A STUDY OF THE IMPLEMENTATION OF THE RCRA CORRECTIVE ACTION PROGRAM

U.S. EPA
Office of Solid Waste
Economics, Methods, and Risk Analysis Division

April 9, 2002

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

TABLE OF EXHIBITS

EXECUTIVE SUMMARY

This report describes the implementation of Corrective Action under the Resource Conservation and Recovery Act (RCRA) at nearly 900 facilities. These facilities represent the universe of sites that had implemented stabilization measures and/or selected a final remedy by 1997. The facilities represented in this study are diverse in terms of industrial or commercial purpose, location, extent of contamination, cleanup activities, and other factors. This diversity reflects a flexible Corrective Action program that can be tailored to meet the needs of specific regulated facilities. This executive summary briefly outlines the scope and main findings of the report.

A. Introduction

The Permits and State Programs Division (PSPD) of EPA's Office of Solid Waste (OSW) developed the RCRA Corrective Action Questionnaire, which contained 125 questions on a broad spectrum of issues in Corrective Action. The purpose of the survey was to:

- Collect current information on the implementation of Corrective Action, including the nature of contamination, the Corrective Action decision-making process, and the remedies selected;
- Support future RCRA regulatory initiatives and guidance development; and
- Enable EPA headquarters to more effectively support states and EPA Regions in implementing the Corrective Action program.

EPA developed a sample frame of all Corrective Action facilities that had selected a final remedy and/or implemented stabilization measures. EPA identified 889 facilities in this sample frame and surveyed a statistically representative sample of these facilities. EPA contacted the federal and state regulators responsible for overseeing these sites and requested that they complete the survey. Responses were received in Spring 1997.

This report extrapolates data from the sample of sites to represent the RCAID universe of 889 Corrective Action sites that had selected a final remedy and/or implemented a stabilization measure. Thus, unless otherwise noted, this report presents statistical estimates related to this specific universe of 889 facilities, rather than either actual counts of facilities in this universe or estimates of the entire Corrective Action universe. These findings are subject to limitations associated with the design and content of the survey, the accuracy of the survey responses, and the confidence levels associated with extrapolated variables.

B. Facility Description

Priority. RCRA facilities that had implemented stabilization measures and/or selected a final remedy (RCAID facilities) tended to be high priority facilities. Almost 80 percent of them had a high priority National Corrective Action Priority System (NCAPS) ranking. There is strong overlap between the RCAID sample and the facilities used to track EPA's progress under the Government Performance and Results Act (GPRA).

Location. The survey was designed to be statistically representative at the national level, not the state or EPA Regional level. Thus, the results should not be used for state-by-state or Region-by-Region comparisons. The state in which a facility was located, however, affected whether the lead regulator was the state or EPA Region.

Land Use. Most RCAID facilities were industrial sites, as expected. Few facilities were reported as having an on-site residential land use. However, based on the extrapolated sample results, over half of the facilities had residential land use within one-half mile of the facility boundary in the direction of possible contaminant migration.

Industry. The majority of facilities in the RCAID universe were in manufacturing industries. Of the extrapolated facilities with a reported industry:

- 35 percent were in the chemical manufacturing sector;
- 21 percent were in wood preserving, petroleum refining, or another manufacturing industry;
- 18 percent were in a services sector (e.g., dry cleaning, business services); and
- 26 percent were scattered among other classifications.

Number of Units and Facility Size. Most RCAID facilities had at least five solid waste management units that were potentially subject to RCRA Corrective Action. More than 90 percent of RCAID facilities were smaller than 1,000 acres and about a third were smaller than 10 acres.

C. Nature of Contamination and Exposure

Major Sources of Contamination. Spills were a major source of contamination at over half of the facilities. Landfills, surface impoundments, and underground storage tanks also contributed significantly to facility contamination.

Types of Media Contaminated. Almost all RCAID facilities (90 percent) had both soil and groundwater contamination, while just under one-third of the RCAID facilities had sediment contamination. Contamination had migrated beyond the facility boundary at almost half of the RCAID facilities.

Types of Contaminants. Volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) were the most common contaminants at RCAID facilities. Over one-half of RCAID facilities had dense non-aqueous phase liquid (DNAPL) and/or light non-aqueous phase liquid (LNAPL) contamination.

Ground Water Use and Contamination. Over half of RCAID facilities were situated above an actual or potential source of on-site drinking water, based on responses for survey respondents who knew the location of nearby aquifers. Contamination had been detected in more than 90 percent of these aquifers.

Over half of RCAID facilities were located within two miles, in the direction of groundwater flow, of an aquifer that was designated as an actual or potential source of drinking water. At over half of these facilities, the off-site ground water was being used for drinking water. Also, at 80 percent of these facilities, contamination had been detected in an actual or potential source of drinking water.

Surface Water Use and Contamination. Nearly all of the facilities were located within two miles of a body of surface water. Surface water bodies were found within a quarter mile of 60 percent of the facilities. About 40 percent of the RCAID facilities had surface water adjacent to or within the facility boundary. The surface water body closest to the facility was used as a source of drinking water for only 14 percent of RCAID facilities and over half of these water bodies had been contaminated by the facility.

D. Remedy Selection

Remedy Selection Process

Evaluation of Remedial Alternatives. Based on the extrapolated survey results, about half of the RCAID universe had completed a Corrective Measures Study (CMS), with about one-quarter of these facilities using a phased approach for CMS. Of the facilities that completed a CMS, one-quarter used Superfund presumptive remedy guidance and an additional 15 percent considered the presumptive remedies but found that they were not applicable. Almost 20 percent of the respondents for facilities that did not employ a presumptive remedy reported that they were not aware of the presumptive remedy guidance or did not know it could be used for RCRA Corrective Action

Action Levels. Almost 60 percent of the RCAID universe used one or more types of action levels. Action levels were developed on a facility-specific basis at 14 percent of facilities. More commonly facilities took action levels from standardized lists such as the state action levels, EPA Regional action levels, and proposed Subpart S levels. Over half of the RCAID facilities used action levels for soil.

Risk Assessments. Approximately half of the RCAID universe conducted some form of facility-specific risk assessment as part of the remedy selection process. RCAID facilities with residential, recreational, and/or agricultural use on site (as well as industrial and/or commercial use) were more likely to have both human health and ecological risk assessments than facilities with only industrial and/or commercial land uses. About 80 percent of the human health risk assessments were conducted by the owner or operator rather than by the lead regulatory agency. Most of the human health risk assessments used the Risk Assessment Guidance for Superfund (RAGS), either alone or in conjunction with other guidance. In performing the ecological risk assessment, almost all facilities used EPA guidance.

Public Participation. Approximately 80 percent of the extrapolated RCAID facilities engaged in some form of public participation. The most common forms were announcements in newspapers, magazines, and journals. Public participation rarely was reported to have influenced the selection of the remedial alternatives.

Voluntary Corrective Action. About half of the extrapolated RCAID universe was reported to have conducted voluntary remedial action. High priority facilities and facilities with EPA as the lead regulatory agency were slightly more likely to undertake voluntary Corrective Actions than were lower ranked facilities or facilities with a state lead. However, these differences were not statistically significant. Of the facilities that conducted voluntary remedial actions, over half were provided some level of assurance that the cleanup should satisfy regulatory requirements, primarily through the lead regulatory agency's approval of proposed work plans.

Remedies Selected

Institutional Controls. Slightly more than half of all extrapolated RCAID facilities employed some form of institutional controls. Generally, when facilities used institutional controls as a part of the remedy, they employed multiple institutional controls. The most common institutional controls employed were compliance monitoring and restrictive covenants/deed restrictions.

Location and Extent of Treatment. The RCAID survey did not ask about the percent of contaminated media that was anticipated to be treated versus managed without treatment. It did, however, ask about the percent of contaminated media identified at the facility that was anticipated to be treated on-site. Respondents for:

- 28 percent of facilities anticipated treating no contaminated media on site;
- 13 percent of facilities anticipated treating up to 50 percent on site;
- 8 percent of facilities anticipated treating 50 to 75 percent on site;
- 23 percent of facilities anticipated treating 76 to 99 percent on site; and
- 27 percent of facilities anticipated treating 100 percent on site.

Some additional amount of the media could be expected to be treated off site. These figures must be interpreted carefully because they represent expectations about future treatment, rather than actual treatment.

Natural Attenuation. Approximately 20 percent of the extrapolated RCAID facilities selected natural attenuation as a remedial alternative or as one component of a remedial alternative. Most of the facilities using natural attenuation for ground water had known or suspected DNAPL contamination. At the sites that used natural attenuation, the primary classes of contaminants were VOCs and organics. None of the sites that used natural attenuation had metal or pesticide contamination.

Technical Impracticability. Technical impracticability determinations for ground water were rare. Such determinations for soil contamination were only slightly more frequent, with the basis for these determinations relying on risks to workers and prohibitive costs.

Corrective Action Management Units (CAMUs) and Areas of Concern (AOCs). Neither CAMUs nor AOCs were widely used at RCAID facilities.

Effect of Land Use on Remedy Selection. Of the almost 95 percent of extrapolated facilities that did not have any on-site residential land use, just over one third used a residential exposure scenario to select a remedy and about one fourth used a non-residential exposure scenario to select the remedy. The remaining facilities did not know how land use affected the remedy selection, did not respond to the question, or used non-residential land use to justify an extension in the remedial schedule.

For the facilities without a nearby off-site residential land use, EPA and state regulators noted that the off-site non-residential land use supported a decision to base cleanup numbers on non-residential exposure at only 6 percent of the facilities, and that it did not influence on-site remedial decisions at 70 percent of the facilities.

Financial Responsibility. The survey indicated that about one-fourth of the extrapolated RCAID facilities had already demonstrated financial responsibility. About 70 percent of facilities that identified a financial assurance mechanism used the financial test or corporate guarantee and 20 percent used a letter of credit.

E. Remedy Implementation

Environmental Indicators. Facilities managing cleanups under EPA oversight were more likely to have had environmental indicators identified than facilities under state oversight. Facilities with a high NCAPS ranking were more likely to have environmental indicators identified than other facilities and were likely to have achieved the human exposures and the groundwater releases controlled determinations.

Of the extrapolated facilities that had environmental indicators identified, over half had achieved the Human Exposures Controlled Determination and about half had achieved the Groundwater Releases Controlled Determination. About 10 percent of the facilities achieved these determinations by demonstrating that there were no releases to warrant additional controls.

Cost. The cost of cleanup at RCAID facilities varied widely, with estimates ranging from less than $1 million to more than $50 million. Of facilities with reported total costs, over half had estimated total cleanup costs of less than $5 million. Less than 10 percent had estimated total costs of more than $50 million. Other cost findings included the following:

- Facilities with only one contaminated medium tended to be less costly to remediate than facilities with several contaminated media.
- The percentage of facilities with off-site migration had higher cleanup costs on average than facilities without off-site migration.
- Facilities with only a commercial use on site tended to have much lower costs than average, with virtually all of these sites having estimated costs of less than $1 million.

Time Required to Complete Corrective Actions. Survey respondents for about one-fourth of RCAID facilities anticipated that Corrective Action would take less than five years. Respondents for 20 percent of facilities anticipated that Corrective Action would take more than 30 years. As expected, RCAID survey data showed that the cost of Corrective Action and the time required to complete Corrective Action were positively correlated. Further, facilities with multiple contaminated media, migration of contaminants off-site, or multiple contaminant types tended to have longer remediation time frames than other facilities.

CHAPTER 1: INTRODUCTION

The Environmental Protection Agency (EPA) promulgated Corrective Action regulations more than 15 years ago (50 FR 28702, July 15, 1985). While EPA and other organizations have analyzed potential changes in the Corrective Action Program, this report is the first significant analysis of the actual implementation of the program on a national level. As the basis of this report, EPA surveyed EPA Regional and state regulators responsible for a national sample of facilities conducting Corrective Action that had selected a final remedy and/or implemented stabilization measures. The survey requested information on the type and extent of contamination at the facility, the process through which Corrective Action was implemented at the facility, and the remedial alternatives selected to address facility-wide contamination. The results of this survey were compiled into the RCRA Corrective Action Implementation Database (RCAID). This report presents the findings.[1]

This chapter describes the purpose of the RCAID study, the RCRA Corrective Action Questionnaire, the sample design, the database, the methodology for extrapolating results from the database, and the major limitations of this analysis.

A. Background and Purpose of RCAID Study

The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA), requires EPA to establish a national regulatory program to ensure that hazardous waste is managed in a manner protective of human health and the environment. A key component of this Corrective Action program is the timely and protective cleanup of releases at hazardous waste management facilities.

Since 1990, EPA has conducted a variety of analyses to assess the costs and benefits of potential changes to the Corrective Action or Subpart S Program. For the most part, these analyses have relied on the Corrective Action Regulatory Impact Analysis database (CARIA), which contains information on predicted remedies, costs, and benefits at a statistically representative sample of 79 treatment, storage, and disposal facilities (TSDFs), and on the basic size, general Corrective Action status, and SIC codes for facilities in the entire Corrective Action universe. The facility data in CARIA reflect the universe of facilities subject to Corrective Action in 1990. Projected remedies, costs, and benefits in CARIA were based on facility characteristic data collected in 1992 and 1993.

While EPA maintains current information on the general characteristics of facilities in the Corrective Action universe, the Agency had not compiled information on remedial action decisions at these facilities and the parameters influencing such decisions. Limited information on certain Corrective Actions was available from statement of basis reports and the 1993-1994 Corrective Action review reports. However, this information covered a small number of sites and was not designed to evaluate how Corrective Action has been implemented nationwide.

[1] EPA published a version of this report on September 25, 2000 and a version of the *Highlights Report* on October 18, 2000. Based on a subsequent review of the groundwater point of compliance (POC) data (in particular, the response rates to the POC questions) and the statistical methods used in analyzing those data, EPA has reevaluated the POC findings. The new POC findings are discussed on page 4-7 of this version of the report. The *Highlights Report* no longer presents the POC results. These changes regarding the POC findings represent the only changes made in producing the April 9, 2002 version of each report.

The Permits and State Programs Division (PSPD) of the Office of Solid Waste (OSW) administered the RCRA Corrective Action Questionnaire in the Spring of 1997 in order to develop a nationally representative picture of how Corrective Action has been implemented. The information collected through this survey provides EPA with a better understanding of the program. The information also enables EPA Headquarters to more effectively support states and EPA Regions in implementing the Corrective Action Program and will support future RCRA regulatory initiatives and guidance development.

B. Questionnaire Overview

The RCRA Corrective Action questionnaire was sent to EPA Regional and state RCRA regulators responsible for Corrective Action at a sample of sites, as described below. The questionnaire contains 125 questions. A complete copy of the questionnaire is included in Appendix A. Fifty-three multiple choice questions requested information on a facility-wide basis on:

- General facility characteristics (e.g., name, address, size, years of operation, primary activities and contaminants, and lead regulatory agency);
- Status of Corrective Action (e.g., selection of final remedy, implementation of stabilization measures, environmental indicators, and National Corrective Action Priority System (NCAPS) ranking);
- Sources of contamination and contaminants of concern (e.g., number of units, areas of concern, media contamination, and migration);
- Groundwater contamination;
- Surface water contamination;
- Risk assessment and action levels (e.g., land use, effect of land use on remedial decisions, risk assessments, and action levels used);
- Remedy selection process (e.g., use of phased approaches, natural attenuation, technical impracticability, conditional remedies, and cleanup costs);
- Institutional controls;
- Public participation;
- Voluntary remedial actions; and
- Financial assurance.

The remainder of the survey contains four sets of 18 questions on unit-specific contamination and remedy selection. EPA Regional and state regulators could respond to the questions for up to four units, for a possible total of 72 additional responses. These questions address the type of unit, contamination, remedies selected, and cleanup cost. EPA Regional and state regulators were directed to contact the facility owner or operator to request information on the cost and timing of Corrective Actions.

C. Development of the Sample

The main purpose of the Corrective Action Questionnaire was to collect information on the implementation of the Corrective Action Program. Given this purpose and the need to work with a reasonable number of facilities, EPA designed a sample frame to cover those facilities that had been through the Corrective Action Program in some way. Thus, the universe, that is, the group of facilities from which the sample was selected, was composed of all Corrective Action facilities with a final remedy selected and/or stabilization measures in place. In the summer of 1996 when EPA constructed this sample frame, 889 facilities met this criterion, according to the Resource Conservation and Recovery Information System (RCRIS).

EPA designed a statistically representative sample from the 889 sites in the sample frame mentioned above. The sample was stratified and weighted to represent the RCAID universe of 889 facilities based on two criteria:

(1) Whether a final remedy had been selected or stabilization measures had been implemented (but a final remedy had not been selected); and

(2) The Standard Industrial Classification (SIC) code of the facility.

Facilities within each remedy status grouping, that is, final remedy or stabilization measures, were then categorized into the seven SIC codes of greatest frequency within the sample frame: SIC codes 24, 28, 29, 33, 34, 9X, and an "Other" category. Fifty-five facilities were selected for the initial sample.

EPA compared this sample of facilities to the random sample of 79 facilities that was used in CARIA, the analysis of the costs and benefits of the Subpart S Proposed Rule in 1993. EPA identified the subset of these 79 facilities that was in the sample frame of 889 facilities. Any facilities in this CARIA subset that were not included in the sample selected for the Corrective Action Questionnaire in the first step were added to this sample. This process added 29 facilities to the sample. Thus, the Corrective Action Questionnaire was sent in early 1997 to EPA Regional and state regulators responsible for 84 facilities, composed of 55 facilities from the first sample selection and 29 facilities that were added from the CARIA sample.

In the original random selection process for RCAID, EPA desired to preserve the stratification from the possibility that nonrespondents would alter its structure and thus negatively affect the data quality of the database. Therefore, alternate facility lists were selected for each stratum from the list of 889 facilities in the RCAID universe. These alternate lists were to be employed in the case that a facility in the original sample did not respond to the questionnaire. A list of alternates for each stratum was developed and put in random order. Therefore, if a facility from the stratum "Final/SIC 24," for example, did not respond to the questionnaire, the first facility from the list of randomly ordered alternates for "Final/SIC 24" would be selected. If that alternative facility also did not respond, the next facility from the random alternates list would be selected, and so on. This protocol, however, was not followed to completion in the original questionnaire process. Alternate facilities were not always chosen in the event of a nonresponse. Therefore, the data quality of the RCAID was weakened by these under-represented strata.

Regulators responsible for 62 of the 84 facilities responded to the survey. The response for one of these facilities was removed from the sample because the facility was not listed in RCRIS as one of the 889 facilities that had either implemented stabilization measures or selected a final remedy. The distribution of the remaining 61 responses according to the sample design resulted in one stratum containing only one respondent and a few other strata with low response rates. Extrapolation from the sample to the national universe based on the survey stratification, however, required at least two responses in each stratum.

To remedy this weakness in the 61 responses, EPA decided in the fall of 1988 to sample additional facilities in the weakest strata. In this effort, EPA followed the protocol established in the original sampling process, which, as described above, was designed to address the problem of nonrespondents by establishing a list of randomly selected alternates for each stratum.

In order to most efficiently increase the database quality, EPA first added a facility from the weakest stratum (i.e., the stratum with only one respondent). EPA then reassessed the stratum coverage after including this new facility and identified the "new" weakest stratum. A facility was then selected from this stratum. The process continued until four additional survey responses were received. Three of the responses were from the "stabilization-other SICs" strata and the fourth was from the "final-other SICs" strata. Exhibit 1-1 below represents the final sample. For a discussion of the characteristics of the sampled facilities, see Chapter 2.

Exhibit 1-1
RCAID Universe, Respondents, and Stratum Weights

Category	Lumber and Wood (SIC 24)	Chemicals and Allied Products (SIC 28)	Petroleum Refining (SIC 29)	Primary Metals (SIC 33)	Fabricated Metals (SIC 34)	Federal Facilities	Other SICs	Total
Universe of Facilities								
Final	6	41	5	6	13	26	93	190
Stabilization	43	186	52	41	36	73	239	670
CARIA[a]	1	9	4	2	1	3	9	29
Total	50	236	61	49	50	102	341	889
Facility Respondents								
Final	3	3	3	4	3	3	3	22
Stabilization	2	3	4	2	2	4	4	21
CARIA	1	7	4	2	1	2	5	22
Total	6	13	11	8	6	9	11	65
Stratum Weights per Facility Respondent								
Final	2.00	13.67	1.67	1.50	4.33	8.67	31.00	-
Stabilization	21.50	62.00	13.00	20.50	18.00	18.25	59.75	-
CARIA	1.00	1.29	1.00	1.00	1.00	1.50	1.80	-

[a] The 29 CARIA facilities were in the sample frame but were not in the original sample.

D. Database

EPA entered the data collected from the Corrective Action Questionnaires for the 65 facilities into RCAID. RCAID is a PC-based database formatted using Microsoft Access. EPA applied a thorough quality assurance/quality control (QA/QC) protocol to check the accuracy of the data entry and to test the validity of the data. The QA/QC protocol is described in Appendix B.

E. Extrapolation

In this report, EPA extrapolated data from the sample of sites to represent the universe of Corrective Action sites with a final remedy selected and/or stabilization measures implemented. The extrapolation reflects the weights of individual facility responses, which are based on the universe of 889 facilities, as presented in Exhibit 1-1. Each response was multiplied by the weight for the facility to calculate that response's "share" in the national universe. For example, a facility in SIC 29 that had implemented stabilization measures but had not selected a final remedy was given a weight of 13. If this facility used mailings as its method of public participation, that facility would represent 13 facilities in the national universe that used mailings for public participation. Each response for the 65 facilities was inflated in this manner to estimate public participation rates and methods for the full universe of 889 facilities. This method of extrapolation is a standard statistical approach used to assess the characteristics of a universe by gathering information from a known subset. These extrapolations provide the basis for this report.

F. Major Limitations of the Analysis

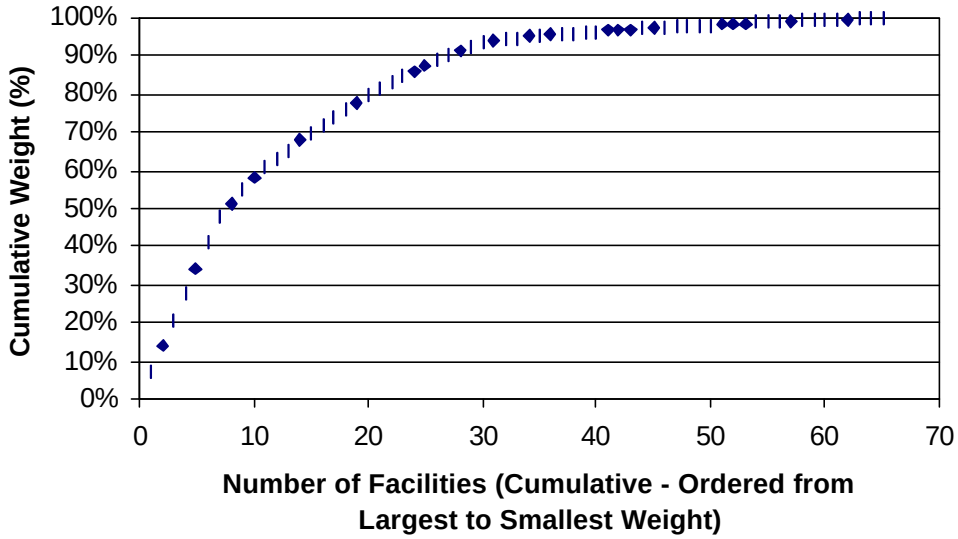
The findings presented in this report are subject to three primary limitations related to the design and content of the survey, the accuracy of the survey responses, and the confidence levels associated with extrapolated variables. Each of these limitations is discussed below.

The design and content of the survey do not allow several key policy issues to be analyzed. First, the unit-specific section of the survey contained questions on specific remedies and risk assessments that may have produced interesting extrapolated results. The survey does not allow extrapolation of the unit-specific answers to a national universe because, due to the burden involved, respondents were not requested to answer the questions for all units subject to Corrective Action. Thus, extrapolating these selective unit data would not provide a representative picture of all units at Corrective Action sites from the sample frame. Second, the survey did not include questions on all important topics, such as the quantity of contaminated media. Third, some survey questions may have been difficult for many respondents to interpret, resulting in a large number of "unknown" or blank responses.

The completeness and accuracy of individual responses determine the quality of the analysis. Throughout the survey, the number of unknown and non-responses varied. Individual respondents may not have had complete information available to them, which may have led to unintended errors in their responses. To remedy any internal inconsistencies within an individual facility's responses, EPA applied the QA/QC protocol described in Appendix B. As appropriate, EPA presented percentages based on "known" responses. When percentages were based on a sub-sample of facilities, the number of relevant responses was noted. EPA examined the non-responses for patterns by type of facility, type of remedy, and other facility classifications. No patterns were apparent. Therefore, it appears that no bias was introduced into the analysis by these non-responses.

The distribution of the survey responses across the strata resulted in a few heavily weighted facilities and many low to medium weight facilities. For instance, as shown in Exhibit 1-2, 7 of the 65 facilities with the heaviest weights accounted for almost 50 percent of the total weight for extrapolated facilities. Twenty-nine of the 65 facilities accounted for less than 5 percent of the total weight. Extrapolation from these heavily weighted facilities increases the uncertainty of the results, but does not bias the results. For this reason, EPA identified the confidence intervals for primary variables and conducted statistical tests on the data. These statistics are presented in Appendix C.

Exhibit 1-2
Distribution of Facility Survey Responses by Weight



CHAPTER 2: FACILITIES SAMPLED

Thousands of facilities that generate and manage hazardous waste have releases that are subject to RCRA Corrective Action requirements. This universe ranges from facilities with one small contaminated solid waste management unit that is leaking contaminants to ground water to facilities over 1000 acres in size with extensive contamination spread across a large number of units. Some facilities have completed Corrective Action, others are just starting the process.

The RCAID universe, or sample frame for this report, in contrast, examines only 889 facilities. All of these facilities had selected a final remedy and/or implemented stabilization measures at the time the sample frame was developed in 1996. EPA chose this subset of the RCRA Corrective Action universe in an effort to gain a more complete and meaningful understanding of the Corrective Action Program's implementation.

This chapter describes the RCAID sample of facilities. It is organized into seven sections which address: the Corrective Action facility priority, Corrective Action status, number of units and facility size, facility location, industrial categories, proximity to ground water and surface water, and local land use. Where relevant data existed, these facilities are compared to the full Corrective Action universe, the Corrective Action facilities used in tracking EPA's progress under the Government Performance and Results Act (GPRA), and the sites on the Superfund National Priority List (NPL). Data presented in this section are used throughout the report.

Selected Findings in Chapter 2

- Approximately 80 percent of RCAID facilities had a high NCAPS ranking.
- Almost 90 percent of RCAID facilities were industrial sites and 70 percent were in a manufacturing industry.
- Over half of all RCAID facilities had residential land use within one-half mile of the facility boundary in the direction of possible contamination migration.
- Approximately one-third of RCAID facilities were smaller than 10 acres, while just under 10 percent were over 1,000 acres.
- Almost half of RCAID facilities were located above an actual or potential source of on-site drinking water.

A. Corrective Action Facility Priority

EPA uses the National Corrective Action Priority System (NCAPS) to identify high, medium, and low priorities among the thousands of sites subject to Corrective Action requirements. Based on the survey results, 77 percent of the RCAID facilities had a high NCAPS ranking, whereas only 24 percent of the Corrective Action universe had a high ranking.[2] See Exhibit 2-1. The RCAID universe contains facilities that, at the time of sample selection, had selected a final remedy and/or implemented stabilization measures, which tend to be high NCAPS facilities.

[2] These percentages were calculated from RCRIS Subject to Corrective Action Universe, January 1998.

As part of the Agency's system for planning, budgeting, and accountability under the framework established by the GPRA, EPA and the states have identified a set of 1,714 high-priority facilities for achieving Corrective Action goals. Fifty-six of the 65 facilities in the RCAID sample were in the GPRA universe. This strong overlap between RCAID and GPRA facilities is not surprising. Like facilities with high NCAPS ranking, GPRA facilities are priorities for EPA or state oversight and therefore are likely to have selected a final remedy and/or implemented stabilization measures. Thus, the RCAID and GPRA facilities also had similar NCAPS rankings, as shown in Exhibit 2-1.[3]

Exhibit 2-1
NCAPS Ranking of Corrective Action Universe, GPRA Universe, and RCAID Universe

NCAPS Ranking	Number of Facilities (Percent of Total)		
	Corrective Action Universe (RCRIS)[a]	GPRA Universe (EPA Defined)	RCAID Extrapolations
High	1,541 (24%)	1,512 (88%)	612 (77%)
Medium	1,591 (25%)	142 (8%)	48 (6%)
Low	1,675 (26%)	52 (3%)	31 (4%)
Not Ranked	1,526 (24%)	8 (0%)	104 (13%)
Total Reported	6,333 (100%)	1,714 (100%)	795 (100%)[b]

[a] Source: RCRIS "Subject to Corrective Action Universe," January 1998.
[b] Respondents for 94 extrapolated facilities (11% of the full RCAID universe of 889 facilities) provided no information or did not know their priority.

B. Corrective Action Status

As described in Chapter 1, EPA developed the RCAID sample by using the Resource Conservation and Recovery Information System (RCRIS) database to identify the 889 facilities that had selected a final remedy and/or had implemented stabilization measures. EPA then developed the sample, which was stratified and weighted by (1) whether a final remedy had been selected or stabilization measures had been implement (but not final remedy selected) and (2) SIC codes. Unfortunately, at a few sample facilities the survey responses regarding remedy status were inconsistent with the RCRIS data on remedy status which the Agency used in developing the original stratification and weighting schemes. EPA choose to adopt the remedy status responses, rather than retain the facility status given in the RCRIS data employed to develop the sampling strategy. Even though this problem was encountered at only a few sample facilities, extrapolation of these facilities results in a skewing of the figures on remedy status for the overall RCAID universe. Therefore, as shown in Exhibit 2-2, the extrapolated RCAID results show a significantly higher percent of facilities with final remedies selected (57 percent) than shown for the actual RCAID universe (23

[3] The GPRA list did have a higher proportion of highly ranked facilities, with 88 percent of the facilities receiving high NCAPS rankings, compared to 77 percent in the extrapolated RCAID universe. However, the difference was not statistically significant. The 95 percent confidence interval for the point estimate of 77% was 51% to 100%. See Appendix C for more details on generation of the confidence intervals. The percentage of unranked facilities in the GPRA universe was negligible, while an estimated 13 percent of the RCAID universe was unranked.

percent). As a result of these discrepancies, this report generally does not compare results for facilities with final remedies selected versus facilities with stabilization measures implemented.

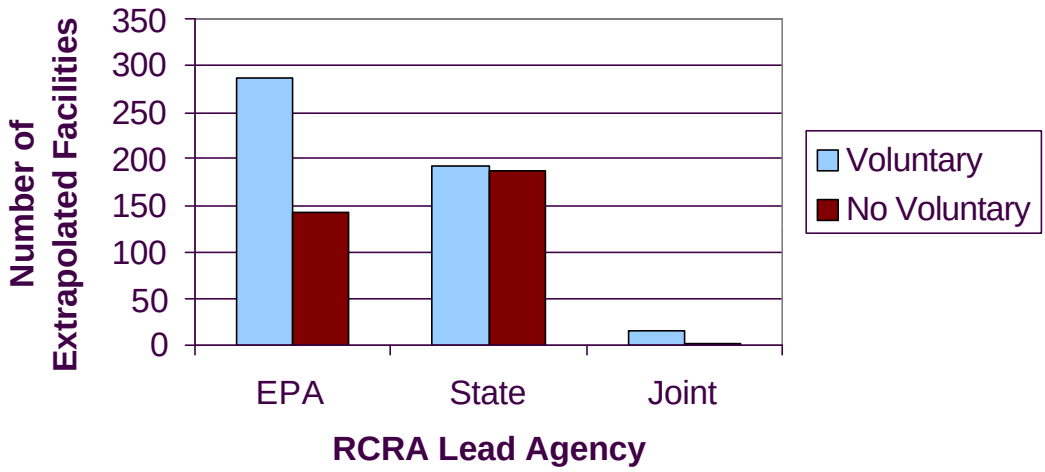
Exhibit 2-2
Status of Stabilization Measure Implementation and Final Remedy Selection

Corrective Action Status	Actual RCAID Universe	Extrapolated RCAID Results
Final Remedy Selected, With or Without Stabilization Measures Implemented	23%	57%
Stabilization Measures Implement; No Final Remedy Selected	77%	40%
Neither Stabilization Measure nor Final Remedy	0%	3%[a]

[a] These facilities were in the final sample even though they reported in the survey that they had neither implemented stabilization measures nor selected a final remedy. EPA decided to remain consistent with the sampling protocol and retain the facilities in the RCAID sample.

At over half of all extrapolated facilities, the respondents indicated that the facilities had implemented some form of voluntary remedial action, which was defined as a remedial action not specifically required in a permit or order. See Exhibit 2-3. These voluntary measures ranged from removal of contaminated soil to groundwater pump and treat. Facilities under an EPA-lead for Corrective Action oversight were slightly more likely to have implemented voluntary measures (62 percent), compared to facilities conducting Corrective Action under a state-lead (50 percent). However, 95 percent confidence intervals reported in Appendix C indicate that these two numbers are not statistically different.

Exhibit 2-3
Implementation of Voluntary Remedial Actions by Lead Agency
(RCAID Extrapolations)



C. Number of Units and Facility Size

As Exhibit 2-4 shows, most facilities had at least five solid waste management units that were potentially subject to RCRA Corrective Action. Thirty extrapolated facilities had 50 or more units and 2 facilities had almost 650 units.

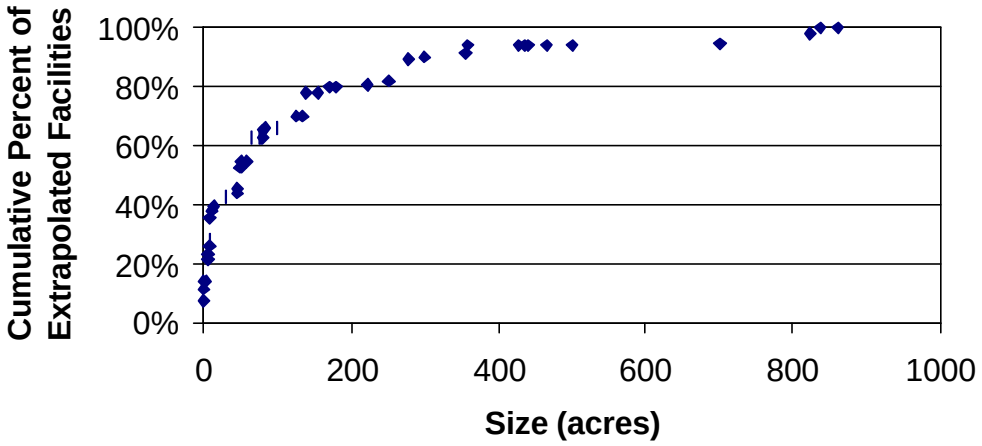
Exhibit 2-4
Number of Units Per Facility
(RCAID Extrapolations)

Number of Units	Number of Facilities	Percent of Total Facilities
Less than 5 units	235	29%
5 to 9 units	272	33%
10 to 25 units	210	26%
More than 25 units	103	13%
Total*	820	100%

* Total percentage does not sum due to rounding. Sixty-nine facilities did not know or did not provide the number of units at the facility.

Of the RCAID universe, more than 90 percent of the facilities were smaller than 1,000 acres and about a third were smaller than 10 acres. Exhibit 2-5 shows the cumulative percent of facilities in the size range of 0 to 1,000 acres. The remaining facilities were more than 1,000 acres, with the largest facility totaling 52,300 acres.

Exhibit 2-5
Distribution of Facilities by Size[a]
(Cumulative number of facilities in size category, based on RCAID extrapolations)



[a] Based on responses for 808 facilities under 1,000 acres. Seventy-five facilities were larger than 1,000 acres and five facilities provided no size estimate.

There was no clear relationship between number of units and facility size. Thus, facility acreage was not considered a good proxy for the number of units. The weighted average number of units for facilities of different acreage were as follows:

- Less than 5 acres: 9 units;
- 5 to 10 acres: 11 units;
- 10 to 30 acres: 5 units;
- 30 to 50 acres: 9 units;
- 50 to 200 acres: 9 units; and
- More than 200 acres: 21 units.

D. Facility Location

As described in Chapter 1, RCAID contains a representative stratified sample of selected Corrective Action facilities. The survey was stratified across two variables: status of remedy selection and industrial classification. No attention was given to facility location, either at the state or regional level.

While state-by-state or Region-by-Region comparisons of the RCAID data were not intended (and are not valid), Exhibit 2-6 demonstrates how the extrapolated sample matched the universe in facility location. The data show that a sample of 65 facilities should not be extrapolated to demonstrate findings at the state-by-state, or even Region-by-Region level. The RCAID extrapolations significantly over-sampled (i.e., more than 20 excess facilities in the extrapolated sample compared to the actual universe) from Delaware, Georgia, Indiana, Mississippi, Pennsylvania, South Carolina, Tennessee, and Virginia. The states that were substantially under-sampled were California, Kentucky, New Jersey, Ohio, and Texas. These data on the over- and under-sampling show that Region 3 was heavily over-sampled and Regions 1, 7, 9, and 10 were heavily under-sampled. Over half of the sample (55 percent) was from Regions 3 and 4, even though they accounted for less than one-third (30 percent) of the universe. This result is to be expected for variables not included in the original sampling approach. Overall, there was no suggestion of undue bias due to facility location.

EPA, the state, or EPA and the state jointly oversee Corrective Actions. In all states where the state is not authorized by EPA to run a Corrective Action program, EPA is the lead agency for RCRA Corrective Action oversight. In contrast, if a facility is located in a state authorized to run a Corrective Action program, the lead agency for RCRA Corrective Action varies among EPA, the state, and a joint lead between EPA and the state.

Exhibit 2-7 shows that 52 percent of RCAID facilities had EPA-lead oversight, 43 percent had state-lead oversight, and 4 percent had joint-lead oversight. Most states had an EPA-lead or all state-lead for all facilities in the sample. Only in Alabama, Maine, and Wyoming did EPA and the state share the lead for the facilities in the sample. In Mississippi, either EPA had the lead or the lead was shared between EPA and the state. In Regions 3, 5, and 10, EPA had the lead for Corrective Action for all facilities in the sample. Facilities located in Regions 6 and 8 were led only by the state. The other Regions had mixed lead oversight responsibilities.

Exhibit 2-6
Location of Facilities in the Extrapolated Sample and the RCAID Universe by State and Region

State/Region	Extrapolated Sample	Universe	Difference
CT	4	12	-8
MA	1	7	-6
ME	1	7	-6
NH	0	1	-1
RI	0	2	-2
VT	2	2	0
Region 1 Subtotal	8	31	-23
NJ	2	59	-57
NY	63	50	13
PR	13	8	5
VI	0	1	-1
Region 2 Subtotal	78	118	-40
DE	45	2	43
MD	0	8	-8
PA	80	31	49
VA	60	8	52
WV	4	12	-8
Region 3 Subtotal	189	61	128
AL	1	16	-15
FL	24	34	-10
GA	70	45	25
KY	4	30	-26
MS	40	12	28
NC	31	22	9
SC	61	28	33
TN	72	21	51
Region 4 Subtotal	303	208	95
IL	10	12	-2
IN	61	12	49
MI	0	10	-10
MN	0	4	-4
OH	0	32	-32
WI	0	6	-6
Region 5 Subtotal	71	76	-5

Exhibit 2-6 (continued)
Location of Facilities in the Extrapolated Sample and the RCAID Universe by State and Region

State/Region	Extrapolated Sample	Universe	Difference
AZ	0	1	-1
LA	24	24	0
NM	18	10	8
OK	0	14	-14
TX	46	84	-38
Region 6 Subtotal	88	133	-45
IA	0	4	-4
KS	1	10	-9
MO	3	22	-19
NE	0	6	-6
Region 7 Subtotal	4	42	-38
CO	68	58	10
MT	0	1	-1
ND	0	0	0
SD	0	0	0
UT	0	1	-1
WY	2	10	-8
Region 8 Subtotal	70	70	0
AR	19	10	9
CA	44	90	-46
GU	0	1	-1
HI	0	2	-2
NV	0	1	-1
TT	0	1	-1
Region 9 Subtotal	63	105	-42
AK	0	3	-3
ID	0	6	-6
OR	0	13	-13
WA	14	23	-9
Region 10 Subtotal	14	45	-31

Exhibit 2-7
RCAID Facilities by Region, State, and Lead Agency
(Number of RCAID Extrapolated Facilities)

State/ Region	State Authorization[a]	EPA Lead	State Lead	Joint Lead	Total
CT	No	4	0	0	4
MA	No	1	0	0	1
ME	Yes	0	0	1	1
VT	Yes	0	2	0	2
Region 1 Subtotal		5	2	1	8
NJ	No	2	0	0	2
NY	Yes	0	62	1	63
PR	No	13	0	0	13
Region 2 Subtotal		15	62	1	78
DE	No	45	0	0	45
PA	No	80	0	0	80
VA	No	60	0	0	60
WV	No	4	0	0	4
Region 3 Subtotal		189	0	0	189
AL	Yes	0	0	1	1
FL	No	22	0	2	24
GA	Yes	0	70	0	70
KY	Yes	0	4	0	4
MS	No	22	0	18	40
NC	Yes	0	31	0	31
SC	Yes	60	2	0	61
TN	No	64	0	9	72
Region 4 Subtotal		167	106	30	303
IL	Yes	10	0	0	10
IN	Yes	61	0	0	61
Region 5 Subtotal		71	0	0	71
LA	Yes	0	24	0	24
NM	Yes	0	18	0	18
TX	Yes	0	46	0	46
Region 6 Subtotal		0	88	0	88
KS	No	1	0	0	1
MO	Yes	2	0	1	3
Region 7 Subtotal		3	0	1	4
CO	Yes	0	68	0	68
WY	Yes	0	0	2	2
Region 8 Subtotal		0	68	2	70
AR	Yes	1	18	0	19
CA	Yes	0	39	1	44
Region 9 Subtotal		1	57	1	63

State/ Region	State Authorization[a]	EPA Lead	State Lead	Joint Lead	Total
WA	Yes	14	0	0	14
Region 10 Subtotal		14	0	0	14
Total of All States/Regions		464 (52%)	384 (43%)	36 (4%)	889

[a] A state may receive EPA authorization for its entire RCRA program or for specific components of the program. In this exhibit, authorization status refers to the Corrective Action component only.

E. Industrial Categories

Based on the extrapolated survey results, the majority of facilities in the RCAID universe were in manufacturing industries. Of the facilities with a reported SIC, 35 percent had their business activities classified in the chemical manufacturing sector (SIC 28), as shown in Exhibit 2-8. Twenty-one percent were from the wood preserving, petroleum refining, or other manufacturing industries (SICs 24, 29, and 30-37, respectively), 18 percent were from the services sector (SICs 72 and 73), and the remaining facilities were scattered among other industrial classifications. Respondents for one-quarter of the RCAID facilities did not report an SIC.

Exhibit 2-8
Facility Industrial Classifications
(RCAID Extrapolations)

Industry (SIC)	Number of Facilities	Percent (of 663 facility responses)
Chemical Manufacturing (28)	233	35%
Other Manufacturing, includes metals (30, 33, 34-37)	142	21%
Services, includes dry cleaning, business services (72, 73)	120	18%
National Security (9711)	66	10%
Petroleum Refining (29)	57	9%
Wood Preserving (24)	26	4%
Transportation and Public Utilities (40, 49)	12	2%
Wholesale Trade (50, 51)	7	1%
Total Known	663	100%

F. Proximity to Ground Water and Surface Water

Almost half of the extrapolated RCAID facilities were located above an actual or potential source of *on-site* drinking water.[4] Groundwater contamination had been detected at 90 percent of these facilities. Where RCAID facilities were located above on-site aquifers, three-fourths of the aquifers were not being used as drinking water.

More than half of the extrapolated facilities were located within two miles of an actual or potential source of drinking water in the direction of groundwater flow. The *off-site* ground water was used as a source of

[4] Forty-three percent were not located above an actual or potential on-site drinking water aquifer and 11 percent reported unknown or no information.

drinking water at almost half of these facilities. See Chapter 3 for a discussion on the extent of groundwater use and contamination at RCAID facilities.

RCRA facilities may also contaminate surface water and thereby present a risk to human health and the environment. Sixty percent of the extrapolated RCAID facilities were adjacent to or within a quarter mile of a surface water body. The type of water body closest to most facilities was a river (42 percent) or a creek (30 percent). About 14 percent were adjacent to a bay, bayou, or lake. Other facilities were located near channels or the ocean. See Chapter 3 for information on the extent of surface water contamination at RCAID facilities.

G. Local Land Use

The types of land use at or near facilities may influence RCRA Corrective Action decisions. For example, facilities with on-site or nearby residential land use may set more stringent cleanup standards and therefore may select more stringent and costly remediation technologies than facilities without on-site or nearby residential land use. EPA encourages early communication among interested parties regarding land use and supports the use of those communications to develop realistic assumptions regarding future land use and to clarify how land use assumptions influence risk assessment, remedial alternatives, and remedy selection.[5] EPA stated in the 1996 ANPRM that non-residential future use might be appropriate to consider at many RCRA Corrective Actions because a large number of the facilities were actively managed industrial sites.[6]

RCAID data corroborate the assumption that most Corrective Action facilities were industrial sites. As shown in Exhibit 2-9, 87 percent of facilities were used primarily for industrial purposes. Only six percent of the facilities were reported as having an on-site residential land use. However, 60 percent had residential land use within one-half mile of the facility boundary in the direction of possible contaminant migration.[7] Of these facilities, almost half had reported contaminant migration beyond the facility boundary. Such facilities may need to consider potential residential exposures in planning cleanup activities.

Exhibit 2-9
Land Use at RCAID Facilities
(RCAID Extrapolations)

Land Use	Primary On-Site Land Use	Other On-Site Land Use[a,b]	All On-Site Land Use[a]	½ Mile Radius Land Use[a]
Industrial	87%	1%	88%	52%
Commercial	11%	14%	25%	71%
Residential	0%	6%	6%	60%
Recreational	0%	7%	7%	31%
Agricultural	0%	1%	1%	12%
Unknown/No Information	1%	1%	3%	0%

[a] More than one answer was allowed for this question.
[b] Seventy-nine percent of facilities named only one land use.

[5] EPA Directive, "Land Use in the CERCLA Remedy Selection Process," 1995.

[6] 61 FR 19431, May 1, 1996.

[7] Unfortunately, the survey did not query facility respondents on their projections for future land use, which may be used in the remedy selection process.

CHAPTER 3: NATURE OF CONTAMINATION AND EXPOSURE

The nature and extent of contamination at RCRA Corrective Action facilities are diverse. Contamination ranges from small spill areas requiring soil cleanup to extensive soil, sediment, and groundwater contamination, including polluted drinking water sources. This chapter describes the RCAID data relating to:

- Major sources of contamination;
- Types of media contaminated;
- Types of contaminants;
- Groundwater use and contamination; and
- Surface water and contamination.

Where possible, relevant comparisons are made between RCAID sites, Superfund National Priority List (NPL) sites, and the subset of RCAID facilities in the GPRA list.[8]

Selected Findings in Chapter 3

- Spills were a major source of contamination at more than half of RCAID facilities.
- Over 90 percent of RCAID facilities had soil and groundwater contamination.
- Almost half of RCAID facilities had migration of contamination beyond the facility boundary.
- Volatile organic compounds, the most common contaminant type, were found at more than 80 percent of RCAID facilities.
- Over half of RCAID facilities were within a quarter mile of a body of surface water.
- More than 90 percent of respondents for RCAID facilities reported that contamination had been detected in an actual or potential source of drinking water.

A. Major Sources of Contamination

The source of a release of hazardous constituents may affect the nature and extent of contamination. For example, landfills and surface impoundments are likely to receive multiple waste streams. Releases from these facilities often will have several types of contaminants and therefore may be costly to cleanup. Contamination from a spill area, while often likely to contain only one or a small number of waste types, may spread rapidly across the ground or outside of the facility due to a lack of engineering controls, but may be contained before reaching ground water.

[8] Data for Superfund NPL sites are largely from "Treatment Technologies for Site Cleanup: Annual Status Report," U.S. EPA, April 1997. These data were based on sites with Records of Decisions (RODs) prepared by the end of the fiscal year 1996. Some Superfund NPL data are from the letter from Elliot P. Laws to Congressman John D. Dingell, January 28, 1994 (OSWER Directive 9200.2-21). These data generally reflect sites on the NPL as of August 1993.

Survey respondents were asked to name the one or two areas of concern that contributed most significantly to contamination at the facility. On average, 1.8 primary areas of concern were provided per respondent. These major areas of concern are shown Exhibit 3-1. Over half of the respondents for extrapolated facilities listed spills as a major source of concern. Landfills, surface impoundments, and underground storage tanks also contributed significantly to facility contamination.

Exhibit 3-1
Primary Areas of Concern for Extrapolated RCAID Facilities

Area of Concern	Percent of Facilities[a]	Area of Concern	Percent of Facilities[a]
Spill area	54%	Waste pile	5%
Landfill	35%	Sewer	3%
Surface impoundment	27%	Container/container storage area	3%
Underground tank	26%	Land treatment unit	< 1%
Aboveground tank	11%	Other (e.g., ditches, wells, and pits)	19%

[a] Multiple responses to the survey question were allowed.

B. Types of Media Contaminated

The type of media contaminated at a facility affects risks to human health and ecosystems, remedy selection, cleanup cost, and time required to complete the remedy. For example, if a facility has contaminated ground water, the remedy often includes long-term pumping and treatment. Almost all RCAID facilities had soil and groundwater contamination. Ninety-nine percent of the extrapolated facilities had soil contamination, 91 percent had groundwater contamination, and 90 percent had both soil and groundwater contamination. See Exhibit 3-2. In addition, almost one-third of the RCAID facilities had sediment contamination. RCRA Corrective Actions not in the RCAID universe, and therefore arguably of lower priority, may be less likely to have contaminated multiple media than the RCAID facilities.

Of the 65 sample (non-extrapolated) RCAID facilities, 56 facilities appeared on the GPRA priority list. These 56 facilities had proportions of contamination by media similar to the 65 sample facilities, with slightly higher proportions of the GPRA sub-sample showing sediment and surface water contamination.[9] The NPL sites were slightly less likely to have contaminated multiple media than were the RCAID facilities. Among the 1,249 NPL sites, 72 percent had contaminated soil, 76 percent had contaminated ground water, 22 percent had contaminated sediment, and 12 percent had contaminated sludge.

[9] The data for the 56 GPRA facilities were not extrapolated to represent the entire GPRA universe of 1,714 facilities because the 56 facilities are not a representative random sample of the GPRA universe. Thus, the same stratification and weights for the RCAID universe do not apply to the GPRA universe.

Exhibit 3-2
Media Contaminated at RCAID, GPRA, and NPL Sites[a]

Media Contaminated	RCAID (889 extrapolated facilities)	GPRA in RCAID (56 of 65 sample facilities)	NPL[b] (1,249 facilities)
Soil	99%	96%	72%
Ground Water	91%	96%	76%
Sediment	31%	39%	22%
Surface Water	22%	34%	-- [c]
Sludge	--[c]	--[c]	12%
Air	5%	7%	-- [c]

[a] RCAID survey defined contamination to include above background levels, levels of concern, or action levels.
[b] Based on "Cleaning Up the Nation's Waste Sites," see footnote 7 above. In the 1994 letter to Congressman Dingell, EPA reported that 15% of NPL sites with signed RODs had surface water contamination and 8% had contaminated air. That letter also reported that, of those sites with signed RODs, only 50% and 66% had contaminated soil and ground water, respectively. Sediment and sludge estimates in this letter match the NPL percentages above.
[c] Survey or other data source did not address this medium.

When contamination migrates beyond the facility boundary, the facility may be required to conduct an expanded cleanup, increase the level of institutional controls, and/or expand public involvement throughout the cleanup process. Almost half of the extrapolated RCAID facilities had migration of contamination beyond the facility boundary, as shown in Exhibit 3-3. Surface water and air contamination migrated off site about 80 percent of the time, groundwater and sediment contamination about half of the time, and soil contamination less than 10 percent of the time.

Exhibit 3-3
Media Contaminated and Migration of Contamination Beyond the Facility Boundary[a]
(RCAID Extrapolations)

Media	Facilities With Contaminated Media	Facilities with Off-Site Migration via Specified Media		
		Number of Facilities	Percent of facilities with specified contaminated media	Percent of all RCAID facilities
Soil	881	60	7%	7%
Ground Water	807	392	49%	44%
Sediments	272	130	48%	15%
Surface Water	194	158	81%	18%
Air	44	34	77%	4%
Total	889	431	48%	48%

[a] RCAID survey defined contamination to include contamination above background levels, levels of concern, or action levels. Facility respondents could identify more than one contaminated medium.

An examination of off-site land uses within a one-half mile radius of the facility boundary demonstrated that a lower proportion (53 percent) of facilities near residential land uses had contamination beyond the facility boundary compared with facilities near other land uses. See Exhibit 3-4. It is difficult, however, to assess whether the lower proportion is meaningful since many facilities were reported to have more than one nearby off-site land use. Respondents for 55 facilities reported all five types of off-site land uses within a one-half mile radius of the facility boundary.

Exhibit 3-4
Migration of Contamination Beyond Facility Boundary and Land Use Within One-Half Mile[a]
(Extrapolated RCAID Facilities)

	Industrial	Commercial	Residential	Recreational	Agricultural
Migration	291	372	233	136	70
No Migration	119	216	207	84	28
Migration/Total	71%	63%	53%	62%	71%

[a] Based on 885 useful responses, which exclude non-responses and responses of "unknown." Facility respondents could specify more than one type of land use.

C. Types of Contaminants

The risks, remediation technologies, cost, and pace of Corrective Action depend on the type of hazardous constituents in the contaminated media. Volatile organic compounds (VOCs) were found at 84 percent of the extrapolated RCAID facilities, semi-volatile organic compounds (SVOCs) were found at 41 percent of facilities, metals at 23 percent, polychlorinated biphenyl (PCBs) at 10 percent, and pesticides at 5 percent. Twenty percent of facilities had other types of contaminants (e.g., radionuclides, total phenols, dioxins).

Over half of extrapolated RCAID facilities had only one type of contaminant, as shown in Exhibit 3-5. Respondents for less than one-third of extrapolated RCAID facilities reported three or more types of contaminants.

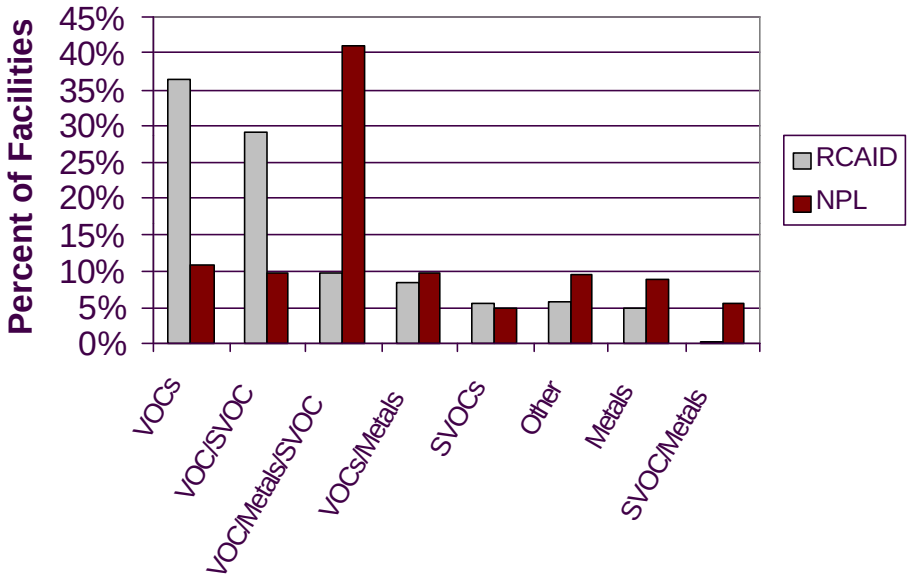
Exhibit 3-5
Number of Types of Contaminants at Extrapolated RCAID Facilities*

1 type: 442 facilities (51%)
2 types: 151 facilities (17%)
3 types: 219 facilities (25%)
4 types: 41 facilities (5%)
5 types: 11 facilities (1%)

** Response of "Other" included as a "type" of contamination.*

Superfund NPL sites tended to have more contaminant types than RCAID facilities. Exhibit 3-6 illustrates the different combinations of VOCs, SVOCs, and metals found at RCAID and NPL sites. The most common contaminant types at RCAID facilities were VOCs alone or a combination of VOCs and SVOCs. In contrast, the most frequent contaminant types at the Superfund NPL sites were a combination of VOCs, SVOCs, and metals. The greater complexity of contamination at NPL sites may cause NPL cleanups to be more difficult, costly, and time consuming on average than RCRA Corrective Actions. As discussed in Chapter 5, the average cost of remediation was higher at Superfund sites than at RCAID facilities.

Exhibit 3-6
Media Contaminant Groups at RCAID and Superfund NPL Sites



Source of Superfund data: "Cleaning up the Nation's Waste Sites," see footnote 7 above. Pesticides and PCBs are assumed to be SVOCs in both RCAID and NPL data.

Dense non-aqueous phase liquids (DNAPLs) and light non-aqueous phase liquids (LNAPLs) are difficult contaminants to remove from ground water. DNAPLs tend to pool at the bottom of aquifers and LNAPLs float on the top. Thus, the presence of DNAPLs or LNAPLs at a facility tends to imply a more expensive and time consuming cleanup. Or, in some situations, remediation of NAPLs may be technically infeasible.

Thirty-nine percent of extrapolated RCAID facilities had DNAPLs and 37 percent had LNAPLs. However, the difference in these percentages was not statistically significant. Twenty-four percent of facilities had both DNAPL and LNAPL contamination on-site. Fifty-five percent had DNAPLs, LNAPLs, or both.[10] Contamination by DNAPLs occurred at similar rates among Superfund and RCAID facilities. EPA estimated that DNAPLs were present at approximately 35 percent of all Superfund sites. Five percent of Superfund sites had definite DNAPL contamination and 30 percent had a "high potential" for DNAPL contamination.[11]

The presence of non-aqueous phase liquids seldom resulted in determinations that remediation was technically impractical. Less than one percent of all facilities used the presence of DNAPLs as a basis for such a determination. No facilities used the presence of LNAPLs as a basis for technical impracticability. See Chapter 4 for a discussion of technical impracticability determinations.

[10] These percentages were based on the number of extrapolated facilities where the respondents knew whether known of suspected DNAPLs (830) or LNAPLs (809) were present.

[11] 1994 letter from Elliot P. Laws to Congressman John D. Dingell, see footnote 7. Data on LNAPL contamination at NPL sites were not available from this source.

D. Groundwater Use and Contamination

RCRA facilities may contaminate actual or potential sources of drinking water and thereby pose a significant risk to human health or a significant cost for obtaining alternate water supplies if not remediated. Over half of RCAID facilities where the survey respondent knew the location of nearby aquifers were located above an actual or potential source of on-site drinking water; the respondents for the other half of facilities did not answer the question or answered "unknown." Of these 400 facilities that were located above an actual or potential source of on-site drinking water:

- One-fourth of these aquifers were actual sources of drinking water and the remaining three-fourths were potential sources;
- More than 90 percent of the facilities had contamination detected in the actual or potential source of drinking water[12] (just over 10 percent detected in the actual source and approximately 80 percent detected in the potential source);
- No facility was reported as having contaminated an actual public drinking water source.

Off-site drinking water sources also can be an exposure pathway if contaminated. More than half of RCAID facilities were reported as being located within two miles, in the direction of groundwater flow, of an aquifer that was an actual or potential source of drinking water; the respondents for the other half of facilities did not answer the question or answered "unknown." Of these 397 facilities within 2 miles:

- 55 percent were within 2 miles of an actual source of drinking water. Approximately 80 percent of such facilities had contaminated the aquifer, including a few facilities that had contaminated a public drinking water source.
- Almost 30 percent were within 2 miles of a potential source. About 85 percent of such facilities had contaminated the aquifer.
- Whether the aquifer was an actual source or a potential source was unknown for the remaining 15 percent. There was no information on the groundwater contamination at these facilities.

E. Surface Water Use and Contamination

Bodies of surface water, including wetlands, creeks, rivers, lakes, ponds, estuaries, and oceans, were found within a quarter mile of over half of the extrapolated RCAID facilities. Nearly all of the facilities are within two miles of a body of water. See Exhibit 3-7. Of the facilities located within one mile of surface water, one-third had contamination detected in the water, sediments, or both (10, 10, and 13 percent, respectively).

[12] Many of these responses were difficult to interpret. While the questions presuppose a single aquifer beneath a facility, some of the respondents appeared to be addressing multiple aquifers (e.g., an on-site aquifer was an actual source of drinking water, yet the facility contaminated a potential source of drinking water).

Exhibit 3-7
Distance to Surface Water from Facility Boundary[a]
(RCAID Extrapolations)

Distance of Surface Water From Facility Boundary	Number of Facilities	Percent of Total
Adjacent to or within facility boundary	336	39%
Within 1/4 mile of facility boundary	177	21%
Between 1/4 and 1 mile from facility boundary	204	24%
1 to 2 miles from facility boundary	123	14%
Over 2 miles from facility boundary	24	3%
Total	864	100%

[a] Respondents for 25 facilities did not report a distance to the nearest surface water body from the facility boundary.

The surface water body closest to the facility was used as a source of drinking water for only 14 percent of RCAID facilities (122 extrapolated facilities). Of these 122 facilities, over half had detected contamination in a medium associated with the surface water body:

- 50 percent detected contaminants in the surface water;
- Less than 5 percent detected contaminants in the sediments associated with the surface water body; and
- 5 percent detected contaminants in both surface water body and sediments.

For 95 percent of the facilities that had contaminated a nearby surface water body, the drinking water intake was more than five miles downstream from where the contaminated entered the surface water body. Only 3 extrapolated facilities were within 1 mile of a drinking water intake.

CHAPTER 4: REMEDY SELECTION

This chapter examines the remedy selection process, the remedies selected, and the financial responsibility requirements for RCAID facilities.

Selected Findings in Chapter 4

- Almost 30 percent of RCAID facilities used innovative site characterization approaches.
- Almost 60 percent of facilities used one or more type of action level.
- About half of RCAID facilities conducted some form of facility-specific risk assessment as part of the remedy selection process.
- Approximately 80 percent of RCAID facilities engaged in some form of public participation. Public participation, however, seldom was reported to have influenced remedy selection.
- Almost 60 percent of facilities were required to use institutional controls.
- Almost 20 percent of RCAID facilities selected natural attenuation as a remedial alternative.
- About one-fourth of RCAID facilities had already demonstrated financial responsibility at the time of the survey.

A. Remedy Selection Process

EPA has long recognized the need for the Corrective Action program to be procedurally flexible, with many different approaches to remedy selection. This section discusses the following aspects of the remedy selection process:

- Innovative site characterization;
- Phased Corrective Action;
- Evaluation of remedial alternatives;
- Action levels;
- Risk assessments;
- Land use and risk assessments;
- Public participation; and
- Voluntary Corrective Action.

1. Innovative Site Characterization

A site characterization describes the nature, extent, direction, movement, and concentration of releases at a facility. This information is critical to determining the potential risks and supporting the selection and implementation of corrective measures. EPA has seen tremendous improvements in site characterization efficiency when innovative approaches were used. Almost 30 percent of the extrapolated RCAID universe used some type of innovative characterization. Some facilities used more than one innovative approach. See Exhibit 4-1. Although innovative characterization approaches were used at facilities of all priority

rankings, low priority facilities were more likely than medium and high priority facilities to employ these approaches.

Whether the lead regulatory agency was EPA or a state did not appear to affect whether innovative site characterization was used. Twenty-eight percent of all facilities used innovative site characterizations, including 30 percent of facilities for which EPA had lead regulatory responsibility and 25 percent of the facilities for which the state had lead regulatory responsibility. This difference was not statistically significant.

Exhibit 4-1
Innovative Site Characterization

Almost 30 percent of RCAID facilities used one or more innovative site characterization approaches:

Direct Push Sampling Techniques	15%
On-Site Gas Chromatography and Mass Spectrometry Analytical Techniques	9%
X-Ray Fluorescence	6%
Assay Kits	4%

2. Phased Corrective Action

Significant efficiencies can be gained by phasing Corrective Action at individual facilities to focus first on areas of the facility that represent the greatest risk to human health and the environment. Response actions can be taken quickly at high priority areas of the facility while low priority areas can be addressed later. Approximately 70 percent of extrapolated RCAID facilities used a phased approach for at least one step in the Corrective Action process:

- 60 percent of the RCAID universe used a phased approach for the RCRA Facility Investigation (RFI);
- 13 percent used a phased approach for the Corrective Measures Study (CMS); and
- 30 percent used a phased approach to select and implement the remedial alternatives.

The phased approach was used more often by facilities with medium and low NCAPS rankings than by facilities with high rankings. A phased approach was also more likely if the lead regulatory agency was the state (84 percent of RCAID facilities with a state lead) or if there was a joint state/EPA lead (94 percent of facilities with a joint lead) than if EPA was the lead agency (57 percent of facilities with an EPA lead). These differences, however, were not statistically significant.

3. Evaluation of Remedial Alternatives

The purpose of a Corrective Measures Study (CMS) is to identify and evaluate potential Corrective Action remedial alternatives. Approximately half of the extrapolated RCAID universe had completed a CMS, with about one-quarter of the facilities with a completed CMS using a phased approach. The CMS should focus on realistic remedies. Presumptive remedies are preferred technologies for common categories of sites (e.g., wood treatment sites). Since 1991, the Superfund program has developed presumptive remedy guidance to use past experience to streamline remedy selection at Superfund sites. To ensure consistency in remedy selection and implementation and to reduce the cost and time required to investigate and remediate similar types of sites, EPA encourages the use of Superfund presumptive remedies at RCRA Corrective Action sites.

The CMS should determine whether any presumptive remedy is appropriate for the Corrective Action. Of the more than 50 percent of extrapolated facilities with a completed CMS, one-fourth used Superfund presumptive remedy guidance. An additional 15 percent considered the presumptive remedies, but found

that they were not applicable. At the time of the survey, presumptive remedies had been established for municipal landfills, volatile organic contamination in soil, and wood treating sites. Almost 20 percent of the respondents for facilities that did not employ a presumptive remedy reported that they were not aware of the presumptive remedy guidance or did not know it could be used for RCRA Corrective Action.

Use of presumptive remedy guidance did not depend on whether the state or EPA had lead regulatory responsibility. Half of the facilities that used the guidance were not ranked and the other half were high priority facilities. No medium or low priority facilities employed the guidance.

4. Action Levels

Action levels are constituent-specific and medium-specific contaminant levels determined to be indicators of potential harm to human health and the environment. They are used to help determine what contamination should be cleaned up. Almost 60 percent of the extrapolated RCAID universe used one or more types of action levels. Action levels were developed on a facility-specific basis at 14 percent of all extrapolated RCAID facilities. More commonly action levels were taken from standardized lists such as state action levels (used by 29 percent of RCAID facilities), EPA Regional action levels (18 percent), and proposed Subpart S levels (17 percent). Action levels were used most often for soil, as shown in Exhibit 4-2.

Exhibit 4-2
Use of Action Levels Across Media Types

Medium	Percent of Extrapolated RCAID Facilities
Soil	54%
Ground Water	38%
Surface Water	13%
Sediment	12%
Air	< 1%

Use of action levels did not appear to depend on whether the remedial alternative was based on residential or non-residential land use assumptions, which was not surprising since there are separate action levels for residential and nonresidential scenarios.

5. Risk Assessments

The goal of the Corrective Action program is to control or eliminate risks to human health and the environment. Therefore, remedial decisions should be risk-based. Risk assessments evaluate the nature of the risks at a facility to help determine what remedies will be protective of human health and the environment. Site-specific risk assessments are not necessary at sites where risk-based decisions can be made using standardized risk considerations.

Slightly more than half of the extrapolated RCAID universe conducted some form of facility-specific risk assessment as part of the remedy selection process. Fifteen percent of RCAID facilities conducted both a human health and an ecological risk assessment, about 35 percent conducted only a human health risk assessment, and 1 percent conducted only an ecological risk assessment.

Almost 80 percent of the human health risk assessments were conducted by the owner or operator rather than by the lead regulatory agency. Most of the human health risk assessments (80 percent) used the Risk Assessment Guidance for Superfund (RAGS) either alone or in conjunction with other guidance. The majority of the ecological risk assessments (65 percent) were semi-quantitative, 25 percent were quantitative, and 15 percent were qualitative. Virtually all of the ecological risk assessments relied on EPA guidance.

Risk assessments were conducted for over half of the unextrapolated 162 units with useful information in the risk assessment questions in the survey. Sixty-five units conducted human risk assessments while 31 units conducted ecological risk assessments:[13]

- For 6 of the 65 units, the human health risk assessment resulted in more stringent remedial alternatives and at 3 of the 31 units the ecological risk assessment resulted in more stringent remedial alternatives.

- At 7 of the 65 units, the remedial alternative was less stringent due to the results of the human health risk assessment.

- Of the remaining units, the risk assessment made no difference in the selection of a remedial alternative.

6. Land Use and Risk Assessment

EPA expects that the owners and operators of facilities with potentially significant risks to human populations or to the ecosystem are more likely to perform risk assessments to gauge these threats than are owners and operators of facilities without such risks. Presumably, such assessments are more likely at facilities with residential, recreational, or agricultural use on site or close to the facility boundary (as well as on-site industrial and/or commercial use) than at facilities with only an industrial or commercial land use. The data gathered for RCAID support this theory. For example,

- Of the facilities with primary commercial land use, only 10 percent conducted both human and ecological risk assessments.

- Of the facilities with primary industrial land use, 56 percent conducted human risk assessments and 15 percent conducted ecological risk assessments.

- Of the facilities with a secondary residential, recreation, and/or agricultural use on site, in addition to a primary industrial or commercial land use, 70 percent conducted a human risk assessment and 67 percent conducted a ecological risk assessment.

7. Public Participation

Approximately 80 percent of the extrapolated RCAID facilities engaged in some form of public participation. As shown in Exhibit 4-3, the most common forms of public participation were announcements in newspapers, magazines, and journals, followed by fact sheets, information repositories, mailings to the facility's mailing list, and public hearings. Use of multilingual communications was rare. The use of public participation mechanisms did not appear to depend on the implementing authority, the lead regulatory

[13] The unit data presented in this report are unextrapolated (see limitations of the analysis in Chapter 1). These figures should be considered as anecdotes rather than as representative of the RCAID universe.

agency, or the NCAPS ranking of the facility. Public participation was reported to have influenced the selection of the remedial alternatives at less than 5 percent of extrapolated RCAID facilities that used public participation techniques. No public comments were received at approximately half of the facilities that employed public participation techniques. Of the RCAID facilities performing final remedies, roughly 95 percent engaged in public participation. Of those facilities implementing stabilization measures, roughly 60 percent engaged in public participation.

Exhibit 4-3
Methods of Public Participation at RCAID Facilities
(Extrapolated Facilities)

Method of Public Participation	Percent of Facilities[a]
Announcements in Newspapers, Magazines, Journals	56%
Fact Sheets	42%
Information Repositories	42%
Mailings to Facility's Mailing List	41%
Informal Public Meetings	26%
Formal Public Hearings	18%
Door-to-Door Contact with Affected Off-Site Residents	3%
Multilingual Communications	3%

[a] Percentages were calculated from 709 extrapolated facilities with either a final remedy selected or a stabilization measure implemented.

8. Voluntary Corrective Action

EPA encourages facility owners and operators to undertake "voluntary" remedial actions, that is, remedial actions that are aimed to meet RCRA requirements, but are not specifically required in a permit or order. Voluntary cleanups have a number of potential advantages, including timeliness, flexibility, and efficient use of owner and operator resources. Although many facilities have been reluctant to undertake voluntary cleanups due to procedural barriers or lack of assurance that EPA and the state will approve the cleanup, respondents indicated that approximately 55 percent of the extrapolated RCAID universe had conducted some type of voluntary remedial action. High priority facilities and facilities with EPA as the lead regulatory agency were slightly more likely to undertake voluntary Corrective Actions than were lower ranked facilities or facilities with state leads. However, these differences were not statistically significant at the 95 percent confidence level.

Oversight of voluntary Corrective Action often includes several different mechanisms. Of the facilities with a voluntary action subject to oversight:

- 50 percent had conducted "routine communications" with the lead regulatory agency;
- 45 percent had regulator "review of proposed work";
- 45 percent had regulator "review of completed work"; and
- 35 percent had "occasional field visits" from the lead regulatory agency.

Fifteen percent of facilities that engaged in voluntary Corrective Action had no "oversight". Of the facilities that conducted voluntary remedial actions, over half were provided some level of assurance that the cleanup should satisfy regulatory requirements, primarily through the lead regulatory agency's approval of proposed work plans.

Facilities using some voluntary measures were less likely to conduct public participation (for the voluntary measures and/or other Corrective Actions) than facilities without any voluntary measures. Of the 495 extrapolated facilities with at least one voluntary measure, nearly 20 percent did not conduct any public participation. In contrast, only 10 percent of the facilities without any voluntary measures did not conduct public participation. Institutional controls were slightly more often employed for facilities that did not conduct voluntary measures than for facilities that conducted voluntary measures.

B. Remedies Selected

This section describes the remedies that had been selected by RCAID facilities. Specifically, it addresses the following topics:

- Application of institutional controls;
- Groundwater remediation and point of compliance;
- Remediation technologies and objectives;
- Location and extent of treatment;
- Use of natural attenuation;
- Technical impracticability determinations;
- Corrective Action Management Units (CAMUs);
- Effect of on-site land use on remedy selection; and
- Effect of off-site land use on remedy selection.

1. Institutional Controls

Slightly more than half of all extrapolated RCAID facilities employed some form of institutional controls, after excluding no responses and "unknown" responses. Generally, when facilities used institutional controls as a part of the remedy, they employed multiple institutional controls. Eighty percent of the RCAID facilities using institutional controls used multiple controls. Restrictive covenants (which were defined to include deed restrictions), on-site use restrictions, access restrictions, and compliance monitoring were used as sole institutional controls at one or more facilities. Off-site restrictions were the only institutional controls that were not used alone, although off-site use restrictions were employed in conjunction with other institutional controls at 15 percent of facilities that used institutional controls. The most common institutional controls were compliance monitoring and restrictive covenants/deed restrictions, as shown in Exhibit 4-4.

Facilities that based remedial decisions on a non-residential land use may have used institutional controls to ensure that future exposure scenarios at the facility remain consistent with or more conservative than those projected at the time of remedy selection. Approximately 70 percent of the facilities using institutional controls selected remedies that were based on a non-residential land use scenario. The remaining 30 percent used institutional controls in conjunction with a residential land use scenario.

Exhibit 4-4
Institutional Controls at RCAID Facilities

	Percent of Facilities with Institutional Controls[a]	Percent of all RCAID Facilities[b]
Compliance Monitoring	71%	40%
Restrictive Covenants /Deed Restrictions	70%	39%
On-Site Use Restrictions	57%	32%
Access Restrictions	50%	28%
Notices	45%	25%
Off-Site Use Restrictions	15%	9%

[a] *Percentages calculated from the 424 facilities (56% of total) using institutional controls.*
[b] *Percentages calculated from the 758 RCAID facilities, excluding unknown and non-responses.*

Institutional controls were used less frequently at facilities with low Corrective Action costs than at facilities with high costs. Fifteen percent of facilities with costs below $1 million employed institutional controls, compared to almost 96 percent of facilities with costs of $1 million to $5 million, and 86 percent of facilities with costs exceeding $5 million. Medium ranked facilities were the least likely to use institutional controls.

2. Groundwater Remediation and Point of Compliance

Of the 527 extrapolated RCAID facilities that had evaluated the Groundwater Releases Controlled Determination environmental indicator, almost half (246 facilities) had implemented a remedial action to control the further migration of contaminated ground water. About 10 percent of these 527 facilities (60 facilities) could document that there were no releases to ground water above levels of regulatory concern. The remaining 221 facilities, slightly more than 40 percent, had insufficient data to determine whether groundwater releases had been controlled.

The point of compliance (POC) for ground water is the location at which groundwater cleanup levels must be achieved. In the previous version of this report, EPA presented national level data breaking down the usage of POCs by type. However, EPA's subsequent review of these data suggests that such national level figures are not reliable.[14] Respondents for only 40 percent of the extrapolated RCAID facilities provided

[14] In developing this updated version of the report, EPA explored the statistical methods underlying the estimation of the proportion of facilities that use the facility boundary POC. This assessment suggested that the estimates shown in the previous version of the report did not appear to be adequately robust for presentation. For example, simple and standard modifications made to the survey structure to test for robustness, such as commingling or collapsing strata, led to very different estimates of the proportion of facilities with facility boundary POCs. As a consequence, EPA was not able to provide reliable estimates of how frequently different POC options were actually used across the universe of facilities.

information on the groundwater POC used in the remedies.[15] This low response level resulted in significant problems associated with extrapolation of these data to the national level, potentially introducing bias into the estimates. While unable to develop reliable estimates of the rate at which various POCs are used, EPA was able to conclude generally that the full range of different POC options were used across the universe of facilities, including unit boundary/throughout-the-plume, existing plume boundary, buffer zone, and facility boundary POCs.

3. Remedial Technologies and Objectives

The remedial technologies used as stabilization measures were also frequently used as part of a final remedy, based on the unextrapolated and not necessarily representative unit data. As noted earlier in this report, these and other unit data are not statistically representative of the RCAID universe, based on the survey design. See Chapter 1, Section F for a discussion of the limitations regarding unit-specific data. As shown in Exhibit 4-5, the two most common stabilization technologies were pump and treat (30 units) and cap and cover (18 units). These two technologies were also the two top final remedies, but in the reverse order: cap and cover (30 units) and pump and treat (15 units). Stabilization measures and final remedies had similar overall objectives, see Exhibit 4-6. The most common objective was preventing human exposures.

4. Location and Extent of Treatment

The RCAID survey did not ask about the percent of contaminated media that was anticipated to be treated versus managed without treatment. However, EPA did request information on the percent of contaminated media identified at the facility that was anticipated to be treated on-site. Respondents for:

- 28 percent of facilities anticipated treating no contaminated media on site;
- 13 percent of facilities anticipated treating up to 50 percent on site;
- 8 percent of facilities anticipated treating 50 to 75 percent on site;
- 23 percent of facilities anticipated treating 76 to 99 percent on site; and
- 27 percent of facilities anticipated treating 100 percent on site.

Some additional amount of the media could be expected to be treated off site. These figures must be interpreted carefully because they represent expectations about future treatment, rather than actual treatment. These percentages did not vary significantly based on the types of on-site or nearby off-site land use.

Based on a weighted average of the figures above and assuming that the amount of contaminated media generated at each facility does not vary significantly by the likelihood of on-site treatment, roughly half of contaminated media at RCAID extrapolated sites was anticipated to be treated on site.

[15] Survey respondents were asked in the survey to provide information about the groundwater point of compliance at up to four units at the facility. See Chapter 1, Section B., Questionnaire Overview. Although the POC responses were for unit-specific questions, the results were compiled at the facility level. Respondents for only 2 of the 371 facilities reported using different POCs at different units at the same facility. For these two facilities the most stringent POC was used in compiling the data at the facility level.

Exhibit 4-5
Remedial Technologies Selected
(Number of units with responses, no extrapolation)

Remedial Technology	Interim Measure[a] (Percent of 66 units)	Final Remedy (Percent of 78 units)
Pump and Treat	30 (45%)	15 (19%)
Cap/Cover	18 (27%)	31 (40%)
Free Product Recovery	16 (24%)	5 (6%)
Run-on/Run-off Control	9 (14%)	7 (9%)
Barrier Wall	8 (12%)	10 (13%)
Excavation and Off-Site Incineration	7 (11%)	3 (4%)
Ex-situ Solidification/Stabilization	6 (9%)	7 (9%)
Bio-Remediation	6 (9%)	2 (3%)
French Drain	6 (9%)	1 (1%)
Thermal Desorption	5 (8%)	0 (0%)
In-situ Solidification/Stabilization	4 (6%)	5 (6%)
Natural Attenuation	4 (6%)	5 (6%)
Soil Washing	3 (5%)	1 (1%)
Vitrification	2 (3%)	0 (0%)
Soil Vapor Extraction	1 (2%)	7 (9%)
Excavation and On-Site Incineration	0 (0%)	4 (5%)
Geosynthetic Wall	0 (0%)	3 (4%)
Soil Flushing	0 (0%)	2 (3%)
Bioventing	0 (0%)	1 (1%)
Solvent Extraction	0 (0%)	1 (1%)

[a] Data were not adjusted to delete apparent non-interim treatment technologies (e.g., in-situ solidification) from the interim measure responses.

Exhibit 4-6
Objectives of Interim Measures and Final Remedies for Units
(Number of units providing responses, no extrapolation)

Objectives of the Remedial Alternative	Interim Measures (of 66 units)	Final Remedy (of 78 units)
Prevent exposures to human populations	60%	66%
Prevent exposures to the environment	45%	53%
Prevent further on-site migration of contaminants	36%	32%
Stop off-site migration of contaminants	36%	15%
Prevent off-site migration of contaminants	32%	19%
Return media to maximum beneficial use	23%	18%

5. Natural Attenuation

Natural attenuation relies on natural processes such as biodegradation, dispersion, dilution, or adsorption to achieve remedial goals. In certain circumstances, natural attenuation can be an acceptable component of remedial actions for contaminated ground water or soil. Approximately 20 percent of the extrapolated RCAID universe of facilities selected natural attenuation as a remedial alternative or as one component of a remedial alternative for on-site and/or off-site contamination. At roughly five percent of facilities, natural attenuation was one component of the remedy for both soil and ground water, while at an additional five percent, it was a component for ground water only. At 10 percent of facilities, natural attenuation was selected as a remedy for off-site contamination. At less than one percent of facilities natural attenuation was used as the sole remedy for ground water and soil.

At almost all of the facilities using natural attenuation for ground water, there were known or suspected DNAPLs. At the sites that used natural attenuation, the primary classes of contaminants were VOCs and organics, although one-third of these sites also had PCB contamination. None of the sites that used natural attenuation had metal or pesticide contamination.

6. Technical Impracticability Determinations

A determination that a cleanup is technically impractical is made when the scale of operations required is of such a magnitude and complexity that the treatment alternative would be impracticable. In such cases, non-treatment alternatives may be chosen that address, as best as possible, the existing contamination. A technical impracticability determination for ground water was made at less than one percent of extrapolated RCAID facilities. The determination was based on the presence of DNAPLs, complex geology, and inaccessibility. At these facilities, the ground water had not migrated off site and there was no contamination of actual or potential drinking water sources. At about five percent of the RCAID facilities, a technical impracticability determination was made for soil. At all but one of these facilities, the determination was made because of risks to workers and prohibitive costs. At the remaining facility, potential remedies were infeasible from an engineering perspective.

7. Corrective Action Management Units

In 1993, EPA promulgated the CAMU regulations to provide relief from specific RCRA standards that can preclude desirable remediation options or unnecessarily add to remedial costs. For example, with a CAMU, a facility can consolidate remediation wastes from the facility into one area for treatment without triggering the land disposal restrictions (LDRs). Less than one percent of extrapolated RCAID facilities employed a CAMU. This infrequent use of CAMUs may have resulted from the legal challenges to the CAMU rule since 1993. Although the lawsuit had been stayed at the time of the survey, facilities may have been reluctant to incorporate CAMUs into their remedial designs because the outcome of the litigation was not yet certain.

Approximately 10 percent of facilities used a related unit, the Area of Contamination (AOC), which in certain circumstances also allows for consolidation of contaminated media without triggering RCRA Subtitle C requirements. All of the facilities that used a CAMU or AOC had contaminated soil. If a facility has contaminated soil in several different areas and plans to treat it on site, a CAMU or AOC could significantly reduce costs by allowing soil to be consolidated for treatment. Since the survey was completed, facilities have been given the additional option to temporarily store waste on site prior to treatment using "staging piles" (see EPA's final Hazardous Waste Identification Rule for Contaminated Media (HWIR Media) (63 FR 65873, November 30, 1998)).

8. Effect of On-Site Land Use on Remedy Selection

The RCAID survey queried facilities on the effects of on-site land use on remedy selection. While the majority of the extrapolated facilities had only commercial or industrial primary land uses on-site, many facilities reported having residential or recreational secondary uses on-site. Residential land use designations may cause facilities to select more effective and therefore more costly remedies. Conversely, a non-residential land use may allow facilities to extend the schedule for starting cleanup or to base their cleanup goals on industrial or commercial exposure scenarios which are less stringent than residential exposure scenarios.

For the 95 percent of all facilities that did not have any on-site residential land use:

- Almost 25 percent had a remedy decision based on non-residential land use designation;
- About 5 percent had received an extension of the remedial schedule based on the non-residential land use designation;
- 35 percent had a cleanup based on a residential exposure scenario, that is, the non-residential land use did not influence the remedial decision. At three-fourths of these facilities, nearby land was used for residential purposes.
- 35 percent had respondents who did not respond to the question or reported an unknown effect from the non-residential use designation.[16]

[16] These totals exclude the two sample facilities (weights 18.25 and 1.5) whose respondent reported on-site residential land use but also reported that the on-residential land use affected their remedial decision.

9. Effect of Off-Site Land Use on Remedy Selection

In the 1996 ANPRM, EPA suggested that facilities select remedies based on non-residential exposure assumptions where such assumptions are appropriate given reasonable future use of the facility and surrounding land. The RCAID survey, however, shows only limited consideration of off-site land uses, possibly because the survey largely reflected decisions that were made before the ANPRM was published. Thus, off-site land uses may be a more important factor in the future than suggested by the RCAID results.

For the 40 percent of RCAID facilities with no residential land use nearby:

- 5 percent had a remedy decision that reflected non-residential off-site land use;
- 70 percent had a remedy decision that was not influenced by the non-residential land uses; and
- The remaining 25 percent did not respond to the question.

Of the 60 percent of RCAID facilities with residential land use within one-half mile:

- 35 percent were required to cleanup to residential levels, about half of which had off-site migration of contaminants.[17]
- 35 percent had remedial decisions that were not influenced by residential off-site land use. Of these facilities, more than half had off-site contaminant migration.[18]
- 30 percent had respondents who did not answer this survey question.

C. Financial Responsibility

EPA requires assurances of financial responsibility for Corrective Action (40 CFR 264.101(c)). The current regulatory language gives the Agency and authorized states considerable discretion in implementing the requirement. While EPA proposed more specific financial assurance requirements in 1986 and 1990, the proposals were not finalized.

The survey indicated that about one-fourth of the extrapolated RCAID Corrective Action facilities had already demonstrated financial responsibility and one-half of the facilities had not demonstrated financial responsibility. The respondents for the remaining 25 percent did not answer the question or did not know whether the facility had demonstrated financial responsibility. Additional facilities may be required to demonstrate financial responsibility later in the Corrective Action process because, as is discussed below, financial assurance is commonly not required until a final remedy is selected and final remedies had not been selected for about 40 percent of extrapolated RCAID facilities.

EPA and states have flexibility about when to require demonstrations of financial assurance. Consistent with the 1986 and 1990 proposed rulemakings, most extrapolated facilities that had demonstrated financial assurance were subject to the requirements at the time of remedy selection or subsequently during

[17] These summaries exclude the sample facility (weight = 18.25) whose respondent was inconsistent in reporting both that off-site land use supported using residential exposure scenarios and that off-site land use did not influence on-site decisions.

[18] The remaining facilities with off-site residential land use did not have a response to the question.

corrective measures implementation. By waiting until this stage in the process, the amount of financial assurance required can be based on specific estimates of the costs of implementing the selected remedies.

The type of financial assurance mechanism used was identified for about 15 percent of the extrapolated facilities. Of these respondents, 70 percent used the financial test or corporate guarantee and 20 percent used a letter of credit. The financial test and corporate guarantee are the least expensive mechanisms, but they are available only to firms that are financially large and viable or have a large and viable corporate parent or partner. Thus, RCAID data indirectly indicate that most of the facilities with financial assurance were owned or operated by large companies.

CHAPTER 5: REMEDY IMPLEMENTATION

This chapter discusses environmental indicators, estimated cleanup costs, and estimated time required to complete facility cleanups. As shown in the previous chapters, facilities conducting RCRA Corrective Actions and the nature of their contamination and remedial actions are diverse. The diversity makes uniform Corrective Action guidelines and timetables impractical. As a result, the lead regulatory agency and facility must work closely to determine the most efficient and effective process on a facility-by-facility basis. Thus, EPA has advocated performance-based measurements of results, rather than reliance on strict regulatory requirements. As long as facilities achieve cleanup objectives that protect human health and the environment, EPA will be flexible in determining the acceptable means to achieve that end.

The merit of the Corrective Action program depends notably on the achievement of its goals and the cost and time required to complete cleanups. In addition, the cost and time required to complete cleanups are important considerations for EPA and authorized states in determining the resources needed for effective program implementation. Facilities with more extensive contamination are likely to require more money for cleanup activities as well as more effort by EPA or the authorized state to oversee the remedial activities. The time and costs estimated by facility respondents in the RCAID universe vary widely.

Selected Findings in Chapter 5

- Of the two-thirds of facilities that had identified environmental indicators by the time of the survey, 61 percent had achieved the Human Exposures Controlled Determination and 54 percent had achieved the Groundwater Releases Controlled Determination.
- The estimated cost of cleanup at RCAID facilities varied widely, ranging from under $1 million to over $50 million.
- Most facilities had an estimated cleanup cost of less than $5 million.
- Facilities with only a commercial use on-site tended to have much lower costs than average.
- Facilities with higher cost cleanups were more likely than facilities with lower cost cleanups to conduct a human health and/or an ecological risk assessment.
- Most facilities were expected to complete Corrective Action in 10 years or less. Almost 20 percent, however, were estimated to need more than 30 years.

A. Environmental Indicators

While the ultimate goal of the RCRA Corrective Action program is to achieve final cleanups, EPA measures the near-term success against the GPRA goals and annual cleanup targets for controlling current human exposures and migration of contaminated ground water. Measuring and recording progress toward these goals will be a top priority for EPA and the states over the next several years.

The two Corrective Action Environmental Indicators, Current Human Exposures Under Control and Migration of Contaminated Groundwater Under Control, are measures of program progress under GPRA. These environmental indicators are designed to aid facility decision makers by clearly showing where risk reduction is necessary, thereby helping regulators and facility owners and operators reach an earlier

agreement on stabilization measures or final remedies that must be implemented. Focusing on the Environmental Indicators should also reduce delays in the review of cleanup work plans and allow owners, operators, and regulators to concentrate on those problems that potentially pose significant risks. Current Human Exposures Under Control is attained when there are no unacceptable risks to human health due to releases of contaminants at or from the facility subject to RCRA Corrective Action. Migration of Contaminated Groundwater Under Control is attained when the migration of groundwater contamination at or from the facility across designated boundaries is controlled. These boundaries may be facility boundaries or specified boundaries within a facility. Both environmental indicators are facility-wide measures. They are not tied to specific program activities or reports. In the course of implementing effective final remedies, the environmental indicators will be achieved. The implementation of stabilization measures can also achieve the environmental indicators.

A majority of extrapolated RCAID facilities (63 percent) had environmental indicators identified when the survey was taken in 1997. Facilities managing cleanups under an EPA lead were more likely to have had environmental indicators identified than facilities under a state lead. Eighty percent of EPA-led facilities had environmental indicators identified, compared to 45 percent of state-led facilities.

Of the extrapolated facilities that had environmental indicators identified, 343 (61 percent) had achieved the Human Exposures Controlled Determination[19] and 306 (54 percent) had achieved the Groundwater Releases Controlled Determination.[20] See Exhibit 5-1. About 60 extrapolated facilities achieved these determinations by demonstrating that there were no releases to warrant the use of controls. The remaining facilities did not have sufficient data to report a determination.

[19] These facilities include those with either a YE or NC determination (343 facilities, 61%). A "YE", or "Yes" determination (282 facilities, 50%) indicates that remedial measures including treatment and/or exposure controls had been implemented with the result that humans were no longer exposed to contaminant concentrations in excess of specified cleanup levels. A "NC" determination (61 facilities, 11%) indicates that no control measures were necessary to ensure that humans were not exposed to contaminant concentrations in excess of specified cleanup levels. Respondents could also indicate that they lacked sufficient data to specify YE or NC. Since the RCAID survey was administered, EPA has modified the questions and possible responses used to determine whether the environmental indicators have been met.

[20] These facilities include those with either a "YE" or "NR" determination (306 facilities, 54%). A "YE" or "Yes" determination (246 facilities, 44%) indicates that a remedial action had been implemented that was designed and operating (including performance monitoring) to effectively control the further migration of contaminated ground water beyond a designated boundary. A "NR" determination (60 facilities, 11%) indicates that data were sufficient to document that there were no releases to ground water above regulatory concerns. Respondents could also indicate that they lacked sufficient data to specify YE or NC. Since the RCAID survey was administered, EPA has modified the questions and possible responses used to determine whether the environmental indicators have been met.

Exhibit 5-1. Human Exposures and Groundwater Releases Controlled Determinations (RCAID Extrapolated Facilities)

Controlled Determination Conducted	Remedial Measures Implemented	No Control Measures Needed	Insufficient Data to Reach Determination
Human Exposures (506 facilities)	56%	12%	32%
Ground Water (527 facilities)	47%	11%	42%

[a] Thirty-five facilities identified environmental indicators but did not provide any determination; 23 facilities reached a determination for ground water but not for human exposures; and 2 facilities reached a determination for human exposures but not for ground water.

Facilities with a high NCAPS ranking were more likely to have environmental indicators identified than other facilities. Seventy percent of all facilities had a high NCAPS ranking, while 80 percent of the facilities that had evaluated either the human exposures or groundwater releases environmental indicator had a high NCAPS ranking. Further, these high priority facilities were more likely to have achieved the human exposures and the groundwater releases controlled determinations than were low or medium priority facilities. Ninety percent of the facilities achieving these determinations had high NCAPS rankings.

B. Cost

While conducting Corrective Actions, facility owners typically incur capital and equipment costs, operations and maintenance expenses, and planning and compliance costs. The cost of cleanup at RCAID facilities varied widely, with estimates ranging from under $1 million to over $50 million.[21] See Exhibit 5-2. Of facilities with reported total costs, over half had estimated total cleanup costs of under $5 million and less than 10 percent had estimated total costs of over $50 million. On average, data on Superfund NPL sites show that such sites are more costly to remediate, with estimated average total costs of $27 million per non-federal facility.[22]

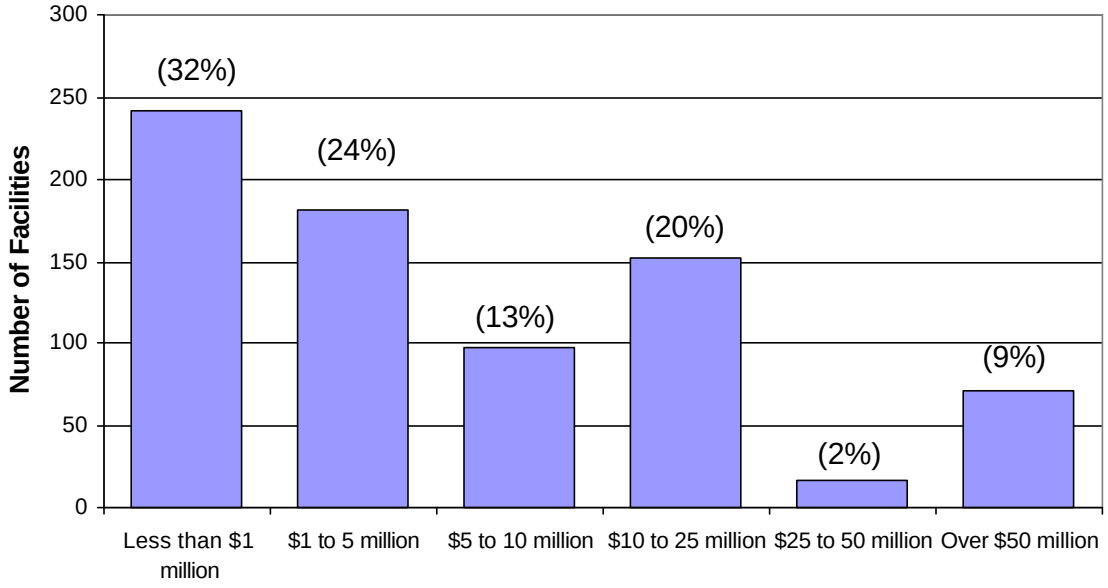
In 1993, EPA estimated that the average cost of Corrective Action remediation (not including investigation) was $6.5 million per facility.[23] This figure seems reasonably consistent with the RCAID survey data, however, a direct comparison is not possible because the survey asked respondents to identify the applicable cost range (e.g., less than $1 million or greater than $50 million) for the facility, rather than the actual estimated cost.

[21] Respondents were not asked to present the total costs in current year dollars. This report summarizes data as they were provided by the survey respondents. Therefore there are some uncertainties regarding these total cost estimates.

[22] Source for estimate: Letter from Elliot P. Laws to Congressman John D. Dingell, January 28, 1994 (OSWER Directive 9200.2-21). Total based on average capital costs of $25 million per site plus annual operation and maintenance expenses of approximately $50,000 per operating unit for an average of 1.8 units for an average of 21 years of operation.

[23] "Draft Regulatory Impact Analysis for the Final Rulemaking on Corrective Action for Solid Waste Management Units: Proposed Methodology for Analysis," Office of Solid Waste, U.S. EPA, March 1993, pp. 5-16.

Exhibit 5-2
Estimated Total Cleanup Costs at RCAID Facilities[a]



[a] Non-responses and responses of "unknown" for 131 facilities are not included.

1. Contamination and Cost

As shown in Exhibit 5-3, facilities with only one contaminated medium tended to be less costly to remediate than facilities with several contaminated media. For example, the entire subset of extrapolated facilities with only soil or groundwater contamination had projected remediation costs less than $1 million. By contrast, only 12 percent of the facilities with four types of contaminated media had projected costs under $5 million.

Exhibit 5-3
Cost of Corrective Action by Media Contaminated
(Cumulative Percentages)

Media Contaminated	< $ 1 million	< $ 5 million	< $ 10 million	< $ 25 million	< $ 50 million	< or ≥ $50 million
Soil only (78 facilities)	100%	100%	100%	100%	100%	100%
Ground water only (3 facilities)	100%	100%	100%	100%	100%	100%
Two types of media (403 facilities)	34%	70%	77%	96%	99%	100%
Three types of media (87 facilities)	25%	46%	50%	50%	51%	100%
Four types of media (184 facilities)	0%	12%	46%	88%	88%	100%
All types of media (3 facilities)	0%	0%	0%	0%	42%	100%
All facilities[a] (758 facilities)	32%	56%	69%	89%	91%	100%

[a] All extrapolated facilities with responses.

Examining the distribution of cleanup costs while controlling for the number of types of contaminants (i.e., VOCs, SVOCs, PCBs, metals, and pesticides) shows similar results. See Exhibit 5-4. Eighty-one percent of the 336 facilities had only one contaminant type have cleanup costs of less than $5 million. By contrast, a majority of the facilities with three or more classes of contaminants faced cleanup costs of over $5 million.

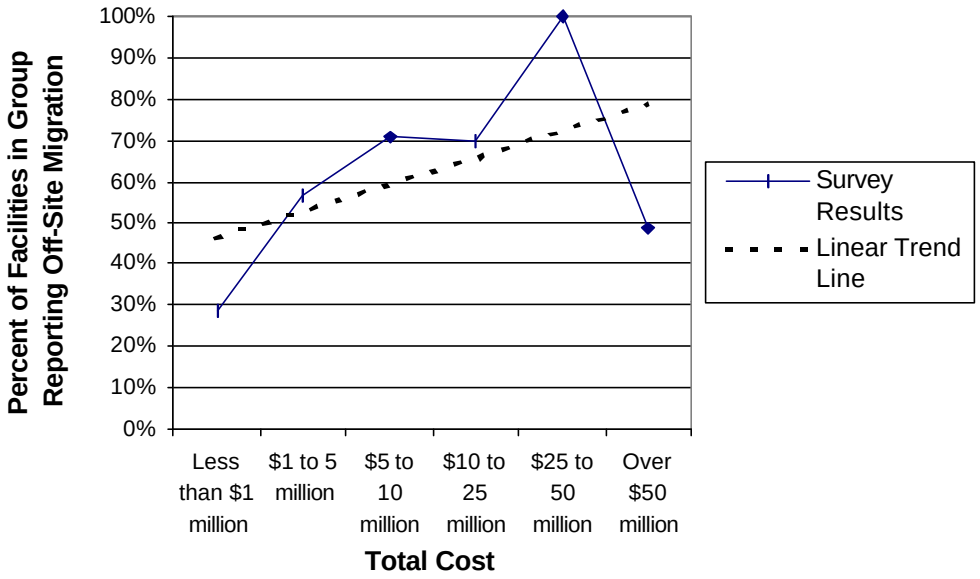
Exhibit 5-4
Corrective Action Costs and Number of Contaminant Types
(Cumulative Percentages)

Number of Contaminants Types	< $ 1 million	< $ 5 million	< $ 10 million	< $ 25 million	< $ 50 million	< or ≥ $50 million
1 type (336 facilities)	67%	81%	85%	97%	97%	100%
2 types (151 facilities)	11%	59%	63%	89%	89%	100%
3 types (219 facilities)	0%	28%	63%	91%	91%	100%
4 types (41 facilities)	0%	0%	2%	9%	45%	100%
5 types (10 facilities)	0%	0%	0%	85%	85%	100%
Total (758 facilities)	32%	56%	69%	89%	91%	100%

[a] All facilities with responses.

Exhibit 5-5 shows the relationship between total estimated cleanup cost and off-site migration of contamination. As shown by the dotted line on the graph, which represents the results of a regression analysis, the percentage of facilities with off-site migration generally increased as the estimated costs of cleanup increased. As shown by the solid line, the portion of facilities with off-site contamination declined from 100 percent to slightly less than 50 percent for facilities with estimated total cleanup costs of between $25 and $50 million and more than $50 million, respectively. This apparent anomaly reflects

Exhibit 5-5
Higher Cost Cleanups Are More Likely to Have Off-Site Contamination



the small sample size: the 100 percent figure represents only 16 extrapolated facilities, whereas the other data points on the solid line represent 71 to 242 extrapolated facilities.

2. Land Use and Cost

The cleanup of facilities with only industrial or commercial uses appeared to be less expensive than the cleanup of sites with multiple uses. However, the differences were not statistically significant at the 95%

confidence level because of the small sample size. See Appendix C statistics on confidence intervals. Exhibit 5-6 shows cleanup costs by type of on-site land use.

Exhibit 5-6
Corrective Action Costs for Facilities with Various On-Site Land Uses[a]
(Cumulative Percent of Land-Use Type)

Primary and/or Secondary On-Site Land Use	< $1 million	< $5 million	< $10 million	< $25 million	< $50 million	< or ≥ $50 million
Industrial (784 facilities)	23%	50%	64%	87%	90%	100%
Commercial (223 facilities)	41%	43%	71%	85%	91%	100%
Residential (57 facilities)	0%	0%	0%	35%	35%	100%
Recreational (60 facilities)	0%	0%	0%	33%	33%	100%
Agricultural (9 facilities)	0%	0%	0%	0%	0%	100%
All facilities (889 facilities)[b]	32%	56%	69%	89%	91%	100%

[a] Facilities may report multiple on-site land uses.
[b] Facilities not reporting a land use were included only in the total. The rows do not sum to the total for this reason and because multiple types of land use were included in the data for each facility.

The 10 percent of RCAID facilities with only a commercial use on-site tended to have much lower costs than average, with 99 percent of these sites having estimated costs of less than $1 million. Their costs may have been low because they had few treatment or disposal units, which could make them industrial sites and lead to extensive contamination that is costly to remediate.

3. Risk Assessment and Cost

Facilities with higher cost cleanups were more likely than facilities with lower cost cleanups to conduct a human health and/or ecological risk assessment. For example:

- 22 percent of facilities with a cleanup costing less than $1 million conducted a human health risk assessment, whereas 77 percent of facilities with cleanups costing $1 to $5 million and 80 percent of cleanups costing more than $5 million conducted such an assessment.
- Less than 1 percent of facilities with a cleanup costing less than $10 million conducted an ecological risk assessment, whereas 57 percent of facilities with cleanups costing at least $10 million conducted such an assessment.

C. Time Required to Complete Corrective Action

The RCAID survey asked how long respondents anticipated it will take to complete all Corrective Action remedial activities at the facility. Respondents for 93 percent of the extrapolated facilities answered this question. They reported that:

- 26 percent of facilities were anticipated to complete remedial activities in less than 5 years;
- 29 percent in 5 to 10 years;
- 26 percent in 10 to 30 years; and
- 19 percent in over 30 years.

The duration of Corrective Action depends on a variety of factors. For example, the time required for less costly cleanups tends to be shorter, while cleanups at facilities with off-site migration or more costly cleanups tend to be longer. The ability of a facility to promptly address contamination and the complexity of the contamination are two important drivers of the total time required to complete cleanup activities. There was a positive correlation between estimated cleanup cost and expected duration of the cleanup at RCAID facilities. Further, facilities with multiple media contamination tended to have longer expected cleanup time frames. The following two sections illustrate these points.

1. Cost and Timing

As expected, RCAID survey data show that the cost of Corrective Action and the time required to complete Corrective Action were positively correlated. Eighty-four percent of the facilities with estimated costs under $1 million were expected to complete all remedial activities in less than 5 years. In contrast, 77 percent of the facilities with estimated costs of over $50 million were expected to take more than 10 years to complete remedial activities. See Exhibit 5-7.

Exhibit 5-7
Cost and Time Required to Complete Corrective Action[a]
(Cumulative Percentages)

Total Cost	Time To Complete Corrective Action			
	< 5 years	≤ 10 years	≤ 30 years	≤ or > 30 years
Less than $1 million (210 facilities)	84%	99%	100%	100%
$1 to 5 million (181 facilities)	10%	56%	100%	100%
$5 to 10 million (97 facilities)	0%	17%	97%	100%
$10 to 25 million (152 facilities)	12%	27%	42%	100%
$25 to 50 million (16 facilities)	0%	6%	6%	100%
Over $50 million (71 facilities)	0%	28%	77%	100%

[a] Does not include response of unknown or non-responses for 96 facilities on the cost question and 66 facilities on the time to complete Corrective Action question.

2. Contamination and Timing

Facilities with multiple contaminated media and migration of contaminants off-site tended to have longer remediation time frames than other facilities. As shown in Exhibit 5-8, facilities with only one contaminated medium tended to have shorter projected remediation time frames than facilities with several contaminated

Exhibit 5-8
Time to Complete Corrective Action by Media Contaminated
(Cumulative Percentages)

Media Contaminated	Time to Complete Corrective Action			
	< 5 years	≤ 10 years	≤ 30 years	≤ & > 30 years
Soil only (60 facilities)	100%	100%	100%	100%
Ground water only (3 facilities)	55%	100%	100%	100%
Two types of media (453 facilities)	28%	71%	91%	100%
Three types of media (118 facilities)	19%	36%	64%	100%
Four types of media (186 facilities)	0%	13%	62%	100%
All five types of media (3 facilities)	0%	0%	58%	100%
All facilities (823 facilities)[a]	32%	56%	69%	100%

[a] Does not include unknown and non-responses for 66 facilities on the time to complete Corrective Action question.

media to remediate. For example, all facilities with only soil or groundwater contamination had an estimated time to complete Corrective Action of 10 years or less. In contrast, only 22 percent of the facilities with three or more types of contaminated media were expected to complete Corrective Action in 10 years or less.

Multiple contaminant types (e.g., soil, ground water, surface water, sediment, air) at a facility were positively correlated with the length of time required to complete Corrective Action. See Exhibit 5-9. A majority of the facilities with 3 or more types of contaminants were expected to require more than 10 years to complete remedial activities. In contrast, a majority of the facilities with fewer than 3 types of contaminants were expected to 10 years or less to complete such activities.

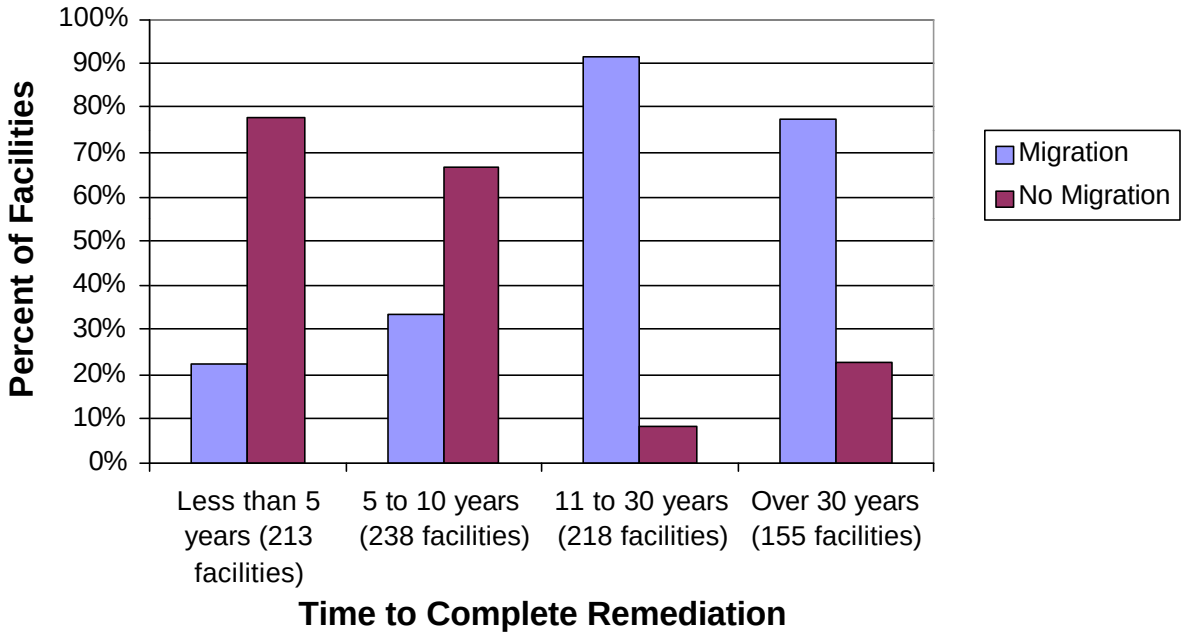
Exhibit 5-9
Time to Complete Corrective Action by Number of Contaminant Types[a]
(Cumulative Percentages)

Types of Contaminants	Time to Complete Correction Action			
	< 5 years	≤ 10 years	≤ 30 years	≤ & > 30 years
5 types (11 facilities)	0%	0%	91%	100%
4 types (41 facilities)	0%	48%	58%	100%
3 types (219 facilities)	0%	2%	73%	100%
2 types (138 facilities)	12%	72%	91%	100%
1 type (413 facilities)	47%	79%	84%	100%
Total (823 facilities)	26%	55%	81%	100%

[a] Does not include unknown and non-responses for 66 facilities.

Facilities with off-site contaminant migration on average were expected to spend more time to complete remedial actions than facilities without off-site contaminant migration. See Exhibit 5-10. For example, 76 percent of the facilities that were expected to require over 30 years to complete Corrective Action had off-site contaminant migration, compared to only 11 percent of facilities that were expected to require less than five years to complete remediation under Corrective Action. Almost 50 percent of the facilities that did not know if there had been off-site contaminant migration were expected to require less than 5 years for Corrective Action. (These facilities are not represented in Exhibit 5-10.)

Exhibit 5-10
Relationship Between Off-Site Contamination Migration and Time to Complete Corrective Action[a]



[a] Does not include unknown and non-responses for 65 facilities.

D. Results of Stabilization and Final Remedy at Individual Units

Facilities implement stabilization (or interim measures) or final remedies at individual solid waste management units, such as a spill area, landfill, waste pile, surface impoundment, or other area with contamination. The RCAID survey requested respondents to identify, for each of up to four units at the facility, the results of the remedial alternative, choosing from a small set of results or specifying other results. Exhibit 5-11 summarizes the responses, distinguishing between the results for units with final remedies and units with stabilization measures. This question received a low response rate. As noted earlier in this report, these and other unit data are not statistically representative of the RCAID universe, based on the survey design.

For units with final remedies, cleanup standards had been met, the source of contamination had been controlled, mass of contamination had been controlled, migration of contamination had been controlled, and the risk to human health and the environment had been controlled almost twice as often as is the case with stabilization measures, as shown in Exhibit 5-11.

Exhibit 5-11
Remedial Alternatives at RCAID Units

Results of the Remedial Alternative	Type of Remedial Alternative Completed	
	Stabilization Measures (percent of 5 units)	Final Remedy (percent of 18 units)
Source of contamination controlled	2 (40%)	14 (78%)
Risk to human health and the environment controlled	2 (40%)	13 (72%)
Migration of contamination controlled	2 (40%)	12 (67%)
Mass of contamination controlled	0 (0%)	7 (39%)
Cleanup standards met	1 (20%)	6 (33%)
Other result achieved	1 (20%)	2 (11%)