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Economic and Cost-Effectiveness Analysis for Proposed Effluent Limitations Guidelines and Standards for the Landfills Point Source Category

ECONOMIC ANALYSIS AND COST-EFFECTIVENESS ANALYSIS OF PROPOSED EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR THE LANDFILLS POINT SOURCE CATEGORY

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Table of Contents

Economic Analysis of Proposed Effluent Limitations Guidelines and Standards for the Landfills Category

Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Landfills Category

Chapter 1

Introduction and Overview

1.0 Overview and Definitions

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a)). To implement these amendments, the U.S. Environmental Protection Agency (EPA) issues effluent limitations guidelines and standards for categories of industrial dischargers. The regulations that the EPA establishes are:

- **Best Practicable Control Technology Currently Available (BPT)** These regulations apply to existing industrial direct dischargers, and generally cover discharge of conventional pollutants.

- **Best Available Technology Economically Achievable (BAT)** These regulations apply to existing industrial direct dischargers and the control of priority and non-conventional pollutant discharges.

- **Best Conventional Pollutant Control Technology (BCT)** BCT regulations are an additional level of control for direct dischargers beyond BPT for conventional pollutants.

- **Pretreatment Standards for Existing Sources (PSES)** These regulations apply to existing indirect dischargers (i.e., facilities which introduce their discharges into Publicly Owned Treatment Works, or POTWs). They generally cover discharge of toxic and non-conventional pollutants that pass through the POTW or interfere with its operation. They are analogous to the BAT controls.

- **New Source Performance Standards (NSPS)** These regulations apply to new industrial direct dischargers and cover all pollutant categories.

- **<u>Pretreatment Standards for New Sources (PSNS)</u>** These regulations apply to new indirect dischargers and generally cover discharge of toxic and non-conventional pollutants that pass through the POTW or interfere with its operation.

Table 1-1 below provides more detailed information about these six types of regulations.

This Economic Analysis (EA) assesses the economic impact of the proposed effluent limitation guidelines and standards for the Landfills Industry Category. This rulemaking proposes limitations of each type, but PSES and PSNS limitations are proposed only for hazardous waste landfills.

EPA is proposing to exclude landfills operated in conjunction with other industrial or commercial operations which only receive waste generated on-site (captive facility) and/or receive waste from off-site facilities under the same corporate structure (intra-company facility) so long as the wastewater is commingled for treatment with other non-landfill process wastewaters. A landfill which accepts off-site waste from a company not under the same ownership as the landfill would not be considered a captive or intracompany facility and would be subject to the landfills category effluent guideline when promulgated.

Table 1-1. Levels of Pollutant Controls

	CONTROLS ON DIRECT DISCHARGERS	CONTROLS ON INDIRECT DISCHARGERS
EXISTING SOURCES	**BPT (Best Practicable Control Technology Currently Available)**: The lowest level of control, BPT targets conventionals but can also control priority and nonconventional pollutants.	(No controls for indirect dischargers comparable to BPT for directs, since indirect dischargers discharge wastewater into a POTW, which treats conventional pollutants.)
	BCT (Best Conventional Pollutant Control Technology): Controls conventionals only. Limits for conventionals must be set equal to or more stringent than BPT.	(No controls for indirect dischargers comparable to BCT for directs, since indirect dischargers discharge wastewater into a POTW, which treats conventional pollutants.)
	BAT (Best Available Technology Economically Achievable): Applies to existing facilities. Usually, limits can be set only for priority pollutants and nonconventionals. Conventionals can only be controlled incidentally or as a surrogate / indicator for priority pollutants and/or nonconventionals. BAT limits can be set equal to or be more stringent than BPT regulations.	**PSES (Pretreatment Standards for Existing Sources)**: Generally analogous to BAT regulations for direct dischargers. EPA determines which pollutants to regulate in PSES on the basis of whether or not they pass through, cause an upset in or otherwise interfere with the operation of a POTW or its sludge practices. PSES usually begins with BAT control technology, adjusted on the basis of pass-through and interference considerations. Limits are usually set only for priority pollutants and nonconventionals. Conventionals can only be controlled incidentally, as a surrogate/indicator for priority pollutants and nonconventionals, or if the industry discharges large enough loadings to cause a national problem for pass-through or interference.*
NEW SOURCES	**NSPS (New Source Performance Standards)**: Applies to new sources. Can be promulgated for conventionals on the basis of BPT limitations. NSPS limits can be set equal to or be more stringent than BPT regulations (e.g., require BPT technology plus additional treatment). Can be promulgated for priority pollutants and nonconventionals on the basis of BAT limitations. NSPS limits can be set equal to or be more stringent than BAT regulations.	**PSNS (Pretreatment Standards for New Sources)**: Applies to new sources. Generally analogous to NSPS. Generally promulgated for priority pollutants and nonconventionals

* Limits for Oil and Grease were set in Petroleum Refining to prevent nation wide interference problems. See 40 CFR-419

1.1 Summary of the Proposed Rule

The proposed rule subcategorizes the landfills industry into two subcategories: hazardous and non-hazardous landfills. For the purposes of this rule, non-hazardous landfills accept only non-hazardous wastes, as defined in the Resource Conservation and Recovery Act (RCRA). Landfills that accept hazardous wastes or a mixture of hazardous and non-hazardous wastes and any landfill in operation before 1980 are assigned to the hazardous landfill subcategory. The industry profile in Chapter 3 provides more detailed definitions.

The proposed regulations for the non-hazardous subcategory include BPT, BCT, BAT and NSPS limitations. The proposed regulations for the hazardous subcategory include BPT, BCT, BAT, PSES, NSPS and PSNS limitations.

Best Practicable Control Technology (BPT)

EPA proposes to establish concentration-based BPT limitations that reflect the best practicable technology performance. The technology basis for BPT for non-hazardous landfills is end-of-pipe treatment using equalization followed by biological treatment, clarification and multimedia filtration. For hazardous waste landfills, EPA proposes equalization with chemical precipitation with primary clarification followed by biological treatment with secondary clarification as the basis for BPT.

Best Conventional Pollutant Control Technology (BCT)

EPA proposes to set BCT equal to BPT limitations for both hazardous and non-hazardous waste landfills.

Best Available Technology Economically Achievable (BAT)

EPA proposes to set BAT equal to BPT limitations for both hazardous and non-hazardous waste landfills.

New Source Performance Standards (NSPS)

EPA proposes to set NSPS equal to BPT limitations for both hazardous and non-hazardous waste landfills.

Pretreatment Standards for Existing Sources (PSES)

EPA proposes to establish PSES equivalent to BAT limitations for hazardous waste landfills. However, EPA proposes no PSES limitations for the non-hazardous subcategory.

Pretreatment Standards for New Sources (PSNS)

EPA proposes to establish PSNS limitations equivalent to PSES limitations for hazardous waste landfills. However, EPA proposes no PSNS limitations for the non-hazardous subcategory.

1.2 Selection of the Proposed Regulatory Options

In EPA's engineering assessment of the best practicable control technology currently available for the non-hazardous subcategory, the Agency evaluated three potential technologies commonly in use by the industry: chemical precipitation, biological treatment and multimedia filtration. Chemical precipitation, an effective treatment technology for the removal of metals, was discarded as an option due to the low concentration of metals typically found in non-hazardous landfill leachate.

BPT Option I consists of equalization followed by biological treatment with clarification. Various types of biological treatment such as activated sludge, aerated lagoons, and anaerobic and aerobic biological towers or fixed film reactors were included in the calculation of limits for this option. Biological treatment was chosen due to its effectiveness in removing the large organic loads commonly associated with leachate. The costing for Option I was based on the cost of aerated equalization followed by an extended aeration activated sludge system with secondary clarification and sludge dewatering. Approximately 30 percent of the non-hazardous facilities employed some form of biological treatment and 13 percent had a combination of equalization and biological treatment.

Option II for the non-hazardous subcategory consists of Option I technology with the addition of a multimedia filter after the biological treatment. This option was chosen due to the ability of the biological system to control the organics and the effectiveness of the filter in the removal of total suspended solids (TSS) that may remain after biological treatment. Approximately 10 percent of the direct discharging non-hazardous facilities used the technology described in Option II.

EPA selected Option II, equalization followed by biological treatment and multimedia filtration, as the technology basis for BPT limitations for the non-hazardous landfills subcategory. This option was chosen based on the comparison of the two options in terms of costs, pounds of pollutant removals, economic impacts and environmental benefits. BPT Option II removed significantly more pounds of conventional pollutants than Option I for a moderate cost increase. Furthermore, by adding a multimedia filter to the biological system, the treatment system has the ability to dampen the variability of the suspended solids discharged from the biological system. Option I did not control the removal of TSS as well as Option II. Furthermore, the Agency determined that both options resulted in three facilities incurring significant economic impacts.

With respect to hazardous waste landfills, EPA's 1994 Waste Treatment Industry Questionnaire Phase II: Landfills (hereafter referred to as the survey) found no respondents classified as direct dischargers. All of the hazardous landfills not excluded from the regulation were classified as either indirect or zero dischargers. Therefore, the Agency relied on technology transfer in order to set BPT standards for direct dischargers. The Agency deems it necessary to set standards for direct discharges from hazardous landfills because there may be facilities not included in the survey discharging directly to surface waters. Additionally, facilities that are currently zero dischargers or are discharging to a POTW may decide to discharge wastewater directly to surface waters in the future.

EPA assessed three potential technology options for consideration as BPT for the hazardous subcategory: chemical precipitation, biological treatment and zero discharge. Chemical precipitation was considered because of the high metals concentrations typically found in hazardous landfill leachate. Biological treatment was chosen as an appropriate technology because of its ability to remove the high organic loads present in the leachate. Finally, EPA considered a zero discharge option as a potential BPT requirement because a large section of the industry is currently achieving zero discharge status. The zero discharge, or alternative disposal, option would require facilities to dispose of their wastewater in a manner that would not result in wastewater discharge to a POTW or directly to a surface water.

EPA has tentatively determined that it should not propose zero or alternative discharge requirements because, for the industry as a whole, zero or alternative discharge options are either not viable or the cost is wholly disproportionate to the benefits and thus it is not "practicable."

One demonstrated alternative disposal option for large wastewater flows is underground injection. However, this is not considered a practically available option on a nationwide basis because it is not allowed in many geographic regions of the country where landfills may be located.

The second widely used disposal option involves contract hauling landfill wastewater to a Centralized Waste Treatment facility (CWT). EPA's survey demonstrated that only landfills with relatively low flows (under 500 g.p.d.) currently contract haul their wastewater to a CWT. The costs of contract hauling are directly proportional to the volume and distance over which the wastewater must be transported, generally making it excessively costly to send large wastewater flows to a CWT, particularly if it is not located nearby. EPA evaluated the cost of requiring all hazardous landfills to achieve zero or alternative discharge status. For the purposes of costing, EPA assumed that a facility would have to contract haul wastewater off-site because it may be impossible to pursue other zero or alternative discharge options. EPA concluded that the cost of contract hauling off-site for high flow facilities was unreasonably high and disproportionate to the removals potentially achieved. In addition, EPA concluded that the wastewater shipped to a CWT will typically receive treatment equivalent to that proposed today, and that zero/alternative discharge requirements would result in additional costs to dischargers without greater removals for hazardous landfill wastewaters.

Based on the characterizations of the hazardous landfill leachate and on the technology options available through technology transfer, the Agency chose chemical precipitation with biological treatment as the only BPT option for the hazardous subcategory.

In developing BCT limits, EPA considered whether there are technologies that achieve greater removals of conventional pollutants than proposed for BPT, and whether those technologies are cost-reasonable according to the prescribed BCT tests. In both subcategories, EPA identified no technologies that can achieve greater removals of conventional pollutants than proposed for BPT that also pass the BCT cost-reasonableness tests. Accordingly, EPA proposes BCT effluent limitations equal to the proposed BPT limitations.

For BAT limitations in the non-hazardous subcategory, EPA evaluated three potential technologies currently used in the industry: chemical precipitation, biological treatment plus multimedia filtration and reverse osmosis. Chemical precipitation, an effective treatment technology for the removal of metals, was eliminated from consideration as an option due to the very low concentration of metals found in non-hazardous landfill leachate. Biological treatment followed by multimedia filtration was chosen as Option I due to the ability of the biological system to remove the large organic loads commonly found in the leachate and the effectiveness of the filter in the removal of TSS that may remain after biological treatment. This treatment option is the same as the option selected for BPT in the non-hazardous subcategory.

As a second option for BAT in the non-hazardous subcategory, EPA assessed the benefits and removals of a biological treatment system with a multimedia filter followed by a single-stage reverse osmosis. Reverse osmosis was considered as a viable option due to its very effective removal of toxic and conventional pollutants. However, after a thorough analysis of this option, the Agency determined that the biological treatment system and the multimedia filter established as BPT were removing the majority of toxic pollutants. The small incremental removal of toxic pounds achieved by Option II beyond Option I removals was not justified by the large cost for the reverse osmosis treatment system.

With respect to hazardous landfills, EPA's survey of landfills in the United States found no hazardous landfills that are classified as direct dischargers. All of the hazardous landfills included in the EPA survey were indirect or zero dischargers. Therefore, the Agency relied on technology transfer from the hazardous indirect database in order to set BAT for the direct hazardous dischargers. EPA evaluated three potential technology options: chemical precipitation, biological treatment, and zero discharge. Chemical precipitation was considered a very good option because of the high concentrations of metals found in hazardous landfill leachate. Biological treatment was also chosen as an appropriate technology because of its ability to remove the high organic loads present in the leachate. Finally, EPA considered a zero discharge option as a potential BPT requirement. Zero discharge, or alternative disposal, would require facilities to dispose of their wastewater through evaporation, land application, deep well injection, solidification, recirculation, or by contract hauling the waste to a CWT facility. The zero discharge option was not considered feasible for the same reasons outlined in the BPT discussion.

Based on the characterizations of the hazardous leachate and on the technology options available through technology transfer, the Agency chose chemical precipitation with biological treatment as the only BAT option for the hazardous subcategory.

EPA is proposing New Source Performance Standards (NSPS) that would control the same conventional, priority, and non-conventional pollutants proposed for control by the BPT effluent limitations. The technologies used to control pollutants at existing facilities are fully applicable to new facilities. Furthermore, EPA has not identified any technologies or combinations of technologies that are demonstrated for new sources that are different from those used to establish BPT/BCT/BAT for existing sources. Therefore, EPA is proposing NSPS limitations that are identical to those proposed in each subcategory for BPT/BCT/BAT.

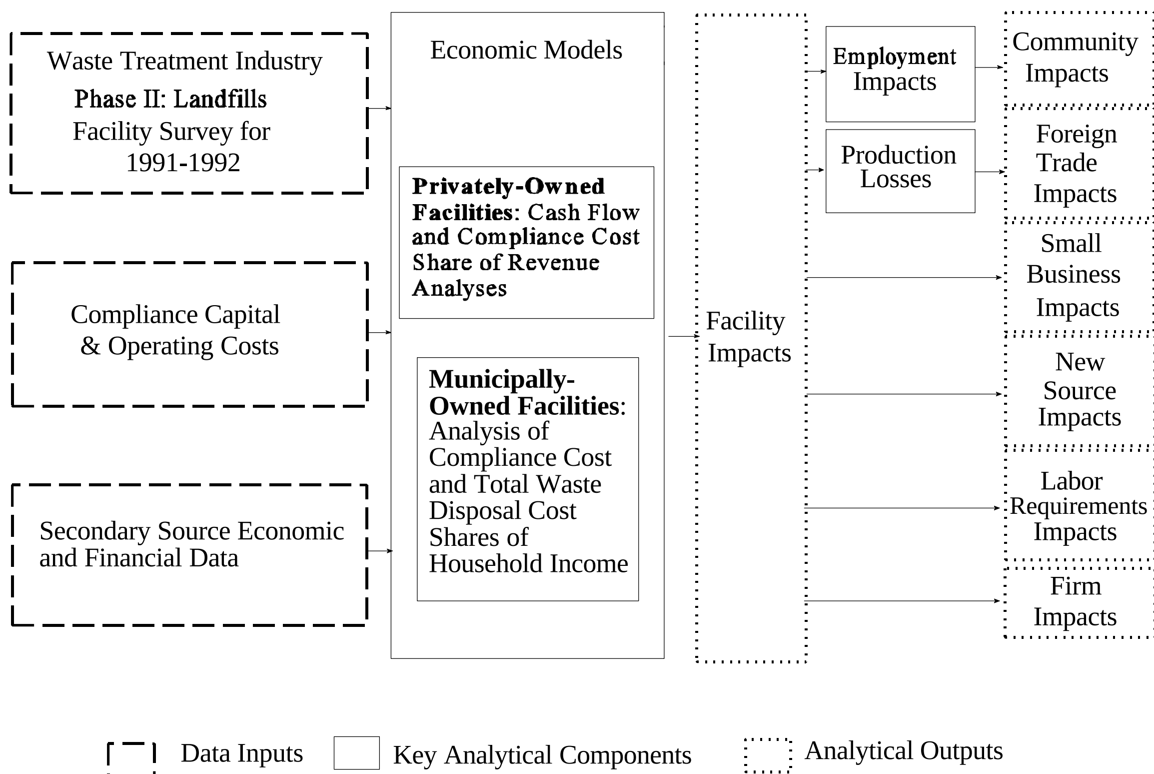
The Agency is not proposing to establish pretreatment standards for existing sources (PSES) for the non-hazardous subcategory. The Agency's decision not to establish PSES for this subcategory was based on several factors. In EPA's analysis of the indirect discharging landfills, the raw leachate concentrations were found at levels that were about one-half of the inhibition value of a POTW biological treatment system. EPA also found no evidence of contamination problems of POTW biosolids as a result of landfill leachate. Furthermore, in EPA's study of the indirect dischargers, EPA found no documented persistent problems with POTW upsets as a result of landfill wastewater.

As for hazardous waste landfills, EPA is proposing to establish PSES based on the same technologies as proposed for BPT, BAT, and NSPS for this subcategory. These standards would apply to existing facilities in the hazardous subcategory that discharge wastewater to POTWs and would prevent pass-through of pollutants and help control sludge contamination. According to EPA's database, all existing indirect dischargers already meet this baseline standard. Therefore, no incremental costs, benefits, or economic impacts were developed.

1.3 Structure of the Economic Analysis

This Economic Analysis (EA) describes both the methodology employed to assess impacts of the proposed rule and the results of the analyses. The overall structure of the EA is summarized in Figure 1-1. The two main inputs to the analysis are: 1) data on industry baseline financial and operating conditions, and 2) projected costs of complying with the proposed rule. The industry baseline financial and operating data are based principally on the Waste Treatment Industry Questionnaire Phase II: Landfills (the survey) conducted under the authority of Section 308 of the Clean Water Act (CWA).

Figure 1-1
Economic Impact Analysis of the Landfills Industry
Effluent Limitations Guidelines: Analytic Components



Pursuant to its CWA Section 308 authority, EPA surveyed 252 landfills. The survey asked for balance sheet and income statement information, as well as quantitative and qualitative information regarding each facility's dependence on market sectors, types of customers and business activity. Facilities were asked to characterize the competition they faced in various markets. The survey also gathered data regarding facility liquidation value, cost of capital and the facility's owning firm. EPA supplemented survey data with secondary sources, including trade literature and public filings.

In addition to baseline facility data, the second major type of data input to the analysis is the technical estimate of costs associated with compliance with the regulatory options. EPA developed these estimates based on engineering analysis of the in-scope facilities. The cost estimates were incorporated into the Economic Analysis by adding an annualized capital cost of compliance to the estimated annual operating and maintenance costs of compliance to yield a single, total annualized compliance cost.

For privately-owned landfills, EPA used baseline financial data and estimated annualized compliance costs to calculate baseline and post-compliance cash flows at the level of the entire facility as well as for waste treatment operations alone. Facilities that convert from non-negative to negative facility-level cash flows as a result of incurring compliance costs are considered closures associated with the regulation. EPA also calculated the ratio of compliance costs to revenue as a secondary measure of financial stress short of closure.

Municipally-owned landfills were subjected to two impact tests based on median household income. The first test calculates the ratio of compliance costs to median household income. When this ratio equals or exceeds 1 percent, the facility is deemed to incur severe impacts. The second test calculates the ratio of total landfill disposal costs — that is, baseline costs plus incremental compliance costs — to median household income. In this case, ratios exceeding 1 percent indicate moderate impacts.

The Economic Analysis builds from the facility-level impact analysis, the results from which then drive the other components of the EA (see Figure 1-1). The firm-level impact analysis evaluates the effect of facility-level compliance costs on the parent firm. The community impact analysis examines how employment losses due to projected facility closures affect not only the people that were employed by the facility but also the communities to which these people belong. Landfill closures might conceivably influence the U.S. trade balance by decreasing export-related activity and increasing imports.

EPA also examined the proposed rule to determine if it would create barriers to entry. If existing firms were to gain a significant financial advantage over new firms in complying with the rule, then the rule might deter new entrants and reduce market competition.

Finally, EPA assessed the regulatory impact on small businesses, in accordance with the requirements of the Regulatory Flexibility Act. The key methodological component of this analysis was the identification of small businesses. EPA used small business thresholds provided by the Small Business Administration, which defines small businesses by firm-level employment or revenues, depending on the industry. In the Regulatory Flexibility Analysis, EPA applied these thresholds and found no small businesses among the in-scope facilities.

1.5 Organization of the Economic Analysis Report

The remaining parts of the Economic Analysis are organized as follows. Chapter 2 describes the data sources consulted for this EA. Chapter 3 profiles the landfills industry and examines the economic and financial structure and performance of its markets. Following the background material in Chapters 2 and 3, Chapter 4 details the methodology used to estimate facility impacts and presents the results. Chapters 5 through 9 connect the results of the facility impact analysis to potential collateral effects on firms, foreign trade, communities, new entrants and small businesses. Chapter 10 summarizes the environmental impact assessment.

Chapter 2

Data Sources

2.0 Introduction

This chapter describes the primary and secondary sources that provided economic and financial data used to assess the expected economic impact of the landfills rule.

2.1 Primary Source Data

In 1994, EPA mailed the Waste Treatment Industry Questionnaire Phase II: Landfills (hereafter referred to as the survey) to 252 landfills identified at that time, and received 220 substantially complete responses. The survey obtained 1991 and 1992 information on the technical and financial characteristics of facilities to estimate how facilities would be affected by an effluent guideline.

The technical data obtained by this questionnaire include information on facility operating processes that use water, the quantities of water and pollutants discharged by the various processes, the treatment systems that are currently in place for managing discharge of pollutants and other data. These data provided the basis for estimating treatment system and process change costs for complying with various landfills rule options. The estimated technical costs for compliance in turn yielded estimates of the capital and operating costs of treatment systems and any production costs or savings that would accompany installation and operation of a treatment system.

The survey also obtained a variety of financial data from the facilities. These data include: two years (1991-1992) of income statements and balance sheets at the facility and firm levels; selected financial data for landfill and waste treatment operations; estimated value of facility assets and liabilities in liquidation; borrowing costs; employment at the level of the facility as well as by type of operation, and characterizations of market structure. The financial data obtained in the survey provided the basis for assessing how facilities are likely to be affected financially by the proposed rule.

2.2 Secondary Source Data

In addition to enabling numerous analytical tools in the economic impact analyses in this document, secondary source data helped to characterize and update background economic and financial conditions in the national economy and in the landfills industry. For example, secondary source data were used to track the numerous consolidations and facility closures since administering the survey. Secondary source data also contributed significantly to the firm-level analysis and to the characterization of future prospects. Secondary sources used in the analysis include:

- 1987 to 1992 *U.S. Industrial Outlooks*, published by the Department of Commerce, which supplied information for Chapter 3.

- Small business thresholds, by 4-digit industry group from the Small Business Administration, used in the Regulatory Flexibility Analysis and in the preliminary statistical analyses.

- Industry sources, trade publications (especially *EI Digest* and *The Hazardous Waste Consultant*) and press releases, which contributed to the landfills profile presented in Chapter 3 and to the facility and firm-level impact analyses.

- Financial databases, including Robert Morris Associates' *Annual Statement Studies*, Dun & Bradstreet's *Million Dollar Directory* and the Dun & Bradstreet company database. These sources provided diagnostic financial ratios and firm-level income statement and balance sheet values, as well as supplementary identification data.

- The FY 1997 *Economic Report of the President* provided Producer Price Index and Gross Domestic Product deflator series.

- EPA gathered supplementary data for landfills from the *1994 Statistical Abstract of the United States*, published by the Department of Commerce and EPA's *Characterization of Municipal Solid Waste in the United States*.

- Municipality data, including household income and other demographic data used in the facility impact, regulatory flexibility and community impact analyses, were derived from the Bureau of the Census'

County and City Data Book, 12th Edition, 1994, and the Bureau of Economic Analysis' *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II) 2nd Edition*, 1992).

- U.S. Bureau of the Census, *County Business Patterns 1994*, U.S. Government Printing Office, Washington, DC, 1996.

The contributions of these sources to each component of the Economic Analysis are discussed in detail within the corresponding chapters.

Chapter 3

Profile of the Landfills Industry

3.1 Introduction

Once characterized by numerous small facilities, the landfills industry has consolidated into larger facilities under a smaller number of owners. Overcapacity continues to threaten profitability, but firms that own landfills have diversified into a number of waste management activities in order to respond to changing markets, technologies and regulations.

This chapter presents an overview of the landfills industry, focusing on parameters that relate to the industry's ability to respond to regulatory compliance costs. The profile relies in part upon responses to the Waste Treatment Industry Questionnaire Phase II: Landfills (hereafter referred to as the survey) administered in 1994. The survey collected technical, economic and financial data for 1991 and 1992 from a statistically representative sample of landfills. The survey requested facility and firm-level income statement and balance sheet information as well as characterizations of competition and industry practices not available from alternative sources. This profile also incorporates contributions from industry observers and secondary sources.

The following section defines relevant terms and explains the structure of the landfills industry. After the definitions, the profile examines the Subtitle D (non-hazardous wastes) portion of the landfills industry, focusing on market structure and financial performance, and then focuses on the landfill subcategories EPA expects will be required to comply with a landfills rule. The chapter concludes by examining the time period covered by the survey and prospects in the near future.

3.2 Industry Definitions

Landfills are facilities that dispose of solid wastes in an area of land or an excavation in which wastes are placed for permanent disposal, and that is not a land application unit, surface impoundment, injection well, or waste pile. A land application unit is an area where wastes are applied onto or incorporated into the soil surface (excluding manure spreading operations) for agricultural purposes or for treatment and disposal. A surface impoundment is a facility or part of a facility that is a natural topographic depression, human-made excavation, or diked area, formed primarily of earthen materials (although it may be lined with human-made materials), that is designed to hold an accumulation of liquid wastes or wastes containing free liquids and that is not an injection well. Examples include holding storage, settling, and aeration pits, ponds, and lagoons.[1] A facility is a piece of continuous property owned by a single entity. There are often several distinct landfill units located at a facility.

The wastewater flows which are covered by the rule include leachate, gas collection condensate, drained free liquids, laboratory-derived wastewater, contaminated storm water and contact washwater from truck exteriors and surface areas which have come in direct contact with solid waste at the landfill facility. Groundwater, however, which has been contaminated by a landfill and is collected, treated, and discharged is excluded from this guideline. A discussion of the exclusion for contaminated groundwater flows is included in Chapter 2 of the Development Document.

The industry can be classified according to the type of solid waste it accepts and by the type of entity that owns the landfill. Depending on the type of wastes disposed at a landfill, the landfill may be subject to regulation and permitting under either Subtitle C or Subtitle D of RCRA.

Subtitle C hazardous waste landfills receive wastes that are identified or listed as hazardous wastes under EPA regulations. RCRA Subtitle C hazardous waste regulations apply to landfills that presently accept hazardous wastes or have accepted hazardous waste at any time after November 19, 1980. Performance regulations governing the operation of hazardous waste landfills are included in 40 CFR Parts 264 and 265.

Subtitle D landfills can accept wastes which are not required to be sent to Subtitle C facilities. Subtitle D landfills which do not presently accept household refuse or have not accepted household refuse after October 9, 1991 are subject to the performance regulations included in 40 CFR Part 257. These landfills are termed Subtitle D Non-municipal Landfills in this document, and may accept such non-hazardous wastes as construction and demolition debris, ash, or sludge. Facilities which presently accept household refuse are subject to the performance regulations included in 40 CFR Part 258 Revised Criteria for Municipal Solid Waste Landfills. Municipal Solid Waste Landfills (MSWLFs) may also receive other types of RCRA Subtitle D wastes, such as ash, non-hazardous sludge, and industrial solid waste.

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[1] Definitions of landfills, land application units and surface impoundments are found in CFR 257.2.

Landfills are subdivided further for analysis according to whether they are owned by private firms or by government entities — typically municipalities. This profile will refer to *privately-owned* and *municipally-owned* landfills to refer to these two types of ownership.

These distinctions across ownership types and types of wastes received create four subtypes of landfills for this profile:

	Privately-Owned	*Publicly-Owned*
Accepts Hazardous Waste	**Privately-Owned Hazardous Waste Landfill**	**Municipally-Owned Hazardous Waste Landfill**
Accepts Non-Hazardous Waste	**Privately-Owned Subtitle D Non-Hazardous Landfill**	**Municipally-Owned Subtitle D Non-Hazardous Landfill**

EPA is proposing to exclude landfills operated in conjunction with other industrial or commercial operations which only receive waste generated on-site (captive facility) and/or receive waste from off-site facilities under the same corporate structure (intra-company facility) so long as the wastewater is commingled for treatment with other non-landfill process wastewaters. A landfill which accepts off-site waste from a company not under the same ownership as the landfill would not be considered a captive or intracompany facility and would be subject to the landfills category effluent guideline when promulgated.

3.3 Subtitle D Landfills (Non-Hazardous Wastes)

Subtitle D facilities handle two kinds of non-hazardous waste: municipal waste and non-municipal waste. By far, the majority of data available from secondary sources pertains to municipal waste landfills. Because of the relative paucity of data pertaining to Subtitle D non-municipal waste landfills, this profile draws heavily from the landfills survey to characterize this group.

Market Structure

Once characterized by numerous small facilities, landfills have responded to economies of scale and to market uncertainty by consolidating into larger landfills receiving wastes from a wide region through systems of smaller transfer facilities. In 1995, the Environmental Industry Associations (EIA) reported 2,893 facilities compared to 5,726 facilities in 1991and 7,575 facilities in 1988. Overall, the number of landfills declined 62 percent from 1988 to 1995.[2]

Economies of scale occur when high fixed costs or certain production technologies yield decreasing unit costs as the level of production increases. While economic theory predicts that the unit cost of production should eventually increase with output, there is typically a range of output over which producing more of a commodity can decrease the average cost of each unit produced.

Typically, scale economies result from fixed costs, which are those costs that do not vary with the level of output. For instance, an oil drilling operation incurs substantial exploration, testing and drilling costs before producing a single barrel of oil.[3] If the facility produces only one barrel of oil, the cost of that first barrel is the entire fixed cost of the operation, plus any costs specifically incurred during the extraction of that barrel of oil. If, on the other hand, the facility produces two barrels of oil, then the fixed cost is allocated over both barrels, and the unit cost falls by approximately a half.

Economies of Scale Due to Fixed Costs (Hypothetical Example)

Production Quantity	**Fixed Costs** *Exploration, permits, etc.*	**Variable Costs** *Oil well operating costs, etc.*	**Unit Cost Per Barrel**
1 barrel	$100	$2	$102
2 barrels	$100	$4	$52

Scale economies can also result from a production technology that operates more cost-effectively at higher levels of output. Internal combustion engines, for instance, sometimes become more fuel efficient at higher operating temperatures associated with higher rates of output. Landfills experience significant scale economies because of both high fixed costs and production technologies, resulting from regulatory as well as non-regulatory factors.

Compliance determination, initial permitting and monitoring involve regulatory costs that are invariant with respect to output or that increase less than proportionately with production volume. In particular, Federal

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[2] Repa, E.W. and A. Blakey. *Municipal Solid Waste Disposal Trends, 1996 Update,* Environmental Industry Associations, 1997. The 1988 value was obtained by the authors from the Government Accounting Office

[3] Economists sometimes distinguish between sunk costs and fixed costs. While fixed costs include all costs that do not vary with output, sunk costs are those fixed costs that cannot be recovered in liquidation. The distinction is not needed here because any kind of fixed cost contributes to economies of scale.

regulation of landfill leachate and groundwater contamination in 1993 added high fixed costs of compliance to assorted costs from prior regulations. EIA reported that these federal regulations encouraged the building of larger landfills to spread out the high costs of complying with the new environmental standards over a larger revenue base.[4] Table 3-1 lists regulatory actions relevant to both hazardous and non-hazardous landfills, as the next section of this chapter will discuss scale economy phenomena among hazardous waste landfills similar to scale economies among Subtitle D landfills.

Table 3-1. Major Regulatory Events Affecting Landfills

1980 Section 3001 of RCRA	Categorized and regulated hazardous wastes
1984 Hazardous and Solid Waste Amendment to RCRA	Prohibited placing untreated hazardous waste on or in the land; banned corrosive, metal and cyanide wastes and bulk liquids; promulgated heavy metal and organic toxins treatment standards; for new or expanded hazardous waste landfills, required double liners and leachate collection systems.
1988-90 Land Disposal Restrictions	Standards set for concentrations of hazardous wastes permitted in landfills.
1993 Federal Regulations for Municipal Landfills	Established minimum technology standards for landfills; set groundwater monitoring and corrective action requirements; required control of landfill leachate for 30 years after closure.

Source: Environmental Protection Agency

In addition to capital compliance costs related to pollution abatement and monitoring, fixed costs include efforts needed to address increasingly combative communities around new landfills, which compound the high cost of scarce land for new landfill sites.

Landfills also experience economies of scale for several non-regulatory reasons. First, the landfills entail certain fixed capital costs for facility construction and fixed overhead costs, including administrative worker salaries and a portion of utilities that do not vary with the level of output. One study by the National Bureau of Economic Research showed that the average unit cost of a typical municipal landfill declines by about 70 percent as its capacity increases from 227 to 2,700 metric tons per day.[5] In addition, the use of transfer stations to consolidate waste for transport to medium to large-sized regional facilities is generally less expensive than transporting the same aggregate amount of waste in smaller parcels. Handling costs can decrease as the rate of wastes handled increases by taking advantage of specialized machinery or labor.

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[4] Repa, E.W. and A. Blakey. *Municipal Solid Waste Disposal Trends, 1996 Update,* Environmental Industry Associations, 1997.

[5] Beede, D.N. and D.E. Bloom. *Economics of the Generation and Management of Municipal Solid Waste,* National Bureau of Economic Research, 1995, pg. 21.

As a result, the industry shifted away from small, local facilities toward the practice of transporting waste from local transfer stations to larger, more distant regional landfills.

In recent years, waste treaters have integrated both horizontally and vertically. That is, small landfills have combined into larger landfills, but the industry has also combined different types and stages of waste treatment activities into single facilities or firms. This vertical integration positions waste treaters to accommodate the current trend among communities to adopt an integrated waste management approach. In integrated waste management, landfills are the least preferred method of waste management. A community would preferentially seek to manage wastes through waste reduction, recycling, and composting. Firms engaged in landfills have vertically integrated to offer waste management services at a number of stages in the handling of solid wastes, such as recycling, transfer and collection.

Origins of Overcapacity

Overcapacity in the industry dates from the 1980s, when a rapid rate of landfill closures generated predictions of capacity shortages. States responded with legislation to divert waste from landfills and to increase recycling. In addition, a cyclical downturn in the general economy during the late 1980's reduced the rate of waste generation from commercial and industrial sources. These events markedly reduced solid waste volumes. Meanwhile, landfill capacity did not decline as quickly as predicted, because most closures were small sites. Thus, the number of closing facilities proved misleading.

Overcapacity arose from inaccurate forecasts of decreasing capacity. In the late 1980s, articles warned about an impending garbage and landfill "crisis."[6] The industry responded by building larger regional landfills. States responded by enacting disposal capacity requirements as part of broader waste management laws. These requirements usually specified that counties and solid waste management boards had to guarantee a set number of years of disposal capacity. To meet these goals, a number of states passed laws requiring that certain percentages of waste be diverted from landfills (often by recycling or incineration).

Consequently, disposal capacity increased between 1991 and 1995, rather than decreasing as predicted. In 1995, the majority of states (38) had more than ten years of disposal capacity, compared to 1991, when the majority of states (29) had less than ten years of disposal capacity.

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[6] Rasmussen, S. *Case Study: 1991 Municipal Solid Waste Landfill Criteria Regulatory Impact Analysis*, prepared for Resources for the Future, 1996, pg. 5.

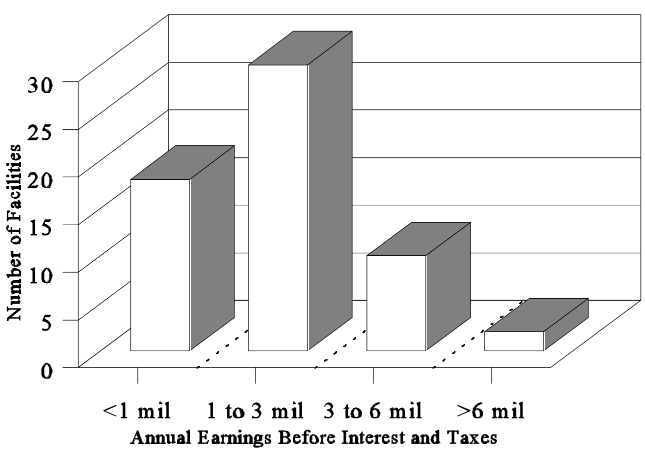
Despite the trend toward consolidation and integration, a sizeable number of small landfills remain. In particular, municipally-owned facilities tend to be smaller than privately-owned facilities, and these non-profit entities have not participated in industrial consolidation to the extent of private landfills. As of 1996, roughly 78 percent of landfills are reported to be owned by the government, yet they account for less than half the nation's MSW disposal capacity by volume.[7]

Privately-owned and municipally-owned facilities also differ in the types of waste landfilled. Residential wastes constitute a higher proportion of wastes handled by municipally-owned landfills than private landfills. On the other hand, privately-owned landfills often handle industrial waste, construction and debris, brush, and sewage, in addition to residential and commercial MSW. About 90 percent of commercial waste is handled by privately-owned companies.

Financial Performance

Financial indicators in this profile are based on survey data, and results are sample weighted to represent national estimates. Return on assets and earnings data are provided for privately-owned facilities only, since municipally-owned landfills typically do not operate to generate profits. Values are expressed in 1992 dollars, and where respondents provided two years of data, as requested by the survey, values presented here represent constant dollar averages.

Figure 3-1. Distribution of Privately-Owned Landfills By Earnings Size



Most privately-owned landfills earn between $1 million and $3 million annually in earnings before interest and taxes (Figure 3-1). Facilities in this earnings range account for half the facilities in the survey sample, on a weighted basis.

Profitability, as measured by pre-tax return on assets, is relatively high with a large percentage of the facilities earning returns greater than 15 percent. On a weighted basis, 39 facilities (65

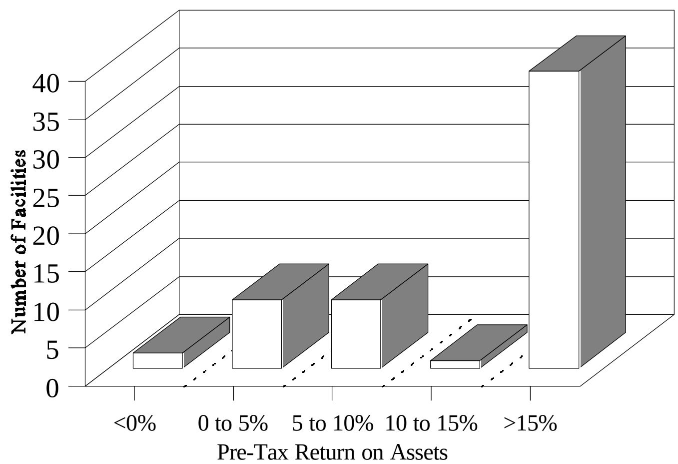
[7] McCarthy, J.E. *Congressional Research Service Report for Congress: Solid Waste Issues*, Environmental and Natural Resources Policy Division, 1995, pg. 5.

percent) fall into that highest range. Only two facilities (3 percent) earned negative returns on a pre-tax basis. Figure 3-2 presents these results.

Municipally-owned receive the bulk of their revenues from either taxes or fees. Few facilities receive substantial funding from both sources.

Future Trends

Figure 3-2. Distribution of Privately-Owned Landfills By Return on Assets



Because of the increased disposal capacity (see Figure 3-3), the number of MSW landfills in the U.S. is expected to remain constant in the near future. Additional disposal capacity will probably be added on a regional basis only as existing capacity is depleted. A number of small landfills located in arid or remote locations may close after the special extensions to Subtitle D expire for these facilities on October 9, 1997. The shutdowns, however, are not projected to be as extensive as the ones in the past. In addition, disposal capacity is not expected to change significantly in the near future.

While the total amount of MSW generated annually continues to rise, the rate of this growth is slowing. Per capita MSW generation is expected to remain constant at 4.4 pounds per person per day through the year 2000. The main reason for this trend is the effect of state and local efforts to keep yard waste out of the waste management system. In spite of the steady per capita MSW generation rate, however, the amount of MSW generated is expected to increase to 223 million tons by the year 2000 and 262 million tons by the year 2010 due to natural population growth and sustained long-term economic growth.[8]

Issues that may have a significant impact on the MSW landfills industry in the future include federal rulings regarding interstate shipment of waste and flow control. Interstate shipment of waste has become more common in recent years due to local shortages of disposal capacity, particularly in the Northeast and on the West

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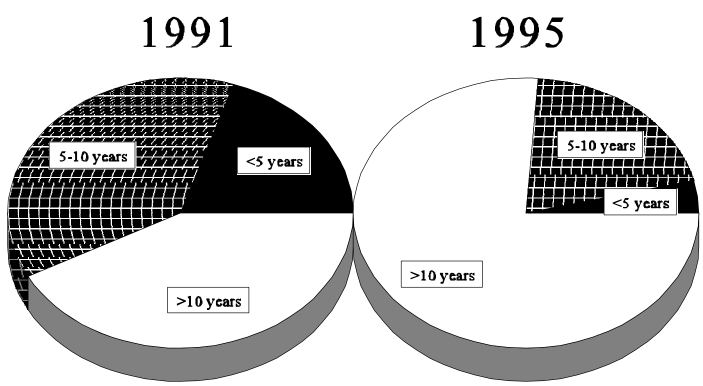
[8] U.S. Environmental Protection Agency, *Characterization of Municipal Solid Waste in the United States: 1995 Update*, 1995, pg. 1-3.

Coast, the national trend towards larger regional disposal facilities, and differences in landfill standards. To avoid becoming the dumping ground for waste from nearby states, several states have passed restrictions on waste transported into their states. Resolutions of associated court cases will likely have a significant impact on the structure of the MSW landfills industry.

Figure 3-3. Remaining Disposal Capacity
Distribution for U.S. States (1991-1995)



Source: Municipal Solid Waste Disposal Trends, 1996 Update, Environmental Industry Assoc.

Chapter 4

Facility Impact Analysis

4.0 Introduction

The facility-level economic impact analysis assesses how the landfills rule would affect individual landfills, which are the smallest unit of analysis in the Economic Analysis (EA). Other economic impact analyses build from the facility impacts estimated in this chapter. Facilities differ from firms in that facilities are geographically contiguous entities, while a firm might own more than one facility, at various locations. The next chapter assesses firm-level impacts, but this chapter provides the basis for estimating the extent of facility closures and associated production and employment losses that may result from the proposed rule.

Based on the facility impact analysis, EPA finds that the proposed landfills rule is economically achievable and will not subject affected facilities to unmanageable or unreasonable financial or economic burdens.

This analysis draws largely from facility economic and financial data obtained from responses to the Waste Treatment Industry Questionnaire Phase II: Landfills (hereafter referred to as the survey) administered in 1994 to a sample of landfills that EPA expects would have to comply with the landfills rule. Additionally, engineers used technical survey and other data to estimate compliance costs for each facility under each regulatory option. In this chapter, EPA uses economic and financial responses from the survey to evaluate the impact of compliance costs on the financial condition of Subtitle D direct dischargers proposed for inclusion in the rule.[9]

The facility impact analysis and related impact analyses that follow exclude hazardous waste landfills, though the proposed effluent guidelines also apply to this subcategory. Indirect discharging hazardous waste landfills will incur no incremental costs and experience no impacts due to the landfills rule. As for direct dischargers, no survey respondents identified themselves as direct discharging hazardous waste landfills, and so EPA had no data to perform an economic analysis for this subcategory and has no information that such facilities exist. While EPA does propose that the regulation include a provision for hazardous waste, direct discharging,

[9] See Chapter 1 for a discussion of the landfill subcategories and regulatory option selection.

commercial landfills, EPA's best estimate is that there are currently no facilities in this subcategory and therefore no regulatory impacts.

The Economic Analysis also excludes captive/intra-firm landfills, which receive wastes only from the firm that owns the landfill, and non-hazardous indirect discharging landfills. The proposed landfills rule does not apply to these facilities.

The major sections of this chapter explain the methodology behind each component of the facility impact analysis and present the results. EPA applied four kinds of financial tests:

- **After-Tax Cash Flow Test** This test examines whether a facility loses money on a cash basis. If a facility's cash flow is negative when averaged over the period of analysis, then the facility's management and ownership are determined to experience severe economic impacts.

- **Compliance Cost Share of Revenue** This test examines whether a facility's estimated compliance costs amount to 5 percent or more of revenue, in which case the facility would be determined to experience moderate economic impacts.

- **Compliance Cost Share of Household Income** This test examines whether a municipally-owned facility's estimated compliance costs equal or exceed 1 percent of the median household income in the jurisdiction governed by the municipality that owns the facility. If so, the facility is deemed to experience severe economic impacts.

- **Total Landfill Disposal Cost Share of Household Income** This test examines whether a municipally-owned facility's total landfill disposal costs — including compliance costs — equal or exceed 1 percent of the median household income in the jurisdiction governed by the municipality that owns the facility (where publicly-owned). If so, the facility is deemed to experience moderate economic impacts.

The appropriate tests for each facility depend on the type of facility in question. The facility impact analysis distinguishes between two types of non-hazardous landfills, depending on ownership: privately-owned and municipally-owned landfills.[10] Either type may accept municipal or non-municipal waste or both, and municipally-owned facilities may be operated by private businesses. However, the landfills evaluated in this facility impact analysis do not generate any hazardous leachate. Facilities that commingle hazardous with non-hazardous leachate are classified as hazardous for the purpose of the rule.

Table 4-1 indicates which facility impact tests EPA applied to each group of facilities. The compliance cost share of revenue test and after-tax cash flow test were performed for all privately-owned landfills. They do not apply to municipality-owned landfills, which are operated on a non-profit basis. Instead, EPA applied the compliance cost share of household income and total landfill disposal cost share of household income test to all municipally-owned landfills.

Table 4-1. Facility Impact Tests Applied to Each Subcategory of Landfills

Landfills Subcategory	Estimated National Population*	After-Tax Cash Flow	Compliance Cost Share of Revenue	Compliance Cost Share of Household Income	Total Landfill Cost Share of Household Income
Subtitle D Non-Hazardous Waste Landfills					
Privately-Owned Direct Dischargers	60	✔	✔		
Municipality-Owned Direct Dischargers	98			✔	✔
Indirect Dischargers	762	Not regulated by the proposed rule.			
Hazardous Waste Landfills					
Direct Dischargers	0	No section 308 survey responses.			
Indirect Dischargers	6	No incremental costs.			

* Before exclusion of baseline closures

Since all of these tests evaluate compliance costs, the next section describes how annualized compliance costs were calculated. The following sections detail the methodology underlying each test. The chapter concludes with a presentation of the results.

4.1 Compliance Costs

Upon promulgation of effluent guidelines, each in-scope facility can either meet the guidelines by applying pollution prevention and control technology, or it can substitute alternative waste management

[10] Each of these subcategories can be further subdivided according to the type of non-hazardous waste accepted: municipal or non-municipal. The analysis was conducted with this further level of detail, but yielded no gain in information. Therefore, results are aggregated to the level of subcategorization relevant to the proposed rule.

technologies not regulated by the guidelines. While an actual facility would be expected to choose the least costly option, the facility impact analysis described here uses the conservative assumption that each facility complying with the regulation does so by making the capital expenditures and incurring operating costs to meet the guidelines within the scope of the regulation. To the extent that facilities substitute alternative treatment and disposal methods not included in the landfills rule, actual costs to industry will be less than compliance costs evaluated in the facility impact analysis.

Engineering analysis yielded estimates of how much each facility would need to spend to comply with each regulatory option. The estimated expenditures comprised an *operating and maintenance costs* component, which recurs annually, and a one-time *capital cost of compliance* component. In order to perform the economic impact tests, EPA combined the two cost components into a single *annualized* cost. When the annualized cost is properly calculated, the facility should be indifferent between a) incurring the annualized cost every year, and b) incurring a capital cost plus operating and maintenance cost the first year and then only operating and maintenance costs each subsequent year.

The facility impact analysis proceeds on an after-tax basis because after-tax cash flow is the portion of cash flow that the facility can use to meet regulatory compliance costs. It is also a commonly used indicator of the ongoing viability of business enterprises. In this analysis, EPA calculated after-tax annualized costs (ATC_{Ann}) as follows:

$$ATC_{Ann} = ATC_{OM} + ATC_{C,Ann}$$

where

ATC_{Ann}	=	After-tax, annualized cost of compliance
ATC_{OM}	=	After-tax operating and maintenance cost of compliance
$ATC_{C,Ann}$	=	After-tax, annualized capital cost of compliance

The only adjustment needed to calculate ATC_{OM} from technical estimates of operating and maintenance costs is to subtract the offsetting benefit the facility would experience from reduced taxes. EPA used a marginal corporate tax rate of 34 percent, which implied that for every dollar of operating and maintenance compliance costs, before taxes, the facility would lose 66 cents in after-tax profit.[11] Therefore,

$$ATC_{OM} = (1 - \tau) \times C_{OM}$$

where

ATC_{OM}	=	After-tax operating and maintenance cost of compliance
C_{OM}	=	Operating and maintenance cost of compliance (pre-tax)
τ	=	Marginal corporate tax rate (34% in this analysis)

The engineering estimates of capital costs of compliance need to be annualized as well as adjusted for taxes. EPA annualized capital costs by amortizing them over 15 years, using a discount rate of 7 percent. The 15 year time period conforms with EPA practice and reflects a technical estimate of the useful life of the relevant kinds of capital. The 7 percent discount rate is consistent with OMB's measure of the social opportunity cost of capital (see Executive Order #12866) and represents a conservative estimate of the real, after-tax cost of capital for a typical facility using both equity and debt financing.[12] EPA showed, in developing the landfills rule impact methodology, that annualized compliance costs are only modestly sensitive to large variations in the discount rate.

To calculate offsetting tax benefits, EPA used straight-line depreciation over 15 years — the estimated useful lifetime of the relevant capital goods. Therefore, the facility applies 1/15th of the capital cost of compliance to each year's income calculations for tax purposes. Current tax codes allow businesses to use

[11] While the survey gathered data regarding total tax expenses and income, such data can only yield estimates of average tax rates. Industry respondents generally are not able to estimate the marginal tax rates required by the impact analysis without considerable burden and inaccuracy. Therefore, EPA uses the highest corporate tax rate as the best estimate of the marginal tax rate facing most facilities.

[12] EPA performed a sensitivity test in the Metal Products and Machinery Phase 1 proposed effluent guidelines economic analysis to show that annualized costs are quite insensitive to discount rates over a reasonable range. In a review of prior economic impact analyses, the Office of Water similarly found that the use of OMB's 7% rate is probably preferable to collecting facility-specific measures of costs of capital because of the burdensome data requirements and the practically insignificant analytical benefits associated with alternatives. (See "Review of Data Gathering and Methodology Issues for Effluent Guideline Economic Impact Analyses (Draft)," August 1996.)

straight-line depreciation or a Modified Accelerated Cost Recovery (MACRS) depreciation schedule.[13] EPA chose the straight-line method for this analysis because it is the simpler and more conservative method.

The annualized, after-tax capital cost of compliance is calculated as follows:

$$ATC_{C,Ann} = \frac{r}{1-(1+r)^{-t}} \times C_C - \frac{C_C}{t} \times \tau$$

where

$ATC_{C,Ann}$	=	After-tax, annualized capital cost of compliance
C_C	=	Capital cost of compliance
r	=	Discount rate (7% in this analysis)
t	=	Amortization period (15 years)
τ	=	Corporate tax rate (34%)

In the above formula, the first expression on the right-hand side is the annualized equivalent of the lump sum capital cost, C_C. The second expression is the offsetting benefit in the form of reduced taxes. Each year, the taxable income is reduced by 1/15 the total capital cost of compliance. The tax associated with that depreciation is τ times the depreciation.

Finally, substituting numeric values into the above formulas, the calculation of annualized, after-tax compliance costs becomes:

$$ATC_{Ann} = 0.66 \times C_{OM} + (0.1098 \times C_C - \frac{C_C}{15} \times 0.34)$$

ATC_{Ann}	=	After-tax, annualized cost of compliance
C_C	=	Capital cost of compliance
C_{OM}	=	Operating and maintenance cost of compliance

[13] The "15-Year" class of depreciable property includes "municipal wastewater treatment plants" and other property with a class life of 20 to 25 years. 1992 U.S. Master Tax Guide, Commerce Clearing House, Inc., 1991.

ATC_{Ann} is the compliance cost subtracted from baseline cash flow in the after-tax cash flow test, and it is also the value compared to total revenue in the compliance cost share of revenue test.

Offsetting Revenue Increases

Hypothetically, some facilities might offset a portion of compliance costs by passing them through to customers in the form of higher prices, but landfills have little capacity to do so in their markets. EPA used the conservative assumption in this analysis of zero cost pass-through. Since EPA finds that industry would not bear unmanageable impacts in the zero cost pass-through case, it follows that it would not bear unmanageable impacts under any other cost pass-through assumption.

Some facilities might also ameliorate impacts by substituting alternative waste treatment and handling techniques or changing the mix of services they offer. The current facility impact analysis excludes these dynamic, long-run responses that can mitigate the financial impact of effluent guidelines.

4.2 Methodology Underlying the After-Tax Cash Flow Test

Cash flow measures a business's ability to make a profit on a day-to-day basis. Negative cash flow indicates that the business does not bring in enough cash to meet its cash expenses and costs. While a facility with positive cash flow might or might not be viable in the long run, negative cash flow definitely presents a problem to businesses and is often the first "trigger" for radical changes in business operations, such as closure, and for more sophisticated financial evaluations, such as net present value analysis, which are typically not conducted on a regular basis.

Because taxes compete for cash with other cash expenses, the relevant measure of cash flow to evaluate regulatory impacts is the after-tax cash flow. This is a value that business managers report and monitor on an ongoing basis, which contributes to its appropriateness for assessing facility impacts.

The after-tax cash flow test is conducted both in the baseline case and post-compliance case, and it is applied to privately-owned landfills only, because publicly-owned facilities generally operate on a non-profit basis. If a facility's baseline cash flow is not negative, but, after incurring estimated compliance costs, the facility's cash flow becomes negative, then EPA would determine that facility to experience severe economic impacts *as a result of the proposed rule*. If, on the other hand, a facility exhibits negative cash flow before the adoption of a landfills rule, then the negative cash flow must be attributed to some prior cause.

EPA conducted the after-tax cash flow test using facility-wide income statement values, which provide the optimal basis for measuring the financial health of an affected business entity. EPA chose not to repeat the analysis using costs and revenues associated with waste treatment operations alone because waste treatment revenue differed from total facility revenue in only four instances, and then by no more than 5 percent in each case.

The after-tax cash flow test involves calculating, for each sample facility, the average after-tax cash flow (ATCF) over the years for which income statement data were obtained in the survey. The calculations are as follows:

1. Express all income statement values for a sample facility as a two-year average, in 1992 constant dollars, based on the Producer Price Index for finished goods (PPI). The PPI is the appropriate deflator because the alternative use for equity invested in waste treatment facilities is most likely investment in other forms of industrial production. The survey requested financial data for 1991 and 1992, and most facilities reported values for both of these years. However, a few facilities were not in operation in one or more of these years, or accounting procedures changed during the period in a way that precluded responding for one of the years. For these facilities, the average is the properly deflated value for the year for which the respondent reported data.

2. Compute facility-level after-tax cash flow in 1992 dollars for each year of data. *After-Tax Cash Flow* (ATCF) was computed as follows:

$$ATCF = (1-\tau)(R-C+D)$$

where

ATCF	=	After-tax cash flow
R	=	Total revenue in 1992 dollars (1991-1992 average)
C	=	Total costs and expenses (1991-1992 average)

D	=	Depreciation expense (1991-1992 average)
τ	=	Corporate tax rate, assumed to be 34 percent

3. Calculate post-compliance cash flows. The above calculations yielded baseline after-tax cash flows, based on survey responses. EPA estimated post-compliance cash flows by subtracting after-tax, annualized compliance costs from baseline cash flows. Thus,

$$ATCF_{PC} = ATCF - ATC_{Ann}$$

where

ATCF	=	Baseline after-tax cash flow
$ATCF_{PC}$	=	Post-compliance after-tax cash flow
ATC_{Ann}	=	After-tax, annualized cost of compliance

Facilities with non-negative baseline cash flow ($ATCF \geq 0$) but negative post-compliance cash flow ($ATCF_{PC} < 0$) are classified as incurring significant adverse impacts due to regulation. Facilities with negative cash flows in the baseline case would continue to have negative cash flow with or without the addition of regulatory compliance costs and are not candidates for facilities incurring significant adverse impacts due to the landfills rule, under the after-tax cash flow test.

4.3 Methodology Underlying the Compliance Cost Share of Revenue Test

In previous rulemaking efforts, policy makers have found the relationship between compliance costs and the revenue size of regulated entities useful in assessing the likely impacts of compliance costs. The cash flow analysis does not fully address this issue because cash flow depends on both costs and revenue. A very large facility — in terms of revenue — could have very small cash flow if its costs are relatively high. Therefore, the results of the cash flow test vary according to profitability, not the according to the size of compliance costs and facility revenue.

In the compliance cost share of revenue test, each facility's annualized compliance cost is expressed as a ratio to facility revenue. Ratios equal to or in excess of 5 percent are considered moderate impacts. Since the survey gathered revenue data both for the facility as a whole and for waste treatment operations alone, EPA simply averaged facility revenues in 1992 dollars over the period of the survey and then divided the average revenue for each facility by its annualized compliance cost.

$$CCSR = \frac{ATC_{Ann}}{R}$$

where

CCSR	=	Compliance cost share of revenue
R	=	Total facility revenue in 1992 dollars (1991-1992 average)
ATC_{Ann}	=	After-tax, annualized cost of compliance

An alternative methodology substituting waste treatment revenues for total facility revenues from all activities yielded only small changes in compliance cost shares and no difference in the number of significant impacts.

4.4 Methodology Underlying the Compliance Cost Share of Household Income Test

Municipally-owned landfills were subjected to two impact tests based on median household income. The first test calculates the ratio of compliance costs to median household income. When this ratio equals or exceeds 1 percent, the facility is deemed to incur severe impacts. The next section will describe the second test, which calculates the ratio of total landfill disposal costs — that is, baseline costs plus incremental compliance costs — to median household income. In this case, ratios exceeding 1 percent indicate moderate impacts.

Median household income is an appropriate measure of scale against which to compare compliance costs because the costs incurred by municipally-owned landfills, which operate on a not-for-profit basis, fall primarily upon the landfills' household customers through a variety of mechanisms, such as increased landfill fees and taxes, decreased municipal landfill services or decreased wages earned by landfill employees.[14] Households

[14] Some landfills that are owned by governments are operated by for-profit businesses. It is possible that contractual obligations might compel profit-seeking businesses to bear the compliance costs in the short run. However, in the long run, the business would be expected to increase prices to, at least partially, compensate for the cost increase. This analysis evaluates a worst-case situation in which all compliance costs are borne by the landfill users via price increases.

account for the large majority of municipal landfill customers. Table 4-2 shows that household waste accounted for 79.8 percent of wastes (by tonnage) sent to municipally-owned landfills.

Therefore, this facility impact analysis uses the ratio of compliance costs to median household income to estimate the impact on both the household and industrial components of each municipality that owns a landfill. The analysis does not assume that only households incur costs; it only assumes that the shares of compliance costs borne by households and commercial customers vary little between municipalities. This is the appropriate assumption because there is no precisely quantifiable way to predict the variation between municipalities in the share of compliance costs likely to fall on households.[15] Given that there is no predictable variation in the ratio of household to commercial shares of compliance costs, the ratio of compliance costs to household income provides exactly the same information as the ratio of compliance costs to commercial revenue or combined household and commercial income. EPA selected household income because this is the parameter for which the most accurate data are available.

Table 4-2. Source of Wastes Received by Municipally-Owned Landfills

Source of Waste	**Percent of All Wastes** *1991/1992 average*
Households	79.8
Commercial Sources	13.6
Other (non-differentiated)	6.7

National estimates based on the landfills survey question 5.9

EPA has previously employed the compliance cost share of household income test in assessing, for example, the impacts of the Solid Waste Disposal Facility Criteria Final Rule-40 CFR 257 and 258. In that analysis significant impacts were indicated where per-household total annualized costs equaled or exceeded one percent of median household income. Comparison of annualized household compliance costs to median household income is also recommended as one of the analytic tests for government entities in EPA's guidance on implementing the requirements of the Regulatory Flexibility Act.[16]

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[15] For example, using the ratio of household to commercial population or waste shares fails because the distribution of compliance costs depends primarily on supply and demand elasticities in commercial input and output, household labor and household consumption markets — not on the size of households compared to industry. Allocating compliance costs according to fees and taxes currently paid by households and commercial taxpayers also fails, because the actual incidence of tax burdens is not related to the distribution of cash tax assessments and payments.

[16] In this guidance, EPA suggests two tiers of significant impacts: 1% of income and 3% of income.

The impact test required two data inputs, in addition to compliance costs as calculated previously:

1. Determine the population of households. The number of households is obtained from the landfills survey (Section A, question A.20), which asks for the number of households served by each respondent. This is the population over which fee increases would be distributed. This method may lose some accuracy to the extent that households that pay compliance costs but do not receive landfill service have more or less income than households that receive landfill service but do not pay compliance costs.[17] The best available information suggests that, among municipally-owned landfills, the population of households served is substantially similar to the population likely to contribute toward meeting compliance costs.

2. Determine the median household income. Median household incomes were obtained from the *County and City Data Book* (U.S. Bureau of the Census) for the jurisdictions served by the landfill as reported in the landfills survey (question 5.13). Facilities listed as many as fourteen jurisdictions. The median income associated with each landfill is the population-weighted average of the median incomes of the jurisdictions served.[18]

The ratio of compliance costs to household income can then be calculated as follows:

$$CCSI = \frac{ATC_{Ann}}{H \times I}$$

where

CCSI	=	Compliance cost share of household income
ATC_{Ann}	=	After-tax, annualized cost of compliance
I	=	Median household income among jurisdictions served
H	=	Number of households served

[17] However, even substantial differences in the tails of income distributions between served households and households incurring costs might not affect the median significantly.

[18] Responses to the landfills survey did not indicate whether the landfills accepted waste from the entire area of the jurisdictions listed or only segments of the jurisdictions. The analysis assumes that the landfill serves the entire jurisdiction for all jurisdictions listed.

4.5 Methodology Underlying the Landfill Disposal Cost Share of Household Income Test

For municipally-owned facilities, EPA also evaluated whether the incremental compliance costs *in combination with current disposal costs* equal or exceed 1 percent of household income. Communities with very high landfill expenses in the baseline may experience stress from even small compliance costs. When the total post-compliance disposal costs equal or exceed the threshold, EPA finds moderate impacts.

Waste disposal costs per household prior to promulgation of the rule are calculated as each facility's price per ton for disposing of household waste — obtained from the landfills survey (question 4.28) — multiplied by the national average quantity of waste generated per household. The national average waste generation per capita, exclusive of recycling, is 0.62 tons per year.[19] The average number of persons per household is 2.64.[20] Therefore, average waste generation per household, exclusive of recycling, is 0.62 × 2.64 = 1.64 tons per year. Using this value, average post-compliance waste disposal costs per household are calculated as follows:

$$TCSI = \frac{\frac{ATC_{Ann}}{H} + (1.64 \times C_{Base})}{I}$$

where

TCSI	=	Total landfill disposal cost share of household income
ATC_{Ann}	=	After-tax, annualized cost of compliance
I	=	Median household income among jurisdictions served
H	=	Number of households served
C_{Base}	=	Baseline disposal cost per ton

4.6 Results

This section presents facility impact results for each subcategory expected to incur costs under the landfills rule. These subcategories include Subtitle D direct dischargers that accept wastes from firms other than

[19] *Characterization of Municipal Solid Waste in the United States*, 1994 update

[20] *Statistical Abstract of the United States*, 1994

their own. The proposed rule does not include Subtitle D indirect dischargers. As discussed above, indirect discharging hazardous waste landfills will not incur incremental costs due to the proposed landfills rule, and no indirect discharging hazardous waste landfills returned responses to the survey. Therefore, no impact analysis was conducted and no results will appear for these facilities.

In aggregate, the 151 landfills (excluding 7 projected baseline closures) expected to incur compliance costs under the landfills rule are associated with approximately $7.65 million in annualized, pre-tax compliance costs under the proposed Option II (see Table 4-3). Of the total, privately-owned facilities are estimated to bear $2.90 million, or 38 percent, with the remaining 62 percent of compliance costs incurred by municipally-owned landfills. Under Option I, facilities are estimated to incur $6.05 million in pre-tax compliance costs. After-tax compliance costs sum to $6.77 million under the proposed Option II and $5.27 million under Option II.

Table 4-3. Aggregate Compliance Costs
National Estimates in 1992 Constant Dollars

	Pre-Tax		**After-Tax**	
	Option I	**Option II**	**Option I**	**Option II**
Privately-Owned	$2,162,380	$2,903,800	$1,516,376	$2,024,091
Municipally-Owned	$3,753,888	$4,747,454	$3,753,888	$4,747,454
All Landfills	$5,916,268	$7,651,254	$5,270,264	$6,771,545

Table 4-4 shows that, with respect to privately-owned, Subtitle D direct dischargers, two landfills are expected to fail the after-tax cash flow test as a result of either regulatory option and thus incur severe impacts. This amounts to less than 4 percent of the 53 facilities in the subcategory. The two landfills accounted for $4.0 million in revenues out of $920.1 million earned nationally by in-scope, privately-owned landfills and employed 20 employees, out of 4,272 employees nationally.[21]

[21] Average 1991-1992 revenues, expresses in 1992 constant dollars. Employment is measured in full-time equivalent workers, rounded upward to whole numbers.

Table 4-4. Number of Subtitle D Direct Dischargers Estimated To Incur Significant Impacts
By Regulatory Option, Type of Impact Test and Type of Facility Ownership

Privately-Owned Landfills				
Estimated National Population*	Number of Facilities Incurring Significant Impacts:			
	After-Tax Cash Flow		**Compliance Cost Share of Revenue**	
	Option I	**Option II**	**Option I**	**Option II**
53	2	2	0	0
Municipally-Owned Landfills				
Estimated National Population	Number of Facilities Incurring Significant Impacts:			
	Compliance Cost Share of Household Income		**Total Landfill Cost Share of Household Income**	
	Option I	**Option II**	**Option I**	**Option II**
98	0	0	0	0

* after exclusion of baseline closures

The compliance cost share of revenue test yielded no facilities estimated to experience moderate impacts. The maximum compliance cost share of revenue identified was less than 4 percent under Option II and less than 3 percent under Option I.

No municipally-owned landfills are estimated to incur significant impacts under either option. In every case, incremental costs per household of complying with an effluent guideline, as well total post-compliance landfill disposal costs per household, amount to less than 1 percent of median household incomes.

Chapter 5

Firm-Level Impacts Analysis

5.1 Introduction

While Chapter 4 assessed the facility-level impacts of a landfill effluent guideline, this chapter estimates the impacts on firms. Firm-level impacts may exceed those assessed at the facility level, particularly when a firm owns more than one facility that will be subject to regulation.

Firms differ from facilities in that firms are business entities or companies, which may operate at several physical locations. Facilities are individual establishments defined by their physical location, whether or not they constitute an independent business entity on their own. Some facilities in the survey sample are single-facility firms. In these cases, the firm-level impact depends only on the facility-level impact. In other cases, sampled facilities are owned by multi-facility firms, so that the impact on the parent firm depends not only on that facility, but also on the impacts on and characteristics of other facilities owned by the same firm.

In this analysis, significant adverse impacts on firms are indicated when firm-level compliance costs exceed 5 percent of firm revenues. Using this criterion, EPA finds no significant adverse impacts on affected firms and therefore determines that the proposed effluent guideline will not be accompanied by unreasonable economic burdens on firms that own in-scope landfills.

5.2 Methodology

EPA assessed firm-level impacts by estimating the ratio of firm-level compliance costs to revenues earned by the firm. A threshold of 5 percent was used to indicate significant adverse impacts.

Firm revenues were obtained from the landfills survey and Dun & Bradstreet. However, firm-level compliance costs posed a greater challenge, because the survey could not always determine how many facilities a responding firm might own that would be in-scope but that did not receive a survey. For instance, if Firm A owns two responding facilities within the survey sample, each of which is estimated to incur $1,000 in compliance costs, as well as a number of other facilities not in the survey sample, then Firm A would incur at least $2,000 in compliance costs, but possibly much more, depending on how many other facilities Firm A owns that would also incur compliance costs. Collecting data for every facility owned by each surveyed firm is often prohibitively burdensome.

However, the survey did collect data regarding the number of other landfills owned by the firm that owned each respondent, and the survey also solicited the number of such landfills that were captive. Therefore, the maximum number of landfills in each parent firm that could *possibly* be subject to the landfills rule is the total number of landfills in the firm less the number of captive landfills. The firm-level analysis assumes the "worst-case" scenario that all these potentially regulated facilities are in fact regulated by the current rule.

The compliance costs assigned to regulated facilities for which no survey data were received are the average compliance costs among facilities that did respond to the survey within the same firm. For example, if a firm has ten facilities, two of which are captive, then the firm-level methodology assumes that all eight facilities that could be in-scope are in fact in-scope. If the survey included four of these facilities, and the estimated compliance costs for each facility based on engineering analysis are as follows:

Sampled Facility #1	$10,000
Sampled Facility #2	$20,000
Sampled Facility #3	$30,000
Sampled Facility #4	$40,000

then the compliance cost assigned to each of the facilities not in the survey is $50,000 — the average compliance cost among the four sampled facilities.

Algebraically, the firm-level compliance cost for each firm that owns at least one-in-scope facility in the sample is calculated as follows:

$$CC_{firm} = \frac{(N_{total} - N_{captive})}{N_{sample}} \times \sum_{i=1}^{N_{sample}} CC_i$$

where

CC_{firm} = Total annualized compliance cost for the firm

N_{total}	=	Total number of landfill facilities owned by the firm
$N_{captive}$	=	Number of captive landfill facilities owned by the firm
N_{sample}	=	Number of landfill facilities owned by the firm in the survey sample
CC_i	=	Total annualized compliance cost for sample facility *i* in the firm

In addition to the assumption that all non-captive landfill facilities owned by a firm are in-scope, EPA includes some other assumptions that tend to make the analysis more conservative.

- This chapter does not examine the ability of firms to transfer capital, labor and technology between facilities. This exclusion tends to overestimate impacts, since such transfers would reduce the economic impact of effluent guidelines.

- The firm-level analysis applies all of the financial impacts on facilities to their parent firms additively, without allowing for scale economies that might benefit a firm. For instance, if rule familiarization and compliance determination are conducted centrally, a firm might be able to avoid the costs of these activities at each site.

- Also, EPA conducted the firm-level impact analysis under the assumption that compliance costs could not be offset by higher product prices or lower input prices. In a fully dynamic analysis, some portion of the compliance costs may be passed on to customers and to upstream industries and labor markets that supply inputs to landfills.

While the methodology does not generate statistically representative sample of firms and their associated impacts, it does illustrate EPA's judgment that compliance costs are unlikely to constitute a significant share of firm-level revenues, even when firms own many regulated facilities.

5.3 Results

Nine firms own the fifteen sampled landfills that are open during the period of analysis and for which firm-level data were available. Among these firms, the maximum estimated compliance cost shares of firm-level revenue range from 0.00 percent to 1.56 percent under Option I and from 0.01 percent to 2.14 percent under the proposed Option II. In no case do firm-level compliance costs exceed 5 percent of revenues.

Table 5-1 summarizes the firm-level impacts. Of the nine firms, seven are estimated to experience no more than 0.1 percent impacts on revenues. The seven firms account for 99.92 percent of revenues in the firm impact analysis. One firm is estimated to incur between 0.1 percent and 1 percent impacts, accounting for 0.05 percent of firm revenues, and only one firm is estimated to incur compliance costs from 1 to 5 percent of revenues. That firm accounts for 0.03 percent of revenues in the firm impact analysis. The distribution of impacts is the same under either regulatory option.

Table 5-1. Firm-Level Impacts *(Options I and II yield identical results.)*

	<0 .1%	**0.1% to 1%**	**1% to 5%**	**> 5%**
Number of Firms	7	1	1	0
% of Industry Revenue	99.92%	0.05%	0.03%	0.00%

Chapter 6

Foreign Trade Impacts

The landfills category does not engage in substantive foreign trade. Therefore, EPA finds that — especially in light of the small estimated regulatory impacts on the industry — the proposed rule will have no significant impact on U.S. foreign trade.

Chapter 7

Community Impacts

7.1 Employment Impacts

The only facility closure identified in the facility impact analysis occurs in a facility with a sample weight of 1.96. This sample facility employs ten employees, including six involved in landfill operations.[22]

The Bureau of Economic Analysis (BEA) estimated employment multiplier for sanitary service industries is 4.9349 in the affected state.[23] Therefore, estimated direct and indirect employment losses are estimated to total 49 FTEs. Indirect employment losses occur when firms that buy from or sell to the closing facility incur economic impacts and when employees of the closing facility experience reduced income and contribute less to aggregate demand within the local economy. Maximum direct plus indirect FTE losses amount to less than 0.01 percent of the state's total 1992 employment of 1.78 million persons.[24]

Due to the negligible scale of FTE losses, EPA estimates that the proposed rule will not be associated with significant adverse community impacts. Furthermore, employment losses due to regulatory closures are typically offset to some extent by employment gains in the manufacture, sales, installation and operation of compliance equipment and facilities.

7.2 Executive Order No. 12898

EPA obtained 1990 county-specific census data regarding populations of various demographic and economic groups throughout the United States in order to determine whether minority or low-income populations

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[22] These ten employees represent 20 employees nationally at two facilities. Therefore, even assuming that both facilities represented by this sample facility are in the same state, the *maximum possible estimated* direct employment loss in that state is 20 full-time equivalent employees (FTEs).

[23] *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II) 2nd Edition*, (May 1992) Bureau of Economic Analysis , Washington, D.C.

[24] *Statistical Abstract of the United States, 1993*, U.S. Department of Commerce, Washington, D.C.

experience disproportionate adverse economic impacts as a result of the rule. However, the small number of employment losses precludes any determination of statistically significant disproportionalities in impacts.

For example, the standard deviation in county populations of white persons is 178,207, and the standard deviation in numbers of households with incomes above $15,000 per year is 3,906. In this context, a logit analysis of the significance of 49 FTE losses would not have sufficient precision to detect any disproportionate, much less significant, adverse impacts on relevant demographic groups.[25]

[25] Even assuming the unlikely case that all 97 FTE losses nationally occur in a single county would not change this conclusion.

Chapter 8

Impacts on New Sources

The proposed rule includes limitations that will apply to new discharging sources within the landfills category. EPA examined the impact of these regulations for new dischargers to determine if they would impose an undue economic and financial burden on new sources seeking to enter the industry.

In general, EPA estimates that, when new and existing sources face the same discharge limitations, new sources will be able to comply with those limitations at the same or lower costs than those incurred by existing sources. Engineering analysis indicates that the cost of installing pollution control systems during new construction is generally less than the cost of retrofitting existing facilities. Thus, a finding that discharge limitations are economically achievable by existing facilities also means that those same discharge limitations will be economically achievable to new facilities.

Chapter 9

Analysis of Small Entity Impacts

9.1 Introduction

This chapter examines the expected effects of the proposed landfills rule on small entities as required by the Regulatory Flexibility Act (RFA). The RFA calls for the Agency to prepare a Regulatory Flexibility Analysis for proposed regulations that are expected to have a significant impact on a substantial number of small entities. The purpose of the Act is to ensure that, while achieving statutory goals, government regulations do not impose disproportionate impacts on small entities.

The RFA also calls for the identification of record-keeping and reporting requirements, as well as any Federal rules that duplicate, overlap or conflict with the proposed rule. There are no incremental reporting and record-keeping requirements directly associated with the proposed landfills rule. In addition, no known Federal rules duplicate, overlap or conflict with the proposed rule.

As shown in this chapter, EPA finds that the proposed rule will not impose significant impacts on a substantial number of small entities. For privately-owned small businesses, EPA estimated economic impacts as the ratio of compliance costs to sales at the level of the parent firm. For municipally-owned entities, EPA estimated economic impacts as the smaller of the ratio of compliance costs to facility revenues or to government revenues. EPA estimates that no more than one small entity nationally would incur impacts greater than 1 percent of revenues as a result of complying with the proposed rule, and no small entities would exceed a 3 percent impact threshold.

Section 9.2 discusses the definitions and methodology underlying EPA's findings. Section 9.3 presents detailed results.

9.2 Methodology

The Agency followed Small Business Administration (SBA) and RFA guidelines in determining which landfills were small entities:

1. EPA identified those facilities included in the landfills survey that were subject to compliance costs and therefore subject to impacts of the regulation.

2. EPA determined the definition of a small entity appropriate for each facility, according to whether the facility was municipally-owned a privately-owned small business.

3. For each type of ownership, EPA identified and applied the test of impact significance described above.

Because the RFA requires EPA to determine whether or not a substantial number of entities incur significant impacts, the determination of need for regulatory flexibility under the RFA should reflect both the severity of impacts on individual entities and also the number of entities affected. A regulation can have significant impacts on a substantial population either by requiring a moderate number of small entities to incur very high facility impacts, or by requiring a larger number of small entities to incur a more moderate level of facility impacts.

In order to evaluate impact, each parent firm of an in-scope facility must be compared to the relevant definition of small entity to determine if it is a small entity or not. Then, the relevant compliance costs and the appropriate measure of revenue must be determined. Both the small entity definition and relevant revenue measure depend upon the type of ownership associated with the facility. Compliance costs are the total, annualized compliance costs derived in the facility impact analysis. They include engineering estimates of recurring compliance costs and a one-time capital cost.

Municipally-Owned Landfills

With respect to municipally-owned entities, the RFA defines small entities as government jurisdictions with populations of less than 50,000. EPA obtained populations of government jurisdictions from the Bureau of the Census *City and County Data Book*. The survey had also collected respondent estimates of the population of the area *served* by each landfill. In the past, EPA also has considered the service area population as a measure of entity size. However, EPA used jurisdictional population to define small governmental jurisdictions because the Bureau of the Census data were more reliable and consistent, and because jurisdictional population was deemed more appropriate. A separate analysis (not presented here) using service area population confirmed that neither the quantitative nor qualitative analytical findings vary according to which measure was used.

To calculate compliance cost shares of revenue, EPA considered two analytical methodologies. First, EPA compared compliance costs to government revenues. However, the Agency also considered, as an alternative, the option of comparing compliance costs to facility (i.e., landfill) revenues. Conceptually, the more fungible municipal revenue accounts are, the more relevant total government revenue should be to evaluating the impact of compliance costs on municipalities. To the extent that municipally-owned landfills are barred from accessing revenues from other activities, such as general property taxes and other general funds, compliance costs might be better evaluated in the context of landfill facility revenues alone. Given data limitations and the fact that most municipalities own one or few Subtitle D landfills, facility revenue would proxy for landfill revenues, in the latter option.

In practice, EPA conducted both analyses and used the smaller of the ratio of annualized compliance costs to facility revenues or to government revenues to determine impacts. By using the minimum ratio, the analysis examines the ratio of compliance costs to facility (landfill-targeted) revenues for those landfills intended to cover their operations with landfill-targeted revenues. At the same time, the methodology examines the ratio of compliance costs to general (non-targeted) revenues for those landfills funded by non-targeted funds, or by funds not reported in facility income statements.

Privately-Owned Landfills

The SBA defines privately-owned firms operating in SIC 4953 (refuse systems) with revenues less than $6 million annually as small entities.[26] By this definition, a facility would belong to a small entity if and only if its revenue combined with revenues from its parent firm and all affiliates total $6 million or less. EPA obtained relevant revenue data from the landfills survey and from Dun and Bradstreet's Marketing Services division.

The degree of impact on each small entity is measured by using some of the methodology described in the firm-level analysis (Chapter 5) to address the problem that the survey was not designed as a random sample of firms. For example, if a small entity includes a sampled facility with a sample weight of two, that could mean that the sampled facility represents two facilities in two separate firms or in one firm. In Chapter 5, the methodology assumed the "worst-case" scenario that both regulated facilities belonged to the same firm and that all other facilities in that firm would also be regulated, incurring costs similar to the sampled facilities.

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[26] Table of Size Standards, March 1, 1996. SBA advised using this standard for current dollar firm revenues over a time period including 1992 (personal communication, Bob Ray, Office of Size Standards, October 1996).

The regulatory flexibility analysis is performed first using the same assumption as in Chapter 5 — that all non-captive landfills owned by multi-site firms in the analysis are regulated. This maximizes the potential impact on each firm while minimizing the number of firms affected. Then the analysis is repeated using the assumption that the sampled facility is the only facility in the firm to incur costs. This second assumption maximize the *number* of firms that can incur impacts but, because the national estimates of compliance costs are distributed over a larger number of firms, the impact on any individual firm is minimized. Thus, the two iterations of the regulatory flexibility analysis describe a set of upper bounds on the intensity of impacts and numbers of entities experiencing impacts.

9.3 Results

The Agency evaluated the impacts of two regulatory options on 150 direct discharging Subtitle D facilities (national estimate) represented by 39 sample facilities that were open during the period of the analysis and for which small entity classification data were available. These 39 sample facilities were owned by 34 firms or government entities, of which 9 are small entities. On a national basis, therefore, EPA estimates that there are no fewer than 34 entities and no more than 145 entities (since two firms owned seven of the sample facilities).[27]

Table 9-1 shows the estimated lower and upper bounds on the number of firms or government entities owning in-scope facilities and the corresponding numbers of small entities. Notably, EPA estimates that there are no more than 39 small entities on a national basis--not a large number.

Table 9-1. Number of Firms or Government Entities Owning Subtitle D Landfills *(National Estimates)*

Subcategory	# of Facilities	# of Entities	# of Small Entities
Lower Bound	150	39	9
Upper Bound	150	145	39

Table 9-2 shows that no more than one small entity is expected to incur compliance costs above 1 percent of revenue under either Option I or Option II, while no small entities open during the period of analysis are expected to incur costs above 3 percent of revenue.

[27] If two firms own 7 of the sample facilities and none of the others, then there are 143 other facilities that could possibly belong to single-site entities. Thus, these 143 remaining facilities can account for no more than 143 entities. Including the two known multi-site firms, the number of in-scope firms or government entities cannot exceed 145.

Table 9-2. Magnitude and Frequency of Small Business Impacts *(Open Landfills)*

Subcategory	Number of Small Entities	Number of Entities With Compliance Costs > 1% of Revenue		Number of Entities With Compliance Costs > 3% of Revenue	
		BPT Option I	BPT Option II	BPT Option I	BPT Option II
Lower Bound	9	0	0	0	0
Upper Bound	39	0	1	0	0

Consequently, EPA finds that the proposed rule would not, if promulgated, have a significant economic impact on a substantial number of small entities.

Chapter 10

Summary Environmental Assessment

10.1 Introduction

This chapter quantifies the water quality-related benefits associated with achievement of the proposed BAT (Best Available Technology) and PSES (Pretreatment Standards for Existing Sources) controls for hazardous and non-hazardous landfills. Based on site-specific analyses of current conditions and changes in discharges associated with the proposal, the Agency estimated in-stream pollutant concentrations for 65 priority and nonconventional pollutants from direct and indirect discharges using stream dilution modeling. EPA assessed the potential impacts and benefits to aquatic life by comparing the modeled in-stream pollutant concentrations to published EPA aquatic life criteria guidance or to toxic effect levels. EPA projected potential adverse human health effects and benefits by: (1) comparing estimated in-stream concentrations to health-based water quality toxic effect levels or criteria; and (2) estimating the potential reduction of carcinogenic risk and noncarcinogenic hazard (systemic) from consuming contaminated fish or drinking water. Estimates of upper-bound individual cancer risks, population risks, and systemic hazards result from modeled in-stream pollutant concentrations and standard EPA assumptions. The assessment evaluates modeled pollutant concentrations in fish and drinking water to estimate cancer risk and systemic hazards among the general population, sport anglers and their families, and subsistence anglers and their families. Due to the hydrophobic nature of the two chlorinated dibenzo-p-dioxin (CDD) congeners and one chlorinated dibenzofuran (CDF) congener under evaluation, EPA projected human health benefits for only these pollutants by using the Office of Research and Development's Dioxin Reassessment Evaluation (DRE) model to estimate the potential reduction of carcinogenic risk and noncarcinogenic hazard from consuming contaminated fish. EPA used the findings from the analyses of reduced occurrence of in-stream pollutant concentrations in excess of both aquatic life and human health criteria or toxic effect levels to assess improvements in recreational fishing habitats that are impacted by hazardous and non-hazardous landfill wastewater discharges (ecological benefits). These improvements in aquatic habitats are expected to improve the quality and value of recreational fishing opportunities.

The chapter presents evaluations of the effect of the discharges on potential inhibition of operations at publicly owned treatment works (POTW) and on concentrations of pollutants in sewage sludge (thereby limiting its use for land application) based on current and proposed pretreatment levels. Estimations of the inhibition of

POTW operations are made by comparing modeled POTW influent concentrations to available inhibition levels and estimations of contamination of sewage sludge are made by comparing projected pollutant concentrations in sewage sludge to available EPA regulatory standards. The chapter also presents economic productivity benefits estimations based on the incremental quantity of sludge that, as a result of reduced pollutant discharges to POTWs, meet criteria for the generally less expensive disposal method, namely land application and surface disposal. In addition, the chapter presents the potential fate and toxicity of pollutants of concern associated with hazardous and non-hazardous landfill wastewater based on known characteristics of each chemical.

Performed analyses include discharges from a representative sample set of 43 direct non-hazardous landfills, 3 indirect hazardous landfills, and 85 indirect non-hazardous landfills. EPA extrapolated results for only direct non-hazardous landfills, to the national level (approximately 158 landfills), based on the statistical methodology used for estimated costs, loads, and economic impacts. In this chapter, EPA provides the results of these analyses, organized by the type of discharge (direct and indirect) and type of landfill (hazardous and non-hazardous).

10.2 Comparison of Instream Concentrations with Ambient Water Quality Criteria (AWQC)/Impacts at POTWs

10.2.1 Direct Discharges

Non-Hazardous Landfills (Sample Set)

The water quality modeling results for 43 direct non-hazardous landfills discharging 32 pollutants to 41 receiving streams indicate that at current discharge levels, in-stream concentrations of one pollutant will likely exceed acute aquatic life criteria or toxic effect levels in one of the 41 receiving streams. In-stream concentrations of three pollutants will likely exceed chronic aquatic life criteria or toxic effect levels in 12 percent (5 of the total 41) of the receiving streams. The proposed BAT regulatory option will eliminate acute aquatic life excursions. The regulatory option will also reduce the chronic aquatic life excursions to two pollutants in three receiving streams. Additionally, at current discharge levels, the modeling results project that in-stream concentrations of one pollutant (using a target risk of 10^{-6} (1E-6) for carcinogens) will exceed human health criteria or toxic effect levels (developed for consumption of water and organisms) in 5 percent (2 of the total 41) of the receiving streams. EPA projects no excursions of human health criteria or toxic effect levels (developed for organisms consumption only). The proposed BAT regulatory option will not reduce human health criteria or toxic effect levels (developed for consumption of water and organisms) excursions. The proposed BAT regulatory option reduces pollutant loadings by 52 percent.

Non-Hazardous Landfills (National Extrapolation)

Extrapolations of modeling results of the sample set include 158 non-hazardous landfills, discharging 32 pollutants to 154 receiving streams. From the extrapolated in-stream pollutant concentrations, one pollutant is projected to exceed human health criteria or toxic effect levels (developed for water and organisms consumption) in 3 percent (4 of the total 154) of the receiving streams at both current and proposed BAT discharge levels. The proposed rule will reduce excursions of chronic aquatic life criteria or toxic effect levels due to the discharge of three pollutants in four receiving streams. Proposed BAT discharge levels will reduce the number of excursions from 97 excursions in 38 receiving streams at current conditions to 44 excursions in 34 receiving streams.

10.2.2 Indirect Dischargers

Hazardous Landfills (Sample Set)

EPA expects compliance of all the hazardous landfills included in the sample set with the baseline treatment standards established for indirect dischargers. EPA did, however, evaluate the effects of hazardous landfill discharges to POTWs and their receiving streams.

Water quality modeling results for three indirect hazardous landfills that discharge 60 pollutants to three POTWs with outfalls on three receiving streams indicate that at current discharge levels, no in-stream pollutant concentrations will likely exceed aquatic life criteria (acute or chronic) or toxic effect levels. Additionally, at current and proposed pretreatment discharge levels, projections indicate that the in-stream concentration of one pollutant (using a target risk of 10^{-6} (1E-6) for carcinogens) will exceed human health criteria or toxic effect levels (developed for consumption of water and organisms) in one receiving stream with the magnitude of the excursion at only twofold or less. Projections show no excursions of human health criteria or toxic effect levels (developed for organisms consumption only). Pollutant loadings show a 42 percent reduction.

In addition, this chapter includes an evaluation of the potential impact of the three hazardous landfills, which discharge to three POTWs, on the inhibition of POTW operation and contamination of sludge. Projections show no inhibition or sludge contamination problems at the three POTWs receiving wastewater.

Non-Hazardous Landfills (Sample Set)

EPA evaluated the potential effects of POTW wastewater discharges on receiving stream water quality at only current discharge levels for a representative sample of 85 indirect discharging non-hazardous landfills. EPA is not proposing pretreatment standards for these indirect discharges from non-hazardous landfills based on preliminary data analyses, which show no documented persistent problems with POTW upsets or with inhibition or sludge contamination. Pollutant loadings for the 85 landfills at current discharge levels are 506,335 pounds-per-year.

Modeling results for the 85 indirect non-hazardous landfills that discharge 32 pollutants to 80 POTWs with outfalls on 80 receiving streams indicate that at current discharge levels no in-stream pollutant concentrations will likely exceed human health criteria or toxic effect levels (developed for water and organisms consumption/organisms consumption only). Projections indicate that in-stream concentrations of three pollutants will exceed chronic aquatic life criteria or toxic effect levels in two of the receiving streams, with a twofold or less magnitude of the excursions. Projections show no excursions of acute aquatic life criteria or toxic effect levels. Nor do projections show inhibition or sludge problems at the 80 POTWs receiving discharges from the 85 non-hazardous landfills.

10.3 Human Health Risks and Benefits

Projections for both direct and indirect landfill (hazardous and non-hazardous) wastewater discharges, show the excess annual cancer cases at current discharge levels and, therefore, at proposed BAT and proposed pretreatment discharge levels to be far less than 0.5 for all populations evaluated from the ingestion of contaminated fish and drinking water. This benefit, therefore, projects no monetary value to society. Projections indicate systemic toxicant effects from fish consumption for both direct and indirect non-hazardous landfill discharges. For direct discharges (sample set), projections indicate that systemic effects will result from the discharge of one pollutant to one receiving stream at both current and proposed BAT discharge levels. Estimates indicate an affected population of 328 subsistence anglers and their families. Results, extrapolated to the national level, project an estimated population of 643 subsistence anglers and their families affected from the discharge of one pollutant to two receiving streams. For indirect discharges, projections show systemic toxicant effects at only current discharge levels due to the discharge of one pollutant to one receiving stream. Projected estimates indicate a population of 52 subsistence anglers and their families to be affected. Evaluations do not include systemic toxicant effects at proposed pretreatment levels. Currently, the reduction of systemic toxic effects does not include estimation of monetary values.

10.4 Ecological Benefits

Projections show potential ecological benefits of the proposed rule, based on improvements in recreational fishing habitats, for only direct non-hazardous landfills wastewater discharges. Projections indicate that the proposed rule will not completely eliminate in-stream concentrations in excess of aquatic life and human health ambient water quality criteria (AWQC) in any stream receiving wastewater discharges from indirect hazardous landfills (evaluations include indirect non-hazardous landfills at only current discharge levels; therefore, the analysis excludes them). For direct non-hazardous landfill discharges, the proposed BAT regulatory option eliminates concentrations in excess of AWQC at one receiving stream. Estimation of the monetary value of improved recreational fishing opportunity involves first calculating the baseline value of the receiving stream using a value per person day of recreational fishing, and the number of person-days fished on the receiving stream. Calculations then show the value of improving water quality in this fishery, based on the increase in value to anglers of achieving contaminant-free fishing. The resulting estimate of the increase in value of recreational fishing to anglers on the improved receiving stream is $64,300 to $230,000 (1992 dollars). Based on extrapolated data to the national level, projections indicate that the proposed regulation completely eliminates in-stream concentrations in excess of AWQC at two receiving streams. The resulting estimate of the increase in value of recreational fishing to anglers ranges from $126,000 to $450,000.

The estimated benefit of improved recreational fishery opportunities is only a limited measure of the value to society of the improvements in aquatic habitats expected to result from the proposed rule. Additional benefits, which could not be quantified in this assessment, include increased assimilation capacity of the receiving stream, protection of terrestrial wildlife and birds that consume aquatic organisms, maintenance of an aesthetically pleasing environment, and improvements to other recreational activities such as swimming, water skiing, boating, and wildlife observation. Such activities contribute to the support of local and State economies.

10.5 Economic Productivity Benefits

EPA evaluated potential economic productivity benefits based on reduced sewage sludge contamination and sewage sludge disposal costs at POTWs receiving the discharges from indirect hazardous and non-hazardous landfills. Because projections do not show sludge contamination problems at the three POTWs receiving wastewater from three hazardous landfills, or at the 80 POTWs receiving wastewater from 85 non-hazardous landfills, projections do not include economic productivity benefits.

10.6 Pollutant Fate and Toxicity

EPA identified 68 pollutants of concern (priority, nonconventional, and conventional) in wastestreams from hazardous landfills. EPA evaluated 60 of these pollutants to assess their potential fate and toxicity based on known characteristics of each chemical.

Most of the 60 pollutants have at least one known toxic effect. Based on available physical-chemical properties and aquatic life and human health toxicity data for these pollutants, 13 exhibit moderate to high toxicity to aquatic life, 16 are classified by EPA as known or probable human carcinogens, and 43 are human systemic toxicants. In addition, 23 have EPA drinking water values (MCLs or action levels), and 20 are designated by EPA as priority pollutants. In terms of projected partitioning, 18 of the evaluated pollutants are moderately to highly volatile (potentially causing risk to exposed populations via inhalation). In the same terms, 12 have a moderate to high potential to bioaccumulate in aquatic biota (potentially accumulating in the food chain and causing increased risk to higher trophic level organisms and to exposed human populations via consumption of fish and shellfish). Also, three are moderately to highly adsorptive to solids. Twelve are resistant to biodegradation or slowly biodegraded.

EPA also identified 38 pollutants of concern (priority, nonconventional, and conventional) in wastestreams from non-hazardous landfills. Evaluations included 32 of these pollutants to assess their potential fate and toxicity, based on known characteristics of each chemical.

Most of the 32 pollutants have at least one known toxic effect. Based on available physical-chemical properties and aquatic life and human health toxicity data for these pollutants, 5 exhibit moderate to high toxicity to aquatic life, 24 are human systemic toxicants, and 8 are classified as known or probable carcinogens by EPA. Eight of the pollutants have EPA drinking water values (MCLs) and EPA designated seven as priority pollutants.

In terms of projected environmental partitioning among media, seven of the evaluated pollutants are moderately to highly volatile. Also, two have a moderate to high potential to bioaccumulate in aquatic biota, two are moderately to highly adsorptive to solids, and two are slowly biodegraded.

Evaluations did not include the impacts of the two conventional and five nonconventional pollutants (one additional pollutant, amenable cyanide, is evaluated as cyanide) when modeling the effect of the proposed regulation on receiving stream water quality and POTW operations or when evaluating the potential fate and toxicity of discharged pollutants. These pollutants are total suspended solids (TSS), 5-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total dissolved solids (TDS), total organic carbon (TOC), hexane extractable material, and total phenolic compounds. The discharge of these pollutants may adversely affect human health and the environment. For example, habitat degradation may result from increased suspended particulate matter that reduces light penetration, and thus primary productivity, or from accumulation of sludge particles that alter benthic spawning grounds and feeding habitats. High COD and BOD_5 levels may deplete oxygen concentrations, which can result in mortality or other adverse effects on fish. High TOC levels may interfere with water quality by causing taste and odor problems and mortality in fish.

10.7 Documented Environmental Impacts

The Environmental Assessment also includes summaries of documented environmental impacts on aquatic life, human health, POTW operations, and receiving stream water quality, based on a review of published literature abstracts, State 304(l) Short Lists, State Fishing Advisories, and contact with State environmental agencies. States identified two direct discharging landfills and ten POTWs receiving the discharges from twelve landfills as point sources that cause water quality problems and are included on their 304(l) Short List. State contacts indicate that of the two direct facilities, one is no longer a direct discharger and the other is currently in compliance with its permit limits and is no longer a source of impairment. All POTWs listed report no problems with landfill wastewater discharges. In addition, States issued fish consumption advisories for waterbodies which receive the discharge from four direct discharging landfills and thirteen POTWs receiving the discharge from landfills. However, the majority of advisories are based on chemicals that are not pollutants of concern for the landfills industry.

Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Landfills Point Source Category

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Table of Contents

Section 1

Introduction

This cost-effectiveness analysis supports the proposed effluent limitations guidelines and standards for the Landfills Industry. The report assesses the cost-reasonableness of two Best Practicable Technology (BPT) regulatory options for directly discharging Subtitle D non-hazardous landfills, which discharge effluent directly to a waterway. It also assesses the cost-effectiveness of one Best Available Technology Economically Achievable (BAT) regulatory option for directly discharging Subtitle D non-hazardous landfills.

Cost-effectiveness analysis is used in the development of effluent limitation guidelines to evaluate the relative efficiency of alternative regulatory options. It is also used to compare the efficiency of a proposed regulation with the efficiency of previous regulations. Cost-effectiveness is defined as the incremental annual cost (in 1981 constant dollars) per incremental toxic-weighted pound of pollutant removed. This definition includes the following concepts:

Toxic-Weighted Removals — Because pollutants differ in their toxicity, the reductions in pollutant discharges, or pollutant removals, are adjusted for toxicity by multiplying the estimated removal quantity for each pollutant by a normalizing weight, called a *Toxic Weighting Factor (TWF)*. The TWF for each pollutant measures its toxicity relative to copper, with more toxic pollutants having higher TWFs.

Annual Costs — The cost-effectiveness analysis uses the estimated annual costs of complying with the alternative regulatory options. The annual costs include annual expenses for operating and maintaining compliance equipment and for meeting monitoring requirements, and an annual allowance for the capital outlays for pollution prevention and treatment systems needed for compliance. These costs are calculated on a pre-tax basis (i.e., without any adjustment for tax treatment of capital outlays and operating expenses). In addition, the annual allowance for capital outlays is calculated using a discount rate of 7 percent. Finally, the compliance costs are calculated in 1981 dollars to facilitate a comparison of cost-effectiveness values for regulations developed at different times for different industries.

Incremental Calculations

The incremental values that are calculated for a given option are the change in total annual compliance costs and the change in removals from the next less stringent option, or the baseline if there is no less stringent option, where regulatory options are ranked by increasing levels of toxic-weighted removals. Thus, the cost-effectiveness values for a given option are relative to another option, or, for the least stringent option, to the baseline.

The result of the cost-effectiveness calculation represents the unit cost of removing the next pound-equivalent of pollutants. Cost-effectiveness is strictly a relative measure used for comparative purposes. This analysis does not provide an absolute scale by which a particular cost-effectiveness value can be assigned a qualitative judgment. Because cost-effectiveness values are calculated using normalized pound-equivalent removed, the cost-effectiveness value for a given option may be compared with the values of other options being considered for a given regulation; because cost-effectiveness values are always expressed in constant 1981 dollars, they may be compared with values calculated for other industries or past regulations.[28]

Although not required by the Clean Water Act, cost-effectiveness analysis is a useful tool for evaluating options for the removal of toxic pollutants. It is not intended to analyze the removal of conventional pollutants, however, such as oil and grease, biochemical oxygen demand and total suspended solids. Removals of these pollutants are not included in the cost-effectiveness calculation.

In this report, EPA presents a measure referred to as cost-reasonableness in the assessment of BPT limitations as required under CWA Section 304(b)(1)(B). Cost-reasonableness is the ratio of costs to raw (non-normalized) pounds removed by each option.

[28] For several reasons, cost-effectiveness ratios between regulations are not exactly comparable. For example, TWFs are revised over time to incorporate updated toxicological data, the costs may not be evaluated consistently on a pre-tax or after tax basis, and the opportunity cost of capital may vary. Therefore, comparisons between options of a given regulation are more reliable than comparisons between regulations.

The remaining parts of this report are organized as follows. Section 2 defines cost-effectiveness, discusses the cost-effectiveness methodology and describes the relevant regulatory options of the proposed rule. Section 3 presents the findings of the analyses for cost-reasonableness and cost-effectiveness. Section 4 compares the cost-effectiveness of the proposed regulation with the cost-effectiveness values calculated for previously promulgated rules. In addition, the report includes two appendices. Appendix A lists the pollutants of concern and their CAS numbers. Appendix B gives the Toxic Weighting Factor (TWF) for each pollutant.

Section 2

Methodology

2.1 Overview

Section 2 defines cost-effectiveness, describes the steps taken in the cost-effectiveness analysis, and characterizes the regulatory options considered in this analysis.

In developing effluent limitations guidelines, EPA uses cost-effectiveness calculations to compare the efficiency of alternative regulatory options in removing pollutants. Cost-effectiveness is defined as the incremental annual cost of a pollution control option in an industry or industry subcategory per incremental pollutant removal. The increments are calculated relative to another option or, for the least stringent option, to existing treatment. Pollutant removals are measured in copper-based "pounds-equivalent." The cost-effectiveness value, therefore, represents the unit cost of removing the next pound-equivalent of pollutant.

Three factors are of particular importance in cost-effectiveness calculations: (1) the normalization of pounds of pollutant removed to copper-based pounds-equivalent; (2) the incremental nature of cost-effectiveness; and (3) the fact that cost-effectiveness results are used for comparison purposes rather than on an absolute basis. First, the analysis is based on removals of pounds-equivalent — a term used to describe a pound of pollutant weighted by its toxicity relative to copper. These weights are known as toxic weighting factors. Copper is used as the standard pollutant for developing toxic weighting factors because it is a toxic metal commonly released in and removed from industrial effluent. The use of pounds-equivalent reflects the fact that some pollutants are more toxic than others. By expressing pollutant removals in common terms, the removals can be summed across pollutants to give a meaningful basis for comparing cost-effectiveness results among alternative regulatory options or different regulations.

Second, cost-effectiveness analysis is done on an incremental basis to compare the incremental, or marginal, cost and removals of one control option to another control option or to existing treatment. To determine incremental cost-effectiveness, the regulatory options are ranked in increasing order of stringency, where stringency is the aggregate pollutant removals, measured in pounds-equivalent. If two or more options remove equal amounts of pollutants, these options are then ranked in increasing order of cost. After the options are ranked, incremental costs and removals are calculated between each option and the next less stringent option. Incremental values for the least stringent option are calculated relative to existing treatment.

Third, no absolute scales exist for judging cost-effectiveness values. The values are considered high or low only within a given context, for example when compared to other regulatory options or when compared to effluent limitations guidelines for other industries.

Cost-effectiveness analysis involves a number of steps, which may be summarized as follows:

- Determine the relevant wastewater pollutants;
- Estimate the relative toxic weights of priority and other pollutants;
- Define the pollution control approaches;
- Calculate pollutant removals for each control option;
- Determine the annualized cost of each control option;
- Rank the control options by increasing stringency and cost;
- Calculate incremental cost-effectiveness values; and
- Compare cost-effectiveness values.

These steps are discussed below.

Pollutant Discharges Considered in the Cost-Effectiveness Analysis

Some of the factors considered in selecting pollutants for regulation include toxicity, frequency of occurrence, and the amount of a pollutant in the waste stream. Thirty-eight pollutants were identified as pollutants of concern. These pollutants were detected at treatable levels in the untreated wastewater stream and are included in the cost-effectiveness calculation (see Appendix A).

Relative Toxic Weights of Pollutants

Cost-effectiveness analyses account for differences in toxicity among the regulated pollutants by using toxic weighting factors (TWFs). Relatively more toxic pollutants have higher TWFs. These factors are necessary because different pollutants have different potential effects on human and aquatic life. For example, a pound of nickel (TWF=0.036) in an effluent stream has significantly less potential effects than a pound of cadmium (TWF=5.16). The toxic weighting factors are used to calculate the *toxic pound-equivalent* unit — a standardized measure of toxicity.

In the majority of cases, toxic weighting factors are derived from both chronic freshwater aquatic criteria (or toxic effect levels) and human health criteria (or toxic effect levels) established for the consumption of fish. These factors are then standardized by relating them to copper. The resulting toxic weighting factors for each pollutant of concern are provided in Appendix B. Table 2-1 shows some examples of the effects of different aquatic and human health criteria on weighting factors.

Table 2-1. Weighting Factors Based on Copper Freshwater Chronic Criteria

Pollutant	**Human Health Criteria* (g/l)**	**Aquatic Chronic Criteria (g/l)**	**Weighting Calculation**	**Toxic Weighting Factor**
Copper**	--	12.0	5.6/12.0	0.467
Hexavalent Chromium	3,400	11.0	5.6/3,400 + 5.6/11	0.511
Nickel	4,600	160.0	5.6/4,600 + 5.6/160	0.036
Cadmium	170	1.1	5.6/170 + 5.6/1.1	5.120
Benzene	12	265.0	5.6/12 + 5.6/265	0.488

Criteria are maximum contamination thresholds. Using the above calculation, the greater the values for the criteria used, the lower the toxic weighting factor. Units for criteria are micrograms of pollutant per liter of water.

* Based on ingestion of 6.5 grams of fish per day.

** While the water quality criterion for copper has been revised (to 12.0 g/l), the cost-effectiveness analysis uses the old criterion (5.6 g/l) to facilitate comparisons with cost-effectiveness values for other effluent limitations guidelines. The revised higher criteria for copper results in a toxic weighting factor for copper not equal to 1.0 but equal to 0.467.

Source: Environmental Protection Agency

As indicated in Table 2-1, the toxic weighting factor is the sum of two criteria-weighted ratios: the "old" copper criterion divided by the human health criterion for the particular pollutant, and the "old" copper criterion divided by the aquatic chronic criterion. For example, using the values reported in Table 2-1, 10.96 pounds of copper pose the same relative hazard in surface waters as one pound of cadmium, since cadmium has a toxic weight 10.96 times (5.12/0.467 = 10.96) as large as the toxic weight of copper.

2.2 Pollution Control Options

This section summarizes the two BPT options and the one BAT option for Subtitle D non-hazardous landfills. The BPT and BAT options apply to direct dischargers.

BPT Technology Options

Option I : Biological Treatment. EPA first assessed the pollutant removal performance of biological treatment. EPA selected this as Option I due to its effectiveness in removing the large organic loads commonly associated with leachate. BPT Option I consists of aerated equalization followed by biological treatment. Various types of biological treatment such as activated sludge, aerated lagoons, and anaerobic and aerobic biological towers or fixed film reactors were included in the calculation of limits for this option. The costing for Option I was based on the cost of aerated equalization followed by an extended aeration activated sludge system with secondary clarification and sludge dewatering. Approximately 30 percent of the direct discharging non-hazardous facilities employed some form of biological treatment and 13 percent had a combination of equalization and biological treatment.

Option II: Biological Treatment and Multimedia Filtration. The second technology option considered for BPT treatment of non-hazardous landfill wastewater was aerated equalization and biological treatment as described in Option I, followed by multimedia filtration. Approximately 10 percent of the direct discharging non-hazardous facilities used the technology described in Option II.

BAT Technology Option

Option III: Reverse Osmosis. The single BAT option consisted of BPT option II (biological treatment followed by multimedia filtration, as described above) followed by a single stage reverse osmosis unit. Reverse osmosis was selected for evaluation because of its effective control of a wide variety of toxic pollutants, in addition to conventional and nonconventional parameters.

2.3 Calculation of Pollutant Removals

EPA calculated the reduction in *at-stream* pollutant loadings to the receiving water body for each control option. *End-of-pipe* and *at-stream* pollutant removals may differ because a portion of the end-of-pipe loadings for indirect dischargers may be removed by a POTW before entering the receiving water body. As a result, the at-stream removal of pollutants due to PSES regulations are generally less than end-of-pipe removals.

The following example may help to clarify how at-stream pollutant removals are calculated for indirect dischargers: If a facility discharges 100 pounds of cadmium in its waste water to a POTW and the POTW has a removal efficiency for cadmium of 40 percent, then the POTW removes 40 pounds of cadmium. The cadmium discharged to surface waters is only 60 pounds. If a regulation results in a reduction of cadmium in the facility's waste water to 30 pounds, then the POTW removes 12 of the 30 pounds it receives from the facility, and the amount discharged to surface waters is 18 pounds. As a result, the reduction in discharges to surface waters is 42 pounds, although the reduction in facility discharges to the POTW is 70 pounds. In general, at-stream loadings for facilities that discharge to a POTW are calculated by multiplying end-of-pipe loadings by (1 - POTW removal efficiency). The cost-effectiveness calculations in this analysis reflect the fact that the actual reduction of pollutant discharge to surface waters is not 70 pounds (the change in the amount discharged to the POTW), but 42 pounds (= 60 - 18), the change in the amount ultimately discharged to surface waters.

2.4 Annualized Costs for Each Control Option

Full details of the methods used to estimate the costs of complying with the regulatory options can be found in the Technical Development Document and the Economic Analysis Report. A brief summary of the compliance cost analysis is provided below.

Two categories of compliance costs are included in the cost-effectiveness analysis: (1) capital costs, including costs for equipment, retrofitting and upgrading control technology, permit modification, and land; and (2) operating, maintenance, and monitoring costs. Although operating, maintenance, and monitoring costs occur annually, capital costs are a one-time “lump sum” cost. To express the capital costs on a annual basis, capital costs were annualized over the expected useful life of the capital equipment, 15 years, at a discount rate of 7 percent. Total annualized costs are the sum of annualized capital costs and the annual operating, maintenance and monitoring costs. The cost-effectiveness analysis presented in the main body of this report uses pre-tax costs as the basis for its calculations.

The engineering analysis yielded compliance costs estimates in 1992 dollars, the base year of the landfill industry regulatory analysis. To increase the consistency of these cost-effectiveness values with those of other promulgated rules, the compliance costs used in the cost-effectiveness analysis were deflated from 1992 to 1981 dollars using the Engineering News Record's Construction Cost Index (CCI). This adjustment factor is:

$$Adjustment\ \ factor \ = \ \frac{1981\ \ CCI}{1992\ \ CCI} \ = \ \frac{3535}{4985} \ = \ 0.709$$

BPT compliance costs are presented in 1996 dollars in addition to the 1992 base year dollars. Compliance costs used in the cost-effectiveness analysis were inflated from 1992 to 1996 dollars using the Engineering News Record's Construction Cost Index (CCI). This adjustment factor is:

$$Adjustment\ \ factor \ = \ \frac{1996\ \ CCI}{1992\ \ CCI} \ = \ \frac{5620}{4985} \ = \ 1.127$$

2.5 Calculation of Incremental Cost-Effectiveness Values

Options were ranked in order of increased stringency, measured in aggregate removals of pounds-equivalent of pollutants. After the options had been ranked, incremental cost-effectiveness values were calculated. Cost-effectiveness values were calculated separately for indirect and direct dischargers. For each discharger category, the cost-effectiveness value of a particular option was calculated as the incremental annual cost of that option divided by the incremental pounds-equivalent removed by that option. Algebraically, this equation is:

$$CE_k \ = \ \frac{ATC_k \ - \ ATC_{k-1}}{PE_k \ - \ PE_{k-1}}$$

where:

CE_k = Cost-effectiveness of Option k;

ATC_k = Total annualized compliance cost under Option k; and

PE_k = Removals in pounds-equivalent under Option k.

The numerator of the equation is the incremental cost in moving from Option k-1 to Option k. Similarly, the denominator is the incremental removals associated with the move from Option k-1 to Option k. Thus, cost-effectiveness values are measured in dollars per pound-equivalent of pollutant removed. When k corresponds to the least stringent option (k = 1), the incremental costs and removals are the increments in moving from the baseline case to Option k.

2.6 Comparisons of Cost-Effectiveness Values

Two types of comparisons are typically done using cost-effectiveness values. First, the cost-effectiveness values for the alternative regulatory options and technologies under consideration may be compared among themselves to identify which options offer relatively higher or lower cost-effectiveness in achieving pollutant reductions. Second, the average cost-effectiveness of regulatory options can be used to assess the cost-effectiveness of controls relative to previously promulgated effluent limitations guidelines for other industries.

Section 3

Cost-Effectiveness Results

3.1 Cost-Effectiveness Analysis for Subtitle D Non-Hazardous Landfills

BPT Regulatory Options

CWA Section 304(b)(1)(B) requires a cost-reasonableness assessment for BPT limitations. In determining BPT limitations, EPA must consider the total cost of treatment technologies in relation to the effluent reduction benefits achieved by such technology. This inquiry does not limit EPA's broad discretion to adopt BPT limitations that are achievable with available technology unless the required additional reductions are wholly out of proportion to the costs of achieving such marginal level of reduction.

Tables 3-1 summarizes the BPT regulatory options applicable to direct dischargers in the Subtitle D non-hazardous landfills subcategory. The regulatory options are listed in order of increasing stringency on the basis of estimated pollutant removals. Annualized compliance costs are shown in 1992 and 1996 dollars. Pollutant removals include total suspended solids and biochemical oxygen demand (BOD) removals, and are reported on an unweighted basis. Since BPT options consider the removal of conventional pollutants no pound-equivalent removals are calculated. As a result, the cost-measure of an option is expressed in dollars per *pound* for BPT options, not dollars per *pound-equivalent*, and the resulting value is referred to as *cost-reasonableness*, not *cost-effectiveness*. In addition, costs are conventionally presented in nominal dollars, not in 1981 dollars. BPT options are also not considered incrementally to each other. Therefore, the cost-reasonableness value presented in Table 3-1 is an average, not an incremental, value.

Table 3-1 shows that BPT Option I achieves 676,280 pounds of removals, at an annual cost of $5.97 million (1992 dollars). The average cost-reasonableness of Option I in 1996 dollars is estimated to be approximately $10 per pound removed.

Table 3-1. National Estimates of Landfill Costs and Pollutant Removals, Subtitle D Non-Hazardous Direct Dischargers (BPT)

Regulatory Option	Annualized Cost, $millions		Pollutant Removals	Average Cost-Reasonableness
	1992 Dollars	*1996 Dollars*	*Raw Pounds*	*($1996/lb)**
Option I	5.97	6.73	676,280	10
Option II	7.73	8.72	760,782	11

Source: Environmental Protection Agency
*Rounded to the nearest dollar.

Option II, the proposed option, achieves 760,782 pounds of removals, at an annual cost of $7.73 million (1992 dollars). The estimated average cost-reasonableness of Option II in 1996 dollars is approximately $11 per pound removed.

EPA considers the cost-reasonableness values of Option II to be acceptable. While Option II has a higher cost-reasonableness value than Option I, it achieves more significant removals at a relatively low cost. On the basis of this analysis, EPA determines that the proposed Option II is cost-reasonable, and that the cost-reasonableness of the two considered regulatory options supports the choice of Option II as the proposed BPT option for direct dischargers in the Subtitle D non-hazardous landfills subcategory.

BAT Regulatory Options

Tables 3-2 and 3-3 summarize the cost-effectiveness for BAT Option III, the only BAT regulatory option applicable to direct dischargers in the Subtitle D non-hazardous landfills subcategory. Annual compliance costs are shown in 1992 dollars, as reported in the Economic Analysis, and in 1981 dollars. Pollutant removals are reported on both an unweighted and toxic-weighted basis. Table 3-2 shows absolute costs and removals, while Table 3-3 presents incremental costs, removals and cost-effectiveness.

Costs and removals of the BAT Option III are compared to costs and removals achieved by BPT Option II. While BPT Option II is not a BAT technology under consideration, it is presented in this section as the technology basis against which incremental values for BAT Option III are calculated.

As shown in Table 3-2, BAT Option III achieves 478,435 pounds of removals on an unweighted basis and 9,323 pounds-equivalent of removals on a toxic-weighted basis. Annual costs are $27.46 million (1981 dollars). Incremental costs over BPT Option II are $21.97 million (1981 dollars), and incremental toxic-weighted removals are 1,646 pounds. The resulting cost-effectiveness is $13,346 per pound-equivalent.

Table 3-2. National Estimates of Landfill Annualized Costs and Pollutant Removals, Subtitle D Non-Hazardous Direct Dischargers (BAT)

Regulatory Option	Annualized Cost, $millions		Pollutant Removals	
	1992 dollars	*1981 dollars*	*Raw Pounds*	*Pounds-Equivalent*
BPT Option II	7.73	5.48	465,657	7,677
BAT Option III	38.72	27.46	478,435	9,323

Source: Environmental Protection Agency

Table 3-3. National Estimates of Landfills Incremental Costs, Removals and Cost-Effectiveness, Subtitle D Non-Hazardous Direct Dischargers (BAT)

Regulatory Option	Incremental Cost *($ millions, 1981)*	Incremental Removals *(lbs-eq)*	Cost-Effectiveness *($/lb-eq)**
Option III	21.97	1,646	13,346

Source: Environmental Protection Agency
*Rounded to the nearest dollar.

EPA does not consider the cost-effectiveness value of BAT Option III to be sufficiently low and therefore does not propose a BAT regulatory option for direct dischargers in the non-hazardous landfills subcategory.

Section 4

Cost-Effectiveness Values for Previous Effluent Guidelines and Standards

Table 4-1 presents, for direct dischargers, the baseline and post-compliance pollutant loadings and resulting cost-effectiveness values that were calculated for previous regulations. The values for the proposed Subtitle D non-hazardous landfill regulatory options are also listed in this table. All cost-effectiveness values are presented in 1981 dollars and are based on Toxic Weighting Factors normalized to copper.

Table 4-1: Industry Comparison of Cost-Effectiveness Values for Direct Dischargers
Toxic and Nonconventional Pollutants Only, Copper Based Weights (1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (To Surface Waters) (000's)	Pounds Equivalent Remaining at Selected Option (To Surface Waters) (000's)	Cost Effectiveness of Selected Option Beyond BPT ($/lb-eq. removed)
Aluminum Forming	1,340	90	121
Battery Manufacturing	4,126	5	2
Can Making	12	0.2	10
Coal Mining	BAT=BPT	BAT=BPT	BAT=BPT
Coastal Oil and Gas †			
- Produced Water	5,998	506	3
- Drilling Waste	7	0	292
- TWC‡	2	0	200
Coil Coating	2,289	9	49
Copper Forming	70	8	27
Centralized Waste Treatment † (co-proposal)			
- Regulatory Option 1	3,372	1,267	5
- Regulatory Option 2	3,372	1,271	7
Electronics I	9	3	404
Electronics II	NA	NA	NA
Foundries	2,308	39	84
Non-Hazardous Landfills	**BAT=BPT**	**BAT=BPT**	**BAT=BPT**
Inorganic Chemicals I	32,503	1,290	< 1
Inorganic Chemicals II	605	27	6
Iron & Steel	40,746	1,040	2
Leather Tanning	259	112	BAT=BPT
Metal Finishing	3,305	3,268	12
Metal Products & Machinery I †	140	70	50
Nonferrous Metals Forming	34	2	69
Nonferrous Metals Mfg I	6,653	313	4
Nonferrous Metals Mfg II	1,004	12	6
Offshore Oil and Gas**†	3,808	2,328	33
Organic Chemicals, Plastics...	54,225	9,735	5
Pesticide Manufacturing (1993)	2,461	371	15
Pharmaceuticals †	208	4	1
Plastics Molding & Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp & Paper	61,713	2,628	39
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** Produced water only, for produced sand and drilling fluids and drill cuttings, BAT=BPT.
† Proposed rule.
‡ Treatment, workover, and completion fluids.

Appendix A

Landfills Pollutants of Concern

Name	CAS Number
CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS	
Biochemical Oxygen Demand (BOD)	None
Chemical Oxygen Demand (COD)	None
Nitrate/Nitrite	None
Total Dissolved Solids	None
Total Organic Carbon	None
Total Suspended Solids*	None
Total Phenols	None
PRIORITY AND NONCONVENTIONAL POLLUTANTS	
1,4-Dioxane	123911
1234678-HPCDD	35822469
2-Butanone	78933
2-Propanone	67641
4-Methyl-2-Pentanone	108101
Alpha-Terpineol	98555
Ammonia as Nitrogen	7664417
Arsenic	7440382
Barium	7440393
Benzoic Acid	65850
Boron	7440428
Chromium	7440473
Chromium (Hexavalent)	18540299
Dichlorprop	120365
Disulfoton	298044
Hexanoic Acid	142621
MCPA	94746
MCPP	7085190
Methylene Chloride	75092
Molybdenum	7439987
N,N-Dimethylformamide	68122
O-Cresol	95487
OCDD	3268879
P-Cresol	106445
Phenol	108952
Silicon	7440213
Strontium	7440246
Titanium	7440326
Toluene	108883
Tripropyleneglycol Methyl Ether	20324338
Zinc	7440666

Appendix B

Toxic Weighting Factors

Name	Toxic Weighting Factor
CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS	
Biochemical Oxygen Demand (BOD)	0
Chemical Oxygen Demand (COD)	0
Nitrate/Nitrite	0
Total Dissolved Solids	0
Total Organic Carbon	0
Total Suspended Solids*	0
Total Phenols	0
PRIORITY AND NONCONVENTIONAL POLLUTANTS	
1,4-Dioxane	0.000228
1234678-HPCDD	4200000
2-Butanone	0.000022
2-Propanone	0.000008
4-Methyl-2-Pentanone	0.00012
Alpha-Terpineol	0.001018
Ammonia as Nitrogen	0.0045
Arsenic	4.029474
Barium	0.001991
Benzoic Acid	0.000328
Boron	0.177215
Chromium	0.026675
Chromium (Hexavalent)	0.51
Dichlorprop	0.093
Disulfoton	117.98
Hexanoic Acid	0.000341
MCPA	0.015876
MCPP	0.006916
Methylene Chloride	0.000418
Molybdenum	0.201439
N,N-Dimethylformamide	0.000002
O-Cresol	0.003283
OCDD	420000
P-Cresol	0.00236
Phenol	0.028
Silicon	0
Strontium	0
Titanium	0.029319
Toluene	0.005628
Tripropyleneglycol Methyl Ether	0.000008
Zinc	0.051