APPLICATION OF THE PHASE IV LAND DISPOSAL RESTRICTIONS TO CONTAMINATED MEDIA: COSTS, COST SAVINGS, AND ECONOMIC IMPACTS

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CHAPTER 1. INTRODUCTION

In the 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA), Congress specified that land disposal of hazardous waste is prohibited unless the waste first meets treatment standards established by EPA or is disposed of in units from which there will be no migration or hazardous constituents for as long as the waste remains hazardous. The HSWA amendments require that treatment standards must substantially diminish the toxicity or mobility of hazardous waste, so that short- and long-term threats to human health and the environment are minimized. Today's final rule addresses a set of LDR proposals, Notices of Data Availability (NODA), and one final rule, collectively known as "The Phase IV Land Disposal Restrictions rule ('Phase IV')." Phase IV is the latest in a series of Land Disposal Restrictions (LDR) rules that establish treatment standards for newly listed and identified wastes and that address other hazardous waste matters.

This document analyzes the impact of the Phase IV rulemaking on the treatment of contaminated media. The analysis covers:

- New soil treatment standards for soil contaminated with hazardous waste;
- New LDR treatment standards for media contaminated with newly identified mineral processing wastes; and
- New LDR treatment standards for media that exhibit the toxicity characteristic (TC) for metal constituents.

The rulemaking's effect on media contaminated with Manufactured Gas Plant (MGP) wastes is analyzed in the "Application of Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes: Regulatory Impact Analysis."[1] The rulemaking's effect on process waste is analyzed in several regulatory impact analyses.

Based on the analysis documented in this paper, EPA expects that the rulemaking will slightly increase treatment costs for selected volumes of soil that exhibit the TC for metals, while slightly decreasing treatment costs for other volumes of soil under the new soil treatment standards. The rulemaking is not

[1] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, "Regulatory Impact Analysis: Application of Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes," Jan 1998.

expected to significantly affect the costs of treating contaminated sediment, ground water, debris, or the costs of treating media contaminated with newly identified mineral processing wastes.

The remainder of this introductory chapter has four parts. The first three parts summarize the new soil treatment standards, the new LDR standards for media contaminated with mineral processing waste, and the new LDR standards for media that exhibit the TC for metals. The fourth section provides an overview of the remainder of this report.

1.1 New Soil Treatment Standards

Currently, hazardous contaminated soil and other hazardous media are subject to the same treatment standards as the contaminated restricted wastes. Hazardous contaminated media are subject to the appropriate treatment standards listed in the Universal Treatment Standards (UTS) Table in 40 CFR 268.48(a). In the Phase IV rule, the Agency is promulgating new soil standards that will apply specifically to hazardous soil that is restricted from land disposal, including hazardous soils contaminated by TC metals and mineral processing wastes. The new soil standards require the concentration of each hazardous constituent to be reduced by 90 percent or to 10 times the UTS, whichever less stringent.

As discussed in the preamble to the final rule, EPA is establishing these new soil standards to address specific treatability issues posed by hazardous soil. The UTS levels were established with industrial process waste in mind. The composition of contaminated soils is quite different from process wastes, which often makes attainment of current UTS levels infeasible or inappropriate. While facilities currently have the option of obtaining a treatability variance in this situation, obtaining a variance often causes delays and increases costs. Additionally, EPA has long recognized that the difficulty and cost of meeting the current LDR standards provide incentives for facilities to pursue a legal option of capping or treating hazardous contaminated soils in-situ to avoid the application of LDRs, rather than excavating the soil and treating it more effectively using the best demonstrated available technology (BDAT).

Thus, the Agency is establishing these alternative LDR standards in order to provide regulatory flexibility for facilities generating hazardous soil. EPA believes that the new soil standards will significantly improve the management of hazardous soil by increasing treatment options and reducing procedural delays. EPA also believes that these standards will encourage implementation of more aggressive or permanent remedies, substantially reduce hazardous constituent concentration, and also "minimize threats" to human health and the environment, as required by RCRA Section 3004(m).

The new soil treatment standards apply to soil that is hazardous because it exhibits a characteristic of hazardous waste or contains listed waste. Other final rule provisions also affect soil and other media containing listed waste. Revised 40 CFR 268.3(c) requires media contaminated with listed hazardous waste to be treated for all hazardous constituents reasonably expected to be found in the waste, instead of only the primary constituents listed in 40 CFR 268.40, as is currently the case. (If these media also exhibit the toxicity characteristic, they may already be subject to a requirement to treat all underlying hazardous constituents.)

1.2 Standards for Media Contaminated With Mineral Processing Wastes

In the Phase IV rulemaking, EPA finalizes treatment standards for newly identified characteristic mineral processing wastes that are not excluded from RCRA under the Bevill Amendment. Under the current requirements, media contaminated with these wastes are not subject to the LDRs. Under the final rule, these media must comply with the LDR standards for characteristic wastes, that is, the UTS levels for all underlying hazardous constituents (UHCs). Debris, however, may be treated using the alternative debris treatment standards. Sediment and debris contaminated with newly identified mineral processing wastes also must be treated to UTS levels for all UHCs. Soils contaminated with newly identified mineral processing wastes must meet the newly promulgated soil standards described above.

1.3 Standards for TC Metals Media

Until this rule, all process wastes and contaminated media exhibiting the toxicity characteristic for metals that also fail the extraction procedure (EP) were subject to treatment standards equal to the TC levels.[2] Because the characteristic levels and lead and chromium LDR levels are insufficient to minimize human health and environmental threats, additional treatment of these remediation wastes left on site is normally required. EPA is now requiring that facilities treat TC metal wastes to existing UTS standards for all TC metals and UHCs. Sediment and debris exhibiting the TC for metals will also have to meet the new standards. Debris, however, may be treated under the alternative treatment standards for hazardous debris. Soils exhibiting the TC for metals will have to comply with the newly promulgated soil standards described above.

In addition to establishing new treatment standards for eight TC metal wastes (arsenic, barium, cadmium, chromium, lead, mercury, and selenium), EPA

[2] See 55 FR 22520, June 1, 1990.

is revising the UTS for nonwastewater forms of the following 12 metal constituents (six TC metals and six non-TC metals):

- Antimony;
- Barium;
- Beryllium;
- Cadmium;
- Chromium;
- Lead;
- Nickel;
- Selenium;
- Silver;
- Thallium;
- Vanadium; and
- Zinc.

The Agency also is setting new treatment standards for wastewater forms of barium, cadmium, chromium, lead, selenium, and silver TC wastes at levels equal to the previous wastewater UTS levels.

1.4 Outline of This Document

This report estimates the incremental costs and the cost savings associated with the three parts of the Phase IV rule summarized above. The remainder of this report is organized as follows:

- Section 2 presents the methodology and the major limitations;
- Section 3 describes the results; and
- Section 4 analyzes the economic impacts of the projected incremental costs of the rulemaking on small entities.

In addition, Appendix A describes the soil and sediment database used in this analysis and Appendix B presents detailed (e.g. industry-by-industry) results of the economic impact analysis.

CHAPTER 2. METHODOLOGY

This chapter describes the methodology for estimating the incremental costs and cost savings of the application of the Phase IV rule to contaminated media.

- Section 2.1 describes the development of the contaminated soil and sediment database, which contains volume, constituent, and constituent concentration data for a sample of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial action and RCRA corrective action sites.

- Section 2.2 summarizes the formulas used to assign treatment methods and costs to soil and sediment in the database under both the baseline and the post-regulatory analyses.

- Section 2.3 explains how and why the database was partitioned into three portions for purposes of this analysis: soils exhibiting the TC for organics, soils and sediments exhibiting the TC for metals only, and non-TC soils and sediments, which are assumed to contain listed waste.

- Section 2.4 describes the estimation of the amount of contaminated soil and sediment treated annually under various remediation programs.

- Section 2.5 explains the approach for estimating baseline soil and sediment treatment costs.

- Section 2.6 outlines the approach for estimating the cost savings associated with the new soil treatment standards.

- Section 2.7 describes the analysis of possible incremental costs of the new requirements on soil and sediment contaminated with mineral processing wastes.

- Section 2.8 discusses the approach for estimating the incremental costs of treating all UHCs in soils and sediments exhibiting the TC for metal wastes.

- Section 2.9 presents the analysis of the impact of the new TC metal and mineral processing waste treatment standards on the management of contaminated groundwater and contaminated debris.

- Section 2.10 describes the major data limitations of the analysis.

This methodology is summarized in Exhibit 2-1.

2.1 Developing the Contaminated Soil and Sediment Database

In order to assess the cost impacts from the Phase IV rule on contaminated soil and sediment, the affected volumes of these media had to be characterized. These volumes are generated through CERCLA, RCRA corrective action, RCRA closures, state superfund, and voluntary cleanup programs. Characterizing these volumes is most reliably done through examining data on volumes of such media generated in past remedial actions. Therefore, EPA compiled a database containing available soil and sediment data on existing CERCLA remedial action and RCRA corrective action sites, as reported in CERCLA Records of Decision (RODs) and several databases compiled for analyses of RCRA corrective action initiatives. (Detailed data were not available for other remediation programs.) Because this analysis analyzes the effect of the Phase IV requirements on cleanups that will occur in the future, EPA does not have data on the soils and sediments that will be generated at those cleanups. Instead, the Agency developed this database to predict the nature of soils and sediments that will be cleaned up in the future. In addition, the database volumes were not used to predict the number and size of future cleanups; separate data sources were examined tor those estimates, as described in Section 2.4.

The data for each site include contaminated soil and/or sediment volumes for a distinct segment of the cleanup and the types and maximum concentrations of hazardous constituents present. Because detailed data on sediment contamination at RCRA corrective action sites were not available, the impact of Phase IV on the management of sediment at RCRA sites was derived from data for CERCLA remedial action sediment and RCRA corrective action soil. The RODs and corrective data sources are described more fully in Appendix A.

The complete database contains data on 535 soil and sediment sites (or particular volumes) with approximately 44 million tons of contaminated media. The 535 sites include 326 CERCLA sites with approximately 9 million tons of contaminated soil, 88 CERCLA sites with just under one million tons of contaminated sediment, and 121 RCRA corrective action sites with 34 million tons of contaminated soil. The database is further described in Appendix A.

Exhibit 2-1
Methodology for Analyzing Impact of Phase IV on Contaminated Media

Step	Key Outputs
1. Develop database for a sample of CERCLA remedial action and RCRA corrective action sites (Section 2.1)	Site-specific data on volume and maximum constituent concentrations for: • CERCLA remedial action soil • RCRA corrective action soil • CERCLA remedial action sediment
2. Develop approach to assign baseline treatment methods and costs for soil and sediment at sample sites (Section 2.2)	Formulas for assigning treatment methods and costs based on site constituents, concentrations, and volumes.
3. Partition database volumes based on whether volumes exhibit the TC for metals, the TC for organics, or no TC (Section 2.3)	Sites and volumes that: • Exhibit TC for organics or for organics and metals (soil) • Exhibit TC for metals only (soil and sediments) • Do not exhibit TC and are assumed to contain listed waste (soil)
4. Estimate volume of contaminated soil and sediment treated annually by various remediation programs (Section 2.4)	Annual volume of soil treated at: • CERCLA remedial actions • RCRA corrective actions • RCRA closures • State superfund cleanups • Voluntary cleanups Annual volume of sediment treated at: • CERCLA remedial actions • RCRA corrective actions
5. Estimate soil and sediment treatment costs in the baseline (Section 2.5)	Average treatment cost per ton for: • CERCLA remedial action, state superfund, and voluntary cleanup soil • RCRA corrective action and RCRA closure soil • CERCLA remedial action sediment • RCRA corrective action sediment
6 Project Phase IV treatment and costs for soil and sediment for sample sites for each partitioned volume (Section 2.6 through 2.8)	Average treatment cost per ton for each partial volume for: • CERCLA remedial action soil • RCRA corrective action soil • CERCLA remedial action sediment
7. Multiply changes in weighted average treatment costs from Steps 5 and 6 by annual volumes from Step 4 to project total annual cost savings (Sections 2.6 through 2.8)	Annual costs or cost savings for: • CERCLA remedial action, state superfund, and voluntary cleanup soil • RCRA corrective action and RCRA closure soil • CERCLA remedial action sediment • RCRA corrective action sediment
8. Discuss potential changes in treatment costs for contaminated ground water and contaminated debris (Section 2.9)	• Qualitative discussion of Phase IV impacts.

2.2 Assigning Treatment Methods and Costs

Compliance approaches for both the baseline and the post-regulatory scenarios are based on a host of site-specific factors, all of which could not be taken into consideration in this analysis. Given the available information, treatment technologies were assigned for each site (or particular volume) in the database, for both baseline and post-regulatory scenarios, based on three factors:

- The types of hazardous constituents in the contaminated soil or sediment;
- Their maximum concentration; and
- The volume to be remediated.

This approach to projecting soil and sediment treatment methods was originally developed to support the analysis of the proposed hazardous waste identification rule for contaminated media (HWIR-Media). See the "Economic Assessment" of the proposed HWIR-Media rule.[3] The approach has been adapted to analyze the impact of the Phase IV rule on contaminated soil and sediment. Although the approach, as originally developed, projects both in-situ and ex-situ treatment, the LDRs including the Phase IV standards apply to soil and sediment treated ex-situ only. Thus, while the modeling described here covers both in-situ and ex-situ treatment, the projected Phase IV incremental costs and cost savings reflect only changes in ex-situ treatment.

The Agency, nevertheless, recognizes that changes in the LDRs also create incentives for shifts between in-situ and ex-situ management. For example, less stringent soil treatment standards may prompt remediation decision makers at some sites to use ex-situ instead of in-situ soil treatment technologies. These shifts could occur, despite the generally higher cost of ex-situ versus in-situ treatment, because the LDR-compliant ex-situ treatment methods may be less costly under the relaxed LDRs then under the baseline. In these situations, treatment costs will be higher under the new soil treatment standards than under the baseline because the remediation decision maker found the advantages of ex-situ treatment (e.g., greater effectiveness, more protective management of the residuals, and a permanent remedy that avoids the potential long-term costs of an inadequate remedy) exceeded the disadvantages of higher costs. EPA expects that facility managers will use the more expensive ex-situ option only if they believe that the long-term financial benefits of more protective treatment will exceed the additional short-term expense. In any case, such shifts may

[3] U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, "Economic Assessment of the Proposed Hazardous Waste Identification Rule for Contaminated Media", April 1, 1996.

not occur frequently and EPA has not quantified the additional short-term cost or long-term benefits associated with the more expensive treatment methods.

The approach for assigning treatment methods was reviewed by EPA and industry remediation experts to ensure that it was reasonable and appropriate for this analysis. There are many limitations associated with assigning treatment technologies using just a few parameters and without considering other site-specific parameters that might influence the selection of treatment technologies (e.g., distance to nearest residence or drinking water source). Nevertheless, as is discussed further below, the treatment technologies used in this analysis generally reflect the current and expected use of the technologies over the next five years and effectively incorporate the use of technologies approved under RCRA treatability variances.

The predicted treatment technologies for soil and sediment and their estimated average treatment costs per ton are based on several data sources, including the following:

- Corrective Action RIA Technologies List, Corrective Action Regulatory Impact Analysis, Office of Solid Waste, U.S. EPA, March 1994: a comprehensive list of innovative treatments and treatment costs developed for the corrective action RIA remedy selection process.

- Vendor Information System for Innovative Treatment Technologies (VISITT), Office of Solid Waste and Emergency Response, U.S. EPA, EPA 542-R-93-001, April 1996: a database containing innovative treatments and treatment costs submitted by developers, manufacturers, and suppliers.

- Regulatory Impact Analysis of Phase II Land Disposal Restrictions Proposed Rule, Office of Solid Waste, U.S. EPA, September 13, 1993.

- Five volumes of the eight-volume series of Innovative Site Remediation Technologies prepared by WASTECH, a multi-organization cooperative project managed by the American Academy of Environmental Engineers: Chemical Treatment (Vol. 2, 1994); Soil Washing/Soil Flushing (Vol. 3, 1993); Stabilization/Solidification (Vol. 4, 1994); Thermal Desorption (Vol. 6, 1993); and Thermal Destruction (Vol. 7, 1994).

- Cleaning Up the Nation's Waste Sites, Market and Technology Trends, Office of Solid Waste and Emergency Response, U.S.

EPA, EPA 542-R-96-005, April 1997.

- *Engineering Bulletin*: In-Situ Soil Vapor Extraction Treatment, Office of Emergency and Remedial Response and Office of Research and Development, U.S. EPA, EPA 540-2-91-006, May 1991.

- Innovative Treatment Technologies Overview and Guide to Information Sources, Office of Solid Waste and Emergency Response, U.S. EPA, EPA 540-9-91-002, October 1991.

- BCD: An EPA-Patented Process for Detoxifying Chlorinated Wastes, Office of Research and Development, U.S. EPA, 1991.

- Handbook on In-Situ Treatment of Hazardous Waste-Contaminated Soils, Risk Reduction Engineering Laboratory, U.S. EPA, EPA 540-2-90-002, January 1990.

- EPA's Contaminated Sediment Management Strategy, Office of Water, U.S. EPA, EPA 823-R-94-001, August 1994.

- Selecting Remediation Technologies for Contaminated Sediment, Office of Water and Office of Research and Development, U.S. EPA, EPA 823-B93-001, June 1993.

- Classification Methods Compendium, Office of Water, U.S. EPA, EPA 823-R-92-006, September 1992.

- Innovative Treatment Technologies: Annual Status Report, Application of New Technologies at Hazardous Waste Sites, Office of Solid Waste and Emergency Response, EPA 542-R-95-008, September 1995.

As shown in the Exhibit 2-2, EPA assigned hazardous constituents to one of four constituent treatability groups based upon their amenability to different remediation technologies:

- Volatile organic compounds (VOCs);

- Semi-volatile organic compounds (SVOCs);

- Aromatic halogenated organic compounds and halogenated pesticides and herbicides (all labeled AHCs in this document for simplicity); and

- Metals.

Exhibit 2-2
List of Hazardous Constituents by Treatability Group

Volatile Organic Compound (VOCs)	
1,1,1-Trichloroethane	Cis-1,2-Dichloroethylene
1,1,2-Trichloro-1,2,2-trifluoroethane	Cis-1,3-Dichloropropene
1,1,2-Trichloroethane	Cumene
1,1,2,2-Tetrachloroethane	Cyanide (amenable)
1,1,1,2-Tetrachloroethane	Dibromomethane
1,1-Dichloroethane	Dichlorodifluoromethane
1,1-Dichloroethylene	Dichloromethane
1,2-Dichloroethane	Ethyl Benzene
1,2-Dichloropropane	Ethyl Ether
1,3-Dichloropropene	Methyl Isobutyl Ketone
2-Butanone (MEK)	Styrene
3-Chloropropene	Tetrachloroethylene
Acetone	Toluene
Benzene	Trans-1,2-dichloroethene
Bromodichloromethane	Trans-1,3-dichloropropene
Bromomethane	Trichloroethylene
Carbon Disulfide	Trichlorofluoromethane
Carbon Tetrachloride	Vinyl Chloride
Chloroform	Xylenes
Chloromethane	

Semi-Volatile Organic Compounds (SVOCs)	
1,2,3-Trichloropropane	Acetonitrile
1,2-Dibromo-3-chloropropane	Acetophenone
1,2-Diphenylhydrazine	Acrolein
1,3-Dinitrobenzene	Acrylamide
1,4-Dioxane	Acrylonitrile
2,4-Dimethylphenol	Aniline
2,4-Dinitrophenol	Benzidine
2,4-Dinitrotoluene	Benzo(a)pyrene
2,4-Toluenediamine	Benzyl Alcohol
2,6-Dinitrotoluene	Benzo(a)anthracene
2,6-Toluenediamine	Bis(2-chloroethyl)ether
2-Chloro-1,3-butadiene	Bis(2-chloroisopropyl)ether
2-Ethoxyethanol	Bis(2-ethlyhexyl)phthalate
2-Napthylamine	Butanol
2-Nitropropane	Butyl Benzyl Phthalate
2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	Chlorodibromomethane
3,3'-Dimethoxybenzidine	Chrysene
3,3'-Dimethylbenzidine	Cresols
3-Methylcholanthrene	Dibenzo(a,h)anthracene
7,12-Dimethylbenz(a)anthracene	Diethyl Phthalate
Acenaphthene	Diethylstilbestrol

Exhibit 2-2 (continued)
List of Hazardous Constituents by Treatability Group

Semi-Volatile Organic Compounds (SVOCs) (continued)	
Dimethoate	Methyl Parathion
Dimethyl Phthalate	m-Cresol
Diphenylamine	Naphthalene
Disulfoton	Nitrobenzene
Di-n-butyl Phthalate	N-Nitrosodimethylamine
Di-n-octyl Phthalate	N-Nitrosodiphenylamine
Epichlorohydrin	N-Nitroso-di-n-propylamine
Ethyl Acetate	N-Nitrosomethylethylamine
Ethyl Methacrylate	N-Nitrosopiperidine
Ethyl Methanesulfonate	N-Nitrosopyrrolidine
Ethylene Dibromide	N-Nitroso-diethylamine
Ethylene Thiourea	N-Nitroso-di-n-butylamine
Famphur	Octamethyl Pyrophosphoramide
Fluoranthene	o-Cresol
Fluorene	o-Toluidine
Formaldehyde	Parathion
Formic Acid	Phenol
Furan	Phenylenediamine
Hexachlorocyclohexane	Phorate
Hexachlorocyclopentadiene	Phthalic Anhydride
Hexachloroethane	Pyrene
Hexachloro-1,3-butadiene	Pyridine
Indeno (1,2,3-cd) pyrene	p-Chloroaniline
Isobutyl Alcohol	p-Cresol
Isophorone	p-Toluidine
Maleic Anhydride	Safrole
Methacrylonitrile	sym-Trinitrobenzene
Methanol	Tetraethyl Dithiopyrophosphate
Methoxychlor	Tribromomethane
Methyl Methacrylate	Tris (2,3-dibromopropyl) phospha

Aromatic Halogenated Compounds (AHCs) and Halogenated Pesticides anc	
1,2,4,5-Tetrachlorobenzene	2378 HpCDFurans
1,2,4-Trichlorobenzene	2378 HxCDDioxins
12378 PeCDFuran	2378 HxCDFurans
2,3,4,6-Tetrachlorophenol	2378 PeCDDioxins
2,4,5-Trichlorophenol	2378 TCDDioxin
2,4,5-Trichlorophenoxyacetic acid	2378 TCDFuran
2,4,6-Trichlorophenol	2-Chlorophenol
2,4-Dichlorophenol	3,3'-Dichlorobenzidine
2,4-Dichlorophenoxyacetic acid	Aldrin
23478 PeCDFuran	alpha-HCH
2378 HpCDDioxins	Aramite

Exhibit 2-2 (continued)
List of Hazardous Constituents by Treatability Group

Aromatic Halogenated Compounds (AHCs) and Halogenated Pesticides ar (continued)	
Benzotrichloride	Heptachlor epoxide (a,b,g isome
Benzo(b)fluoranthene	Hexachlorobenzene
Benzyl Chloride	Hexachlorophene
beta-HCH	Kepone
Chlordane	Octachlorodibenzodioxin (OCDD
Chlorobenzene	Octachlorodibenzofuran (OCDF)
Chlorobenzilate	o-Dichlorobenzene
DDD	Pentachlorobenzene
DDE	Pentachloronitrobenzene (PCNB
DDT	Pentachlorophenol
Diallate	Polychlorinated Biphenyls (PCBs
Dieldrin	Pronamide
Endosulfan	p-Dichlorobenzene
Endrin	Silvex (2,4,5-TP)
gamma-HCH (Lindane)	Strychnine and salts
Heptachlor	Toxaphene
Metals	
Antimony	Mercury
Arsenic	Molybdenum
Barium	Nickel
Beryllium	Selenium
Cadmium	Silver
Chromium	Thallium
Copper	Vanadium
Lead	Zinc

Source: *Cleaning Up the Nation's Waste Sites: Markets and Technology Trends*, EPA-542-R-92-012, April 1993, Exhibit A-2. This EPA document relied *Test Methods for Evaluating Solid Waste, Volume 1A: Laboratory Man Physical/Chemical Methods*, Third Edition, November 1987.

To better identify specific treatment technologies, contaminated soil and sediment volumes were also classified into four groups by high or low volume (HV or LV) and high or low concentration (HC or LC). The volume cutoff for both the baseline and the post-Phase IV analysis is 20,000 tons for each treatability group except the four treatability groups that contain AHCs and two or three additional contaminant groups (VOCs, SVOCs, and/or metals). For the three treatability groups with AHCs and two additional contaminants, the volume cutoff is 50,000 tons. For the treatability group with AHCs and all three other contaminants, the volume cutoff is 65,000 tons. Contaminated soil and sediment volumes of less than these 20,000, 50,000, and 65,000 ton thresholds are classified as low volume. Larger volumes are classified as high volume.

Treatment methods vary with soil and sediment volume because economies of scale make some technologies (e.g., vacuum extraction) more economical at large volumes. Conversely, cost of other technologies (e.g., incineration) may become prohibitively expensive for large volumes. The cutoff volumes of 20,000, 50,000, and 65,000 tons (and the high and low concentration cutoffs) were set both to reflect these economies and so that the baseline projections would reflect the expected choice of treatment methods in the absence of Phase IV new soil treatment standards. Because incineration is used more often to treat soils and sediments contaminated with AHCs and the other contaminant types than it is used for other treatability groups, the cutoff volume was increased to reflect these differences in management.

In the baseline analysis, 100 times the UTS was chosen as the dividing point for high and low concentration of organic constituents. Treatment-driving constituents present in contaminated soil and sediment at concentrations less than 100 times UTS were defined as low concentration; while treatment-driving constituents present at concentrations at or greater than 100 times the UTS were defined as high concentration. (The treatment-driving constituent is the constituent in each constituent group with the highest ratio of its concentration to its UTS value.) The 100 times UTS breakpoint was chosen to reflect the expected choice of management methods in the absence of Phase IV new soil treatment standards. A technology-based criteria, like UTS, is an appropriate basis for defining low and high concentrations, because these definitions determine the treatment technology selected in the model. *Later sections of this methodology discuss how and why these baseline concentration cutoffs were redefined for the post-regulatory analysis.*

The concentration of metal constituents was not taken into account in assigning treatment technologies because the concentration generally is not a significant determinant in selecting treatment remedies for metals. For this analysis, immobilization is the only treatment method for metals, as described below. The Agency does, however, recognize that soil and sediment contaminated with very high concentrations of metals may be managed through high-temperature metal recovery. This modeling limitation does not significantly affect the analysis. Only relatively small volumes of media are treated in this manner. In addition, the changes in the LDRs under Phase IV are not likely to affect the selection of this technology.

The remainder of this section describes, in general terms, the treatment technologies assigned for each treatability group. *Because these assignments reflect other factors besides the LDR treatment standards, including site-specific cleanup goals, the assigned technologies (e.g., incineration) may be more than sufficient to satisfy solely the LDRs.*

2.2.1 Treatment Methods for Metals

Immobilization is currently the only technology that is widely used to treat metals. The technology can be used to treat all metal constituents except for selenium.[4] Thus, immobilization is used in this analysis as the treatment technology for all soils and sediments containing metals.

2.2.2 Treatment Methods for VOCs

Vacuum extraction is currently the preferred technology for both halogenated and nonchlorinated VOCs. Bioremediation and thermal desorption also are used to treat VOCs at some sites. Bioremediation is lower in unit cost than vacuum extraction and thermal desorption, but is effective only for biodegradable compounds and can take longer to achieve reductions than vacuum extraction. Therefore, this analysis assumes both vacuum extraction and bioremediation will be used to treat VOCs.

2.2.3 Treatment Methods for SVOCs

Bioremediation and thermal desorption are the most frequently selected innovative technologies for CERCLA remedial action sites with SVOCs. Considering the increasing use of bioremediation, its ability to destroy contaminants, and its low unit cost, this technology is expected to be the preferred technology for low-concentration SVOC wastes. For high-concentration SVOCs, other technologies such as incineration and thermal desorption are more effective at reducing constituent concentrations. These technologies are expected to be the choices for high-concentration, low-volume SVOCs. *Although these*

[4] Because there is no method currently available for treating selenium-bearing wastes effectively, facilities typically obtain a treatability variance for such wastes.

technologies are not necessary to meet the LDRs for soil under Phase IV (e.g., to meet the 90 percent reduction standard), their use was projected because of the importance of site specific risk factors (e.g., need for reductions greater than 90 percent). Because of higher unit costs for thermal desorption and incineration, bioremediation is expected to remain the preferred technology for high-concentration, high-volume SVOC wastes.

EPA's analysis of treatment technology trends indicates that the use of incineration is declining and generally limited low-volume wastes. Thermal desorption, effective at achieving reductions of SVOCs at high concentrations, is gaining in use at sites treating a range of SVOCs at the same time that incineration is declining. To reflect recent treatment trends for high concentration, low-volume SVOC wastes, the predicted technologies for this treatment group were assumed to be 75 percent incineration and 25 percent thermal desorption.

2.2.4 Treatment Methods for AHCs

Bioremediation is predicted to be the preferred technology for low-concentration AHC wastes because of its ability to destroy organic contaminants at a low cost. Bioremediation, however, may be inhibited by high concentration AHCs. For high concentration AHCs, incineration or thermal desorption is more effective at achieving reductions. Yet, as discussed above, the use of incineration for large waste volumes is cost-prohibitive. Soil washing followed by dechlorination has been used effectively to treat AHCs at a number of sites with a lower unit cost than thermal desorption. Thus, these methods were assigned as the preferred technology for high-volume, high-concentration AHCs. Based on available CERCLA data, high-concentration, low-volume AHCs were assigned treatment technologies in the same manner as SVOCs. *Although use of incineration and thermal desorption may not be necessary to meet the Phase IV soil treatment standards (e.g., 90 percent reduction), use of these technologies is projected because of the importance of site-specific risk factors.*

2.2.5 Treatment Methods for Mixed Constituent Treatability Groups

Treatment assignments for soil and sediments with multiple types of constituents were developed by assuming that the treatment-driving organic constituent within a treatment group would determine the technologies used to treat the contaminated media. In addition, all media contaminated with metals as well as organics were assigned to include immobilization. Whether immobilization is in-situ or ex-situ depends on whether the organics treatment technology is in- or ex-situ. Thus, the treatment trains described in exhibits on the following pages were developed to address multiple treatment-driving constituent waste streams.

2.2.6 Estimating Treatment Costs

EPA estimated per ton costs for the soil and sediment treatment methods by consulting numerous data sources. Where appropriate, costs for excavation, treatment, and disposal of residuals were included in the estimates.[5] Exhibit 2-3 presents these unit costs, the specific source for the estimate, and any specific assumptions used in developing the cost.

[5] Excavation and residual disposal costs were factored only into ex-situ treatments.

Exhibit 2-3
Soil and Sediment Treatment Costs Per Ton

Treatment Method	Cost/Ton (1997$)	Sources	Comments
Bioremediation (in-situ)	$67	Vendor Information System for Innovative Treatment Technologies (VISITT), Office of Solid Waste and Emergency Response, U.S. EPA, EPA 542-R-93-001, 1996: a database containing innovative treatments and treatment costs submitted by developers, manufacturers, and suppliers.	Average cost of 31 sites in database.
Bioremediation (ex-situ)	$76	VISITT.	Average cost of 39 sites in database.
Dechlorination	$193	Economic Assessment of the Proposed Hazardous Waste Identification Rule for Contaminated Media, Regulatory Analysis Branch, Communications, Analysis and Budget Division, Office of Solid Waste and Emergency Response, U.S. EPA, April 1996.	Assumes 90% of the wastes are treated and disposed of on site and 10% of the wastes are treated and disposed of off site.
Immobilization (in-situ)	$54	Regulatory Impact Analysis: Application of Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes. Office of Solid Waste, U.S. EPA, January 1998.	--
Immobilization (ex-situ)	$164	Regulatory Impact Analysis: Application of Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes. Office of Solid Waste, U.S. EPA, January 1998.	--
Incineration	$1,375	Economic Assessment of the Proposed Hazardous Waste Identification Rule for Contaminated Media.	Assumes 90% of the wastes are treated and disposed of on site and 10% of the wastes treated are disposed of off site.

Exhibit 2-3 (continued)
Soil and Sediment Treatment Costs per Ton

Treatment Method	Cost/Ton (1997$)	Sources	Comments
Incineration and Immobilization of the Ash	$1,382	Economic Assessment of the Proposed Hazardous Waste Identification Rule for Contaminated Media.	Assumes 90% of the wastes are treated and disposed of on site and 10% of the wastes are treated and disposed of off site.
Soil Washing	$119	VISITT.	Average cost of 19 sites in database. Assumes 90% of the wastes are treated and disposed of on site and 10% of the wastes are treated and disposed of off site.
Thermal Desorption	$110	VISITT. Contaminated Soil Treatment Technologies- Analysis of Treatability Data, Prepared by ICF Inc. under EPA Contract 68-W2-008, Work Assignment 232, Task 4 for Office of Solid Waste, U.S. EPA, April 1997. Innovative Treatment Technologies: Annual Status Report (Seventh Ed.) Applications of New Technologies at Hazardous Waste Sites, U.S. EPA, EPA 542-R-95-008, Sept 1995. Field Demonstration of Thermal Desorption of Manufactured Gas Plant Soils, Prepared by Barr Engineering Co. for EPRI, EPRI TR-105927, Sept 1996.	Average cost for 52 sites in database. Assumes 90% of the wastes are treated and disposed of on site and 10% of the wastes are treated and disposed of off site.
Vacuum Extraction	$150	Economic Assessment of the Proposed Hazardous Waste Identification Rule for Contaminated Media.	--

Exhibits 2-4 and 2-5 show how baseline and post-regulatory soil and sediment volumes were assigned to treatment methods for soil and sediment, respectively. Volumes were assigned a treatment method based on the hazardous constituents present, constituent concentrations, and contaminated soil and sediment volumes. (The difference between baseline and post-regulatory treatment methods depends, in part, on difference in the cutoffs between high and low concentrations.) These exhibits also present the estimated cost per ton in 1997 dollars of each combination of treatment methods.

Sediments were assumed to be managed in the same manner as soil with two exceptions. The cost estimates were increased by $15 per ton to reflect the additional cost of dredging before other management costs are incurred; and in-situ treatment methods were not considered.

The selection of treatment methods identified in Exhibits 2-4 and 2-5 were reviewed by EPA and industry remediation experts to ensure that they were reasonable and appropriate for this analysis. There are many limitations associated with assigning treatment technologies using just a few parameters and without considering site-specific parameters that might influence the selection of treatment technologies (e.g., distance to nearest residence or drinking water source). Nevertheless, the treatment technologies used in this analysis generally reflect the current and expected use of the technologies over the next few years and effectively incorporate the use of technologies approved under RCRA treatability variances. The assignment of technologies was verified in part by using the frequencies of treatment selection used by the Superfund remedial action program,[6] the frequency of treatment selection used in the draft March 1993 Corrective Action Regulatory Impact Analysis methodology, available published data on the volume of remedial waste managed by selected technologies in 1994,[7] articles on use of incineration to treat remediation waste,[8] and knowledge of trends towards increasing use of innovative technologies.[9]

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[6] See, e.g., Innovative Treatment Technologies: Annual Report, Application of New Treatment Technologies at Hazardous Waste Sites, Office of Solid Waste and Emergency Response, EPA 540-R-95-008, September 1995.

[7] E.g., John Hanke, "Hazardous Waste Incineration 1995," EI Digest, May 1995, and Christine L. Seidel, "Mobile Thermal Treatment 1994," EI Digest, December 1994.

[8] E.g., John Hanke, "Hazardous Waste Incineration 1996," EI Digest, May 1996.

[9] Cleaning Up the Nation's Waste Sites: Markets and Technology Trends, Office of Solid Waste and Emergency Response, EPA 542-R-96-005, April 1997.

Exhibit 2-4
Soil Treatment Technologies and Costs

Constituent Type	Concentration/ Volume	Treatment*	Cost/Ton (1997$)
VOCs	LC/LV	50% In-Situ Bioremediation & 50% Vacuum Extraction	$111
	LC/HV, HC/LV, HC/HV	Vacuum Extraction	$150
SVOCs	LC/LV, LC/HV, HC/HV	50% In-Situ Bioremediation and 50% Ex-Situ Bioremediation	$72
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,058
AHCs	LC/LV, LC/HV	50% In-Situ Bioremediation & 50% Ex-Situ Bioremediation	$72
	HC/HV	Soil Wash & Dechlorination	$312
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,058
Metals	LC/LV	In-Situ Immobilization	$54
	LC/HV, HC/LV, HC/HV	Ex-Situ Immobilization	$164
VOCs and SVOCs	LC/LV, LC/HV, HC/HV	50% In-Situ Bioremediation & 50% Vacuum Extraction	$111
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,058
VOCs and AHCs	LC/LV	50% In-Situ Bioremediation & 50% Ex-Situ Bioremediation	$72
	LC/HV, HC/HV	Vacuum Extraction	$150
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,058
VOCs and Metals	LC/LV	50% In-Situ Bioremediation & In-Situ Immobilization, 50% Ex-Situ Bioremediation & Ex-Situ Immobilization	$181
	LC/HV, HC/LV, HC/HV	Vacuum Extraction & In-Situ Immobilization	$204
VOCs, SVOCs, and Metals	LC/LV	50% In-Situ Bioremediation & In-Situ Immobilization, 50% Ex-Situ Bioremediation & Ex-Situ	$181

Constituent Type	Concentration/ Volume	Treatment*	Cost/Ton (1997$)
		Immobilization	
	LC/HV, HC/HV	Vacuum Extraction & In-Situ Immobilization	$204
	HC/LV	75% Incineration & Immobilization of Ash & 25% Thermal Desorption	$1,064
VOCs, SVOCs and AHC's	LC/LV	50% In-Situ Bioremediation & 50% Ex-Situ Bioremediation	$150
	LC/HV, HC/HV	Vacuum Extraction	$150
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,058
VOCs, AHCs, and Metals	LC/LV	50% In-Situ Bioremediation & In-Situ Immobilization, 50% Ex-Situ Bioremediation & Ex-Situ Immobilization	$181
	LC/HV	Vacuum Extraction & In-Situ Immobilization	$204
	HC/HV	Soil Wash, Dechlorination, and Ex-Situ Immobilization	$476
	HC/LV	75% Incineration & Immobilization of the Ash & 25% Thermal Desorption	$1,064
VOCs, SVOCs, AHCs, and Metals	LC/LV	50% In-Situ Bioremediation & In-Situ Immobilization, 50% Ex-Situ Bioremediation & Ex-Situ Immobilization	$181
	LC/HV	Vacuum Extraction & In-Situ Immobilization	$204
	HC/HV	Soil Wash, Dechlorination, & Ex-Situ Immobilization	$476
	HC/LV	75% Incineration & Immobilization of Ash & 25% Thermal Desorption	$1,064
SVOCs and AHCs	LC/LV	50% In-Situ Bioremediation, 50% Ex-Situ Bioremediation	$72
	LC/HV	Soil Wash & Ex-Situ Bioremediation	$195
	HC/HV	Soil Wash & Dechlorination	$312

Constituent Type	Concentration/ Volume	Treatment*	Cost/Ton (1997$)
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,058
SVOCs and Metals	LC/LV, LC/HV	50% In-Situ Bioremediation & In-Situ Immobilization, 50% Ex-Situ Bioremediation & Ex-Situ Immobilization	$181
	HC/LV, HC/HV	Soil Wash, Ex-Situ Bioremediation, & Ex-Situ Immobilization	$359
SVOCs, AHCs, and Metals	LC/LV	50% In-Situ Bioremediation & In-Situ Immobilization, 50% Ex-Situ Bioremediation & Ex-Situ Immobilization	$181
	LC/HV	Soil Wash, Ex-Situ Bioremediation, & Ex-Situ Immobilization	$359
	HC/HV	Soil Wash, Dechlorination, & Ex-Situ Immobilization	$476
	HC/LV	75% Incineration & Immobilization of Ash & 25% Thermal Desorption	$1,064
AHCs and Metals	LC/LV	50% In-Situ Bioremediation & In-Situ Immobilization, 50% Ex-Situ Bioremediation & Ex-Situ Immobilization	$181
	HC/LV	75% Incineration & Immobilization of Ash & 25% Thermal Desorption	$1,064
	LC/HV, HC/HV	Soil Wash, Dechlorination, & In-Situ Immobilization	$421

* The assignment of treatment technologies reflects the LDR standards and other factors, including potential site-specific risk-based cleanup goals.

Exhibit 2-5
Sediment Treatment Technologies and Costs

Constituent Type	Concentration/ Volume	Treatment*	Cost/Ton (1997$)
VOCs	LC/LV, LC/HV, HC/LV, HC/HV	Ex-Situ Bioremediation	$91
SVOCs	LC/LV, LC/HV, HC/HV	Ex-Situ Bioremediation	$91
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,074
AHCs	LC/LV, LC/HV	Ex-Situ Bioremediation	$91
	HC/HV	Soil Wash & Dechlorination	$327
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,074
Metals	LC/LV, LC/HV, HC/LV, HC/HV	Ex-Situ Immobilization	$181
VOCs and SVOCs	LC/LV, LC/HV, HC/HV	Ex-Situ Bioremediation	$91
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,074
VOCs and AHCs	LC/LV, LC/HV, HC/HV	Ex-Situ Bioremediation	$91
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,074
VOCs and Metals	LC/LV, LC/HV, HC/LV, HC/HV	Ex-Situ Bioremediation and Ex-Situ Immobilization	$255
VOCs, SVOCs, and Metals	LC/LV	Ex-Situ Bioremediation and Ex-Situ Immobilization	$255
	LC/HV, HC/HV	Soil Wash, Ex-Situ Bioremediation, and Ex-Situ Immobilization	$374
	HC/LV	75% Incineration & Immobilization of Ash & 25% Thermal Desorption	$1,079
VOCs, SVOCs and AHCs	LC/LV, LC/HV	Ex-Situ Bioremediation	$91

Constituent Type	Concentration/ Volume	Treatment*	Cost/Ton (1997$)
	HC/HV	Soil Wash and Ex-Situ Bioremediation	$210
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,074
VOCs, AHCs, and Metals	LC/LV, LC/HV	Ex-Situ Bioremediation and Ex-Situ Immobilization	$255
	HC/HV	Soil Wash, Dechlorination, and Ex-Situ Immobilization	$491
	HC/LV	75% Incineration & Immobilization of the Ash & 25% Thermal Desorption	$1,079
VOCs, SVOCs, AHCs, and Metals	LC/LV, LC/HV	Ex-Situ Bioremediation and Ex-Situ Immobilization	$255
	HC/HV	Soil Wash, Dechlorination, & Ex-Situ Immobilization	$491
	HC/LV	75% Incineration & Immobilization of the Ash & 25% Thermal Desorption	$1,079
SVOCs and AHCs	LC/LV	Ex-Situ Bioremediation	$91
	LC/HV	Soil Wash & Ex-Situ Bioremediation	$210
	HC/HV	Soil Wash & Dechlorination	$327
	HC/LV	75% Incineration & 25% Thermal Desorption	$1,074
SVOCs and Metals	LC/LV, LC/HV	Ex-Situ Bioremediation and Ex-Situ Immobilization	$255
	HC/LV, HC/HV	Soil Wash, Ex-Situ Bioremediation, & Ex-Situ Immobilization	$376
SVOCs, AHCs, and Metals	LC/LV	Ex-Situ Bioremediation and Ex-Situ Immobilization	$255
	LC/HV	Soil Wash, Ex-Situ Bioremediation, & Ex-Situ	$376

Constituent Type	Concentration/ Volume	Treatment*	Cost/Ton (1997$)
		Immobilization	
	HC/HV	Soil Wash, Dechlorination, & Ex-Situ Immobilization	$491
	HC/LV	75% Incineration & Immobilization of the Ash & 25% Thermal Desorption	$1,079
AHCs and Metals	LC/LV	Ex-Situ Bioremediation and Ex-Situ Immobilization	$255
	HC/LV	75% Incineration & Immobilization of the Ash & 25% Thermal Desorption	$1,079
	LC/HV, HC/HV	Soil Wash, Dechlorination, & Ex-Situ Immobilization	$491

* The assignment of treatment technologies reflects the LDR standards and other factors, including potential site-specific risk-based cleanup goals.

2.3 Partitioning the Database

As previously stated, the soil and sediment database represents an extensive compilation of available data on contaminated soil and sediment volumes, constituents, and constituent concentrations for CERCLA remedial actions and RCRA corrective actions. From this extensive characterization of soil and sediment generation, the impacts of the Phase IV rule on soils contaminated with TC metals, mineral processing waste, and previously regulated wastes can be determined. As the different components of the Phase IV rulemaking will affect soil and sediments contaminated with different wastes, EPA partitioned the database into three groups. (The Agency did not address media exhibiting the characteristic of ignitability, corrosivity, or reactivity because these media volumes are small and are assumed to be not significantly affected by Phase IV.)

Soils and sediments exhibiting the TC for organics. As required by the Phase II LDR rulemaking, all wastes exhibiting the TC for organics currently must treat all UHCs to UTS levels. The new soil standards will relax the soil treatment standards to 10 times UTS or 90 percent reduction. Thus, facilities generating TC organic soils (including those soils that are TC for both organics and metals) may recognize a cost savings because they can use less expensive innovative technologies to treat soils to the less stringent LDR levels. Thus, all soils exhibiting the TC for organics or the TC for both organics and metals are analyzed for potential cost savings under the new soil standards.

Soils and sediments exhibiting the TC for metals only. Prior to this rule, LDR treatment standards for soils exhibiting the TC for metals were set at TC levels; all UHCs were not required to be treated. The Phase IV rule revises the UTS levels for 12 metal constituents and requires that TC metal soils be treated for all UHCs to the new soil standards. Soils exhibiting the TC for metals only, can, and often do, contain organic UHCs at less than TC levels. Facilities generating soils exhibiting the TC for metals only that contain organic UHC's may see additional costs from any treatment required for these organic UHCs.

Soils and sediments contaminated with listed waste. Database volumes that do not exhibit the TC for organics or metals may be contaminated with listed wastes and therefore hazardous or may be determined not to contain hazardous waste. If considered hazardous and subject to RCRA Subtitle C standards if excavated, these volumes may be subject to either increased or decreased treatment costs. Treatment costs for some volumes of soil and sediment may increase because Phase IV requires treatment of all hazardous constituents reasonably expected to be present, rather than just the hazardous constituents identified in 40 CFR 268.40 for the listed wastes contained in the soil. Treatment costs may decline for other volumes of soil because the new soil treatment standards relax required treatment levels from UTS to 10 times UTS or 90 percent reduction.

Available data did not indicate whether soil and sediment in the database were hazardous because they exhibited the TC or were contaminated with listed waste. Thus, EPA identified soil and sediment in the database exhibiting the TC by calculating soil and sediment concentrations equivalent to the TC regulatory levels found in Table 1 of 40 CFR 261.24. To calculate the equivalent soil concentrations from the TC levels, EPA estimated constituent leaching behavior using the Organic Leaching Model (OLM) for organics and constituent-specific $C_{SOIL}:C_{TCLP}$ ratio for metal.

If all of the constituents with TC levels have calculated maximum concentrations below those levels, then the entire site is assumed to be contaminated with listed waste. For sites that have at least one constituent calculated above TC levels, only a portion of the soil may be considered to exhibit the TC. The proportion of the contaminated soil above TC levels was estimated by the following functional relationship, which was derived from a regression analysis of detailed data available for a limited number of CERCLA remedial action sites:[10]

$Y = X^3$; where:

Y = Proportion of site above the TC level; and

$X = (MC - TC)/MC$; where:

MC = Maximum constituent concentration detected in the site, and

TC = TC level.

Analysis of SURFER[11] data yielded the $Y = X^3$ relationship based on an evaluation of both the theoretical fit and the statistical fit of different functional relationships. The theoretical relationship between X and Y should produce an intercept value of zero and a dependent variable coefficient of 1. The intercept

[10] See "Revised Approach to Estimating Proportions of CERCLA and RCRA Corrective Action Remediation Wastes Above and Below Bright Line Levels," memorandum to Lyn Luben, Office of Solid Waste, U.S. Environmental Protection Agency by ICF Incorporated, July 29, 1994.

[11] The SURFER software is a modeling tool that uses a statistical modeling process called the "minimum curve method" to draw constituent concentration contour lines for remediation sites.

should be zero to ensure that Y equals zero when X equals zero (i.e., there is no area above the TC level when the maximum contaminant level equals the TC level). The dependent variable coefficient should equal 1 to ensure that Y approaches 1 as X approaches 1.

To test for the appropriate statistical relationship, EPA ran the regression analyses of Y as a function of X^2 and X^3. The X^3 relationship was the strongest statistical fit, yielding an R^2 of 80 percent for 42 observations generated by SURFER analysis of a limited number of sites with detailed ROD data. EPA also generated 1,248 observations by using the Monte Carlo simulation of site data based on empirical site characteristic data from DOE's Superfund Reauthorization (SURE) model. The statistical fit (R^2) demonstrated by the SURE model was 85 percent. These data indicate that the functional relationship derived from limited SURFER data is consistent with the field data used in the SURE model preprocessor.

By definition, the value of X is greater than zero and less than one for any maximum constituent concentration above the TC level, and the value of X approaches 1 when the maximum concentration is very high relative to the TC level for that constituent. Therefore, the functional relationship used to estimate the value of Y ($Y = X^3$) ensures that Y is also a fraction that approaches 1 when the maximum constituent concentration is very high relative to the TC level for that constituent. This relationship is consistent with the expectation that a substantial proportion of contaminated soil will be above TC levels at those sites where maximum concentrations are substantially higher than TC levels. Conversely, the values of X and Y approach zero when the maximum constituent concentration is just slightly higher than the TC level for that constituent. This relationship is consistent with the expectation that a relatively small proportion of contaminated soils will be above TC levels at sites where maximum concentrations just barely exceed TC levels.

If there are multiple constituents in a treatability group, the constituent with the highest X value is used to determine the volume managed in that treatability group. In addition, the X and Y values defined above must be calculated for each treatability group associated with each volume. For example, if the constituents in a certain volume include both metals and VOCs, then X and Y values must be calculated for the maximum constituent concentrations in each of these treatability groups. If these calculations indicate that 70 percent of the soil volume is above the TC level for VOCs and 20 percent is above the TC level for metals, then this analysis assumes that 20 percent of the site soil volume incurs treatment costs for soil contaminated with both metals and VOCs, and 50 percent of the site soil volume incurs treatment costs for soils contaminated with VOCs only. In effect, this methodology recognizes that different treatment technologies may be used for different portions of a site that have different combinations of contaminants above TC levels.

The methodology for allocating volumes to be above or below TC levels was performed separately for CERCLA remedial action soil, RCRA corrective action soil, and CERCLA remedial action sediment. The results are presented below in Exhibit 2-6. They show that CERCLA soil tend to have higher levels of TC metals and lower levels of TC organics than RCRA soils.

Exhibit 2-6
Partitioned Database Volumes
(Includes Volumes Managed In-Situ and Ex-Situ)

Type of Media	Portion of Database Volumes		
	TC Metals Only	**TC Organics**	**Non-TC (Listed)**
CERCLA Soil	20%	12%	68%
RCRA Soil	7%	18%	75%
CERCLA Sediment	22%	N/A	N/A

2.4 Estimating Amount of Soil and Sediment Subject to LDRs Annually

Hazardous soil and sediment are subject to the LDRs and may be affected by the Phase IV rulemaking if these media are managed ex-situ and are not in a corrective action management unit (CAMU) or an area of contamination (AOC). To estimate the impacts of the final rule on the treatment of such media, EPA estimated the annual generation of contaminated soil subject to the LDRs from the following remediation programs:

- Remedial actions under CERCLA;
- Corrective actions under RCRA;
- Closure of hazardous waste management units at RCRA treatment, storage, and disposal facilities (TSDFs);
- State superfund cleanup programs; and
- Voluntary cleanup programs.

In addition, the Agency estimated the generation of contaminated sediment from CERCLA remedial actions and RCRA corrective actions. The other cleanup programs are not expected to generate large volumes of contaminated sediments.[12]

[12] In addition, the HWIR-Media proposed rule would exclude hazardous sediment dredged from navigable water and managed under the Clean Water Act or Marine Protection, Research, and

To estimate the incremental costs and cost savings of the rule, the Agency projected the volumes of soil and sediment to be treated annually over the five-year period following implementation of the final rulemaking, that is, the first five-year period when the remediation decisions reflect the new rules. The Agency used this medium-term estimate because of the uncertainties associated with longer-term projections and the pace with which the rule will be fully implemented and reflected in the use of different treatment methods. Longer-term projections are subject to substantial uncertainties, such as government remediation and enforcement budgets, potential changes in the CERCLA statute and budget, and the demand for restoring economically valuable contaminated properties (e.g., Brownfields).

The pace of implementation is subject to two major types of uncertainty. First, the pace at which states adopt and implement the less stringent alternative soil standards is uncertain. States are not required to adopt less stringent RCRA rules, such as the new soil treatment standards. Second, the pace at which remedy selection decisions reflect the new rules and are implemented is also uncertain. Because of the time period between remedy selection and remedy constructions, treatment technologies selected after the Phase IV rules are finalized may not result in soil treatment for substantially more than a year. Remedies selected but not implemented before the rules become effective may not be revised to take advantage of any less stringent standards. Some remedies, however, may need to be revised where the Phase IV rules are more stringent.

The Agency used a wide variety of data sources to develop the annual generation estimates. Exhibit 2-7 presents the estimated annual volumes of contaminated soil and sediment treated at CERCLA remedial actions, RCRA Subtitle C corrective actions, RCRA Subtitle C closures at disposal facilities, RCRA Subtitle C closures at treatment and storage facilities, state Superfund cleanups, and voluntary cleanups. These data sources are described below.

Considerably more data were available to characterize the CERCLA remedial action and RCRA corrective action programs than were available to characterize the other remediation programs. For CERCLA, the Agency used the following data sources for the data elements identified in Exhibit 2-7.

Sanctuaries Act from application of RCRA Subtitle C standards.

Exhibit 2-7
Contaminated Soil and Sediment Treated Annually

iation Category	Site Equivalents/ Year Remediated	Site Equivalents/ Year with Soil/Sediment Treatment	Average Tons Treated/ Site	Annual Tons Treated	Annu Treated CAMUs
emedial Action Soil	70	30	28,000[a]	840,000[a]	
ective Action Soil	115	111	7,400[a]	820,000[a]	
ures Soil (Landfills)	40	40	3,900	160,000	
ures Soil Treatment Facilities)	240	199	1,100	220,000	
fund Soil	510	464	280	130,000	
leanup Soil	830	614	830	510,000	
.S	1,805	1,458	NA	2,680,000	
ediment	70	15	9,700	150,000	
ective Action	130	8	9,700	80,000	
OTALS	200	13	NA	230,000	

olumes treated in-situ, which are not subject to LDRs and therefore are not projected to be affected by Phas
d AOC adjustment: 72 percent of the volume of CERCLA remedial action, RCRA corrective action, and RCI
ted in CAMUs or AOCs.

- *Site Equivalents Remediated per Year*. The estimated number of CERCLA remedial actions equivalents[13] per year was based on two data sources. First, EPA Superfund Remedial Program Managers, who oversee CERCLA remedial actions, projected that an average of 109 remedial actions will have completed construction per year over the period from 1996 to 2000.[14]

[13] The term site "equivalent" recognizes that media may be treated at a site over a period of several years. For example, if six sites of equal size were cleaned up over a two-year period, the pace of cleanup would be three site equivalents per year.

[14] See Letter from Elliot P. Laws to Congressman John D. Dingell, January 2, 1994 (OSWER Directive 9200.2-21).

Second, the EPA report entitled "Clean Up the Nation's Waste Sites: Market and Technology Trends" (hereinafter cited "Market and Technology Trends") noted that in recent years, the Agency has added an average of 30 new remedial action sites to the National Priority List (NPL).[15] If this rate continues and remedial action occurs at all these NPL sites, then an average of 30 sites per year will be remediated. For this analysis, the two numbers were averaged ((109 + 30)/2 = 70).

- *Site Equivalents with Soil or Sediment Treatment*. This figure was estimated by multiplying the number of site equivalents cleaned up per year by (1) the percentage of these sites with soil or sediment contamination (72 and 22 percent, respectively) and (2) the percent of such sites with treatment remedies, instead of source control remedies such as capping, institutional controls, monitoring, or relocation (60 and 100 percent, respectively). All these percentages were taken from "Market and Technology Trends" data.[16] While these two sets of figures were for non-federal remedial action sites between 1982 and 1995 and 1992 to 1995, respectively, EPA believes that these data are reasonable to use for federal and non-federal sites remediated in the five years after the Phase IV rule is implemented.

[15] 1996 Edition, U.S. EPA, Office of Solid Waste and Emergency Response, #EPA 542-R-96-005. April 1997.

[16] The estimate that all Superfund sites with contaminated sediment are treated ex-situ reflects an assumption that such sediment is seldom managed in-situ, but rather is excavated and treated.

- *Average Volume Treated per Site*. The estimates of 28,000 tons of soil and 9,700 tons of sediment per site were taken from the remedial action sites in the soil and sediment database described earlier. Although the volume of soil includes soil managed both in-situ and ex-situ, the LDRs do not apply to soil managed in-situ and such volumes are not attributed any costs or cost savings in this analysis (see the methodology for a further discussion of this issue).

- *Portion of Annual Volume Managed Outside of CAMUs and AOCs*.[17] Based on the preceding estimates, 840,000 tons of contaminated soil will be treated annually at CERCLA remedial action sites. Using previous analysis of the CAMU rulemaking, EPA estimates that 72 percent of this soil will be managed in CAMUs or AOCs and therefore will not be subject to the LDRs or affected by Phase IV.[18] Thus, about 240,000 tons per year of CERCLA remedial action soil are potentially affected by the Phase IV rule. The entire volume of contaminated sediment, 60,000 tons/year, is assumed to be treated outside of CAMUs and AOCs.

The RCRA corrective action estimates are based primarily on several analyses of corrective action rules by the Office of Solid Waste, as described below.

- *Sites Remediated per Year*. The estimated number of RCRA corrective actions per year was based on EPA analysis of the RCRA corrective action program.[19] Specifically, the Agency

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[17] This methodology assumes full implementation of the CAMU rule as projected by the CAMU RIA. While available data indicate more limited adoption of CAMUs, EPA expects the use of CAMUs to increase, particularly if a lawsuit regarding the rule is decided in favor of the rulemaking.

[18] RCRA Subtitle C regulations are generally considered as applicable or relevant and appropriate requirements (ARARs) at CERCLA remedial actions. As a result, CERCLA remedial actions are generally conducted in compliance with RCRA Subtitle C standards and may take advantage of the flexibility offered by the CAMU rule. EPA's analysis of the CAMU rule estimated that 72 percent of RCRA corrective action soil would be managed in CAMUs. See, Regulatory Impact Analysis for the Final Rulemaking on Corrective Action Units and Temporary Units, U.S. EPA, Office of Solid Waste, January 11, 1993. This analysis uses the same percentage for CERCLA remedial actions since media in both programs also can be managed in CAMUs or AOCs.

[19] "Draft Regulatory Impact Analysis for the Final Rulemaking on Corrective Action for Solid Waste Management Units: Proposed Methodology for Analysis," U.S. EPA, Office of Solid Waste, March 1993.

projected that 2,289 facilities would be subject to corrective action over a 20-year period or 115 facilities per year.

- *Portion of Sites with Soil or Sediment Treatment*. Based on the RCRA corrective analysis, 97 percent or 2,227 of the 2,289 RCRA corrective action facilities (or 111 facilities per year over 20 years) would be subject to source control or soil treatment. Data on sediments were not directly available from the corrective action analysis. Instead, EPA used data from the "Market and Technology Trends" indicating that historically, only 6 percent of corrective actions have sediment contamination.

- *Average Volume Treated per Site*. The estimate of 7,400 tons of soil treated per site was taken from EPA's RCRA corrective action analysis. For sediments, EPA used the estimate for CERCLA remedial action, 9,700 tons per site, in the absence of RCRA sediment data.

- *Portion of Annual Volume Managed Outside of CAMUs*. This step used the same estimates that were applied to CERCLA remedial action sites. Seventy-two percent of contaminated soil is estimated to be treated outside of CAMUs and AOCs, which are assumed not to be used for contaminated sediment.

Fewer data were available for RCRA closures, state superfund cleanups, and voluntary cleanups than for CERCLA remedial actions and RCRA corrective actions. For these programs, EPA used the decision science technique of expert judgment elicitation to estimate key quantities when reliable data were not otherwise available. This structured process included the following steps:

- Select the parameters to be estimated by the experts;
- Identify experts for possible interviews;
- Prepare background information and supply to the selected experts;
- Conduct the elicitation interviews; and
- Compile the results and apply statistical analysis.

Rather than asking experts to directly estimate the total volume of soil and sediment managed annually, EPA elicited estimates for more fundamental parameters that affect total volumes, such as the remedial time frame, the projected number of sites with remediations over the time frame, the percent of sites with contaminated soil or sediment, and the average volume of soil or sediment managed at individual sites. Attempting to directly estimate total annual soil and sediment volumes can be less accurate because it requires simultaneous consideration all factors that might affect total volumes. Through direct experience or knowledge, experts are more likely to provide accurate estimates of more basic variables. EPA therefore used these fundamental parameters to generate total volume estimates.

EPA identified persons from government, industry, and academia who possessed expertise in CERCLA, RCRA, state, and voluntary cleanup activities. EPA also developed a set of initial estimates of the parameters identified above for each type of remediation program, including RCRA landfill closures, RCRA treatment and storage facility closures, state superfund cleanups, and voluntary cleanups. Preliminary estimates of the parameters affecting annual soil and sediment volumes were sent to experts with an accompanying letter that provided background information. The initial estimates were generated using a variety of remediation data sources.

Annual volumes of contaminated soil and sediment were calculated using the experts' estimates of the remedial time frame, the projected number of sites with remediations over the time frame, the percent of sites with contaminated soil or sediment, and the volumes of media generated at individual sites over the remedial time frame. Because their estimates of these parameters were subject to considerable uncertainty, EPA used DEMOS modeling software to calculate the annual volume of soil and sediment as a function of the parameters estimated by the experts. DEMOS is a decision modeling application that creates an estimate of a desired quantity, such as the total annual volume of soil for state superfund cleanups, that depends on uncertain factors. For each remediation program, DEMOS calculated a probability distribution using the individual expert responses for each of the uncertain input parameters. The software was then used to generate the probability distribution of the annual volume of soil and sediment for each remediation category.

In a few cases, EPA subsequently found data sources that were used instead of the expert judgments. For example, the estimated number of state superfund cleanups per year (510) is based on data from "An Analysis of State Superfund Programs: 50-state Study, 1995 Update," Environmental Law Institute, December 1995. In addition, EPA assumed that soil and sediment at state and voluntary cleanups would be treated off-site to avoid the need for RCRA treatment permits and the associated requirements for facility-wide corrective action. As a result, none of these volumes are assumed to be managed in AOCs or CAMUs.

2.5 Estimating Baseline Soil and Sediment Treatment Costs

In order to model the incremental costs and cost savings of the Phase IV rule, EPA estimated the cost of treating soils and sediments under current requirements. To estimate these baseline costs, the Agency first applied the treatment methods and costs explained in Sections 2.2 to the CERCLA remedial action and RCRA corrective action sites in the soil and sediment database. This step calculated a per ton cost of treating soil and sediment under each program.

Second, the Agency used these per ton costs to estimate the annual treatment cost for soil and sediment potentially affected by Phase IV under the various remediation programs. In this extrapolation from the database sample to the national universe:

- The average CERCLA remedial action ex-situ treatment cost per ton was multiplied by the estimated annual amount of soil ex-situ treated in CERCLA remedial actions, state superfund cleanups, and voluntary cleanups. In other words, soil contamination at state Superfund and voluntary cleanup sites are assumed to have similar types and concentrations of contaminants as CERCLA remediation action sites. State Superfund and voluntary sites, however, have considerably smaller average volumes per site.

- The average RCRA corrective action ex-situ treatment cost per ton was multiplied by the estimated annual amount of soil treated ex-situ in RCRA corrective actions and RCRA closures. Thus, the nature of the contamination at RCRA closures and corrective actions is assumed to be similar.

- The average RCRA corrective action treatment cost per ton also was multiplied by the annual amount of sediment treated in RCRA corrective actions.

- Sediment contaminant data for RCRA corrective actions were unavailable. Thus, EPA assumed that such contamination was more similar to soil contamination for RCRA corrective action sites than sediment contamination for CERCLA remedial action sites.

2.6 New Soil Treatment Standards

As explained earlier, the Phase IV new soil treatment standards will make the treatment standards for contaminated soils less stringent. EPA expects that ex-situ treatment of soil outside of CAMUs or AOCs will shift in three ways:

- To less effective and less expensive treatment;
- To no treatment; and
- To more effective and more expensive treatment.

Each of these impacts on the cost of treating affected contaminated soils is explained below.

Less Effective and Expensive Treatment

The new soil standards will be less stringent than the current standards for soils with hazardous constituents, which require treatment to UTS levels. Under Phase IV, constituents must be treated only to 10 times UTS or to achieve 90 percent reduction in their concentrations, which ever concentration is less stringent. As a result, some remediation decision makers will select cheaper, but somewhat less effective, innovative ex-situ technologies instead of established and more expensive, but also more effective, ex-situ technologies (particularly incineration). This substitution, and the resulting cost savings, will occur only if the less expensive technology can meet any site-specific risk-based cleanup standards as well as the new soil treatment standards.

No Treatment

Soils containing only hazardous constituents with concentrations below 10 times UTS that also meet risk based standards will not be required to be treated under the new soil standards. Where such soils are currently required to be treated to UTS levels, treatment costs may be completely avoided under Phase IV, if the soils meet the conditions explained above. Soils with constituent concentrations above risk-based levels will still require treatment to meet site-specific cleanup goals.

More Effective and Expensive Treatment

For soils that do not exhibit a characteristic but are hazardous because they contain listed waste, the new soil treatment standards may be more stringent than the current requirements.[20] Under Phase IV, non-TC hazardous soils must be treated for all UHCs, not just for the constituents for which the wastes were listed (i.e., the primary constituents), as specified in 40 CFR 268.40. However, EPA

[20] Soil containing listed waste and exhibiting the TC for organics is not subject to more stringent standards because it currently must be treated for all UHCs by virtue of being TC for organics.

does not believe that the additional costs for treating these soils will be significant because:

- Non-listed constituents will typically not be present in non-TC soils containing listed waste at levels exceeding 10 times UTS; or

- Non-listed constituents may already be treated to new soil standard levels because of their site-specific risks or incidentally as a result of intentional treatment for the listed constituents.

2.6.1 Methodology for Estimating Cost Savings or Cost

This section describes the methodology for estimating the three types of impacts of the new soil treatment standards on two categories of hazardous soil: soil that exhibits the TC for organics and soil that does not exhibit the TC, but is assumed to be hazardous because it contains listed waste. The impact of the new standards on soils that are TC only for metals is addressed in Section 2.8.

Less Effective and Expensive Treatment

Soil that is hazardous because it exhibits the TC for organic constituents is most likely to be affected by the new soil standards. Currently, all UHCs in these soils must treated to UTS levels. Under the new soil standards, the TC organic constituents and all UHCs will be subject to less stringent standards of 10 times UTS or 90 percent reduction of the original constituent concentration.

EPA believes that the primary result of the less stringent treatment standards will be that some soils currently incinerated will be treated by less expensive ex-situ treatment methods (e.g., soil washing, dechlorination, and bioremediation). The Agency believes that this will occur because innovative treatment technologies will provide a more appropriate and less costly way to meet the new soil standards.

To estimate the cost savings for TC organic soils under the new soil treatment standards, EPA performed the following four steps:

First, EPA estimated the volume of TC organic soil that will switch from higher-cost ex-situ treatment technologies, such as incineration or thermal desorption, under the baseline to less expensive ex-situ treatment technologies, such as ex-situ bioremediation, under the new soil standards. The Agency estimated this volume by changing two of the baseline assumptions. First, EPA assumed that hazardous constituents with concentrations below the lesser of 10 times UTS or the TC level will not be treated under Phase IV, except incidentally as the result of treating other constituents above such levels. As described below, all TC organic soil volumes will still be treated, but they may be treated for fewer types of constituents. The Agency used the lesser of 10 times UTS or the TC level because 10 times UTS is above TC levels only for a few constituents (primarily metals) and, in such cases, facilities are likely to treat soils that are above the TC level but meet LDR standards to TC levels so that the treated soil can be disposed of outside the Subtitle C system.

The second assumption the Agency changed was the dividing point for high and low concentration, which was increased from 100 to 200 times UTS for organic constituents. By increasing the cutoff, additional volumes of soil are considered as low concentration and projected to be treated with less effective, but also less expensive, innovative technologies that can meet the new 10 times UTS or 90 percent reduction standard. EPA expects that the affected volumes will tend to have the lowest levels of contamination of all soils that are treated by the more effective technologies (that is, the lowest concentration segment of the soil in the high concentration category). The shift from 100 to 200 times UTS captures these volumes.

Changing these two assumptions shifts some CERCLA soil from incineration or thermal desorption to less expensive ex-situ treatment technologies. Specifically, about half of CERCLA TC soils (but only 10 percent of all CERCLA soils) managed ex-situ are projected to be treated with incineration or thermal desorption in the baseline. Fourteen percent of these soils, or about seven percent of all CERCLA soils managed ex-situ, are projected to shift to less expensive treatment under Phase IV. Negligible quantities of CERCLA soil shifted from other higher cost to lower cost ex-situ treatment methods.

For RCRA, negligible amounts of soil shifted treatment categories. Only 18 percent of RCRA soil exhibits the TC for organics and less than one percent of that soil was projected to be incinerated or thermally desorpted. As a result, the remaining steps in the methodology were not applied to RCRA soil. In addition, the following steps focus on changes from incineration/thermal desorption to less expensive treatments because the results of step one did not identify any other significant shifts among treatment methods, even though such shifts are feasible.

Second, the Agency calculated the per ton cost savings for the volumes that shifted from incineration or thermal desorption in the baseline to less expensive ex-situ treatments under Phase IV. The average baseline treatment cost for such soils was $1,064/ton and the average post-regulatory treatment cost was $464/ton, for an average incremental per-ton savings of $600 ($1,064-$464).

Third, EPA applied this per-ton cost savings to TC organic soils treated at CERCLA, state superfund, and voluntary cleanup volumes that are anticipated to switch from incineration/thermal desorption to other ex-situ treatment methods as a result of this rule. Specifically, the $600/ton savings was applied to TC organic soils that are expected to be managed ex-situ and outside a CAMU or AOC, times the portion of these volumes that are incinerated or thermally desorpted in the baseline (52 percent), times the portion of the incinerated or thermally desorpted volumes that shift to other treatment methods (14 percent).

Soil that is hazardous solely because it contains listed waste (or non-TC hazardous soil) may also incur a similar cost savings due to soils switching to less expensive treatment methods. Currently, the listed constituents in such soils must be treated to UTS levels. Under Phase IV, these soils will be subject to the relaxed new soil treatment standards. Any other hazardous constituents in the soil (i.e., UHCs), however, will be subject to the LDRs for the first time under Phase IV. Because the available constituent data for CERCLA remedial actions and RCRA corrective actions do not distinguish between listed and non-listed constituents, it is impossible to determine which constituents are listed constituents. For this reason, this analysis estimates the savings by assuming that the portion of soil incinerated or thermally desorpted in the baseline that shifts to less expensive treatment under Phase IV (14 percent), and the average cost savings per ton ($600/ton) are the same for soil exhibiting the TC for organics and soil contaminated with listed wastes.

No Treatment

As described earlier, some contaminated soil that is treated in the baseline may not require treatment under the new soil treatment standards. This result will not typically occur for TC organic soil, because, as noted above, facilities are expected to treat their TC soils so that they will be non-hazardous and will not have to be disposed of in a Subtitle C facility. A shift to no treatment, however, may occur for soil that is hazardous only because it contains listed waste.

In order to dispose of soils containing listed waste that meets risk-based levels, facilities will have to obtain a contained out determination. EPA believes that obtaining this determination will be a fairly straightforward exercise, since much of the work associated with obtaining the determination will already have been performed during site characterization. To the extent that obtaining the contained out determination will reduce the cost savings of non-TC soils, this analysis overestimates the savings.

EPA believes that the following methodology likely underestimates the savings associated with soils requiring no treatment because soil contaminated at low levels that are treated in-situ in the baseline could be excavated and disposed of off-site in a Subtitle D facility if they meet 10 times UTS levels and Subtitle D disposal is less expensive than in-situ treatment (which it generally is). However, many state superfund or voluntary cleanup programs have a preference for treatment that may minimize such shifts. In any case, this analysis does not estimate the savings associated with shifts from in-situ to ex-situ treatment.

To quantify the cost savings for these soils, EPA performed a number of steps. **First,** the Agency estimated the volume of non-TC CERCLA and RCRA soil in the database by isolating sites that have non-TC volumes and subtracting the volume of TC soil from the total site volume. The resulting total CERCLA non-TC volume in the database was estimated to be 5,938,000 tons, or 68 percent of the total CERCLA volume, and the total RCRA non-TC volume in the database was estimated to be 23,417,000 tons, or 75 percent of the total RCRA volume.

Second, the Agency estimated the volume of non-TC CERCLA and RCRA soil in the database contaminated with constituents present at below concentrations of 10 times UTS. To accomplish this, the Agency:

- Determined, for each site with non-TC soil, which constituent had the highest constituent concentration, relative to UTS levels.

- Estimated, for each site with non-TC soil, the volume of soil contaminated with the most highly concentrated constituent (determined in the previous step) at higher than 10 times UTS levels, using the methodology described in Section 2.3 and substituting 10 times UTS for UTS levels.

- Estimated the volume of soil at each site below 10 times UTS levels by subtracting the volume of soil calculated in the previous step from the total site volume. This step assumes that soils contaminated with the most highly concentrated constituent at the site at levels above 10 times UTS will include all soils contaminated with other constituents above 10 times UTS.[21] The total volumes of non-TC CERCLA and RCRA soil in the database with constituent concentrations below 10 times UTS were 780,000 and 1,749,000 tons, respectively.

Third, EPA estimated the volume of database soils below 10 times UTS that are expected to be treated ex-situ by assigning treatment methods using the methodology described in Section 2.2. Ex-situ volumes with concentrations below 10 times UTS were estimated to be 408,000 tons for CERCLA and 1,004,000 tons for RCRA.

Fourth, EPA estimated the percentage of all non-TC CERCLA and RCRA soils treated ex-situ that fell out of RCRA Subtitle C regulation by dividing the database volume of non-TC soils treated ex-situ with constituent concentrations below 10

[21] See Section 2.3 for more details regarding how soil volumes were estimated.

times UTS (calculated in the previous step) by the total volume of non-TC soil treated ex-situ. The total volume of non-TC soil treated ex-situ was estimated by applying the overall baseline percentage of CERCLA and RCRA soils treated ex-situ (58 and 48 percent for CERCLA and RCRA soils, respectively) to non-TC soils.[22] The resulting ex-situ, non-TC volumes were 3,444,000 tons for CERCLA (5,938,000 X.58) and 11,240,000 tons for RCRA (23,417,000 X.48).

The formula used for estimating the percentage of non-TC RCRA and CERCLA soils treated ex-situ that fall out of Subtitle C regulation was as follows:

[22] The percentages of CERCLA and RCRA soils treated ex-situ in the baseline (58 percent for CERCLA and 48 percent for RCRA) were used here because the model was unable to directly project how non-TC soils will be treated.

$$\frac{\text{Non-TC soil volume treated ex-situ} < \text{10 times UTS}}{\text{Non-TC soil volume treated ex-situ}}$$

For CERCLA, the percentage was estimated to be 12 percent (408,000 / 3,444,000). For RCRA, the percentage was estimated to be 9 percent (1,004,000 / 11,240,000).

Fifth, EPA estimated the per ton cost savings for the soils expected to fall out of RCRA Subtitle C regulation. To accomplish this, the Agency subtracted the estimated cost of Subtitle D disposal ($55) from the estimated per ton cost of treating soils with concentrations below 10 times UTS under the baseline ($285 for CERCLA and $169 for RCRA[23]). The cost of Subtotal D disposal was estimated to be approximately $55 per ton. This estimate includes costs of excavation, waste transport, and landfill tipping fees. Soil excavation costs were assumed to be approximately $16 per ton. Waste transport costs were estimated to average $5 per ton, based on analysis indicating that Subtitle D transport costs are approximately four to seven dollars per ton for every 100 miles of truck or rail hauling.[24] A $34 per ton landfill tipping fee estimate reflects a recent nationwide survey estimate.[25] The resulting per ton cost savings for CERCLA and RCRA were $230 and $114 per ton, respectively.

Sixth, EPA applied the percentages calculated in step four and the per-ton cost savings calculated in step five to non-TC soils generated by various remediation programs. Specifically, the 12 percent and $230 figures were applied to non-TC soils generated at CERCLA, state superfund, and voluntary cleanup sites and the nine percent and the $114 figures were applied to RCRA corrective action and closure sites.

More Effective and Expensive Treatment

The third type of impact of the new soil treatment standards, more effective and expensive treatment, applies only to soil that is hazardous because it contains listed waste. This impact will arise only if the following conditions are met:

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[23] The costs of treating soils with concentrations less than 10 times UTS under the baseline was calculated using the soil and sediment model. Because all volumes expected to fall out of regulation are expected to only have low-concentrations of constituents present, all volumes were assigned the treatment cost appropriate for low-concentration soils.

[24] Konheim and Ketchum, "Exporting Waste: A Report on Locations, Quantities, and Costs of Out-of-State Disposal of New York City Commercial Waste," April 1991.

[25] "The State of Garbage," Biocycle, April 1995, page 2-38.

- The soil contains hazardous constituents that are not listed constituents at levels exceeding 10 times UTS;

- Any current treatment methods do not meet the new soil standards for such constituents; and
- After being treated using current methods, the soil is considered hazardous under the contained-in policy.

The Agency believes that these conditions will seldom arise for the following reasons:

- Contaminated soil, particularly at the older, more expensive to remediate CERCLA remedial action and RCRA corrective action sites, will seldom be found to contain listed wastes. This soil will often be classified as hazardous because it exhibits a characteristic, rather than because it contains listed waste. Soil at these sites may seldom be classified as listed because of the difficulty of identifying specific listed wastes disposed of many years ago.

- The hazardous constituents most likely to be present in such soil and to present a risk to human health and the environment are the listed constituents, which already must be treated to UTS levels.

- Where soil contains non-listed UHCs, the required treatment of the listed UHCs or other constituents posing site-specific risks may bring the non-listed constituent concentrations to levels that are below 10 times UTS or contained-in levels.

EPA did not estimate the increased costs resulting from applying the LDRs to non-listed UHCs in soil that does not exhibit a characteristic. For the reasons described above, these incremental costs are likely to be small. In addition, estimating such costs would be difficult because the available constituent data for CERCLA remedial action and RCRA corrective action sites does not distinguish between listed and non-listed constituents. As a result, it is impossible to determine which constituents are listed constituents.

2.7 Media Contaminated With Mineral Processing Wastes

Media contaminated with newly regulated mineral processing wastes, which include wastes from the processing of ores and minerals, must be treated on-site to TC levels before disposal into a Subtitle D unit.[26] These media are not required to comply with LDR requirements. The Phase IV rule, however, will require media contaminated with newly regulated mineral processing wastes to comply with existing LDR standards for characteristic wastes. Thus, soils containing these wastes must meet the new soil standards and other media must meet the UTS for all UHCs.

As explained in Section 3.1.1 of "Application of Phase IV Land Disposal Restrictions to Newly Identified Mineral Processing Wastes: Regulatory Impact Analysis,"[27] EPA assumes that mineral processing facilities are in full compliance with RCRA Subtitle C requirements (outside of the LDRs) for managing waste materials. Thus, this analysis assumes that all media contaminated with mineral processing wastes that are excavated under RCRA or CERCLA are currently being treated to remove the characteristic, stabilized, and disposed of in a Subtitle D unit.

In order to project the effects of the Phase IV rulemaking on the cost of remediating hazardous media contaminated with mineral processing wastes, EPA:

- Reviewed documentation on the composition of newly identified mineral processing wastes to determine what constituents are found in the wastes;
- Based on the constituents in the media, determined the treatment methods most likely to be used to meet the new standards; and
- Estimated potential cost changes resulting from new treatment methods or additional activities required to meet the new standards.

2.7.1 Composition of Media Contaminated With Newly Identified Mineral Processing Wastes

The vast majority of media contaminated with mineral processing wastes are exempted from Subtitle C and the LDR requirements by the Bevill Amendment of

[26] 54 FR 36592 and 55 FR 2322 required that facilities dispose of such materials in a Subtitle C unit or treat it to TC levels before disposal into a Subtitle D unit.

[27] See footnote 1.

the Solid Waste Disposal Act Amendments (PL 96-482).[28] Of the media that are contaminated with newly identified mineral processing wastes which were brought into the Subtitle C universe in 1990, EPA expects only a small portion to be excavated and thus fall under the LDR requirements. Thus, the only media contaminated with newly identified mineral processing wastes that are potentially affected by the Phase IV rule are those that are excavated and managed outside of a CAMU or AOC. EPA expects that these media contain primarily metal constituents, including cadmium, mercury, arsenic, selenium, chromium, lead, silver, and barium.[29]

2.7.2 Treatment of Media Contaminated with Mineral Processing Wastes

As explained above, EPA assumes that facilities currently treat affected soil and sediment media to TC levels using solidification/stabilization, the most widely used method for treating wastes with metal constituents. EPA anticipates that solidification/stabilization will continue to be the primary method used to treat soil and sediment contaminated with newly identified mineral processing wastes over the period covered by this analysis because it has been found to be effective in treating all metals to UTS levels, except for selenium. Because of the difficulties of treating high concentrations of selenium, media containing this constituent are recognized as likely candidates for a treatment variance under Section 268.44.

The solidification/stabilization process involves mixing the media with reagents that reduce the mobility of its contaminants and/or physically bind or enclose them within a stabilized mass (such as cement). Depending on the chemical and physical properties of the waste, either or both of these methods may be used to prevent leaching. The amount of reagent used depends on the concentration of the waste and the target treatment level.

The results of the final methodology step, examining the potential cost changes resulting from new treatment methods, are discussed in Section 3.3.

2.8 Soil and Sediment that Exhibit the TC for Metals Only

Excavated soils and sediments that are hazardous only because they exhibit the TC for metals are currently treated to site-specific risk-based levels or to the TC level to avoid the requirement to manage treated media in a Subtitle C facility.

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[28] The Bevill Amendment exempts soils generated from the extraction and beneficiation of mineral ores.

[29] See Section 3.1.1, Waste Management Assumptions of Office of Solid Waste, U.S. Environmental Protection Agency

Under Phase IV, all hazardous constituents or UHCs in TC metals soil must be treated to reduce concentrations either to 10 times UTS or UHCs or by 90 percent, and hazardous constituents in sediments must be treated to UTS. Where existing treatments do not meet these new standards, treatment costs may increase.[30] To estimate these incremental costs, EPA performed four analytical steps. The first step explains why any increased treatment costs for the metal constituents in the volumes that are TC for metals only are likely to be low and therefore are not modeled. The other three steps model the increased costs for organic constituents in these volumes.

First, EPA considered the effect of the requirements on metal constituents in soils and sediments that are TC only for metals. Currently, TC metal constituents are treated to below the TC levels or risk-based levels, whichever is lower, while non-TC metal constituents are treated to risk-based levels. Under the Phase IV rule, *all* metal constituents must be treated to the LDR levels. In many instances, however, these constituents will be treated to applicable site-specific risk-based levels or their characteristic levels, if more stringent.

For all metal constituents with TC levels except silver, EPA expects the rule to have no effect on soil treatment. As shown in Exhibit 2-8, the new soil treatment standards are less stringent than TC levels for all constituents, except silver. EPA assumes that soils with these constituents will continue to be treated to the lower of site-specific risk levels or TC levels and therefore treatment methods and costs will not change.[31]

Exhibit 2-8
Comparison of TC and LDR Levels for TC Metal Constituents (mg/l)

Constituent	TC Level	Soil Treatment Standard: 10 x UTS	Sediment Treatment Standard: UTS
Arsenic	5.0	14	1.4
Barium	100	210	21

[30] With more stringent and potentially expensive treatment standards, some media may be managed in-situ, rather than ex-situ, to avoid the LDRs. This shift in management was not captured as an impact of the Phase IV rule.

[31] The Agency recognizes that, in situations where excavated untreated contaminated soils meet the new soil standards but not TC levels, it may be less expensive to dispose of the soils directly in a Subtitle C landfill without treatment (as LDR standards are met). EPA believes that these situations are unlikely to occur frequently and thus did not estimate these potential savings.

Constituent	TC Level	Soil Treatment Standard: 10 x UTS	Sediment Treatment Standard: UTS
Cadmium	1.0	1.1	0.11
Chromium	5.0	6.0	0.60
Lead	5.0	7.5	0.75
Mercury	0.2	0.25	0.025
Selenium	1.0	57	5.7
Silver	5.0	1.4	0.14

Under Phase IV, silver and non-TC constituents in soil must be treated to 10 times UTS (which is just below the TC level for silver) or to achieve 90 percent reduction. Also, metal constituents in sediment must be treated to UTS levels; the new soil standards do not apply to sediment. EPA believes that the incremental costs for meeting these new standards should be negligible for the following reasons:

- Virtually all soils and sediments that are hazardous because they exhibit the TC only for metals are currently stabilized or solidified.
- Current stabilization/solidification methods, designed to meet TC levels, often will meet the new standards for all metal constituents.
- Where current practices do not satisfy the new standards, the treatment can be adjusted at a limited cost to meet the standards, such as by increasing the ratio of reagent to soil.

Second, EPA modeled the application of the new treatment requirements for organic constituents in the database volumes of soils and sediments that exhibit the TC for metals only. Currently, EPA believes that these volumes are frequently treated for their organic constituents, particularly where the organics exceed site-specific risk levels and the treated soil is disposed of on-site. In addition, high concentrations of organics may be treated to avoid their interference with the effectiveness of immobilization. EPA considered two possible changes in treating organics under Phase IV:

- A shift to more extensive and expensive treatment of organics; and

- A shift from no treatment to treatment.

To model the shift to a more extensive and expensive treatment, EPA revised the high-low concentration cutoff for organic constituents from 100 times UTS in the baseline to 25 times UTS for soil and 15 times UTS for sediment under Phase IV. The cutoff for sediment is lower because the new soil standards do not apply to sediment. This high-low concentration cutoff determines when volumes are treated with more effective and expensive treatment methods, such as incineration. Having a lower "high-low" concentration cutoff for organics effectively models a shift to more effective treatment technologies consistent with the more stringent Phase IV requirements. By reducing the cutoff concentration, additional volumes of soil may be treated with these technologies and consequently treatment costs will rise.

This type of treatment impact seems realistic. The 10 times UTS or 90 percent reduction standard for organic UHCs may require more extensive treatment for volumes of contaminated soil and sediment where:

- The site-specific risk-based cleanup level for organics is less stringent than the Phase IV alternative soil standard; and

- The organics treatment technology selected based on any site-specific risk-based cleanup level does not meet the new alternative soil standards.

The Agency expects the affected volumes to be those with the highest levels of organic constituent concentrations that are treated with the less effective technologies (i.e., the highest concentration segment of the media in the low concentration category). The shift in the high-low concentration cutoff from 100 times UTS to 25 or 15 times UTS captures these volumes.

Changing the concentration cutoff shifted approximately eight percent of the TC for metals only of CERCLA soil in the database into categories treated with highly effective treatment methods (e.g., incineration/thermal desorption). A negligible amount of CERCLA sediment and RCRA soil changed categories.

EPA did not model the potential shift from no treatment to treatment of organics in soil and sediment that are for TC metals only. In some cases, TC metals media may not be specifically treated for their organic constituents, if any.

This situation may arise where the concentration of organics is below any site-specific risk-based cleanup levels. Phase IV will require treatment of such constituents if their concentrations are greater than 10 times UTS for soil or UTS for sediments. EPA did not model this type of change for two reasons:

- This situation seems unlikely to arise. Where constituent concentrations are below risk-based levels prior to treatment, the media are likely to be determined not to contain hazardous waste even if the concentrations are greater than 10 times UTS. Moreover, the soil may be eligible for a site-specific variance from the technology-based new soil treatment standards for soils below levels that minimize threats to human health and the environment.

- Our modeling approach projected treatment for organics if any organic constituent concentrations were reported in CERCLA RODs or RCRA corrective action RIA documentation. This approach reflects an assumption that constituent concentrations generally would not be reported if they did not affect remedy selection.

Third, using the revised organics concentration cutoff, EPA reassigned treatment technologies and calculated the changes in the per ton ex-situ treatment costs.

Performing these first three steps yielded nine CERCLA sites in the database with increased costs (of the 97 CERCLA database sites generating soils that are TC for metals only). The estimated cost increase for CERCLA TC metals only soils managed ex-situ at these sites was $19 per ton. This figure was calculated by subtracting the average per ton treatment cost for these CERCLA soils under the baseline from their average per ton treatment cost under Phase IV.

In contrast, no RCRA soil sites had increased costs because no RCRA soil exhibiting the TC only for metals had organics with concentrations greater than 25 times UTS. In fact, over 95 percent of the RCRA TC for metals only volume did not contain any organics. For CERCLA sediments, the average cost per ton increased by a negligible $0.05 per ton. This effect was caused by the shift to incineration and thermal desorption of only 13 out of 221,000 tons. Thus, the remaining steps described were not performed for RCRA soils or CERCLA and RCRA sediments.

Fourth, EPA extrapolated the per ton cost savings from the database sites to the universe of sites remediated annually. The increased cost per ton for CERCLA remedial action TC metals only soil, treated ex-situ, outside of a CAMU or AOC was applied to the annual volumes of such soil generated by CERCLA remedial actions, state superfund cleanups, and voluntary cleanups. No cost savings were attributed to RCRA soils and sediments and CERCLA sediments because the model predicted no increased costs for these media.[32]

2.9 Contaminated Ground Water and Debris

The following section presents the methodology used to analyze the impacts of the new LDR standards on the management of contaminated ground water and contaminated debris. In neither case does the Agency believe that the Phase IV rulemaking will significantly increase treatment costs.

2.9.1 Contaminated Ground Water

Contaminated ground water is potentially subject to the LDRs. If water pumped from the ground exhibits a characteristic of hazardous waste or contains listed waste, it cannot be placed on the land unless it:

- Is determined not to contain hazardous waste under the contained-in policy;

[32] Because the database contains no data on RCRA sediments, CERCLA results were extrapolated to the RCRA universe.

- Has been treated in compliance with the LDRs; or

- Is exempt from the LDRs.

The most common method of addressing ground water contamination is treatment. Alternative remedies include containment of the contamination through subsurface barriers, such as slurry walls, or controlling or limiting direct exposures, such as providing alternate water supplies or closing wells. These non-treatment methods leave the ground water in place and therefore are not affected by the LDRs.

Almost all sites with ground water treatment use pump and treat systems. For example, 99 percent of non-federal NPL sites with ground water treatment have used pump and treat systems.[33] Ninety-three percent of these sites used such systems only, while the other six percent also used in-situ treatment methods, such as air sparging, bioremediation, passive treatment walls, and dual-surface extraction. Only one percent of the sites used in-situ treatment only.

Following pumping, ground water may be managed in several ways, including:

- Treated and discharged in a system subject to a National Pollutant Discharge Elimination System (NPDES) permit under Section 402 of the Clean Water Act;

- Treated in accordance with the pretreatment requirements under Section 307 of the Clean Water Act prior to discharge into publicly owned treatment works (POTWs); and

- Returned to the aquifer through a variety of infiltration or injection methods.

Ground water that is hazardous only because it exhibits a characteristic is exempt from the LDRs if it is managed in either of the first two manners under 40 CFR 268.1(c)(4).

Ground water that is returned to the aquifer also is exempt from the LDRs if it is reinjected through a Class IV underground injection control (UIC) well. A Class IV UIC well, by definition, injects hazardous waste into or above a formation that contains within one-quarter mile an underground source of drinking water.

[33] "Market and Technology Trends," 1996 edition.

Under RCRA Section 3020, such reinjected ground water is not subject to the LDRs. Specifically, under Section 3020, contaminated ground water from Superfund remedial actions and RCRA corrective actions can be disposed of in a Class IV well if it is treated "to substantially reduce hazardous constituents prior to such injection" and the cleanup "will, upon completion, be sufficient to protect human health and the environment." EPA has interpreted this statutory provision to apply instead of the LDR provisions.[34]

Following pumping and treatment, ground water may be returned to the aquifer through methods other than reinjection by a Class IV well, such as infiltration in ditches or pipes laid across a field. Such placement of ground water is potentially subject to the LDRs. Nevertheless, the Agency believes that these situations are likely to be rare.

- Treated ground water is unlikely to be placed on the ground if it contains hazardous constituents at concentrations exceeding any site-specific risk levels (e.g., through volatilization of organics or soil contamination). In situations where the treated water is above risk-based levels but is returned to the aquifer, an injection well is likely to be used because it may avoid these risks.

- If the treated water does not pose any risks, it may be determined to not "contain" hazardous waste.

In addition, where the LDRs apply to treated ground water placed on the ground, current treatment methods may already meet the higher standards imposed by Phase IV.

While the Agency acknowledges that increased ground water treatment costs under Phase IV are conceivable, significant cost increases are unlikely and

[34] OSWER Directive 9234.1-06, December 27, 1989 contains the following guidance: "Although RCRA Section 3020 and the LDR provisions at RCRA Section 3004(f), (g), and (m) arguably can address the same activity, RCRA Section 3020 specifically applies to all CERCLA and RCRA ground-water treatment reinjections into Class IV injection wells. Consistent with traditional principles of statutory construction, RCRA Section 3020--which is directly focused on injections of treated contaminated ground water into Class IV wells during cleanups--should control for such injections; a contrary reading would render Section 3020(b) meaningless. Where Congress has provided two potentially applicable statutory provisions, a choice between them is both necessary and appropriate, and within the discretion of the expert agency. Accordingly, EPA construes the provisions of RCRA Section 3020 to be applicable, instead of LDR provisions at RCRA Section 3004(f), (g), and (m), to reinjection of contaminated ground water into an underground source of drinking water, which are part of CERCLA response action or RCRA corrective action."

could not be estimated with readily available data.

2.9.2 Contaminated Debris

Debris contaminated with hazardous waste is subject to RCRA Subtitle C and the LDRs. Hazardous debris can be treated to comply with the LDRs under one of two primary standards:

- Treated to meet the standards for the hazardous waste or wastes contaminating the debris (assuming the debris is not ignitable, corrosive, or reactive); or

- Treated to meet alternative debris treatment standards that allow particular extraction, destruction, or immobilization technologies under specified performance and/or design and operating standards.

Debris are generally treated using the second approach.[35]

The Phase IV rule does not amend these alternative technology-based treatment standards. It would affect the application of the new soil standards only for hazardous debris that contains UHCs that, by virtue of Phase IV:

- Become restricted contaminants subject to treatment standards; and,

- Are in constituent classes that would make the current debris treatment method inadequate to satisfy the new soil standards.

These situations will seldom, if ever, arise for debris contaminated with TC metals. The only acceptable technologies for metals are immobilization or extraction, excluding thermal desorption (unless it is used to treat mercury contamination). These technologies are also acceptable for any organic constituents, with one exception: dioxin-listed waste cannot be treated using high-temperature metals recovery. If TC metal debris is contaminated with dioxin-listed waste, it cannot be treated using high-temperature metals recovery prior to Phase IV or afterwards. Thus, the requirement to treat organic UHCs in TC metal debris will not change treatment methods or costs.

[35] See, "Cost and Impact Analysis of Land Disposal Restrictions for Newly Listed Wastes and Contaminated Debris (Phase I LDRs) Final Rule," U.S. EPA, Office of Solid Waste, June 30, 1992.

While the promulgation of LDRs for newly identified mineral processing wastes may change the management of contaminated debris, the Agency lacks the data to project the affected volumes or the increased costs. EPA reviewed CERCLA Records of Decisions (RODs) and other documentation of mineral processing site cleanups and could not find adequate data to project this impact of Phase IV. EPA, nevertheless, expects any such increased costs to be relatively small.

The Phase IV rule also may affect the management of debris residuals. These residuals are subject to the waste-specific treatment standards for the waste contaminating the debris. Thus, these residuals may be subject to additional or different treatment under Phase IV. The Agency also lacks the data to estimate the magnitude of these impacts. EPA, however, expects the increased costs to be relatively small.

2.10 Major Data and Modeling Limitations

Modeling the impact of the changes in the RCRA land disposal restrictions on the treatment of contaminated soil and sediment is inherently difficult because remediation decisions reflect a range of critical factors in addition to the federal RCRA regulations.

- Unlike hazardous process waste, hazardous soil and sediment that were contaminated prior to the LDRs are not required to be treated unless the media are excavated. Thus, remediation decision makers may decide, based on site-specific factors, to cap contaminated soil or sediment in place without treatment or to treat it in-situ, avoiding application of the LDRs.

- Likewise, based on site-specific factors, soil and sediment may be managed in AOCs or CAMUs, avoiding the LDRs.

- Treatability variances have been issued frequently for hazardous soil and sediment because of the stringency of the LDRs, which increases the difficulty of modeling the baseline and complicates the identification of regulatory effects.

- When contaminated soil and sediment are subject to the LDRs, treatment goals may be more stringent than the LDRs because of site-specific risk factors (e.g., residential setting, presence of a drinking water source karst terrain). Thus, the changes in the LDRs may not change treatment goals and technologies at many sites.

- Furthermore, remediation decisions may vary from state-to-state based on factors including state risk-based cleanup standards and remediation resources, particularly for state superfund programs.

In addition to these general concerns, the analysis of the potential soil treatment cost savings and incremental costs resulting from the Phase IV rule is qualified by several major data and methodological limitations, which are described below. Many of these limitations also apply to the limited analysis of the potential incremental sediment treatment costs.

Use of Sample of Sites

The contaminated soil and sediment database consists of data from CERCLA RODs signed in 1989 through 1996 and a stratified representative sample of RCRA corrective actions.

CERCLA Sites. While remediation decisions at the CERCLA sites in the database generally will not be affected by the Phase IV rule,[36] the nature of the contamination at these sites should be reasonably representative of the contamination at CERCLA sites potentially affected by the rule. The severity of risks at newly listed CERCLA remedial action (or National Priority List) sites may decline over time, assuming that the highest risk sites are generally listed first. This trend may not significantly affect the likelihood and magnitude of changes in treatment methods under Phase IV. All sites must have a minimum Hazard Ranking System score to be listed on the NPL. In addition, the impact of Phase IV depends largely on the types and concentrations of hazardous constituents at these sites, which may not change significantly over time, particularly during the medium term, five-year projection period of this analysis.

RCRA Corrective Action Sites. Similarly, the sample of RCRA corrective action sites should be reasonably representative of future corrective action sites. This sample of sites was initially developed for EPA's analysis of the RCRA corrective action program in 1990 and 1991 to represent the universe of RCRA corrective actions. It remains reasonably representative of future RCRA corrective actions because the universe of corrective action sites that remain to be remediated has not changed substantially since then. In addition, the original sample, which includes projected remedies, was recently supplemented with data for additional cleanups from available RCRA Statements of Basis. These new data reflect actual remediation decisions and thereby help ensure the representativeness of the expanded sample.

Applying CERCLA and RCRA Corrective Action Data to State Superfund, Voluntary Cleanup, and RCRA Closure Sites

The methodology applies the average cost per ton savings or incremental costs for soil treated ex-situ at CERCLA remedial actions to soil generated at state superfund and voluntary cleanups. State and voluntary cleanup programs generally manage smaller volumes per site of less contaminated soil than the

[36] Remedies have been selected for all sites in the database, since they all have RODs (Records of Decision). These remedies are not likely to be changed by Phase IV, unless Phase IV requires more effective treatment than provided by the selected ex-situ treatment remedy and the remedy has not already been constructed.

CERCLA remedial action program and generally treat soil ex-situ and off-site to avoid the need for RCRA treatment permits and thereby becoming subject to facility-wide corrective action. Whether the types and concentrations of hazardous constituents are different at state and voluntary cleanup sites and CERCLA remedial action sites, however, is unclear because of the absence of detailed site-specific data on the nature of contamination and management practices at state superfund and voluntary cleanup sites. Thus, it remains unclear whether the methodology overestimates or underestimates the increased costs or cost savings at these sites. Similar uncertainty applies to the extrapolation from RCRA corrective actions to RCRA closures. This concern is important because most soil treated ex-situ outside of CAMUs or AOCs is generated by state and voluntary cleanup programs and RCRA closures.

Definitions of High and Low Concentration and High and Low Volume

The baseline and post-regulatory definitions of high and low concentration and high and low volume determine the projected treatment methods. The cutoffs between high and low concentration are multiples of UTS levels (e.g., 100 times UTS). These multiples are somewhat subjective. Constituent-specific concentration cutoffs may be more appropriate than the cutoffs based on a multiple of the UTS. Constituent-specific cutoffs could address the varying toxicity, fate, and transport characteristics of individual constituents and their amenability to the use of different treatment technologies. In addition, high and low volume cutoffs might be more appropriately applied on a technology-specific and/or waste-specific basis.

EPA did not develop more sophisticated concentration and volume cutoffs because of the difficulties involved, the resources required, and the relatively modest expected gains in accuracy. The cutoffs used in the methodology were developed so that the baseline results are realistic, based on available data. The changes in the cutoffs from the baseline analysis to the post-regulatory analysis are designed to identify the types of sites that are likely to be require more or less effective and expensive treatment under Phase IV. In addition, even constituent-specific cutoffs would not reflect the site-to-site differences in meeting either the 90 percent reduction standard or the 10 times UTS standard.

As EPA's approach was not able to examine the effect of the 90 percent reduction standard, EPA estimated the volumes of soil which would be able to take advantage of this standard. The assessment showed that only 3 to 5 percent of the volume had concentrations above 100xUTS levels, and thus would benefit from the 90 percent reduction standard. Therefore, this limitation in the analysis likely has little effect on the overall results.

Trends in Treatment Technologies

The analysis does not account for future trends in the remediation of contaminated soil and sediment, such as the development of new treatment technologies. Baseline treatment methods reflect the current mix of remediation treatments and existing trends towards increased use of innovative treatment methods. Baseline and post-regulatory treatment methods include only technologies that have been successfully used at remediation sites. It is likely, however, that existing technologies will be improved and new technologies developed. The impact of technological innovation on the estimated cost savings is unclear because the changes would reduce costs under both the baseline and the post-regulatory scenarios. However, because this analysis covers only the five years following implementation of the rule, EPA believes that the treatment methods projected in this analysis will not change dramatically due to technological innovation.

Affected Volumes

Contaminated soil and sediment at each site are segregated into volumes that are above and below the toxicity characteristic levels and above and below the high and low concentration threshold. The proportion of contaminated soil or sediment at sites with contamination in these categories is estimated using a functional relationship ($Y = X^3$), as described earlier in this chapter. This equation is based on statistical analysis of a limited sample of sites and therefore its representativeness is uncertain. To verify the model's validity, EPA compared these results with over 1,200 observations using a Monte Carlo simulation that was based on empirical site characterization data from DOE's Superfund Reauthorization (SURE) model. The results indicate that the functional relationship derived from the limited data is consistent with field data used in the SURE model.

EPA, nonetheless, recognizes that the distribution of constituent concentrations does not vary uniformly across sites. Sites often have numerous "hot spots" of highly contaminated soil. Nevertheless, EPA believes that, consistent with the approach used, contaminant concentrations often will decline moving from the area of localized maximum contamination. Thus, for simplicity and because the functional relationship is representative of the sample of sites analyzed, the Agency used this approach to determine volumes.

The assumption that volumes in the different categories will be segregated and managed separately may overestimate or underestimate the costs savings or incremental costs. At some sites, these volumes are likely to be managed together, using the same technology or technology train. The direction and magnitude of this approach's impact on the estimated savings or incremental costs is difficult to gauge because the approach is used in both the baseline and post-regulatory analysis. In addition, the impact is difficult to determine because the model, consistent with current practices, allocates volumes to in-situ and ex-situ treatment methods based, in part, on the volumes subject to remediation. Only the volumes treated ex-situ, however, are subject to the LDRs.

Pace of Remediation Nationally

The numbers that EPA used to estimate the number of sites remediated each year were adapted from a number of different sources. There was considerably more information for CERCLA and RCRA than for state superfund and voluntary cleanup programs, so CERCLA and RCRA estimates may be more accurate. EPA recognizes that these numbers may change due to a variety of factors and that the further out the analysis extends the less accurate they become. In order to minimize the effect of changes to the pace of remediation, the Agency limited the analysis to the five years after the requirements begin affecting remediation decisions.

Soil Contaminated with Listed Versus Characteristic Waste

The data available for the CERCLA remedial action and RCRA corrective action sites in the database do not specify whether soil subject to remediation is hazardous because it exhibits a characteristic or because it contains listed waste. The analysis determines, based on maximum constituent concentrations, whether the soil is likely to exhibit the toxicity characteristic for metals, organics, or both. The analysis also makes the simplifying assumptions that soil exhibiting the TC is not contaminated with listed waste and that soil not exhibiting the TC is contaminated with listed waste.

This approach may overestimate the increased costs imposed by requiring soils exhibiting the TC for metals (but not for organics) to be treated for any organic UHCs. In the baseline, these soils may be treated to UTS levels (rather than risk-based levels) for the organic UHCs if the organic UHCs are listed constituents from listed wastes. Thus, the analysis may underestimate baseline costs and overestimate the incremental post-regulatory costs. EPA, however, does not believe that this overestimate is likely to be significant, in part because of the relatively small estimated incremental costs from the more stringent requirements.

This approach may also underestimate the savings associated with the new soil standards. As the analysis was performed, no cost savings were attributed to soils exhibiting the TC for metals only because it was assumed that these soils were considered hazardous because they exhibited a characteristic, not because they contained listed waste. Soils contaminated with listed wastes are currently required to be treated for listed constituents to UTS levels, so taking listed waste into account would increase the total cost savings associated with the new soil standards (as soils contaminated with listed wastes will now be able to utilize the less stringent new soil standards).

No Increased Costs on RCRA Soils or CERCLA and RCRA Sediments

EPA's modeling showed that the volume of RCRA soils and CERCLA and RCRA sediments affected by this rulemaking to be insignificant, and thus the Agency estimated that the Phase IV rule would not have any significant impacts on these media. As explained, EPA believes that RCRA soils and CERCLA and RCRA sediments are infrequently incinerated under current requirements and that this will continue under Phase IV. However, the Agency recognizes that some volumes of these media may switch treatment categories (i.e., from a less expensive ex-situ treatment method to incineration) and will thus be affected by the Phase IV rule.

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CHAPTER 3. RESULTS

This chapter presents the results of the analysis of the incremental costs and cost savings resulting from the application of the Phase IV LDR rule to contaminated media. It is organized as follows:

- Section 3.1 summarizes the baseline soil and sediment treatment methods and costs;
- Section 3.2 describes the estimated cost savings under the new soil treatment standards;
- Section 3.3 discusses the lack of changes in treatment costs for media contaminated with newly identified mineral processing wastes; and
- Section 3.4 presents the estimated incremental costs for soil that exhibits the TC for metals only.

Exhibit 3-1 summarizes these results.

3.1 Baseline Treatment Methods and Costs

As described in Chapter 2, EPA used data from a sample of CERCLA remedial action soil and sediment contamination sites and RCRA corrective action soil contamination sites to analyze the baseline costs and the incremental costs or cost savings of the Phase IV final rule. Exhibit 3-2 presents the constituent types, concentration, volumes, and corresponding treatment technologies for the largest volume treatability groups across the three remediation categories represented in the soil and sediment database. The exhibit demonstrates that a large fraction of CERCLA soil is contaminated with multiple constituents types and therefore is relatively expensive to treat. Seven percent of CERCLA soil, for example, is contaminated with a high concentration and low volume of constituents in all four constituent groups and is therefore projected to be managed using incineration or thermal desorption combined with immobilization of the resulting residuals at an average cost of $1,064 per ton. Another two percent of the volume is also contaminated with all four types of constituents having high concentration and high volume. Because incineration may be economically infeasible for such high volume sites (greater than 65,000 tons/site for this treatability group), the baseline treatment method is soil washing, dechlorination, and ex-situ immobilization at $476 per ton. The average treatment cost for CERCLA soil managed in-situ or ex-situ is $307/ton. The average ex-situ treatment cost for CERCLA soil is $354/ton.

Exhibit 3-1
Summary of Phase IV Costs/Savings for Contaminated Media

Phase IV Provisions	Media Analyzed	Management Standards		Affected Volumes (tons/year)	Incremental Cost/Savings (million $/year)	
		Baseline	Post-Regulatory			
New Soil Treatment Standards	Soil exhibiting TC for organics or TC for both organics and metals	Treat all TC constituents and all UHCs to UTS	Treat all TC constituents and all UHCs to 10 x UTS or 90 percent reduction	CERCLA = 1000 RCRA = 0 State Superfund = 1,000 Voluntary = 5,000 Total = 7,000	CERCLA = (0.6) RCRA = 0 State Superfund =(0.7) Voluntary = (2.7) Total = (4)	Savings incinera expensi
	Soil containing listed waste	Treat listed constituents to UTS	Treat all listed constituents and UHCs to 10 x UTS or 90 percent reduction	CERCLA = 13,000 RCRA = 11,000 State Superfund = 12,000 Voluntary = 47,000 Total = 83,000	CERCLA = (3.5) RCRA = (1.2) State Superfund =(3.2) Voluntary = (12.8) Total = (21)	Savings incinera expensi treatme UTS. D costs fr Non-TC listed w
Subtotal For the New Soil Standards				CERCLA = 14,000 RCRA = 11,000 State Superfund = 13,000 Voluntary = 52,000 Total = 90,000	CERCLA = (4.1) RCRA = (1.2) State Superfund =(3.9) Voluntary = (15.5) Total = (25)	
Media Contaminated with Mineral Processing Waste	Soil, sediment, ground water, debris	Treat to TC levels	Treat to new soil standards (soils) or to UTS (other media)	No affected volumes predicted	No cost changes	Volume becaus cost ex
Media Exhibiting TC for Metals	Soil exhibiting TC for metals only	Treat to the lower of TC or site risk-based levels	Treat all constituents (including UHCs) to the lower of TC, site risk-based, or alternative standard levels	CERCLA = 35,000 RCRA = 0 State Superfund = 26,000 Voluntary = 102,000 Total = 163,000	CERCLA = 0.7 RCRA = 0 State Superfund = 0.5 Voluntary = 2.0 Total = 3	Increas from les treatme desorpt
	Sediment exhibiting TC for metals only	Treat to the lower of TC or site risk-based levels	Treat all constituents (including UHCs) to the lower of TC, site risk-based, or UTS levels	No affected volumes predicted	No cost changes	Analysis treatme significa
	Groundwater/ debris exhibiting TC for metals only	Treat to the lower of TC or site risk-based levels	Treat all constituents (including UHCs) to the lower of TC, site risk-based, or UTS levels	Not quantifiable	Not quantifiable	Analysis and deb be signi

Exhibit 3-2
Baseline Treatment of Soil and Sediment for Sample Sites*

Media Type	Constituent Types	Concentration/ Volume	Volume	Treatment	Cost per Ton
CERCLA Soil	Metals	LC/HV, HC/LV, HC/HV	15%	Ex-situ immobilization	$164
	SVOCs, AHCs, and Metals	LC/HV	8%	Soil washing, ex-situ bioremediation, and ex-situ immobilization	$359
	VOCs, SVOCs, and AHCs	HC/HV	8%	Vacuum Extraction	$150
	VOCs, SVOCs, AHCs, and Metals	HC/LV	7%	Incineration, or thermal desorption, and immobilization of the ash	$1,064
	VOCs, SVOCs, AHCs, and Metals	LC/LV	6%	50% in-situ and 50% ex-situ bioremediation and immobilization	$181
	SVOCs and Metals	LC/LV, LC/HV	5%	50% in-situ and 50% ex-situ bioremediation and immobilization	$181
	VOCs and Metals	LC/HV, HC/LV, HC/HV	5%	Vacuum extraction and in-situ immobilization	$204
	VOCs, SVOCs, AHCs, and Metals	LC/HV	5%	Vacuum extraction and in-situ immobilization	$204
	AHCs and Metals	HC/HV	5%	Soil washing, dechlorination, and ex-situ immobilization	$476
	VOCs, SVOCs, and Metals	LC/HV, HC/HV	4%	Vacuum extraction and in-situ immobilization	$204
	SVOCs and AHCs	HC/HV	3%	Soil washing and dechlorination	$312
	VOCs	LC/HV, HC/LV, HC/HV	3%	Vacuum extraction	$150
	VOCs and SVOCs	LC/HV	3%	Incineration or thermal desorption	$1,058
	Other Treatability Groups		26%	Various methods	$412
RCRA	Metals	LC/HV, HC/LV,	41%	Ex-situ immobilization	$164

Media Type	Constituent Types	Concentration/ Volume	Volume	Treatment	Cost per Ton
Soil		HC/HV			
	SVOCs and Metals	LC/LV, LC/HV	25%	50% in-situ and 50% ex-situ bioremediation and immobilization	$181
	VOCs	LC/HV, HC/LV, HC/HV	24%	Vacuum extraction	$150
	VOCs and Metals	LC/HV, HC/LV, HC/HV	3%	Vacuum extraction and in-situ immobilization	$204
	SVOCs and Metals	HC/LV, HC/HV	2%	Soil washing, ex-situ bioremediation, and ex-situ immobilization	$359
	VOCs, AHCs, and Metals	LC/HV	1%	Vacuum extraction and in-situ immobilization	$204
	Other Treatability Groups		3%	Various methods	$365
CERCLA Sediment	Metals	LC/HV, HC/LV, HC/HV	23%	Ex-situ immobilization	$181
	SVOCs, AHCs, and Metals	LC/HV	13%	Soil washing, ex-situ bioremediation, and ex-situ immobilization	$376
	VOCs, SVOCs, AHCs, and Metals	HC/LV	10%	Incineration, or thermal desorption, and immobilization of the ash	$1,079
	VOCs and Metals	LC/HV, HC/LV, HC/HV	8%	Ex-situ bioremediation and ex-situ immobilization	$255
	AHCs	HC/HV	7%	Soil washing and dechlorination	$327
	SVOCs and Metal	HC/LV, HC/HV	6%	Soil washing, ex-situ bioremediation, and ex-situ immobilization	$376
	VOCs and SVOCs	LC/LV, LC/HV, HC/HV	6%	Ex-situ bioremediation	$91

Media Type	Constituent Types	Concentration/ Volume	Volume	Treatment	Cost per Ton
	AHCs	HC/LV	5%	Incineration or thermal desorption	$1,074
	AHCs	LC/LV, LC/HV	4%	Ex-situ bioremediation	$91
	Other Treatment Groups		19%	Various methods	$440

* Totals may not add due to rounding.

Key: LC = low concentration LV = low volume
HC = high concentration HV = high volume

In contrast, RCRA soil is typically contaminated with VOCs and/or metals, which are relatively inexpensive to treat. Therefore, the average in-situ and ex-situ cost for treating RCRA soil is only 56 percent of the cost for CERCLA soil, $170/ton versus $310/ton. Similarly, the average RCRA ex-situ soil treatment cost is $179/ton versus $354/ton for CERCLA soil. Fifty-seven percent of RCRA corrective action soil is contaminated with metals only and is projected to be managed using ex-situ immobilization at $164 per ton. Another 24 percent is contaminated with VOCs only and is projected to be managed using vacuum extraction at $150 per ton.

CERCLA soil and CERCLA sediment volumes are contaminated with similar types of contaminants. Thus, the average ex-situ treatment costs for CERCLA soil and sediment are almost identical, $401 and $403 per ton, respectively. Despite having slightly less complex contamination than CERCLA soil, CERCLA sediment is slightly more expensive to manage because of the need for dewatering at $15/ton.

The significant average cost per ton difference between CERCLA soil and sediment sites and RCRA soil sites also reflects the prevalence of incineration and thermal desorption. About 10 percent of CERCLA soil is projected to require incineration or thermal desorption at an average cost of approximately $1,062 per ton. This volume is responsible for 33 percent of the CERCLA soil management costs. Similarly, the 18 percent of the CERCLA sediment that is projected to be treated by incineration or thermal desorption is responsible for 49 percent of the total sediment management costs. In contrast, less than one percent of RCRA soil is projected to require incineration or thermal desorption and only three percent requires the next expensive treatment method, soil washing, which in combination with various secondary treatments, costs $312 to $476 per ton.

Exhibit 3-3 presents the national baseline of soil and sediment ex-situ treatment costs. (See also Exhibit A-3 for the percent of media treated by different treatment methods.) This baseline excludes volumes managed in CAMUs or AOCs, since LDRs do not apply to these cleanups. As described in Chapter 2, the average treatment cost per ton figures for RCRA corrective actions are applied to RCRA closures. Similarly, the average ex-situ treatment cost per ton for CERCLA remedial actions is applied to state superfund and voluntary cleanups. The CERCLA ex-situ cost is used because media generated by state superfund and voluntary cleanups are assumed to be treated primarily off-site and therefore are treated ex-situ. The estimated national ex-situ soil and sediment treatment costs, excluding volumes managed in CAMUs or AOCs, in the absence of the Phase IV rulemaking, are $306 million/year and $24 million/year, respectively. These baseline estimates cover the five-year period following implementation of the Phase IV standards, but do not include the impact of Phase IV.

Exhibit 3-3: National Baseline Ex-Situ Treatment Costs (Excludes Volumes Managed in AOCs or CAMUs)

Remediation Program	Tons Treated Ex-Situ Per Year	Average Cost/Ton	Annual Cost ($ million)
Soil			
CERCLA Remedial Actions	140,000	$354	$50 million
RCRA Corrective Actions	110,000	$179	$20 million
RCRA Closures	50,000	$179	$9 million
State Superfund	130,000	$354	$46 million
Voluntary	510,000	$354	$181 million
Soil Totals	940,000	$326	$306 million
Sediment			
CERCLA Remedial Actions	40,000	$403	$16 million
RCRA Corrective Actions	20,000	$403	$ 8 million
Sediment Totals	60,000	$403	$24 million

* These baseline figures do not represent the actual baseline costs attributable to the LDR rules applied to media, in as much as these costs are largely attributable to the given cleanup authority under which remediation takes place.

3.2 Cost Savings Of The New Soil Treatment Standards

EPA expects that facilities generating soils exhibiting the TC for organic constituents and non-TC soils containing listed wastes will most likely recognize cost savings as a result of the new soil standards. Some soils that are hazardous because they exhibit the TC for organic constituents are likely to incur cost savings because they will be treated with less expensive treatment methods. Some non-TC soils with constituent concentrations below 10 times UTS could recognize cost savings because they will fall out of Subtitle C regulation altogether and will be eligible for disposal in a Subtitle D facility. Based on the methodology described in Chapter 2, EPA estimates that the Phase IV cost savings for facilities generating these soils will be approximately $25 million per year ($4 million for TC organic soils + $21 million for non-TC soils).

3.2.1 Estimated Cost Savings for Soil Exhibiting the TC for Organics

In order to estimate national cost savings from the new soil standards on soil exhibiting the TC for organics, EPA extrapolated the per-ton cost savings calculated using the database (as outlined in Section 2.6) to the universe of sites remediated nationally. In order to estimate the CERCLA soil cost savings, EPA calculated that 12 percent of all CERCLA soil in the database was TC for organics (roughly 1.05 out of 9.09 million tons of CERCLA soil in the database). In addition, about nine percent of CERCLA soil projected to be managed ex-situ was TC for organics (473,000 tons out of 5.24 million tons). The Agency estimates that 52 percent of the TC organic soils treated ex-situ will be incinerated or thermally desorpted in the baseline (246,000 tons/473,000 tons). Finally, of the TC organic soil that is incinerated or thermally desorpted, the analysis showed that 14 percent would switch from incineration or thermal desorption under the baseline to other ex-situ treatment methods as a result of the new soil standards (approximately 35,000 out of 246,000 tons). For these volumes, the average cost savings is $600 per ton. The average per ton cost savings was calculated by subtracting the average per ton cost of other ex-situ treatments from the per ton cost of incineration and thermal desorption.

The model predicted that no TC organic soil at RCRA sites would shift from incineration or thermal desorption to an alternative treatment method. Thus, there are no estimated cost savings for RCRA soil. EPA, however, does expect some low level of savings for these RCRA soils. EPA believes that the cost savings will be substantially lower for RCRA soil than for CERCLA soil because RCRA soils are generally less highly contaminated than CERCLA soils. Furthermore, a significantly smaller share of RCRA soil is incinerated in the baseline. To the extent that TC organics soil at RCRA cleanups will recognize cost savings, this analysis underestimates the savings related to the new soil treatment standards.

Thus, the costs savings shown in Exhibit 3-4 were calculated as follows:

- **CERCLA Remedial Action Soil:** $0.6 million/year = 140,000 (tons/year treated ex-situ outside of a CAMU or AOC) x .09 (portion of soil treated ex-situ exhibiting the TC for organics) x .52 (portion of TC organic soil treated ex-situ that is incinerated or thermally desorpted) x .14 (portion of TC organic soil that switches from incineration or thermal desorption to another ex-situ treatment method) x $600 (average cost savings per ton for soils shifting from incineration or thermal desorption to another ex-situ treatment method).

- **State Superfund and Voluntary Cleanup Soil:** $3.4 million/year = 640,000 (tons/year treated ex-situ outside of a CAMU or AOC) x .12 (portion of all CERCLA soil exhibiting TC for organics)[37] x .52 (portion of TC organic soil treated ex-situ with incineration or

[37] EPA assumed that soil generated at state superfund and voluntary cleanups is similar to all CERCLA soil, rather than just CERCLA soil treated ex-situ. As a result, EPA assumed that 12% of all state superfund and voluntary cleanup soil exhibits the TC for organics, rather than 9%, which reflects only CERCLA soil treated ex-situ.

Exhibit 3-4
Estimated Cost Savings for TC Organics Soil Under The Nev

Remediation Category	Tons Treated Ex-Situ Outside of CAMU or AOC*	Portion Exhibiting TC For Organics	Portion of T[illegible] Organic Soi[illegible] Treated Ex-Situ With Incineration/[illegible]hermal Desorption
CERCLA Remedial Action Soil	140,000	9%	52[illegible]
RCRA Corrective Action Soil	110,000	18%	-
RCRA Closures Soil	50,000	18%	-
State Superfund Soil	130,000	12%	52[illegible]
Voluntary Cleanup Soil	510,000	12%	52[illegible]
Totals	**940,000**	**N/A**	**N/[illegible]**

* See Exhibit 2-7 and accompanying text for an explanation of how these volume

thermal desorption) x .14 (the percentage of TC organic soil that switches from incineration or thermal desorption to another ex-situ treatment method) x $600 or thermal desorption (average cost savings per ton for soils shifting from incineration or thermal desorption to another ex-situ treatment method).

These estimates do not reflect the new site-specific variance from the technology-based new soil treatment standards for soils with concentrations above the new soil treatment levels that minimize threats to human health and the environment. This variance will allow soils that are currently treated below site-specific risk-based levels due to the LDR requirements to be exempted from the new treatment levels if they can meet the risk based standards needed for the variance. These soils may recognize additional savings from the variance, as they may not be required to be treated at all or could be treated to less stringent levels than under the new soil standards.

3.2.2 Estimated Cost Savings for Soil Contaminated with Listed Waste

Soils contaminated with listed wastes are likely to recognize savings from less expensive treatment and from no treatment at all. This section first presents the estimated savings from less expensive treatment and then the savings from no treatment. Overall cost savings for soils contaminated with listed waste are estimated to be approximately $21 million per year.

Savings from Less Expensive Treatment

As noted in Section 2.6, soil that is hazardous because it contains listed wastes will likely achieve some cost savings under the Phase IV new soil treatment standards when some constituents already meet the 10 times UTS standard. These savings could not be estimated directly using the approach applied to TC organic soil because of modeling limitations and because some of these soils also may face increased costs (they must now be treated for all UHCs, including hazardous constituents that are not listed constituents). To estimate an upper bound of these savings, EPA estimated the effects of the percentage of soil shifting from incineration or thermal desorption in the baseline to less expensive treatment under Phase IV. The resulting cost savings per ton were the same for soil contaminated with listed wastes as for TC soil. These estimates represent an upper bound for two reasons:

- Some of these soils may be considered as non-hazardous because they do not “contain” listed hazardous waste under the contained-in policy; and

- The soil may contain UHCs that are not primary constituents and therefore may be subject to increased treatment costs under Phase IV.

Using this methodology, the estimated savings apply to soil generated by CERCLA remedial action, state superfund, and voluntary cleanups, since no RCRA TC soil shifted from incineration to another treatment method. Sixty-eight percent of the database volumes of all CERCLA soil were found not to exhibit the TC and therefore may be hazardous because they contain listed waste. Seven percent of this soil, or 11 percent of the volume treated ex-situ, is expected to be treated by incineration or thermal desorption in the baseline. Then, using the results from the analysis of TC organics soil, 14 percent of the incinerated or thermally desorpted soil is assumed to utilize less expensive treatment methods under Phase IV, at an average savings of $600 per ton. The resulting estimated cost savings are $4.9 million per year, as shown in Exhibit 3-5.

No Treatment

As explained in Section 2.6, some contaminated soil that is treated in the baseline may not require treatment under Phase IV because it will meet the new soil treatment standards and risk based standards upon excavation. Instead of treatment, the soils are expected to be disposed of directly into a Subtitle D landfill, assuming that site owner/operators obtain a contained out determination for the soil.[38] For CERCLA, state superfund, and voluntary cleanups, EPA estimated that 12 percent of non-TC (or listed) soils will meet 10 times UTS levels upon excavation; these sites will recognize a savings of approximately $230 per ton. As shown in Exhibit 3.6, cleanups conducted under these programs are expected to save approximately $2.6 million, $2.4 million, and $9.6 million, respectively. For RCRA corrective action and closure cleanups, EPA estimated that approximately nine percent of non-TC soils will meet 10 times UTS levels upon excavation; these sites will recognize savings of approximately $114 per ton. As shown in Exhibit 3.6, cleanups conducted under RCRA corrective action and closure programs are expected to save approximately $0.8 and $0.4 million, respectively. Total cost savings from soils requiring no treatment under the new soil standards are estimated to be $15.8 million.

3.2.3 Potential Additional Cost Savings In Absence of the CAMU Rule

The results described above for CERCLA and RCRA cleanups assume that

[38] See page 2-36 for more details regarding the contained out determination.

the CAMU rule is completely effective in the baseline and under Phase IV and that 36 percent of soils managed ex-situ (180,000 tons/year for CERCLA, 140,000 tons/year for RCRA corrective action, and 65,000 for RCRA closure) is treated in CAMUs and therefore not affected by the LDRs, including Phase IV. If the CAMU rule was not in

Exhibit 3-5

Estimated Cost Savings for Listed Soils Requiring Less Expens
Under The New Soil Standards

Remediation Category	Tons Treated Ex-Situ Outside of CAMU or AOC*	Portion Non-TC	Portion of Non-TC Soi Treated Ex-Situ With Incineratior or Thermal Desorption
CERCLA Remedial Action Soil	140,000	68%	11%
RCRA Corrective Action Soil	110,000	75%	0%
RCRA Closures Soil	50,000	75%	0%
State Superfund Soil	130,000	68%	11%
Voluntary Cleanup Soil	510,000	68%	11%
Totals	**940,000**	**N/A**	**N/A**

* See Exhibit 2-7 for a complete explanation of how these volumes were

Exhibit 3-6
Estimated Cost Savings for Listed Soils With Constituent Conc
10 Times UTS

Remediation Category	Tons Treated Ex-Situ Outside of CAMU or AOC*	Portion Non-TC	Portion of Non-TC Soi Below 10 Times UTS
CERCLA Remedial Action Soil	140,000	68%	12%
RCRA Corrective Action Soil	110,000	75%	9%
RCRA Closures Soil	50,000	75%	9%
State Superfund Soil	130,000	68%	12%
Voluntary Cleanup Soil	510,000	68%	12%
Totals	**940,000**	**N/A**	**N/A**

* See Exhibit 2-7 for a complete explanation of how these volumes were

place in the baseline or under Phase IV, the additional ex-situ soil volumes affected by Phase IV would increase by 180,000 tons per year (from 140,000 to 320,000 tons) for CERCLA, by 140,000 tons per year (from 110,000 to 250,000 tons) for RCRA corrective actions, and by 65,000 tons per year (from 50,000 to 115,000 tons) for RCRA closures. Thus, the annual cost savings would increase as follows:

- For TC organic soils, from $4.0 million to $4.7 million;
- For listed soils requiring less expensive treatment, from $4.9 million to $6.0 million;
- For listed soils requiring no treatment, from $15.8 million to $20.7 million.

Thus, assuming no CAMU, the total cost savings for the new soil standards is estimated to be $31 million/year ($4.7 million/year + $6.0 million/year + $20.7 million/year).

3.2.4 Major Differences Between HWIR-Media and Phase IV Cost Savings

The $25 million per year projected cost savings for the new soil treatment standards are substantially lower than the $1.048 billion per year projected cost savings for soil for the proposed HWIR-Media rule. This section explains the major reasons for this difference.

No Bright Line

In the HWIR-Media analysis, 84 percent ($881 million/year) of the projected cost savings for contaminated soil were for volumes below the bright line. Under the Phase IV soil treatment standards, these volumes are unlikely to experience a shift to lower cost treatment methods. This soil has relatively low concentrations of hazardous constituents and therefore is currently being treated with low cost treatment methods. The same treatment methods are likely to be used under the new soil treatment standards. In addition, only a small portion of contaminated soil appears to be below 10 times UTS for all hazardous constituents and therefore would not be required to be treated under the new soil treatment standards.

Availability of CAMUs

The HWIR-Media analysis assumed that CAMUs were not available in the baseline or under HWIR-Media. It also incorporated the use of AOCs at CERCLA remedial actions, but not at RCRA corrective actions or closures. For Phase IV, CAMUs and AOCs are assumed to be used in both the baseline and the post-regulatory analysis for CERCLA remedial actions and RCRA corrective actions and closures. These changes from the HWIR-Media analysis reduced the volumes with potential cost savings by almost 50 percent at CERCLA corrective actions and by 72 percent at RCRA corrective actions and closures.

These changes did not affect state superfund and voluntary cleanups and therefore these cleanups are responsible for a higher portion of the total cost savings under Phase IV than under HWIR-Media. Contaminated soil generated by state superfund and voluntary cleanups is assumed to be treated off site so that these facilities avoid the need for a RCRA permit and the associated facility-wide corrective action requirements. By treating the contaminated media off site, no volumes are managed in CAMUs or AOCs.

Less Baseline Incineration

The Phase IV analysis projects less incineration in the baseline than the HWIR-Media analysis. Under HWIR-Media, 17 percent of CERCLA remedial action soil and 1 percent of RCRA corrective action soil, respectively, were projected to be incinerated in the baseline. In the Phase IV analysis, these figures have declined to 10 percent and less than 0.1 percent, respectively. In addition, a fourth of these volumes are projected to be treated using thermal desorption, instead of more costly incineration.

These changes are consistent with trends towards decreasing use of incineration and increasing use of thermal desorption. In addition, they reflect new soil contamination data. Since the HWIR-Media analysis was completed, the soil and sediment database was expanded to include data from the CERCLA RODs for 1994-1996 and RCRA statements of basis. (See Appendix A.) These new sites have lower levels of hazardous constituent concentrations, on average, than other database sites. As a result, treatment costs are lower under both the baseline and post-regulatory scenarios (low levels of constituents are less expensive to treat than high levels).

Slower Pace of Remediation

Incorporating recent EPA data on the number of remedial action sites added to the National Priority List,[39] EPA reduced the projected future number of CERCLA remedial action sites remediated per year to 70 from 109 in the HWIR-Media

[39] "Cleaning Up the Nation's Waste Sites: Market and Technology Trends," supra footnote 8.

analysis. Similarly, the projected number of state superfund cleanups declined from 790 to 510 based on new data from an Environmental Law Institute report entitled "An Analysis of State Superfund Programs: 50-state Study, 1995 Update," December 1995. These changes reduced the CERCLA remedial action and state superfund soil volumes, and thus lowered the projected savings for the Phase IV new soil treatment standards.

No Significant Savings for RCRA Sites or Soils Exhibiting the TC for Metals Only

Under the HWIR-Media analysis, 40 percent of the soil cost savings were for RCRA corrective actions and closures. Most of these savings (37 of 40 percent) were for volumes below the bright line. The Phase IV analysis, in contrast, projects no significant savings for RCRA sites, largely because less than one percent of these volumes is incinerated in the baseline. Similarly, the Phase IV analysis projects no savings for the 25 percent of CERCLA remedial action soil that is TC for metals only.

Ex-Situ Treatment Only

The HWIR-Media rule would have changed the requirements for in-situ as well as ex-situ treatment of contaminated media. For example, facilities conducting in-situ treatment of below-the-bright-line soil could avoid the need to obtain a RCRA treatment permit. Phase IV will not affect in-situ treatment requirements, because the LDRs generally do not apply to contaminated soil treated in-situ. The estimated cost savings for Phase IV do not include any savings for volumes treated in-situ. In addition, to improve the modeling for Phase IV, EPA disallowed any shifts from baseline ex-situ treatment to post-regulatory in-situ treatment. Such shifts in the HWIR-Media analysis may have unrealistically inflated the cost savings for volumes above the bright line.

3.3 No Change In Cost: Media Contaminated with Newly Identified Mineral Processing Wastes

EPA expects that treatment costs for facilities generating media contaminated with newly identified mineral processing wastes will not increase significantly under Phase IV because:

- For soils, the new alternative treatment levels for most TC metal constituents are higher than existing TC levels, as discussed in Section 2.7; and

- For media containing metal constituents with new or lower treatment levels, the stabilization/solidification treatment process currently used also treats non-TC metal constituents. The process can be inexpensively modified in order to account for the new standards.

Thus, EPA expects that generators of soils with these constituents will continue to treat their contaminated wastes to TC levels to avoid Subtitle C regulation of the residuals and will thus have no change in treatment costs.

For silver and non-TC metal constituents in soils or for media that must meet UTS levels, EPA believes that the additional cost of treating wastes to the lower new soil standards will not be significant. In order to meet the new standards, EPA expects that facilities will increase the ratio of reagent to media during the treatment process to decrease the concentration of constituents in the residue. As this change does not significantly modify the treatment process or require any additional treatment steps, the Agency does not expect treatment costs for media containing newly identified mineral processing wastes to increase significantly.

3.4 Increased Costs for TC Metals Soil

EPA expects that facilities managing contaminated soil or sediments exhibiting the TC for metals at CERCLA, state superfund, and voluntary cleanups only could incur increased costs because all UHCs present must now be treated to the new soil treatment standards for soils or to UTS levels for sediments. Based on the analysis described in Section 2.8, EPA estimates that the incremental costs of the Phase IV rule to generators of such contaminated soil will be approximately $3 million per year, an increase of less than one percent of total baseline treatment costs. The analysis estimated negligible incremental costs for cleanups performed under RCRA and for contaminated sediment managed under both CERCLA and RCRA.

In order to calculate the incremental national soil treatment costs from the Phase IV rule, EPA extrapolated the $19 per ton cost increase for soil treatment calculated for CERCLA remedial action sites in the database (outlined in Section 2.8) to the universe of CERCLA sites remediated nationally. These calculations and the estimated volume of soil treated annually are presented in Exhibit 3-7. The increased costs were applied only to soil that exhibits the TC for metals only and is treated ex-situ outside of CAMUs or AOCs. About 20 percent of all CERCLA soils exhibit the TC for metals only, and about 25 percent of CERCLA soil treated ex-situ exhibits the TC for metals only. Thus, the increased cost for CERCLA remedial action soil cleanup is $0.7 million per year (140,000/tons per year treated ex-situ x .25 x $19/per ton).

To determine national costs of Phase IV at state superfund and voluntary cleanups, EPA used the results of the ex-situ analysis of the sample of all CERCLA soil volume in the database. Thus, 20 percent of soil generated by state superfund and voluntary cleanups is assumed to exhibit the TC for metals only. The average incremental cost per ton for treating these soils is assumed to be the same as for CERCLA soil ($19/ton). Thus, the increased cost is $0.5 million per year for state superfund cleanups (130,000 tons/year x .20 x $19/ton) and $2 million for voluntary cleanups (510,000 tons/year x .20 x $19/ton).

Exhibit 3-7
Increased Contaminated Soil and Sediment Treatment Costs under Phase IV For TC Metal-Contaminated Soils and Sediments

Remediation Category	Tons Treated Ex-Situ Outside of CAMUs or AOCs	Percent Exhibiting TC For Metals Only*	Additional Treatment Cost Per Ton	Incremental Cost of Phase IV for TC Metals Only Media
CERCLA Remedial Action Soil	140,000	25%	$19	$0.7 million/yr.
RCRA Corrective Action Soil	110,000	7%	$0	--
RCRA Closures Soil (Landfills)	50,000	7%	$0	--
State Superfund Soil	130,000	20%	$19	$0.5 million/yr.
Voluntary Cleanup Soil	510,000	20%	$19	$2 million/yr.
CERCLA Sediment	60,000	22%	$0	--
RCRA Corrective Action Sediment	30,000	7%	$0	--
Totals	**940,000**	**N/A**	**N/A**	**$3.2 million/yr.**

* Reflects only volumes treated ex-situ.

As explained in Section 2.8, the model predicted no incremental costs for treating RCRA soils and sediments that exhibit the TC for metals, primarily because of the small volume of RCRA media projected to be incinerated/thermally desorpted in the baseline. EPA, however, does expect some low level of incremental costs for these RCRA soils. EPA believes that the incremental costs will be substantially lower for RCRA soil than for CERCLA soil because RCRA soils are generally less highly contaminated than CERCLA soils. Furthermore, a significantly smaller share of RCRA soil is TC for metals only and contains organic UHCs. To the extent that there are incremental costs at RCRA soil and sediment cleanups, this analysis underestimates the overall cost of the Phase IV rule.

The relatively low level of incremental treatment costs is consistent with the new site-specific variance from the technology-based new soil treatment standards for soils with concentrations above levels that can be shown to minimize threats to human health and the environment. This variance could potentially exempt from the new soil standards soils that, in absence of the variance, would have to be treated to below site-specific risk-based cleanup levels. Thus, the variance may decrease the incremental costs associated with the new LDR requirements for some TC metal only soils. However, some TC metal soils will have to be treated to levels lower than the site-specific risk-based cleanup levels applied in the baseline because the minimal threat levels under the LDR variance will be more stringent. For example, current cleanup levels, but not the minimal threat levels, may take into account the effectiveness of engineering and institutional controls in reducing risk.

3.4.1 Potential Incremental Costs In Absence of the CAMU Rule

The results described above for CERCLA remedial actions assume that the CAMU rule is completely effective and 36 percent of ex-situ CERCLA soil (180,000 tons/year) is treated in CAMUs. The CAMU rule allows for the movement, consolidation, and treatment of hazardous wastes within designated areas without triggering the LDRs. Thus, contaminated media managed within CAMUs would be unaffected by the Phase IV rule. If the CAMU rule was not in place, the additional CERCLA soil volumes affected by Phase IV would increase by 180,000 tons per year (or 129 percent) from 140,000 to 320,000 tons per year. Thus, the incremental costs for CERCLA remedial actions would increase by $0.8 million/year to $1.5 million/year.

3.5 Summary of Costs/Cost Savings for Media Impacts of Phase IV LDR Rule

As shown in Exhibit 3-8, the total impacts of the Phase IV LDR Rule as it applies to contaminated media are estimated to be an overall savings of approximately $22

Exhibit 3-8: Summary of Costs/Cost Savings for Phase IV LDR Rule

Soil/Sediment Impacts	Affected Volumes (tons per year)	Baseline Costs (million $ per year)	Post-Regulatory Costs (million $ per year)	Incremental Cost/Cost Savings (million $ per year)
New Soil Treatment Standards				
TC Organic Soils	7,000	6.9	3.0	(3.9)
Listed (non-TC) Soils	8,000	8.7	3.8	(4.9)
Soils below 10xUTS	75,000	19.9	4.1	(15.8)

Subtotal	90,000	36	11	(25)
TC Metal Contaminated Soil/Sediment				
Soil w/ Organic UHCs[1]	163,000	57.7	60.8	3.1
TOTAL	253,000	94	72	(22)

* TC Metal contaminated sediments showed negligible costs, mineral processing waste contaminated media showed no impacts, as did groundwater and debris which are contaminated with wastes addressed in this rule. Totals are rounded.
1 The baseline and post-regulatory costs for TC metal contaminated soils were calculated using the average baseline treatment cost for CERCLA soils of $354 per ton, and the incremental difference in costs identified in section 2.8 as $19 per ton.

million per year. This overall savings is made up of an estimated savings for the new soil treatment standards applied to previously regulated wastes contaminating soil of approximately $25 million per year, and a cost for TC Metal contaminated soils with organic underlying hazardous constituents present of $3 million per year. (See also Exhibit 3-1 for more complete overview of the cost estimates.) These figures are rounded to the nearest million dollars. While a sensitivity analysis has not been performed on the many assumptions employed for this assessment, the total cost savings estimated for the rule is obviously subject to many uncertainties. These uncertainties are discussed in section 2.10 of this document.

In order to estimate the overall costs for the entire Phase IV LDR Rule, including process waste impacts and Manufactured Gas Plant (MGP) contaminated media, please see the preamble for the Phase IV LDR Final Rule.

CHAPTER 4. ECONOMIC IMPACTS

This chapter discusses the economic impacts of the Phase IV rule on industry and analyzes whether a regulatory flexibility analysis (RFA) is required. The chapter contains the following sections:

- Section 4.1 reviews the requirements for an RFA;
- Section 4.2 projects the overall number of firms with increased costs under Phase IV;
- Section 4.3 describes the projected distribution of these affected firms across different industry sectors;
- Section 4.4 estimates the number of small affected firms in each industry;
- Section 4.5 estimates the economic impacts of Phase IV on affected small firms; and
- Section 4.6 explains why Phase IV will not impose significant economic impacts on a substantial number of small entities.

This chapter focuses on the economic effects of soil cleanups performed under CERCLA, state superfund, and voluntary cleanups because this analysis predicted that facilities performing cleanups under RCRA would not see significant additional costs as a result of this rule. While EPA recognizes that treatment costs at some RCRA sites will increase, it believes that the majority of the increased costs of Phase IV as it relates to contaminated media will be at CERCLA, state superfund, and voluntary sites and thus focuses on these cleanups. Additionally, this chapter only examines the incremental costs of the Phase IV rule and not the cost savings related to the new soil treatment standards for contaminated soil.

4.1 Requirements for a Regulatory Flexibility Analysis

The Regulatory Flexibility Act of 1980, as amended by the Small Business Regulatory Enforcement Fairness Act, requires federal agencies to assess whether proposed regulations will have a significant economic impact on a substantial number of small entities. According to EPA's *Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act*, an RFA is required for any notice and comment rule unless the Agency certifies that the rule will not have a significant economic impact on a substantial number of small entities.[40] Because EPA does not expect that the Phase IV rule will have an effect on a substantial number of small entities, an RFA was not prepared.

4.2 Number of Entities With Increased Costs

In order to estimate the economic impacts of Phase IV, EPA first estimated the overall number of firms that will see increased costs. As discussed earlier, the Agency believes that of the sites in the database, approximately 1,108 could potentially have increased costs per year as a result of Phase IV: 30 CERCLA remedial actions, 464 state superfund cleanups, and 614 voluntary soil cleanups per year. In order to estimate the number of firms that could potentially have increased costs from these cleanups, the number of cleanups in each cleanup program was multiplied by the average number of responsible parties per site, using the following assumptions:

- For CERCLA remedial actions, an average of 10 firms are responsible for each cleanup. This assumption is based on the results of EPA's Remedial Project Manager survey, which indicates that about 60 percent of nonfederal sites have 10 or fewer potentially responsible parties and about 40 percent of such sites have more than 10 potentially responsible parties.

- For state superfund and voluntary cleanups, one firm is assumed to be responsible for the cleanup of a whole site. In reality, more than one firm may be responsible and, consequently, this analysis may slightly underestimate the number of firms with increased costs as a result of Phase IV but conversely overestimate the average costs per firm. Firms may also be responsible for cleaning up more than one site, which would result in this analysis overestimating the number of firms with increased costs but underestimating the average incremental costs.

Additionally, for CERCLA sites, six of the 300 entities affected were assumed to be local governments responsible for operating municipal solid waste landfills (MSWLFs) and were thus excluded from the universe of affected small firms. This figure of six sites was calculated by assuming that 23 percent of all

[40] U.S. EPA, "Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act", February, 1997.

CERCLA remedial action sites previously operated as MSWLFs, as indicated by EPA's NPL Characterization Database (which includes all CERCLA cleanups through 1991). Therefore, the annual number of CERCLA remedial actions that would have previously operated as MSWLFs is approximately seven (30 x 0.23). Not all these sites, however, will involve a local government because approximately 80 percent of all MSWLFs nationwide are owned or operated by local governments.[41] Thus, the estimated number of local governments that may be affected by Phase IV is approximately six (7 x .8). The effects of the Phase IV rule on these entities are discussed further in Section 4.7.

This number may slightly underestimate the actual number of local governments affected by this rule because:

- This estimate does not incorporate local government responsibility for sites that are not MSWLFs;
- It does not account for small governments that are responsible for state superfund and voluntary cleanups; and
- Some MSWLFs operated by local governments will have several local governments as owners and operators. For example, all the cities in a county may be responsible for cleanups at a county MSWLF.

As shown in Exhibit 4-1, the estimated total number of entities potentially affected by Phase IV at CERCLA, state superfund, and voluntary cleanups is 1,372. This number includes cleanups performed by both private and public (i.e., federal) entities.

Exhibit 4-1
Annual Number of Entities With Increased Costs Under Phase IV

Type of Cleanup	Sites Potentially Affected	Entities Potentially Affected	Entities Actually Affected

[41] *Directory and Atlas of Solid Waste Disposal Facilities, 1994*, First Edition, Ehartwell Information Publishers. According to this directory, in 1994 about 72 percent of all MSWLFs were owned by governments. In this analysis, the number was rounded up to 80 percent because the portion of MSWLFs owned by governments has been steadily declining from about 80 percent in 1986 and most CERCLA remedial action sites were contaminated prior to 1986.

CERCLA Remedial Action	30	294	8
State Superfund	464	464	13
Voluntary	614	614	17
Total	1,108	1,372	38

Of these 1,372 entities, only a small portion will see increased costs due to higher treatment costs for TC metal soil. To determine the actual number of affected entities, EPA applied the percentage of CERCLA sites affected by Phase IV, as determined by the analysis of the sample sites in the soil and sediment database, to the 1,372 firms potentially affected by Phase IV. Nine sites out of the 326 CERCLA sites (2.8 percent) in the database were predicted to see increased costs. As shown in Exhibit 4-1, applying this percentage to the total number of entities potentially affected yields an annual total of 38 entities with increased costs due to Phase IV requirements.

To determine the total number of entities with increased costs, EPA used a five-year planning horizon. As explained in Section 2.4, the Agency used the five-year planning estimate because of the uncertainties associated with longer-term projections and the pace with which the rule will be fully implemented and reflected in the use of different treatment methods. Longer-term projections are subject to substantial uncertainties, such as government remediation and enforcement budgets, potential changes in the Superfund statute and budget, and the demand for restoring economically valuable contaminated properties (e.g., Brownfields). Thus, over the five years following implementation of this rule, the total number of entities expected to be adversely affected will be 190 (38 x 5).

4.3 Distribution of Affected Entities Across Different Industries

To estimate the distribution of industries and firms responsible for cleanups at CERCLA, state superfund, and voluntary cleanup sites, EPA used a database compiled by Resources For the Future (RFF). The database was developed as part of a study estimating the distribution of cleanup costs among responsible parties and the Superfund trust fund under a series of alternative liability scenarios.[42] The database contains data on 1,134 non-federal National Priority List (NPL) sites obtained from the Remedial Project Manager survey conducted by EPA in August 1993 and other sources, including EPA's *NPL Characterization Database*, the *Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)*, state books of NPL sites, and the *Site Enforcement Tracking System (SETS) Database*.[43] For each site, the industries most likely to be responsible for cleanup costs were identified. The estimated number and percent of CERCLA remedial action sites per industry, as shown by this data, are

[42] Probst, K.N. et al, *Footing the Bill for Superfund Cleanups: Who Pays and How?*, The Brookings Institution and Resources for the Future, Washington, D.C., 1995.

[43] The RFF study also identifies 123 federal NPL sites. No data were collected on these sites, however.

presented in Exhibit 4-2.[44]

As calculated in Section 4.2, an estimated 190 firms will be adversely affected by the Phase IV requirements over the period covered by this analysis. These firms were apportioned to specific industries based on the percentage of CERCLA remedial action sites in each industry. Because data on the industries responsible for state superfund cleanups and voluntary cleanups are not readily available, EPA assumed that the distribution of firms responsible for these cleanups is the same as that of firms responsible for CERCLA remedial actions. The results of this apportionment are shown in Exhibit 4-2. Industries most affected by the changes include:

- Chemicals and allied products (SIC 28);
- Wholesale trade, durable goods (SIC 50); and
- Fabricated metal products (SIC 34).

Approximately 30 percent of the CERCLA sites were not attributed to a specific industry. For this analysis, EPA chose to keep these sites separate because the industries responsible for these cleanups are unknown. An alternative would be to apportion the non-attributed sites to the industries in proportion to the percentage of attributed sites in each industry. Even if EPA took this later approach, the conclusion that the new rule does not pose a significant economic impact on a substantial number of small firms would not change because the number of small firms with significant economic impacts will remain small (see Section 4.6).

4.4 Number of Affected Small Firms In Each Industry

The next step in the analysis was to estimate the number of affected small firms in each industry. This analysis uses the Small Business Administration (SBA) definition of a small business. The SBA defines small businesses at the four-digit SIC code level, generally in terms of number of employees or annual revenues. Because the available data on the firms responsible for CERCLA remedial actions

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[44] EPA did not believe that the industries of the firms identified by the database were representative of the industries expected to be affected by this rule for three reasons. First, remedies at the sites included in the database have already been approved and, in many cases, have already been completed. Second, because the number of affected facilities in the database is so small, it is unlikely that these firms are representative of the industries that will be affected in the future. Third, it is difficult to identify all the firms or industries responsible for each site because of the age of the contamination and the large number of firms involved. Additionally, Chemical Waste Management submitted data to EPA indicating a number of industries expected to be affected by the Phase IV rule with respect to process waste. EPA did not use this data for the analysis of contaminated media because the Agency believes that there are significant differences between the makeup, management, and treatment of the two types of hazardous waste.

are at the two-digit SIC level, this analysis identifies the number of affected firms at the two-digit SIC code level. The SBA definition that was most prevalent among the four-digit SIC codes under each two-digit SIC code was used to define small firms in each industry.

Exhibit 4-2
Distribution of Firms Affected per Year by Industry

SIC Code	Industry	Percent of CERCLA Remedial Action Sites	CERCLA, State Superfund, and Voluntary Cleanup Sites	Entities Affected by Phase IV	Small Firms Affected	
					Upper Bound	Lower Bound
07	Agricultural Services	0.2%	2	0	NA	NA
10	Metal Mining	0.7%	9	1	1	0
12	Coal Mining	0.7%	9	1	1	0
13	Oil and Gas Extraction	0.7%	9	1	1	0
14	Nonmetallic Minerals, Except Fuels	0.7%	9	1	1	1
17	Special Trade Contractors	0.3%	4	1	1	0
20	Food and Kindred Products	0.5%	6	1	1	0
22	Textile Mill Products	0.5%	6	1	1	0
23	Apparel and Other Textile Products	0.5%	6	1	1	0
24	Lumber and Wood Products	3.8%	52	7	7	4
25	Furniture and Fixtures	0.5%	6	1	1	0
26	Paper and Allied Products	0.5%	6	1	1	0
28	Chemicals and Allied Products	13.6%	187	26	24	5
29	Petroleum and Coal Products	2.0%	27	4	3	0
30	Rubber and Miscellaneous Plastic Products	0.5%	6	1	1	0
31	Leather and Leather Products	0.5%	6	1	1	0
32	Stone, Clay, and Glass Products	0.5%	6	1	1	0
33	Primary Metal Industries	2.9%	40	6	5	1
34	Fabricated Metal Products	6.0%	82	11	11	6
35	Industrial Machinery and Equipment	0.2%	2	0	0	0
36	Electronic and Other Electric Equipment	4.6%	64	9	8	2

SIC Code	Industry	Percent of CERCLA Remedial Action Sites	CERCLA, State Superfund, and Voluntary Cleanup Sites	Entities Affected by Phase IV	Small Firms Affected	
					Upper Bound	Lower Bound
37	Transportation Equipment	0.5%	6	1	1	0
38	Instruments and Related Products	0.5%	6	1	1	0
40	Railroad Transportation	0.3%	4	1	0	0
42	Trucking and Warehousing	0.3%	4	1	0	0
45	Transportation by Air	0.3%	4	1	0	0
47	Transportation Services	0.3%	4	1	1	0
49	Electric, Gas, and Sanitary Services	0.3%	4	1	0	0
50	Wholesale Trade, Durable Goods	8.7%	119	16	16	9
72	Personal Services	0.2%	3	0	0	0
75	Automotive Repair, Services, and Parking	0.2%	3	0	0	0
80	Health Services	0.2%	3	0	0	0
82	Educational Services	0.2%	3	0	0	0
87	Engineering and Management Services	0.2%	3	0	0	0
92	Public Administration Justice, Public Order, and Safety	0.3%	5	1	NA	NA
95	Public Administration Environmental Quality and Housing	0.3%	5	1	NA	NA
97	Public Administration National Security and International Affairs	0.3%	5	1	NA	NA
99	Nonclassifiable Establishments	1.3%	17	2	NA	NA
Not Attributed		29.4%	404	56	NA	NA
Orphan		6.6%	91	13	NA	NA
Federal		9.7%	133	18	NA	NA
Total[2]		100.0%	1,372	190	93	34

1 Estimates taken from Probst, K.N. et al.,*Footing the Bill for Superfund Cleanups: Who Pays and How?*, The Brookings Institution and Resources for the Future, Washington, D.C.,

SIC Code	Industry	Percent of CERCLA Remedial Action Sites	CERCLA, State Superfund, and Voluntary Cleanup Sites	Entities Affected by Phase IV	Small Firms Affected	
					Upper Bound	Lower Bound

1995. In some cases, estimates were provided for a group of 2 digit SIC codes. The facilities in these groups have been equally apportioned among the relevant SIC codes.

2 Totals may not match due to rounding.

Because EPA cannot predict specific entities that will be affected by Phase IV, the number of small affected firms could not be determined directly. Instead, the Agency first collected Census data on the distribution of facilities by employee or revenue size categories (e.g., 1 to 4 employees or $100,000 to $249,999 in annual revenues). Appendix B presents the following data by size category for all of the potentially affected industries:

- Number of firms;
- Total annual revenues;
- Total employment; and
- Market share.

Tables B-1 through B-4 show these data for the industries where small entities are defined by the number of employees. Tables B-5 though B-8 show these data for the industries where small entities are defined by their annual revenues. Tables B-9 to B-14 presents the same data on a per-firm level: average revenues, average employment, and average market share by industry and size category. In these appendices, the size categories that correspond with small entities are not shaded and the size categories that correspond with non-small entities are shaded.

EPA apportioned the affected entities in each industry into the various size categories under two scenarios, thus developing a range for the number of affected small firms in each industry. To project the upper bound of this range, the Agency assumed that the affected firms were distributed among the various size categories in proportion to the distribution of all firms within the industry in each size category. Under this assumption, the total number of affected firms in a specific industry in a specific size category is equal to the percentage of firms in the industry that are in this size category multiplied by the total number of affected firms in the industry. Under this assumption, Appendix B, Tables B-15 and B-16 show the distribution of affected firms by industry and size category under this assumption.

EPA considers this assumption to be an upper bound for the number of affected small firms because the size of a firm is not taken into account in the apportionment. Instead, all firms in a particular industry are assumed to have an equal probability of being responsible for cleanup costs. However, many of the waste management practices that may result in the responsibility for cleanup costs take place only at relatively large firms. For example, a significant portion of the firms that are responsible for cleanups have or had on-site waste management units. In general, only larger firms have such units. To the extent that the waste management practices at larger firms are more likely to result in the responsibility for cleanup than the waste management practices at smaller firms, the assumption that affected firms are distributed among size categories in proportion to the distribution of firms within the industry in each size category will overestimate the number of affected firms in the smaller size categories.

To estimate the lower bound of the range, EPA assumed that the affected firms were distributed among the various size categories in proportion to the distribution of revenues within the industry in each size category (i.e., proportional to the market share for each size category). Under this assumption, the total number of affected firms in a specific industry in a specific size category is equal to the market share for that size category multiplied by the total number of affected firms in the industry. This assumes that smaller firms (in terms of revenue) have a lower probability of being responsible for cleanup costs. There are many reasons to believe that revenues are directly related to the probability that a firm will be responsible for cleanup costs. In general, EPA believes the lower bound to be a more accurate representation of the number of affected small businesses because:

- Revenues and production are directly correlated;
- Production and waste generation are positively correlated; and
- To the extent that firms that generate larger quantities of waste are more likely to be responsible for cleanup costs, then revenue and the probability that a firm will perform a cleanup are directly correlated.

This estimate is a lower bound, however, because many other factors that may influence whether a firm will be responsible for cleanup costs do not depend on size. Appendix B, Tables B-17 and B-18 show the distribution of affected firms by industry and size category under the lower bound assumption.

Exhibit 4-2 presents the total number of affected small businesses in each industry under both the upper bound and lower bound assumptions. The Agency expects this number to range from 34 to 93. As shown, this estimate is sensitive to the assumption regarding how the affected firms are distributed throughout an industry. The total upper bound estimate is almost three times the lower bound estimate. The difference between the upper and lower bound assumptions varies by industry. In some industries (e.g., metal mining, transportation equipment), the upper bound estimate may be five or ten times larger than the lower bound estimate but in other industries, particularly in many service industries, the two estimates are much closer.

4.5 Estimating Economic Effects On Affected Small Firms

The final step of the analysis was to estimate the incremental costs for affected small firms as a percentage of revenue. To estimate incremental costs for each small firm, EPA divided the total annual expected incremental cost of Phase IV on cleanup sites ($3.2 million) by the expected annual number of affected entities (38). The resulting total incremental cost per firm is approximately $84,000. EPA then amortized this cost over 20 years because the costs of cleanup corrective will be incurred over many years in the future.

The rationale for discounting is presented in further detail in EPA's RIA guidance.[45] The 20-year time period was chosen in order to be consistent with other EPA and Office of Solid Waste RIAs. Furthermore, EPA used a seven percent discount rate. Although there is no single, correct discount rate, the seven percent real discount rate was selected because it approximates the marginal pre-tax rate of return on an average investment in the private sector in recent years. The seven percent rate is appropriate for cost analyses of public investments and regulatory programs that imposes costs on the general public. Public investment and regulations displace both private investment and consumption; the seven percent discount rate accounts for this displacement.[46]

When annualized over 20 years using a discount rate of seven percent, the annual cost to each firm is approximately $8,000. EPA believes that this estimate represents an upper bound because it assumes that all firms, regardless of size, will have the same incremental cleanup cost. In reality, small firms are likely to have lower costs because they are less likely to be responsible for the larger, more expensive, cleanups than large firms.

In order to determine if this rule will significantly impact small firms, EPA calculated the annual compliance costs as a percentage of sales revenue for each industry. Appendix B, Tables B-9 and B-12 present the average annual revenues by industry and firm size category. Exhibit 4-3 shows, for each industry category with at least one firm projected to be affected, the average annual compliance costs as a percentage of revenue for small firms. The exhibit shows that under the upper bound, all affected small firms except for two are projected to have annual cleanup costs that are less than one percent of total annual revenue. Thus, EPA projects that very few firms will have significant economic effects due to the

[45] U.S. EPA, Office of Policy Analysis. Guidelines for Performing Regulatory Impact Analysis: Appendix C - Analysis of the Choice of Discount Rates, 1989.

[46] Office of Management and Budget. Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs - Circular A-94, October 29, 1992, page 9.

Phase IV rule. Under the lower bound projection, zero small firms will have cleanup costs that are more than one percent of total annual revenue.

Exhibit 4-3
Annual Revenue and Cost of Phase IV as Percentage of Revenue*

SIC Code	Upper Bound Estimate of Number of Small Firms Affected	Lower Bound Estimate of Number of Small Firms Affected	Annual Sales Revenue	Annual Cost as a Percentage of Sales Revenue
07	NA	NA	NA	NA
10	1	0	2,453	0.3%
12	1	0	4,883	0.2%
13	1	0	2,017	0.4%
14	1	1	2,017	0.4%
17	1	0	417	1.5%
20	1	0	7,071	0.1%
22	1	0	4,485	0.2%
23	1	0	1,717	0.5%
24	7	4	1,520	0.5%
25	1	0	2,064	0.4%
26	1	0	7,357	0.1%
28	24	5	7,759	0.1%
29	3	0	11,906	0.1%
30	1	0	4,133	0.2%
31	1	0	2,313	0.3%
32	1	0	2,337	0.3%
33	5	1	6,448	0.1%
34	11	6	2,783	0.3%
36	8	2	3,837	0.2%
37	1	0	3,362	0.2%
38	1	0	3,239	0.2%
47	1	0	352	2.3%
50	16	9	3,741	0.2%
Total	93	34	NA	NA

* Only industry categories that EPA projects will have at least one firm affected are shown.

4.6 Why Phase IV Does Not Impose Significant Economic Impacts On a Substantial Number of Small Entities

To determine if the economic impacts of Phase IV on small entities are significant on a substantial number of small entities, EPA used criteria specified in its "Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act."[47] Based on this guidance, EPA does not expect that the Phase IV rule will impose significant economic impacts on a substantial number of small firms or governments. As shown in Exhibit 4-3, the predicted total number of affected small firms over the next five years ranges from 34 to 93. Even if the high end of the range is used and all affected firms are assumed to have significant economic impacts, the total number of small entities experiencing any type of economic impact will not be substantial (e.g., more than 100).[48] Additionally, as shown in Exhibit 4-2, EPA expects that a wide variety of industries will be affected and that no particular industry will bear the brunt of the costs. Finally, the Agency demonstrated in Section 4.5 that it is unlikely that any small firms affected by the rule will experience annual economic impacts greater than one percent of their annual revenues.

With respect to small governments, the Agency estimated in Section 4.3 that each year, six local governments could *potentially* be affected by these requirements. Thus, over the five years covered by this analysis, 30 local governments could be affected by Phase IV. However, the Agency believes that a substantial number of small governments will not be adversely affected by these requirements because:

- Most of the potentially affected governments will not see increased costs because only 2.8 percent of all cleanup sites are expected to be affected by Phase IV; and

- Only a portion of all governments responsible for MSWLFs will meet the RFA's of small governments.

Because a substantial number of small firms or governments are not expected to experience significant economic impacts, the Agency did not perform

[47] See Table 2, p. 1-18, "Interim Guidance for Implementing the Small Business Regulatory Enforcement Fairness Act and Related Provisions of the Regulatory Flexibility Act," February 1997.

[48] Additionally, for many of the firms with increased costs, the economic impact will not be substantial. Because the total number of affected firms is expected to be less than 100, economic impacts on these firms were not analyzed.

a regulatory flexibility analysis for this rule.

4.7 Why Phase IV Does Not Impose Significant Economic Impacts On a Substantial Number of Large Firms

The previous section explained why EPA does not expect that the Phase IV rule will impose significant economic impacts on small firms. The Agency does not expect that the rule will significantly impact large firms either. Depending on the how small and large firms are defined, the number of large firms affected could range from five to 64. This range was estimated by subtracting from the total number of entities affected (190) non-firm entities (federal, orphan, non-attributed entities, total number 92) and small firms (34 to 93).

EPA does not believe that these large firms will be significantly affected by the rule because:

- The analysis predicted the same incremental cleanup costs for large firms as for small firms (annualized cost of approximately $8,000), as explained in Section 4.5; and

- These costs will be spread over a higher annual revenue than for small firms, resulting in smaller costs as a percentage of revenue.

As the previous section showed that very few firms will likely be significantly impacted, the Agency believes that no large firms will see significant economic impacts as a result of this rule.

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APPENDIX A: SOIL AND SEDIMENT DATABASE

EPA compiled a database containing available soil and sediment data on existing CERCLA remedial action and RCRA corrective action sites, as reported in CERCLA Records of Decision (RODs) and several databases compiled for analyses of RCRA corrective action initiatives. (Detailed data were not available for other remediation programs.) The data for each site include contaminated soil and/or sediment volumes for a distinct segment of the cleanup and the types and maximum concentrations of hazardous constituents present. Because detailed data on sediment contamination at RCRA corrective action sites were not available, the impact of Phase IV on the management of sediment at RCRA sites was derived from data for CERCLA remedial action sediment and RCRA corrective action soil. This appendix describes the development and content of the database.

CERCLA Records of Decision

CERCLA RODs summarize sampling data collected for CERCLA remedial investigations and feasibility studies, define goals for remediation, analyze remediation options, and document the remedy selection. EPA reviewed all RODs signed in federal fiscal years 1989 through 1996 and contained in the Agency's Headquarter's collection of RODs. Each ROD was examined for data on contaminated soil and sediment. Because the circumstances differ from site to site, the number of RODs pertinent to each category of data differed. In addition, a single ROD may pertain to several distinct volumes of remedial waste with different contamination levels, or a single site can have more than one ROD. The database is organized around particular volumes of remedial action waste with their own constituent and constituent concentration data, which are called “sites” for the purposes of the database.

The types of RODs data used to develop components of the soil and sediment database and particular issues or limitations associated with these data are discussed below.

Soil and Sediment Type. RODs generally identify contaminated soil, contaminated sediment, mixtures of contaminated soil and sediment, and mixtures of contaminated soil and/or sediment with old wastes and/or debris. EPA partitioned mixed soil and sediment volumes. Volumes described as soil or sediment mixed with debris accounted for only negligible volumes in the RODs, and were not partitioned, but were counted as soil or sediment.[49]

[49] EPA's National Sediment Management Strategy (U.S. EPA Office of Water, August 1994)

Amount of Soil and Sediment Managed. The volumes reported in the RODs and contained in the database are those volumes that are planned to be managed. There may be some difference between the volumes planned to be managed and the volumes actually managed. A brief analysis of predicted management volumes versus actual management volumes at 12 sites indicated that the RODs may underestimate volumes by approximately 20 percent.[50] These differences, however, should not bias the analysis overall, and would be difficult to correct without the scope of this analysis.

The RODs volume data were not used to estimate the amount of soil and sediment treated annually and potentially affected by Phase IV. Instead, a variety of other data sources were used to estimate the amount of contaminated soil and sediment treated annually under various remediation programs (see Section 2.4). ROD volume data, however, were used as a representative sample of the contamination at CERCLA, state superfund, and voluntary cleanup sites and therefore were critical inputs in calculating the portion of soil and sediment treated using various treatment methods and the resulting average treatment wastes under changes in baseline and Phase IV treatment costs.

Maximum Constituent Concentrations. Most RODs contained maximum constituent concentration data. These actual maximum concentrations and the modeled variation in concentration across the site were used to assign treatment technologies. CAS numbers were added to the constituents to eliminate problems, such as synonyms and typographical errors associated with constituent names. Concentration data for constituent groups (e.g., total volatile organic compounds) were not used in analyses because RCRA treatment standards apply to specific constituents.

In summary, while the RODs data do have some limitations (e.g., data errors in the RODs, incomplete records, and other inconsistencies), EPA believes that these limitations do not bias data obtained from the RODs. Moreover, the estimates used in the Phase IV media analysis are also based on other data sources.

RCRA Corrective Action RIA Databases

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reports that the most frequently reported contaminants in sediments are heavy metals and metalloids, PCBs, and AHCs (page 4). These same contaminant types also predominate in CERCLA RODs sediment data.

[50] Memorandum to Lyn Luben, U.S. Environmental Protection Agency, from ICF Incorporated entitled "Updates on Contaminated Media and Debris Data," November 5, 1993, pages 4-8.

To estimate the annual volume of contaminated soil and sediment remediated at RCRA corrective action facilities and to characterize the contamination at these facilities, EPA primarily used data from three databases compiled for analyses of the RCRA corrective action initiatives:

- The remedial database;
- The RCRA Facility Investigation (RFI) database; and
- The Solid Waste Management Unit (SWMU) database.[51]

These databases do not overlap with the CERCLA RODs data since they address RCRA corrective action facilities only, excluding CERCLA, state superfund, and voluntary cleanup sites. All three databases contain data on individual SWMUs at a stratified random sample of 79 RCRA corrective action facilities. The corrective action RIA methodology used weighting factors or facility weights for each stratum of the sample to extrapolate data and results from sample facilities to national-level totals so that the corrective action data can be presented at the SWMU, facility, or national level. Subsequently, EPA supplemented the corrective action data, compiled from the remedial, RFI, and SWMU databases, with data collected from RCRA corrective action Statements of Basis (SBs).

The *remedial database* contains information on the corrective action management methods for each SWMU at facilities in the corrective action RIA sample. These data, compiled in order to estimate the costs of corrective action, were generated using expert panels assembled by EPA to decide the most appropriate remedy for each SWMU. In addition to specifying remedial activities, the expert panels identified, for each SWMU, the timing and duration of cleanup, the media addressed, and the cost of the cleanup. When contaminated media or other remedial waste were projected to be excavated as part of the remediation, the expert panels estimated the media or other remediation waste volumes. Subsequently, volumes also were estimated for wastes managed in-situ. Although the database identifies the type of media or other remedial waste addressed by most of the remedial activities, media are not specifically identified for non-treatment (containment) remedies. Important limitations of these volume estimates are described below.

The *RFI database* contains information on contaminated media for SWMUs with a release of at least one hazardous constituent at a concentration above Subpart S action levels. EPA collected the data from mock RCRA Facility

[51] See "Draft Regulatory Impact Analysis for the Final Rulemaking on Corrective Action for Solid Waste Management Units: Proposed Methodology for Analysis," U.S. EPA, Office of Solid Waste, March 1993.

Investigation (RFI) packets that were used by expert panels to select appropriate remedies. In turn, data in the mock RFI packets were collected from available source documents (e.g., RFIs, RCRA Feasibility Assessments, or other site studies), or modeling results. Relevant data elements include the volume and type of media exceeding action levels and the maximum concentrations of constituents in the media. Because these data were collected from a wide variety of sources, full data sets are not available for all SWMUs.

The *SWMU database* contains data characterizing the physical characteristics of each SWMU and the waste it contains. The sources of these data are the same sources used to compile the RFI packet database (i.e., available facility studies and other documents). These data were collected in order to model contaminant releases at each facility and to prepare mock RFI packets for the expert panels. Data fields in the SWMU database used in Phase IV contaminated media analyses include the constituents present in the unit and the central tendency value of constituent concentrations in the waste, as originally generated. The estimates of original waste concentrations, however, are highly uncertain. Moreover, the concentration data do not represent current waste concentrations because they do not reflect the effect of leaching, volatilization, hydrolysis, and other fate processes that would deplete constituent mass from the wastes. The Phase IV analysis did not use these constituent concentration data, but instead used the RFI database concentration data.

The balance of this section describes the types of Corrective Action RIA data used to project the treatment of contaminated soil and sediment remediated at RCRA corrective action facilities and how EPA used SBs to supplement these data. It also discusses particular issues or limitations associated with the data.

Facility Weights. The corrective action RIA analyzes a sample of facilities, consisting of two separately selected samples: a federal facility sample and a non-federal facility sample. The two samples were constructed separately using different sampling designs. Both samples were stratified and sampled in order to reflect the composition of the potentially affected universe of RCRA Subtitle C facilities and to over-sample facilities likely to require corrective action. When facility-specific data (e.g., volume of remediated soil) for all 79 sample facilities are multiplied by facility weights and the products are summed across facilities, the result is a nation-wide estimate for all facilities subject to RCRA corrective action authorities.

Soil and Sediment Type. SWMUs with soil contamination were identified based on remedy codes in the remedial database. Soil, soil mixed with sediment, unspecified waste (which may include soil as well as old process waste), and soil mixed with waste were included. EPA has assumed that soil mixed with sediment or old waste is likely to be managed in a similar manner to soil. Thus, mixed volumes of soil and sediment or old waste were not partitioned into individual soil and sediment volumes.

Volume of Soil and Sediment Managed. Data on the volume of contaminated media were gathered from the remedial database. Because data on volumes of remediated media, based on monitoring data or engineering estimates indicating the actual volume of contaminated material at a facility, were rarely available, all volumes are estimated. Volumes of media managed ex-situ were estimated by expert panels. In-situ volumes were estimated based on information available from the expert panel and from SWMU dimensions. Because volumes are not based on actual remediation records, but estimated using assumptions about the area and depth of contamination at a sample of SWMUs, sampling error and errors in the assumed extent of contamination may cause the volume of media to be over- or under-estimated.

Hazardous Constituents. The RFI database and the SWMU database contain constituent names and CAS numbers. Because modeling for EPA's corrective action analyses was limited to five or fewer constituents per SWMU, some SWMUs contain additional constituents that do not appear in the databases.

Constituent Concentrations. The RFI database identifies maximum concentrations detected in soil or sediment, but only for the constituents detected above RCRA Subpart S action levels. No concentration data are available for 66 percent of the total volume addressed by corrective action. EPA considered supplementing RFI concentration data with concentration data from the SWMU database by assuming that soil concentrations equaled the central tendency (i.e., typical) constituent concentrations in the waste, as originally generated. However, because these concentrations do not reflect dilution that occurs as spilled wastes mix with soil, nor do they reflect the effect of leaching, volatilization, hydrolysis, and other fate processes that would reduce concentration in the soil, they are likely to overestimate the maximum concentrations in soil. EPA therefore used only RFI data for which actual concentrations were present.

Subsequently, EPA reviewed data contained in the current universe of SBs to identify additional data on remediation waste volumes and corresponding constituent concentrations to supplement the corrective action sites that were dropped from the two original samples due to insufficient data. Since the two original corrective action samples, compiled from the remedial, RFI, and SWMU databases, were stratified random samples extrapolated to national levels, EPA incorporated data from the SBs into the analysis in a way that preserves these conventions.

First, EPA determined the appropriate sample (federal or non-federal) and strata (based on the original sample design) to which each SB belongs. Next, EPA supplemented the new sites into the appropriate sample and strata. Finally, EPA calculated and applied new facility weights for extrapolating to national levels based on the new distribution of sites by strata. In all, EPA supplemented the corrective action samples with data from 16 SBs that provided data on both remediation waste volumes and corresponding constituent concentrations.

Complete Soil and Sediment Database

The complete database contains data on 535 soil and sediment sites (or particular volumes) with approximately 44 million tons of contaminated media. The 535 sites include 326 CERCLA sites with approximately 9 million tons of contaminated soil, 88 CERCLA sites with just under one million tons of contaminated sediment, and 121 RCRA corrective action sites with 34 million tons of contaminated soil.

Exhibits A-1 and A-2 describe the types of contamination found at all CERCLA soil and sediment and RCRA soil database sites, including volumes treated in and ex-situ and within or outside of CAMUs and AOCs. Exhibit A-1 shows that about 75 percent of each category of site is contaminated with metals, the most common contaminant. Organics are much more prevalent at CERCLA sites than RCRA sites. For example, while 62, 61, and 48 percent of CERCLA soil sites contain AHCs, SVOCs, and VOCs, respectively, only 3, 29, and 30 percent of RCRA soil sites have soil contaminants, respectively. Thus, as shown in Exhibit A-2, only 3 percent of RCRA soil sites have 3 or 4 types of contaminants. In contrast, 49 percent of CERCLA soil sites have 3 or 4 types of contaminants. These differences result in much higher average treatment costs at CERCLA soil sites ($307/ton) than at RCRA soil sites ($170/ton).

Exhibit A-1
Constituents Found at Database Sites
(Percent of Overall Database Volume)

Constituents	CERCLA Soil	RCRA Soil	CERCLA Sediment
Metals	73%	75%	74%
VOCs	48%	30%	22%
SVOCs	61%	29%	40%
AHCs	62%	3%	51%

* Totals exceed 100 percent because volumes are often contaminated with several types of constituents (e.g., both metals and VOCs).

Exhibit A-2
Multiple Types of Constituents at Database Sites
(Percent of Overall Database Volume)

Number of Constituent Types*	CERCLA Soil	RCRA Soil	CERCLA Sediment
One	24%	67%	42%
Two	28%	30%	29%
Three	29%	3%	17%
Four	20%	0%	12%
Totals**	100%	100%	100%

*	The constituent types are metals, VOCs, SVOCs, and AHCs.
**	Totals may not add to 100% due to rounding.

Exhibit A-3 identifies the prevalence of different baseline treatment methods at all database sites, including volumes treated in- and ex-situ. The allocation of volumes to ex-situ treatment methods, however, is designed to reflect volumes treated outside of CAMUs or AOCs, since volumes treated in CAMUs or AOCs are not directly affected by Phase IV. (See also Exhibit 3-1, which presents more detail on the baseline treatment methods.) Consistent with Exhibits A-1 and A-2, immobilization is the most common treatment method, and organics treatment technologies are used considerably more often at CERCLA sites than RCRA sites. In addition, incineration seldom occurs at RCRA soil sites for several reasons. A minority of RCRA sites are contaminated with organics. Most of these volumes have relatively low concentrations of organics and therefore treated by other technologies. In addition, most of this contamination is at high volumes, which are treated in-situ.

Exhibit A-3
Baseline Treatment Methods at Database Sites
(Percent of Overall Database Volume)

Treatment Technology	CERCLA Soil	RCRA Soil	CERCLA Sediment
Ex-Situ Treatment			
Immobilization	44%	57%	74%
Soil Wash	27%	3%	29%
Dechlorination	17%	<1%	10%
Bioremediation	15%	15%	38%
Incineration/Thermal Desorption	10%	<1%	18%
In-Situ Treatment			
Immobilization	29%	18%	--
Vacuum Extraction	28%	30%	--
Bioremediation	11%	13%	--

* Totals exceed 100 percent because volumes are often treated by multiple technologies (e.g., incineration or thermal desorption ion).

Exhibits A-4 and A-5 show the prevalence of different treatment methods for TC organics and TC metals only soils in both the baseline and post-rule scenarios. The use of in-situ treatment methods is not presented because it is not directly affected by this rule. Consistent with Sections 3.2 and 3.4, Exhibit A-4 shows a slight shift away from incineration toward other ex-situ treatment methods and Exhibit A-5 shows a slight shift toward incineration. Additionally, as the analysis predicts that treatment of sediments and RCRA soils will not be significantly affected by Phase IV, the volumes of these media being treated by the different technologies are not expected to change significantly.

Exhibit A-4
Ex-Situ Treatment Methods For TC Organic Soils At CERCLA and RCRA Database Sites
(Percent of TC Organic Soil Volume)

Ex-Situ Treatment Technology	CERCLA Soil		RCRA Soil	
	Baseline	Post Reg	Baseline	Post Reg
Immobilization	21%	28%	35%	35%
Soil Wash	21%	24%	15%	15%
Bioremediation	1%	1%	35%	35%
Dechlorination	21%	24%	0%	0%
Incineration/Thermal Desorption	23%	20%	0%	0%

* Totals may exceed 100 percent because some volumes are treated by multiple technologies (e.g., incineration followed by stabilization) and may be less than 100 percent because ex-situ volumes are being compared to total volume.

Exhibit A-5
Ex-Situ Treatment Methods at CERCLA and RCRA Database Sites
For TC Metal-Only Soils
(Percent of TC Metal Only Soil Volume)

Ex-Situ Treatment Technology	CERCLA Soil		RCRA Soil	
	Baseline	Post Reg	Baseline	Post Reg
Immobilization	40%	39%	96%	96%
Soil Wash	4%	4%	0%	0%
Bioremediation	10%	9%	1%	1%
Dechlorination	4%	4%	0%	0%
Incineration/Thermal Desorption	11%	12%	0%	0%

* Totals may exceed 100 percent because some volumes are treated by multiple technologies (e.g., incineration followed by stabilization) and may be less than 100 percent because ex-situ volumes are being compared to total volume.

EPA did not prepare a table showing treatment methods for non-TC soils because the agency was unable to determine the specific technologies used due to data limitations. The primary data limitation was that CERCLA RODs and RCRA corrective actions data only provided the maximum concentration at the entire site (i.e., no concentration data was provided for soil subsets at each site).

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APPENDIX B:
SUPPLEMENTAL ECONOMIC IMPACT ANALYSIS TABLES