard § 268.41(a), must be treated using that technology or treated using an equivalent treatment method approved by the Administrator or under the procedures set forth in § 268.41(b), unless the hazardous constituents in an extract of the waste or in the waste are less than the concentration levels indicated in § 268.42 or § 268.43, respectively.

(b) For land disposal of a waste listed in Subpart C of this part but not specifically identified in § 268.41, the concentrations of hazardous constituents in the waste extract must not equal or exceed the value given for any hazardous constituent listed in Table CCWE in § 268.42(a). If none of the concentrations of hazardous constituents in the waste extract equal or exceed the specified concentrations listed in Table CCWE in § 268.42(a), the waste may be land disposed without further treatment. If the concentration of any hazardous constituent in the waste extract equals or exceeds a level indicated in Table CCWE in § 268.42(a) for that constituent, the waste must undergo treatment to bring the level below the applicable concentration level before being land disposed.

§ 268.41 Treatment standards expressed as a specified technology.

(a) The following wastes must be treated using the identified technology or technologies, or an equivalent method approved by the Assistant Administrator for Solid Waste and Emergency Response:
[Wastes and designated treatment technologies will be specified in future actions.]

(b) Any person may submit an application to the Assistant Administrator for Solid Waste and Emergency Response demonstrating that an alternative treatment method can achieve a level of performance equivalent to that achieved by methods specified in paragraph (a) of this section. The applicant must show that his treatment method will not present an unreasonable risk of injury to health or the environment. On the basis of such information and any other available information, the Assistant Administrator for Solid Waste and Emergency Response may, in his discretion, approve the use of the alternative treatment method if he finds that the alternative treatment method provides a level of performance equivalent to that achieved by methods specified in paragraph (a) of this section. Any approval must be stated in writing and may contain such provisions and conditions as the Assistant Administrator for Solid Waste and Emergency Response deems appropriate. The person to whom such certification is issued must comply with all limitations contained in such determination.

§ 268.42 Treatment levels expressed as concentrations in waste extract.

Using the test methods described in SW-846 or equivalent methods approved by the Administrator under the procedures set forth in §§ 260.20 and 260.21 of this chapter, the extract from a representative sample of a waste identified in Subpart C of this part, or from the residue of treatment of such a waste, must not contain any of the constituents listed in Table CCWE at a concentration greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of this section.

TABLE CCWE—CONSTITUENT CONCENTRATION IN WASTE EXTRACT

Hazardous constituent	Concentration (in mg/l)
Acetone	2.0
n-Butyl alcohol	2.0
Carbon disulfide	2.0
Carbon tetrachloride	0.1
Chlorobenzene	2.0
Cresols	2.0
Cyclohexanone	2.0
Ethyl acetate	2.0
Ethyl benzene	2.0
Ethyl ether	2.0
HxCDD—All Hexachlorodibenzo-p-dioxins	.001 (1ppb)
HxCDF—All Hexachlorodibenzofurans	.001 (1ppb)
Isobutanol	2.0
Methanol	2.0
Methylene chloride	1.2
Methyl ethyl ketone	2.0
Methyl isobutyl ketone	2.0
Nitrobenzene	0.09
PeCDD—All Pentachlorodibenzo-p-dioxins	.001 (1ppb)
PeCDF—All Pentachlorodibenzofurans	.001 (1ppb)
Pentachlorophenol	1.0
Pyridine	0.7
TCDD—All Tetrachlorodibenzo-p-dioxins	.001 (1ppb)
TCDF—All Tetrachlorodibenzofurans	.001 (1ppb)
Tetrachloroethylene	0.015
2,3,4,6 Tetrachlorophenol	2.0
Toluene	2.0
1,1,1-Trichloroethane	2.0
1,2,2-Trichloro- 1,2,2-tyrifluoroethane	2.0
Trichloroethylene	0.1
Trichlorofluoromethane	2.0
2,4,5 Trichlorophenol	6.0
2,4,6 Trichlorophenol	0.04
Xylene	2.0

§ 268.43 Treatment standards expressed as waste concentrations. [Reserved]

5. By adding Subpart E consisting at this time of § 268.50 to proposed Part 268 to read as follows:

Subpart E—Prohibitions on Storage

§ 268.50 Prohibitions on storage of restricted wastes.

(a) A hazardous waste prohibited from land disposal under Subpart C of this part may not be stored in tanks or containers after the prohibition effective date unless:

(1) The owner or operator of a hazardous waste treatment, storage, or disposal facility stores such waste for 90 days or less; or

(2) A transporter stores manifested shipments of such waste in containers at a transfer facility for 10 days or less; or,

(3) Such waste is accumulated on site by the generator and does not exceed the applicable time limitations set forth in § 262.34 of this chapter.

(b) The prohibition in paragraph (a) of this section does not apply to the conditions of an approved petition under § 268.5 or an approved case-by-case extension under § 268.4.

(c) The prohibition in paragraph (a) of this section does not apply to hazardous wastes that meet the treatment standards specified under Subpart D of this part.

PART 270—EPA-ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT PROGRAM

VII. In Part 270:

1. The authority citation of Part 270 is revised to read as follows:

Authority: Secs. 1006, 2002, 3005, 3007, and 7004 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6905, 6912, 6925, 6927, and 6974).

Subpart B—Permit Application

2. In § 270.14, paragraph (b)(21) is added to read as follows:

§ 270.14 Contents of Part B: General requirements.

* * * * *

(b) * * *

(21) For land disposal facilities, if a case-by-case extension has been approved under § 268.4 or a petition has been approved under § 268.5, a copy of the notice of approval for the extension or petition, whichever is applicable

* * * * *

Subpart C—Permit Conditions

3. In § 270.32, paragraph (b)(1) is revised to read as follows:

§ 270.32 Establishing permit conditions.

* * * * *

(b)(1) Each RCRA permit shall include permit conditions necessary to achieve compliance with the Act and regulations, including each of the applicable requirements specified in Parts 264 and 266 through 268 of this chapter. In satisfying this provision, the Administrator may incorporate applicable requirements of Part 264 and 266 through 268 of this chapter directly into the permit or establish other permit conditions that are based on these parts.

* * * * *

PART 271—REQUIREMENTS FOR AUTHORIZATION OF STATE HAZARDOUS WASTE PROGRAMS

VIII. In Part 271:

1. The authority citation for Part 271 is revised to read as follows:

Authority: Secs. 1006, 2002(a) and 3006 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6901 et seq.)

Subpart A—Requirements for Final Authorization

2. In § 271.1(j), Table 1 is amended by inserting the following entry in chronological order by date of publication in the **Federal Register** to read as follows:

§ 271.1 Purpose and scope.

* * * * *

(j) * * *

TABLE 1—REGULATION IMPLEMENTING THE HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984

Date	Title of regulation
* * *	* *
[Date of publication of the final rule in the **Federal Register**].	Land disposal restrictions.

3. In § 271.10 paragraph (i) is added to read as follows:

§ 271.10 Requirements for generators of hazardous wastes.

* * * * *

(i) The State must require all generators of hazardous wastes restricted from land disposal under Subpart C of Part 268 of this chapter to comply with requirements that are equivalent to the requirements for persons filing petitions under § 268.5 of this chapter.

4. In § 271.12 the introductory text is revised and paragraph (k) is added to read as follows:

§ 271.12 Requirements for hazardous waste management facilities.

The State shall have standards for hazardous waste management facilities which are equivalent to Parts 264 and 266 and § 268.5 of this chapter. These standards shall include:

* * * * *

(k) Requirements for petitions demonstrating land disposal to be protective of human health and the environment, to the extent they are included in § 268.5 of this chapter.

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