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Field Test of the Proposed Revised Hazard Ranking System (HRS)

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FIELD TEST OF THE PROPOSED REVISED HRS

Site Assessment Branch
Hazardous Site Evaluation Division
U.S. Environmental Protection Agency

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Notice

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EXECUTIVE SUMMARY

The Superfund Amendments and Reauthorization Act of 1986 (SARA) requires the U.S. Environmental Protection Agency (EPA) to revise the Hazard Ranking System (HRS) so that, to the maximum extent feasible, it accurately assesses the relative risks associated with actual or potential releases of hazardous substances from a site. The Conference Report on SARA (H. Rep. 962, 99 Cong., 2d Sess. at 199-200 (1986)) makes clear that this mandate does not require detailed risk assessments, but directs EPA to rank sites as accurately as feasible based simply on information available from preliminary assessments and site inspections consistent with the goal of "expeditiously" identifying candidates for response actions. In addition, SARA specifically directs EPA to:

- Assess how surface water contamination affects the human food chain and recreational use of surface water.
- Consider potential contamination of ambient air as well as actual contamination.
- Give a high priority to sites which have contaminated principal drinking water supplies.
- Consider the quantity, toxicity, and concentrations of hazardous constituents in wastes generated primarily by combustion of coal or other fossil fuels (e.g., fly ash, bottom ash, slag waste).

In response to these mandates, EPA proposed HRS revisions for public comment on December 23, 1988 (53 FR 51962). The HRS is used to assess the relative risks posed by releases or threatened releases of hazardous substances from a site, and as a means of identifying releases as national priorities for further investigation and possible remediation. The HRS assigns numerical values (according to prescribed rules) to factors that characterize the potential of any given release to cause harm to public health or the environment. The values are then combined and used to yield a single score that is designed to indicate the potential hazard posed by each site relative to other sites.

EPA initiated a field test of the proposed HRS revisions[1] to help assess the costs and implementation concerns associated with the modifications. The field test had several major objectives:

- To test the feasibility of implementing the new and expanded proposed revised HRS factors.
- To determine the resources required (i.e., costs and technical hours) for specific tasks under the proposed revised HRS.
- To assess the availability of information that would be needed for the evaluation of sites with the proposed revised HRS and to identify difficulties with its use .

The Agency tested the proposed revised HRS by performing inspections at 29 sites nationwide. Sites were not randomly selected, but were primarily selected with characteristics that would help evaluate the proposed new components of the HRS.

[1]In actuality, a "draft" version of the proposed revised HRS was tested. Differences between the "draft" proposed revised HRS and the proposed revised HRS are slight, and essentially all components of the proposed revised HRS were tested. The differences are described in Section 1.5.

Upon completion of the inspections, field test participants prepared scoring packages for each site using the proposed revised HRS instructions. EPA HQ staff reviewed these scoring packages and visited each EPA Regional office to exchange information on implementation concerns, data collection methodologies, and scoring issues associated with the proposed HRS revisions. Other field test materials (e.g., planning documents and project-related reports) were also used to obtain test results.

Generally, the field test achieved its stated objectives. The proposed HRS revisions generally functioned as anticipated and could be evaluated using an appropriate level of effort (LOE). Data to support the various proposed revised HRS factors usually could be collected using information obtained from the site inspections. The primary purpose of this report is to discuss those findings or issues regarding the proposed revised HRS that were brought forward during the field test.

Project participants noted that many of the proposed revisions represented improvements over the current HRS and should allow for more complete and accurate relative assessments of the risks posed by sites. These improvements include the following:

- Hazardous waste quantity. The tiered approach to evaluating this factor provides new mechanisms for evaluating hazardous waste quantity when complete information on the quantities of hazardous substances or hazardous wastes is known. New mechanisms are also available for estimating hazardous waste quantity in the absence of complete information on the types and amounts of hazardous substances deposited.

- Potential releases to the air pathway. The proposed air pathway provides a means of evaluating the threat posed by potential releases of contaminants in addition to observed releases.

Several other proposed revisions were also identified as improvements, but were thought by project participants to warrant some additional review prior to final rule-making. Among these are:

- Distance/dilution weighting of targets. The attenuation of contaminants in the environment is reflected in the application of distance and dilution weights applied to potentially contaminated targets. Dilution weighting factors as currently proposed, however, may not accurately represent the degree of contaminant dilution in large water bodies. Also, study results suggest that the distance weighting factors applied to nearby populations under the onsite exposure pathway's nearby target population factor may require additional review. This factor often scored very high and may not realistically reflect the propensity of nearby populations to come into contact with contaminants at a site.

- Human food chain threat. The proposed surface water pathway provides mechanisms for evaluating the threat to humans posed by actual and potential contamination of the aquatic human food chain. The human food chain target population factor was found to be generally difficult to evaluate and often resulted in disproportionately high human food chain threat scores, particularly for sites located near the coast or near water bodies with low average flows. The target distance limit, dilution weighting factor, and human food chain production factor contributed to the difficulties associated with evaluating human food chain threat targets.

- Human recreation threat targets. The proposed surface water pathway also provides a means of evaluating the threat posed by actual and potential contamination of human recreation areas. The human recreation target population factor was generally difficult and very time consuming to evaluate. This factor appeared to be disproportionately difficult to evaluate relative to its impact on scores. The target distance limits for evaluating recreation use population, which are determined from the accessibility/attractiveness factor, contributed to the problems associated with evaluating human recreation threat targets.

- Onsite exposures. The proposed onsite exposure pathway evaluates the threats associated with direct, physical contact with hazardous wastes or contaminated soil. Resident populations, nearby populations, and terrestrial sensitive environments are the targets which may be affected by such contamination. While project participants felt that the addition of this pathway does much to improve the evaluation of the relative risks associated with sites, some difficulties in scoring the pathway were noted. Some project participants had difficulty in documenting the total area of surficial contamination at a site, identifying contaminated resident population properties, and evaluating both high-risk and total resident populations.

Project participants also recommended that simplification of the proposed revised HRS be pursued, particularly in terms of the instructions for scoring factors; project participants often had difficulty in interpreting the requirements of the proposed revisions. For example, while the tiered approach to evaluating hazardous waste quantity was viewed as a more effective use of data, hazardous waste quantity was perhaps the single most difficult factor to evaluate.

The costs associated with data collection, sampling, evaluation, and administrative requirements in support of revised HRS scoring were found to vary widely among sites. These costs are summarized by pathway in Table ES-1. Note that these costs represent the entire sequential process of pre-remedial site evaluation, that comprehensive evaluations were performed for all pathways at most sites, and that the sites themselves were primarily selected for specific characteristics of interest from the perspective of field testing. As such, these costs may not be representative of the costs associated with site inspections occurring on the greater universe of CERCLA sites. Costs are discussed in detail in Section 5.

Finally, scores for the field test sites were compared under both the proposed revised HRS and the current HRS. Scoring results are discussed in Section 6. Significant scoring results include the following:

- Under the proposed revised HRS, surface water tended to be the highest scoring pathway for the field test sites. Under the current HRS, the ground water pathway tended to score highest.

- Proposed revised HRS surface water pathway scores were usually dominated by the human food chain threat.

- Surface water and air pathway scores were generally higher using the proposed revised HRS than with the current HRS.

- Ground water pathway scores were generally lower with the proposed revised HRS than with the current HRS.

- Overall site scores for the field test sites were generally higher under the proposed revised HRS than under the current HRS.

The ability to extrapolate these results to the greater universe of CERCLA sites is limited because the field test sites were primarily selected to test specific components of the proposed revised HRS. However, these results do provide a useful measure of how actual environmental data perform within the framework of the proposed revised HRS.

TABLE ES-1
SUMMARY OF SITE COSTS
(Based on Field Test Sites)

	LOE Hours	Dollars	CLP Samples
	Range	Range	Range
General Tasks	480 - 1,500	$39,000 - 84,000	3 - 17
Site/Source/Waste Characterization	80 - 530	$20,000 - 79,000	10 - 46
Air Pathway	20 - 270	$900 - 44,000	0 - 23
Ground Water Pathway	50 - 1,360	$3,000 - 156,000	0 - 40
Surface Water Pathway	10 - 290	$500 - 42,000	0 - 28
Onsite Exposure Pathway	10 - 340	$300 - 32,000	0 -15
Total Site*	970 - 3,310	$100,000 - 311,0000	34 - 98

* Represents ranges of actual total site costs for field test sites, not the sum of individual line items.

Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

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SECTION 1

INTRODUCTION

1.0 BACKGROUND

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly called the Superfund, in response to the dangers posed by uncontrolled releases of hazardous substances, pollutants, or contaminants into the environment that occur from hazardous waste sites or facilities. To implement Section 105 of CERCLA, the U.S. Environmental Protection Agency (EPA) revised the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Section 105 required EPA to establish:

> "criteria for determining priorities among releases or threatened releases [of hazardous substances] throughout the United States for the purpose of taking remedial action and, to the extent practicable, taking into account the potential urgency of such action, for the purpose of taking removal action. Criteria and priorities ... shall be based upon relative risk or danger to public health or welfare or the environment ... taking into account to the extent possible the population at risk, the hazard potential of hazardous substances at such facilities, the potential for contamination of drinking water supplies, the potential for direct human contact [and] the potential for destruction of sensitive ecosystems..."

To meet this requirement and help set priorities, EPA developed and adopted the Hazard Ranking System (HRS) as Appendix A of the NCP on July 16, 1982 (47 FR 31180). The HRS is used in the Superfund program to evaluate sites for possible placement on the National Priorities List (NPL). The NPL includes those sites that appear to pose the most serious threats to public health or the environment, and that appear to warrant remedial investigation and possible cleanup under CERCLA. The Superfund Amendments and Reauthorization Act of 1986 (SARA) required EPA to revise the HRS so that, to the maximum extent feasible, it accurately assesses the relative risks of sites. The Conference Report on SARA (H. Rep. 962, 99 Cong., 2d Sess. at 199-200 (1986)) makes clear that this mandate does not require detailed risk assessments, but directs EPA to rank sites as accurately as feasible based simply on information available from preliminary assessments and site inspections consistent with the goal of "expeditiously" identifying candidates for response actions. In addition, SARA specifically directed EPA to consider contamination of the human food chain, drinking water wells, surface water recreation use, and potential contamination of ambient air. In response to these mandates, EPA proposed HRS revisions for public comment on December 23, 1988 (53 FR 51962-52081).

The Agency gathers data to support an HRS score through a series of site investigations consisting of increasingly focused data collection efforts. This series of data collection efforts is intended to provide more detailed information and confidence in determining whether a hazardous waste site (or a hazardous substance facility) is likely to pose risks to public health, welfare, or the environment.

In revising the HRS, EPA is proposing a number of changes to the current HRS which are designed to better assess the risk posed by each site relative to other sites. The process for developing the proposed revisions to the HRS reflects the Agency's efforts to improve this assessment using information that could reasonably be collected. The proposed HRS revisions are intended to provide a scoring system that will allow for the expeditious scoring of sites, yet still increase the accuracy of the scoring system. However, the proposed revised HRS is not designed to be used as a quantitative risk assessment tool.

In 1987, the Agency initiated a field test to help assess the costs and implementation concerns associated with the proposed revisions to the HRS. The field test had several major objectives:

- To test the feasibility of implementing the new and proposed revised HRS factors.
- To determine the resources required (i.e., costs and technical hours) for specific site inspection and scoring tasks under the proposed revised HRS.
- To assess the availability of information that would be needed for the evaluation of sites with the proposed revised HRS and to identify difficulties with its use.

To meet these objectives, EPA tested the proposed revised HRS by performing site inspections at 29 sites nationwide. (The limitations of the field test are discussed within Sections 1.4 and 6.0.) To accomplish this, EPA selected sites with characteristics that would help test the proposed new components of the HRS.

Generally, the field test achieved the objectives stated above. The proposed HRS revisions generally functioned as anticipated and could be evaluated using an appropriate level of effort (LOE). Data to support the various proposed revised HRS factors usually could be collected using information obtained from the site inspections. As such, the primary purpose of this report is to discuss those findings or issues regarding the proposed revised HRS that were brought forward during the field test.

1.1 SARA AND THE HRS

SARA requires that the HRS be reviewed and modified (if appropriate) to account for several considerations. Specifically, Section 105 of CERCLA, as amended by SARA, requires that the HRS consider, to the extent feasible, the following:

- The damage to natural resources associated with releases or threatened releases that may affect the human food chain.
- Contamination or potential contamination of the ambient air that is associated with releases or threatened releases.
- The human health risks associated with actual or potential contamination of surface water used for recreation or as potable water.

Additionally, Section 118 of CERCLA, as amended by SARA, states that a high priority shall be given to including on the NPL those facilities where the release of hazardous substances or pollutants has resulted in the contamination or closing of drinking water wells or a principal drinking water supply. Section 125 requires that the HRS be revised with respect to facilities that contain substantial volumes of wastes generated primarily by combustion of coal or other fossil fuels (e.g., fly ash, bottom ash, slag waste, and waste from control of flue gas emissions). For such facilities, the assessment must consider the following :

- The quantity, toxicity, and concentrations of hazardous constituents present in such wastes.
- The extent of, and the potential for, release of such constituents into the environment.
- The degree of risk to human health and the environment posed by such constituents.

Finally, SARA requires EPA to modify the HRS so that, "to the maximum extent feasible, [it] accurately assesses the relative degree of risk to human health and the environment posed by sites and facilities subject to review."

To meet these requirements, EPA proposed a number of changes to the current HRS. In the proposed revisions, all of the factors considered in the current HRS have been revised in some way, with some "new" factors having been added and some "old" factors deleted.

1.2 THE CURRENT HRS

The current HRS, promulgated in 1982, evaluates the relative threat of a site over five pathways. The scores for three pathways -- ground water, surface water, and air -- are combined into an overall migration score that is the primary consideration in placing a site on the NPL. The two other pathways -- direct contact and fire/explosion -- are evaluated to determine the need for immediate or emergency removal action.

The current HRS uses a structured value analysis approach to scoring sites. This approach assigns values to factors related to or indicative of risk from migration of hazardous substances from the site. A scale of numerical rating values is provided for each factor, and a value is assigned to each factor based on conditions at the site. Individual values are then weighted. The factors are grouped into three factor categories (release, waste characteristics, and targets) and are combined to obtain the factor category scores. Each factor category has a maximum value, as does each of the component factors within the category.

The relevant factor category values are multiplied together within each pathway and normalized to obtain a pathway score. If all three pathway scores are low, the HRS score will be low. However, the HRS score will be relatively high even if only one pathway score is high. EPA considers this an important requirement because some dangerous sites pose threats through only one migration route.

1.3 THE PROPOSED REVISED HRS

The proposed revised HRS retains the same basic approach as the current HRS, while incorporating SARA requirements as well as other improvements identified by the Agency (Figures 1-1 through 1-4). The proposed changes that could have a significant impact on data collection activities include:

- Structure - The revisions propose to retain the ground water, surface water, and air pathways, and add a fourth pathway, onsite exposure. The direct contact and fire/explosion pathways will be dropped.

- Hazardous Waste Quantity - The proposed "tiered" approach to evaluating the hazardous waste quantity factor would allow use of the actual amount of hazardous constituents if these data are available (e.g., analytical results, processing records). If such data are not available, the quantity of waste deposited at the site that contains hazardous substances could be used. If quantities are not available, then the volume or area of the sources present at the site could be used.

- Target Distances - With some exceptions, the distance over which human populations, sensitive environments, or other targets are evaluated will be measured from the sources of contamination at the site (or from the probable point where contaminants enter a surface water body), rather than measuring from the extent of contamination. Also, the distances over which targets are evaluated have been increased for the ground water and surface water pathways.

FIGURE 1-1
GROUND WATER MIGRATION PATHWAY

Current HRS

Release X	**Waste Characteristics** X	**Targets**
Observed Release or Route Characteristics ☐ Depth to Aquifer of Concern ☐ Net Precipitation ☐ *Permeability of Unsaturated Zone* ☐ *Physical State* ☐ Containment	☐ Hazardous Waste Quantity ☐ Toxicity/*Persistence*	☐ Ground Water Use ☐ *Distance to Nearest Well*/Population Served

Revised HRS

Likelihood of Release X	**Waste Characteristics** X	**Targets**
Observed Release or Potential to Release ☐ Depth to Aquifer/ HYDRAULIC CONDUCTIVITY ☐ Net Precipitation ☐ SORPTIVE CAPACITY ☐ Containment	☐ Hazardous Waste Quantity* ☐ Toxicity/MOBILITY	☐ Ground Water Use* ☐ Population* ☐ MAXIMALLY EXPOSED INDIVIDUAL ☐ WELL HEAD PROTECTION AREA

Items in italic under Current HRS have been dropped or replaced.
Items in caps under Revised HRS are new. Most items not in caps have been revised significantly.

**Factor based on several sub-factors.*

FIGURE 1-2
SURFACE WATER MIGRATION PATHWAY

Current HRS

Release X	Waste Characteristics X	Targets
Observed Release or Route Characteristics ☐ *Facility Slope/ Intervening Terrain* ☐ *One Year, 24 Hour Rainfall* ☐ *Physical State* ☐ Distance to Nearest Surface Water ☐ Containment	☐ Hazardous Waste Quantity ☐ Toxicity/Persistence	☐ Surface Water Use ☐ Population Served/ *Distance to Nearest Intake Downstream* ☐ Distance to a Sensitive Environment

Revised HRS

Drinking Water Threat

Likelihood of Release X	Waste Characteristics X	Targets
Observed Release or Potential to Release OVERLAND FLOW ☐ Containment ☐ RUNOFF* ☐ Distance to Surface Water POTENTIAL TO RELEASE BY FLOOD ☐ CONTAINMENT (FLOOD) ☐ FLOOD FREQUENCY	☐ Hazardous Waste Quantity* ☐ Toxicity/Persistence	☐ Surface Water Use* ☐ Population* ☐ MAXIMALLY EXPOSED INDIVIDUAL

+

Human Food Chain Threat

Likelihood of Release X	Waste Characteristics X	Targets
(same as above)	☐ Hazardous Waste Quantity* ☐ Toxicity/Persistence/ BIOACCUMULATION	☐ FISHERY USE ☐ POPULATION*

+

Recreational Threat

Likelihood of Release X	Waste Characteristics X	Targets
(same as above)	☐ Hazardous Waste Quantity* ☐ Toxicity/Persistence/DOSE ADJUSTING FACTOR	☐ POPULATION*

+

Environmental Threat

Likelihood of Release X	Waste Characteristics X	Targets
(same as above)	☐ Hazardous Waste Quantity* ☐ ECOSYSTEM TOXICITY/Persistence	☐ Sensitive Environments

Items in italic under Current HRS have been dropped or replaced.
Items in caps under Revised HRS are new. Most items not in caps have been revised significantly.

** Factor based on several sub-factors.*

FIGURE 1-3
AIR MIGRATION PATHWAY

Current HRS

Release	X	Waste Characteristics	X	Targets
Observed Release		☐ Hazardous Waste Quantity ☐ Toxicity ☐ *Reactivity and Incompatibility*		☐ Land Use ☐ Population Within 4-Mile Radius ☐ Distance to Sensitive Environment

Revised HRS

Likelihood of Release	X	Waste Characteristics	X	Targets
Observed Release or POTENTIAL TO RELEASE ☐ SOURCE TYPE ☐ SOURCE MOBILITY* ☐ SOURCE CONTAINMENT		☐ Hazardous Waste Quantity* ☐ Toxicity/MOBILITY*		☐ Land Use ☐ Population ☐ MAXIMALLY EXPOSED INDIVIDUAL ☐ Sensitive Environments

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Items in italic under Current HRS have been dropped or replaced.
Items in caps under Revised HRS are new. Most items not in caps have been revised significantly.

* *Factor based on several sub-factors.*

FIGURE 1-4
ONSITE EXPOSURE PATHWAY

Revised HRS*

RESIDENT POPULATION THREAT

LIKELIHOOD OF EXPOSURE		WASTE CHARACTERISTICS		TARGETS
☐ OBSERVED CONTAMINATION	X	☐ TOXICITY	X	☐ HIGH RISK POPULATION ☐ TOTAL RESIDENT POPULATION ☐ TERRESTRIAL SENSITIVE ENVIRONMENTS

+

NEARBY POPULATION THREAT

LIKELIHOOD OF EXPOSURE		WASTE CHARACTERISTICS		TARGETS
☐ ACCESSIBILITY/ FREQUENCY OF USE ☐ HAZARDOUS WASTE QUANTITY	X	☐ TOXICITY	X	☐ POPULATION WITHIN 1 MILE

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* *The current HRS includes a direct contact pathway, but that pathway is not used in calculating the overall HRS migration score.*

- Source Characteristics - The proposed HRS places additional emphasis on defining and characterizing the hazardous waste sources at a facility. Sources are evaluated separately for containment, hazardous waste quantity, waste characteristics, and their potential to release hazardous substances.

- Actual vs. Potential Exposure - Those targets (e.g., human populations, individuals, sensitive environments, drinking water supplies) that have actually been exposed to site contaminants will receive higher scores than those potentially exposed. This approach will better reflect the differential exposures and risks to these targets.

- Dilution/Distance Weighting - The proposed revised HRS would apply distance weighting (or for the surface water pathway, dilution weighting) to human populations, individuals, sensitive environments, and other targets potentially exposed to contamination. Therefore, target distance from the site may be important.

- Sensitive Environments - Actual and potential environmental impacts will receive greater emphasis, target distance limits are increased, and the types of sensitive environments to be considered have been expanded.

- Surface Water Pathway - This pathway has been revised to include four surface water "threats" or "subpathways" -- drinking water, human food chain, recreation, and sensitive environments. New factors to assess flood potential have also been incorporated. Targets are weighted based on dilution or flow characteristics of surface water bodies.

- Air Pathway - An observed release will no longer be required to score the air pathway; a mechanism to evaluate the potential for an air release has been included in response to Section 105 of SARA. Targets are weighted based on distance from the site.

- Onsite Exposure Pathway - This new pathway evaluates actual or potential exposure to contaminated soils or shallow wastes associated with the site. Soil sampling of residential, school, or day care property may be important.

Note that additional changes (including revisions to the changes discussed above) are possible as a result of public comment on the proposed rule.

1.4 DESIGN OF THE FIELD TEST

Due to the design of the field test, the sites tested were not randomly selected and are not necessarily representative of the greater universe of CERCLA sites. The group of sites included:

- Sites with features the current HRS could not address (e.g., human food chain exposures, onsite exposures, potential air releases).

- High-scoring and low-scoring sites under the current HRS.

- Different types of sites and sources (e.g., landfills, surface impoundments, waste piles).

A random sample of sites from the universe of sites normally evaluated under CERCLA might have been ideal for the field test. However, a random sample that would be statistically valid may have required many more sites, and the amount of time, effort, and money required to test such a random sample of sites would be prohibitive.

Depending on the purpose of the analysis, the number of sites tested (29) may not provide a statistically valid sample. This limitation was recognized in the design of the field test; however, the

Agency believes that the field test data regarding the proposed revised HRS are useful and will allow EPA to draw broad conclusions regarding the proposed revisions.

1.5 MODEL VERSION USED IN THE FIELD TEST PROJECT

As indicated above, the overall objective of the field test project was to test the proposed revised HRS, particularly the new or expanded HRS factors. The effort focused on the November 10, 1987 version of the "draft" proposed revised HRS rule, rather than the revisions proposed on December 23, 1988. Differences between these versions include the use of the well head protection area factor for the ground water pathway as opposed to the sole source aquifer factor, and greater resolution in defined levels of actual contamination. Other than these differences, essentially all components of the proposed revised HRS were tested. For the remainder of this report, the "draft" or proposed revised HRS will be referred to as the proposed HRS.

1.6 OUTLINE FOR REMAINDER OF REPORT

The remaining portions of the report are briefly described below:

Section 2 - "Methodology" explains the general methodology and corresponding planning documents and work products (i.e., "deliverables") used to obtain field test results. This section provides background information as to how the project was managed and discusses the responsibilities of those offices and individuals involved in the field test. In addition, Section 2 describes what happened during the project.

Section 3 - "Cross-Cutting Issues and Findings" identifies six significant implementation concerns regarding the proposed HRS: (1) identification and characterization of sources; (2) evaluation of toxicity, mobility, and persistence factors; (3) evaluation of the hazardous waste quantity factor; (4) sampling strategy used to document observed releases and to obtain other analytic information; (5) data significance; and (6) evaluation of actual and potential proposed HRS targets.

Section 4 - "Individual Pathway Issues and Findings" identifies implementation issues and discusses selected items for the air, ground water, surface water, and onsite exposure pathways exclusive of those issues addressed in Section 3.

Section 5 - "Cost Analysis" provides information on the resources required to collect data in support of the proposed HRS at the sites tested. Both overall cost averages and ranges, as well as specific data element costs, are presented. Section 5 identifies cost categories and specific elements which contribute most significantly to site inspection costs and the preparation of proposed HRS scoring packages.

Section 6 - "Field Test HRS Scoring Results" discusses the observed impact of various proposed HRS factors and categories on the overall HRS score, as well as on individual pathway scores. This information is based solely on sites involved in the project.

Section 7 - "Major Source Materials" provides citations for source documents and pertinent reference materials.

SECTION 2

METHODOLOGY

2.0 INTRODUCTION

This section describes the field test and explains the general methodology and corresponding materials used to obtain results and findings (Figure 2-1). It also provides information on how the project was managed and discusses the responsibilities of those offices and individuals involved in the field test. For each site, a number of work products or deliverables were prepared through a combined Regional EPA/Field Investigation Team (FIT) effort. (FITs, one in each Region, are groups of multidisciplinary, professional technical personnel who constitute EPA's primary capability for inspecting waste sites at the pre-remedial stage.) These materials form the basis for the results and findings presented in this report.

2.1 PROJECT MANAGEMENT AND SPECIFIC RESPONSIBILITIES

Overall guidance concerning the development and performance of project requirements was provided by the Agency to better ensure that consistent approaches were employed across the field test sites. In addition to specifying project objectives, EPA HQ organized all contractors' involvement; coordinated continuing EPA Regional participation; reviewed project planning documents and work products; assured expedited Contract Laboratory Program (CLP) access and turnaround (e.g., analytical results were generally provided within 30 days of sample collection); and participated in and focused project deliberations.

All 10 EPA Regional offices and their FIT offices were responsible for carrying out planning, background and desktop data collection activities, field work, and reporting requirements for site inspections. For each Region, one person from the FIT office served as the project focal point. A counterpart was also appointed within the EPA Regional office. Each FIT office established site managers and appropriate teams to conduct the inspections. The Regional EPA/FIT offices also worked together to prepare and review initial proposed HRS scoring packages, to determine the resources required (costs, hours, and elapsed time) for specific site inspection tasks, to prepare site-specific summary letter reports discussing field test results and findings, and to assist in disseminating information between all project participants within each Region.

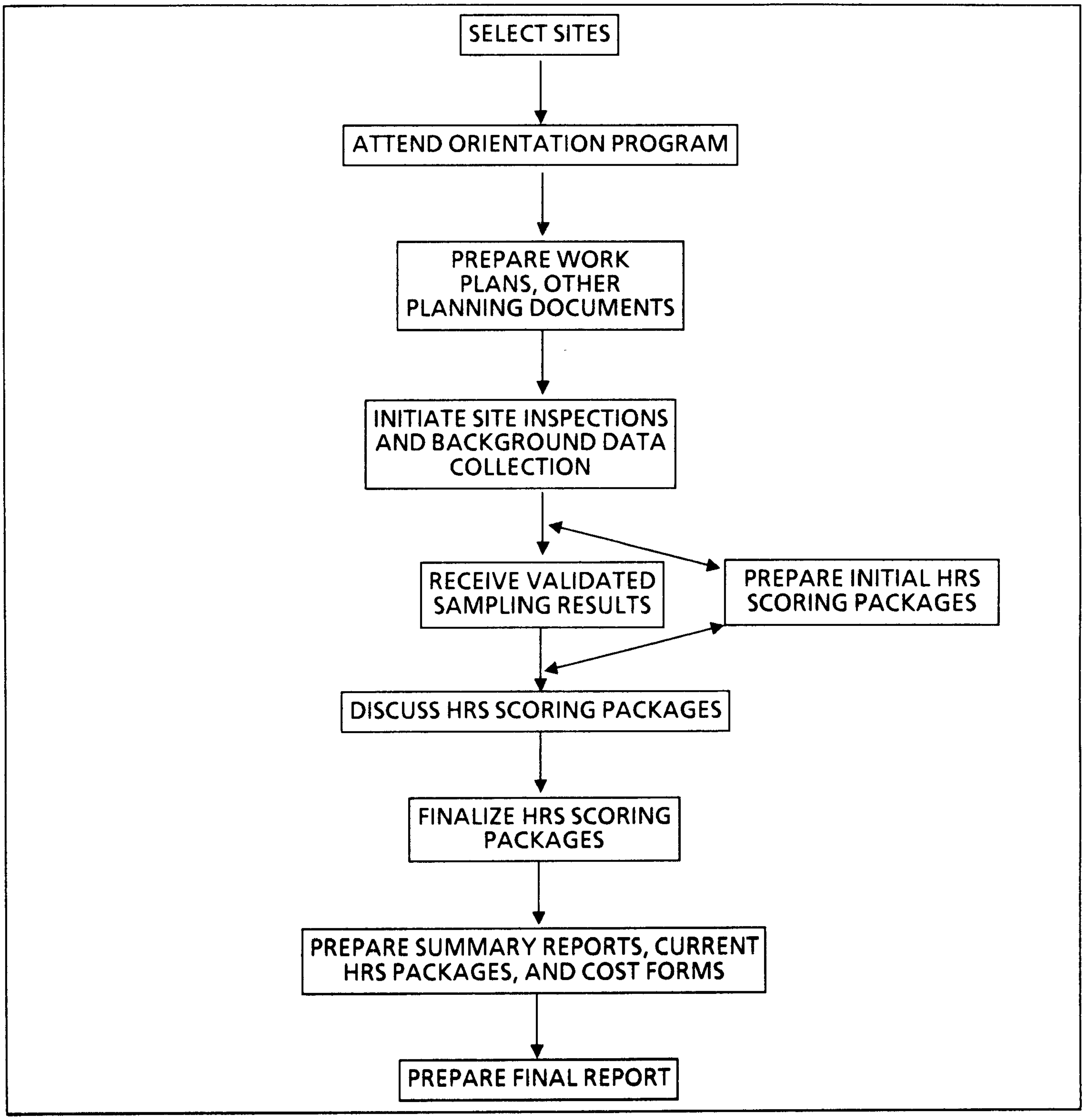
During the start-up of the field test, several mechanisms were established to assist in project management and coordination. These included: periodic progress reports, teleconferences, and reviews of Regional EPA/FIT work plans and initial proposed HRS scoring packages. These mechanisms were intended to disseminate information and clarify project requirements, as well as to address specific concerns raised by the Regions.

FIT offices prepared site-specific work plans and proposed HRS scoring packages and forwarded them to the respective EPA Regions, EPA HQ, and the various contractors. Feedback on these materials was provided to the Regional EPA/FIT offices.

2.2 SITE SELECTION

The sites tested in the project were not selected randomly, but were sites that the Regions had already planned to work on in 1988, or sites that had specific features EPA wanted to test using the proposed HRS (e.g., potential human food chain or onsite exposure concerns). Each Region was encouraged to suggest five to eight sites, along with brief site descriptions, for EPA HQ to consider. To minimize disruptions, the Agency made maximum use of current Regional EPA/FIT activities with

FIGURE 2-1
EXAMPLE OF FIELD TEST PROCESS



some relatively minor modifications for the field test. Potential candidate sites had one or more of the following features:

- A proposed HRS scoring package could be completed by August 31, 1988.
- A site inspection (SI) had been completed; minimal follow-up could address the additional data needed to support the proposed HRS (e.g., human food chain threat, recreation threat, release potential for the air pathway, and onsite exposure pathway).
- An SI was underway; work plans could be adjusted to address the proposed HRS data elements.
- SI activities were planned to start shortly; field work could be completed and sampling results received by July 15, 1988.
- Field work had resulted in a site score less than 28.50 (under the current HRS), but unique site characteristics existed which could be addressed under the proposed HRS.

EPA chose to exclude Federal facilities and sites regulated under Subtitle C of the Resource Conservation and Recovery Act (RCRA) from the list of candidates. The Agency selected two to four sites from each Region for the field test based on available time, site characteristics, and Regional priorities.

2.3 SITE INSPECTIONS

A three-day orientation program for project participants was held in December 1987. Two days were devoted to the proposed HRS. The remaining time was used to provide an overview of the field testing project. Specific project responsibilities were discussed in detail, along with the general schedule and work assignments. Planning considerations for developing site inspection work plans were also introduced. Finally, several factors and issues were identified as priorities for field testing the "implementability" of the proposed HRS. Some of these items required methodologies significantly different from those used under the current HRS and during previous site inspections.

In the next step, the Regional EPA/FIT offices prepared work plans for collecting information to support the proposed HRS for each site. These work plans were necessary to ensure that the site inspection and data collection effort would meet the objectives of the project. Generally, the plans described the proposed methodology for collecting the necessary data for the proposed HRS, along with the procedures utilized for gathering the information needed for other related project objectives. Budget, schedule, milestones, key personnel, and other similar planning considerations were also covered.

The plans provided specific details for all field work (e.g., sampling strategies and site reconnaissances), background data collection activities, and other related tasks. The plans also outlined alternative procedures for collecting information to support selected proposed HRS factors. Each work plan was reviewed by EPA HQ. The Regional EPA/FIT offices revised the work plans to incorporate EPA HQ comments before the site inspections started at most sites.

The site inspections conducted during the field test were primarily designed to collect the data necessary for preparing proposed HRS scoring and documentation packages. The scope of these inspections generally depended on how much data had previously been collected. To fully test the proposed HRS, the Agency supported innovative approaches for collecting data. Also, the Regions were encouraged to collect data for every factor in the proposed HRS, including release potential factors, even in cases where an observed release had been documented for that pathway.

Site inspections included collection of additional background data (i.e., beyond those required for the current HRS), onsite/offsite reconnaissances, and field work. Typical background data collection tasks involved reviewing archival aerial photography; gathering additional target population information; evaluating geologic reports, well logs, and other available data; collecting streamflow data for nearby surface water; and obtaining information on fishery production, recreational surface water use, and sensitive environments within the appropriate target distance limits.

Onsite/offsite reconnaissance was conducted to determine the type of containment present at the site, to measure source dimensions and distances to targets/receptors, to evaluate the size of the drainage area and predominant land use in the vicinity of the site, and to document other proposed HRS factors through visual observations, photographs, and detailed notes.

Field work focused on collection of samples (i.e., air, ground water, surface water, soil, sediment, leachate, and source material) to support the proposed HRS. In some instances, field analytical screening techniques and geophysical surveys were performed to target CLP sample locations and to install monitoring wells. Monitoring wells were installed (or were already in existence) at approximately 60 percent of the sites in the project. For some sites, tasks normally beyond the scope of previous inspections were performed, including the use of ground water seepage meters, drive points, and temporary monitoring wells to collect ground water samples; collection of mollusks and finfish to analyze for human food chain contamination; and use of a computer model to assist in estimating the hazardous waste quantity factor.

2.4 INITIAL PROPOSED HRS SCORING PACKAGES

The Regional EPA/FIT office prepared initial proposed HRS scoring packages for each site, using the proposed HRS instructions and a draft version of the proposed HRS documentation record received during the orientation program. EPA HQ and FIT contractor support staff visited one site in each Region during the field work to familiarize themselves with site characteristics. In addition, a preliminary reference table was developed for use in evaluating the various proposed HRS waste characteristics factors (e.g., toxicity, mobility, persistence).

EPA HQ also sponsored computer searches of national databases to support the determination of various proposed HRS factor values. The goals of this activity were to:

- Identify the databases having relevant HRS-related information.
- Determine which HRS factors the data could support.
- Provide site-specific data in a form that could be used to assign factor values.
- Provide instructions for future use of the databases by Regional EPA/FIT offices and others involved in HRS scoring.

These databases are discussed further in Section 3.6.

EPA HQ, model developers, and contractor support staff evaluated each scoring package, prepared written comments, and met to discuss general and site-specific issues. These comments generally fell into three major categories: (1) implementation concerns; (2) model development/design issues; and (3) QA/QC documentation requirements.

The review of Regional EPA/FIT planning documents and work products represented a significant effort to exchange information on these issues, as well as on data collection methodologies. EPA HQ staff and contractors visited each Region after they had reviewed the initial proposed HRS scoring packages submitted by the Region. The Regions and FIT provided feedback to EPA HQ on the proposed HRS revisions and how they felt the revisions "captured" the relative risks at the sites tested.

Approximately one day was devoted to each site during the Regional visit. The Regional EPA/FIT project manager described each site briefly; provided an overview of field work; identified significant technical, data collection, and implementation issues; and discussed other relevant topics. A thorough discussion followed, focusing first on sources found at the site and the quantity of hazardous wastes associated with these sources, and concluding with a review of each pathway and its factors.

2.5 OTHER FIELD TEST WORK PRODUCTS

After each Regional visit, EPA HQ forwarded a list of follow-up items for each initial scoring package to the Regional EPA/FIT office. These items were derived from reviews of each package, including review of QA and model development issues, and discussions during the Regional meeting. In response, the Regional EPA/FIT offices provided the revised documentation to EPA HQ and discussed other issues as necessary. These responses completed the HRS scoring process for each site involved in the field test.

The Regional responses helped EPA HQ to better understand the various innovative data collection methods employed at the sites, as well as to develop more "refined" proposed HRS scores. These scores (both individual factor values and overall pathway scores) will be used to help fine-tune the proposed HRS, and have provided input for the development of a proposed HRS database for additional Agency studies.

Each Regional EPA/FIT office developed a summary report for each site. This report discussed findings gathered throughout the project and focused on the Regional experience in testing the proposed HRS.

The Regional EPA/FIT offices also prepared an abbreviated version of a current HRS scoring package consisting of scoresheets along with an abridged documentation record. This information permitted an initial examination of the scoring impact of factors or categories that have changed between the current and proposed HRS. These results are discussed in Section 6.

To meet one of the field test objectives -- determine the resources required for specific site inspection and scoring tasks under the proposed HRS -- a cost information form was prepared for each site. The form provided a basis for estimating resources (i.e., overall costs, unit or factor costs, and hours) required for specific project management and data collection tasks. The form also gathered information concerning the types of alternative data collection procedures used to support selected proposed HRS factors (e.g., special field tasks, computer databases, and "desktop" information).

Generally, all data collection and project administrative functions were considered in completing the cost form, including:

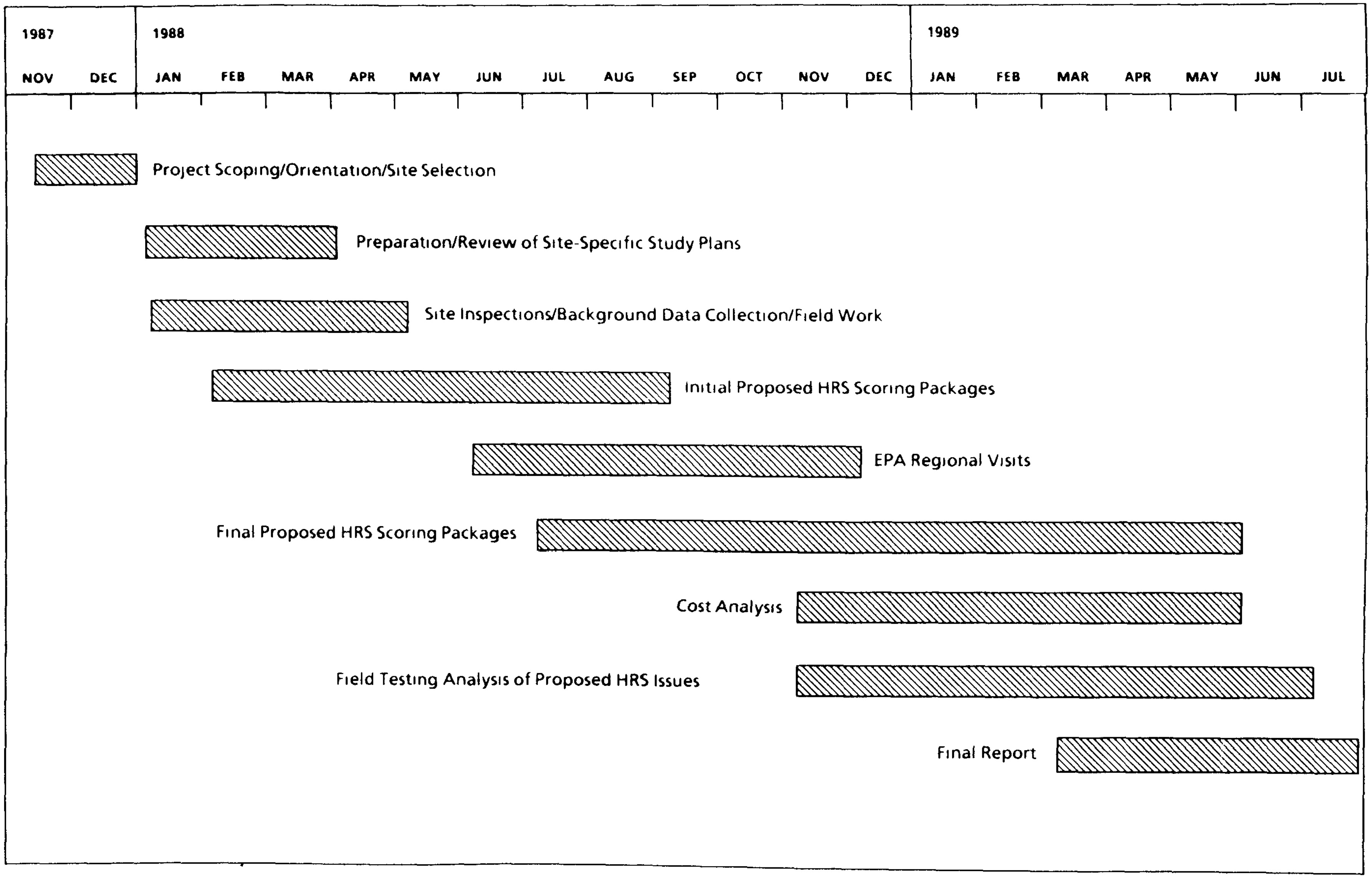
- General FIT technical or project management activities.
- Collection of background data and review of existing data.
- Onsite and offsite reconnaissance.
- Sampling activities.
- Special field investigation tasks (e.g., drilling boreholes, conducting geophysical surveys, installing monitoring wells).
- Proposed HRS scoring package preparation.

The cost forms provided sufficient detail to cover all significant tasks undertaken to score a site and represented the "best estimate" of the costs incurred to support proposed HRS scoring at each site. The resources required to collect data in support of the proposed HRS are discussed in Section 5.

2.6 GENERAL SCHEDULE

The field test required approximately 18 months (Figure 2-2). The overall task was to perform site inspections needed to prepare initial and final proposed HRS packages for 29 sites nationwide. The most time-consuming activity, completion of the final packages, involved a series of EPA HQ and contractor reviews for each package, as well as visits to all 10 EPA Regions.

FIGURE 2-2
GENERAL PROJECT SCHEDULE



SECTION 3

CROSS-CUTTING ISSUES AND FINDINGS

3.0 INTRODUCTION

Project participants identified several cross-cutting issues (i.e., issues that apply to two or more pathways) while collecting information to support the proposed HRS. These issues, which represent a combination of implementation concerns and model development items, are applicable throughout the proposed HRS scoring process. The issues include:

- Identification and characterization of sources.
- Evaluation of toxicity, mobility, and persistence factors.
- Evaluation of the hazardous waste quantity factor.
- Sampling strategy to document observed releases and to obtain other analytic information.
- Data significance (i.e., conditions necessary to document an observed release).
- Evaluation of actual and potential proposed HRS targets (i.e., human populations, sensitive environments, and resource uses).

This section discusses significant findings and results relating to these issues. Specific examples are provided where appropriate. Some of these issues were unresolved during the field test and are the subject of ongoing Agency studies, including the development of revised HRS guidance as well as other analyses and considerations to further improve the accuracy and implementation of the model.

3.1 IDENTIFICATION AND CHARACTERIZATION OF SOURCES

The proposed HRS differs from the current HRS by placing additional emphasis on defining and characterizing the sources of contamination found at a facility. The current HRS generally measures target distances from the locations where hazardous substances (the term "hazardous substances" refers to CERCLA hazardous substances, pollutants, and contaminants as defined in CERCLA Sections 101(14) and 101(33), as amended) were originally deposited and the locations where hazardous substances have migrated. For the proposed HRS, target distances are generally measured from sources. A source is defined as any area where a hazardous substance has been deposited, stored, disposed of, or placed.

In the current HRS, sources (i.e., the different means of storage or disposal at the site) are generally only evaluated for assigning containment factor values and waste characteristics. Under the proposed HRS, however, careful characterization of each source found at the site is important for several reasons. For example, sources are evaluated separately not only for containment, but also for hazardous waste quantity, waste characteristics, and their potential to release specific hazardous substances. Some factors in the proposed HRS depend on the types of sources at the site. For example, when evaluating potential to release in the proposed air pathway, sources must meet minimum size requirements to receive a source type factor value other than zero. Also, when evaluating the hazardous waste quantity factor based on volume or area, different equations are used for the different types of sources identified at the site.

The site inspections performed during field testing included characterizing the types of sources found at the site. Field teams measured source dimensions, looked for evidence of containment, and determined waste disposal or storage methods. This information was needed to identify types of sources to be evaluated for the proposed HRS. Sampling was also conducted to delineate source boundaries and characterize the types of hazardous substances associated with each source. This sampling was also necessary to support objectives for additional samples collected (e.g., to document an observed release or demonstrate actual contamination of nearby targets).

Four significant items related to the identification and characterization of sources were identified:

- Definition of source boundaries across all pathways.
- Description of source types present at the site.
- Containment descriptions for the air, ground water, and surface water pathways.
- Point in time at which the site is scored (i.e., initial vs. current conditions).

Although the last item has implications throughout all pathways, as well as for several cross-cutting issues and individual proposed HRS factors, it will only be discussed in this section.

3.1.1 Definition of Source Boundaries

The boundaries of a "facility" under CERCLA are generally defined by those locations where wastes have been deposited, stored, disposed of, or placed, or have come to be located. At several sites, project participants were unsure of how to treat this last category -- areas contaminated by the migration of wastes. For example, wastes spilled at one location could be transported via rainfall or erosion away from the source. It was unclear whether these contaminated areas should be considered as part of the source for proposed HRS scoring purposes (e.g., for measurement of target distances). In the same manner, spills and leaks from drum storage or other source areas may also contaminate the nearby ground surface. Whether such areas are considered as part of the storage area, or as a separate source, has an impact on site definition and scoring.

Another issue brought forward during testing involved consistent definition of source boundaries across all pathways. Project participants commented that the size of the source may be different for each pathway under the proposed HRS. This was particularly true for the onsite exposure pathway, where definition of the site was difficult because many field test personnel felt that the data obtained from their site inspections did not provide a high level of confidence in establishing the areal extent of contamination. Participants were unclear on how to determine the area of surficial contamination for this pathway at several sites; this determination is the primary means of differentiating between onsite/resident targets and offsite/nearby targets. The proposed HRS does not clearly indicate whether the source boundaries established for the air, ground water, and surface water pathways are the same as those used for the onsite exposure pathway.

3.1.2 Description of Source Types

Adequately scoring the site involves describing and characterizing the sources of hazardous substances. Field test personnel raised several issues when attempting to select the appropriate source type (e.g., landfill, waste pile, surface impoundment) for contamination at a site. Although a variety of methods were used, difficulties arose concerning how to select source type for several situations. Specific cases included:

- Wastes found inside buildings and structures (whether abandoned or active).

- Wastes present within inactive surface impoundments that have since been filled in.

- Areas potentially contaminated from spillage or leakage from another waste-disposal location.

- Contaminated streams and their sediments.

- Seeps or leachate from below-ground sources.

During the Regional visits, EPA HQ staff and project participants spent considerable time discussing issues relating to source type descriptions. The consensus was that better definitions are necessary to differentiate between the various source types (e.g., waste piles vs. contaminated soil).

Under the air pathway, the proposed HRS provides conditions for defining and evaluating multiple sources as a single source if they meet all of the following criteria:

- Sources of the same type.
- Sources containing the same hazardous substances.
- Sources with the same containment characteristics.

Participants found these criteria were too restrictive considering the information collected during the site inspections and the conditions found at the sites tested. At many sites, it was difficult without extensive sampling to determine whether multiple storage areas contained the same hazardous substances. Field test personnel were also unclear as to how to evaluate sources that were part of another source (e.g., buried drums within a landfill).

3.1.3 Containment Descriptions

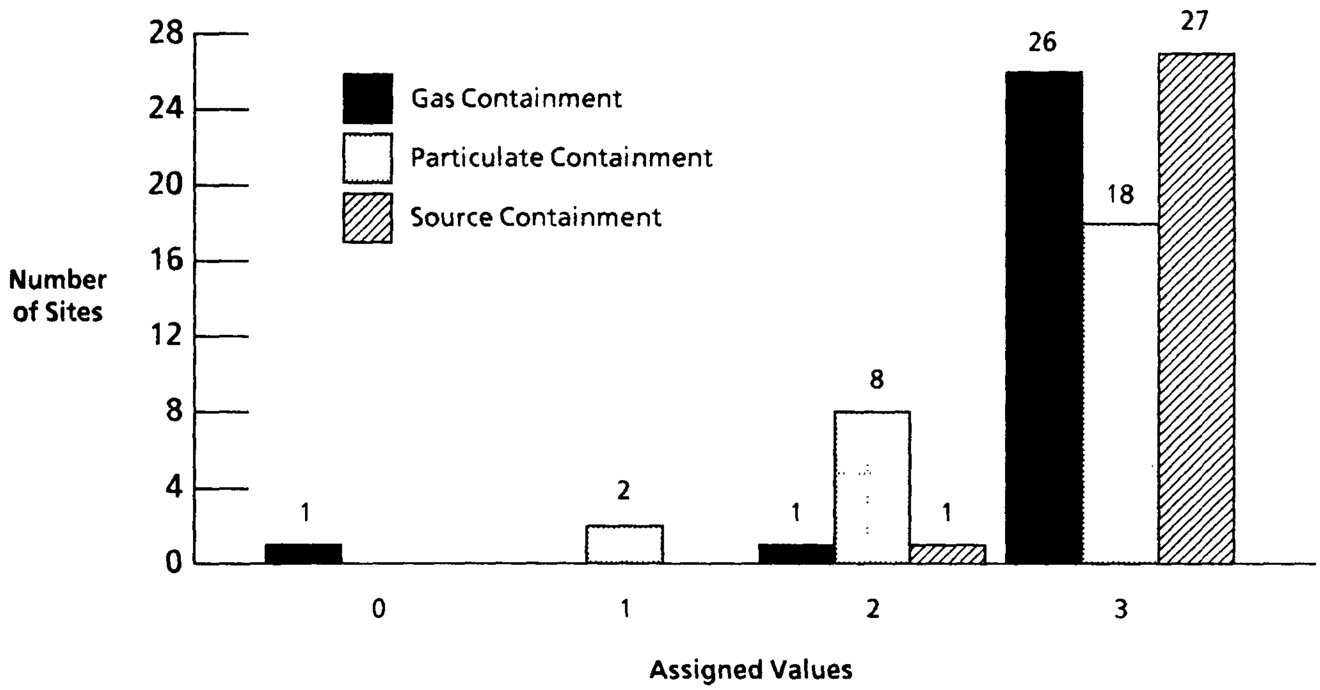
Except for the onsite exposure pathway, all pathways in the proposed HRS evaluate containment factors for the likelihood of release category. The containment factors in the proposed ground water and surface water pathways address more types of sources than does the current HRS, and the rating scale was expanded to provide more meaningful discrimination among sites. However, some field test personnel remarked that the containment descriptions were too specific, given the types of sites normally evaluated in Superfund. All sites tested received the maximum containment factor value (10 points) for the proposed ground water and surface water pathways.

For the proposed air pathway, the containment factor assesses the potential for sources to release both gaseous and particulate emissions. Nearly all sites tested received the maximum containment factor value for gaseous containment, as well as for overall source containment (3 points) for this pathway. Values were somewhat more widely distributed for particulate containment (Figure 3-1). Most of the issues identified concerning the air containment factor involved the containment descriptions, specifically those dealing with the thickness of uncontaminated soil cover for source types such as landfills, contaminated soil, or waste piles. Project participants were sometimes unclear as to how to identify the thickness of cover and how to evaluate sources with varying degrees of containment. At some sites, the uncontaminated soil cover varied in thickness across the surface of the source being evaluated, and it was unclear what value should be assigned for gas containment. It was also difficult to evaluate containment for wastes inside buildings since this type of source does not appear to be well defined by either the current or proposed HRS.

3.1.4 Initial vs. Current Conditions

The point in time at which the site is scored received much discussion during field testing. Timing plays a critical role in defining and characterizing sources. Interim response actions or partial cleanups (e.g., removal of leaking drums) may change the types of sources present at the site. The source identification issue cannot be separated from the issue of initial vs. current site conditions.

FIGURE 3-1
AIR PATHWAY:
CONTAINMENT FACTOR VALUES
(Based on 28 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

Other scoring factors affected by timing include containment, hazardous waste quantity, site-specific waste characteristics, observed releases, levels of contamination, target distances, and a number others.

Several project participants commented that the proposed air and onsite exposure pathways should be evaluated on current conditions because they felt current conditions may be more representative of the threats posed by these pathways. For example, at one site, drums in a storage area were removed during an emergency response action. If the drums were removed with their contents intact, it may not be appropriate to include them in the hazardous waste quantity evaluation. However, if the contents of the drums have leaked to surrounding soils, it may be appropriate to include the removed drums in the evaluation of hazardous waste quantity.

3.2 EVALUATION OF TOXICITY, MOBILITY, AND PERSISTENCE FACTORS

Both the current and proposed HRS include a waste characteristics factor category in all pathways. For the proposed air, ground water, and surface water pathways, two factors are included: (1) toxicity combined with either mobility or persistence; and (2) hazardous waste quantity. The onsite exposure pathway considers toxicity only and does not include hazardous waste quantity in the waste characteristics factor category. This section discusses general issues and findings relating to:

- Distribution of toxicity, mobility, and persistence factor values for each pathway.
- Use of the proposed HRS hazardous substance reference table.

3.2.1 Distribution of Toxicity, Mobility, and Persistence Factor Values

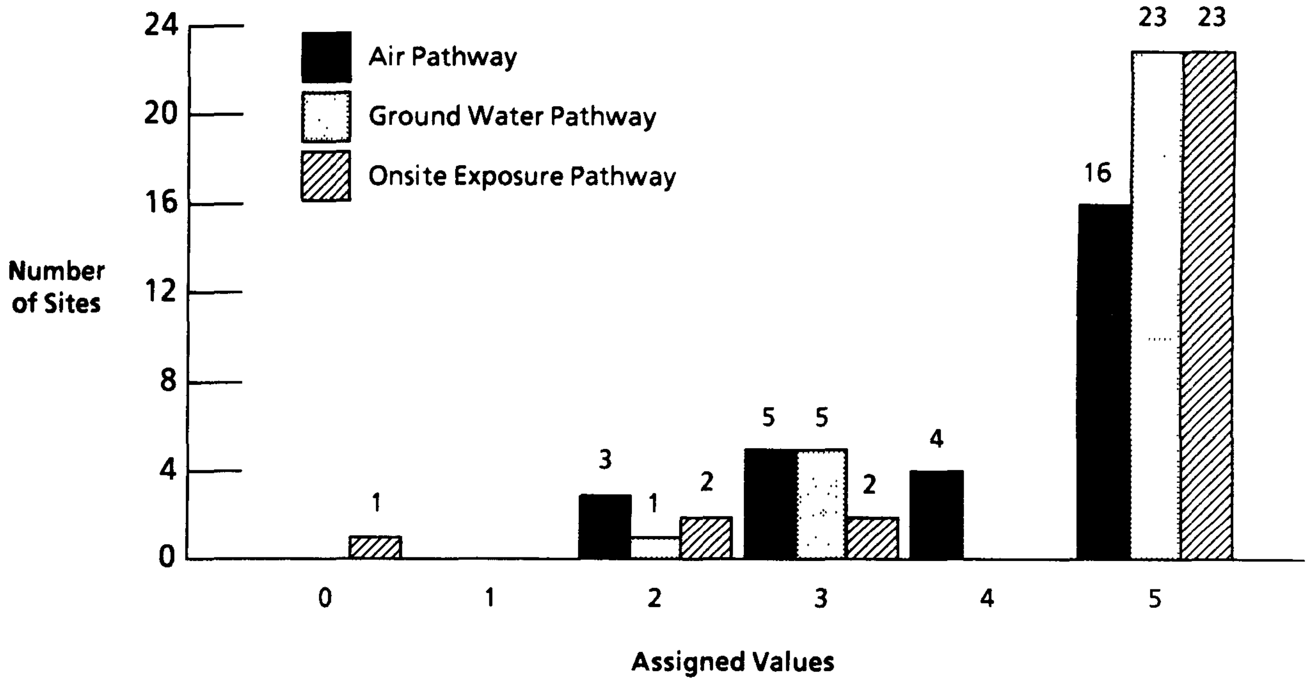
Both the current and proposed HRS toxicity rating systems are intended to distinguish the relative hazard associated with different hazardous substances. The toxicity factor in the proposed HRS considers acute toxicity, as well as carcinogenic and chronic noncarcinogenic toxicity, and the rating scale was slightly expanded to provide more meaningful discrimination among sites. The field test results provide indications of the extent of discrimination provided by the proposed HRS toxicity factor among the sites tested.

The percentage of sites receiving maximum toxicity, mobility, or persistence values among the various proposed pathways and surface water threats is summarized in Table 3-1. At approximately 80 percent of the sites tested[1], the proposed ground water and onsite exposure pathways received the maximum toxicity factor value of 5 (Figure 3-2).

In addition, about 80 percent of the sites recorded a maximum toxicity factor value for the proposed surface water drinking water threat (Figure 3-3). In contrast, about 40 percent of the sites received the maximum toxicity (or ecotoxicity) factor value for the surface water human recreation and environmental threats.

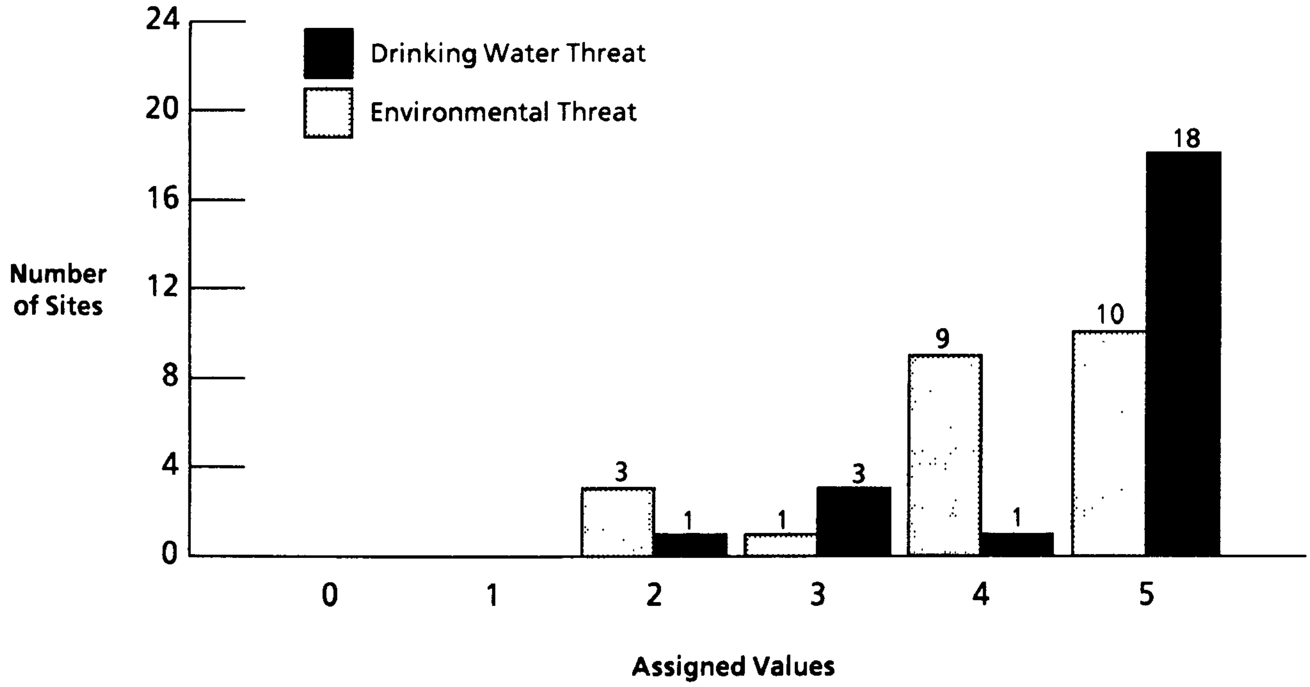
[1]All averages presented in this report were calculated based on the number of sites for which the particular pathway or factor was evaluated. Not all pathways were evaluated for each site due to: the absence of nearby surface water or the absence of an overland flow segment to surface water (six sites); the lack of observed contamination as defined in the onsite exposure pathway (one site); or the assignment of a value of zero for the containment factor under a particular pathway (one site).

FIGURE 3-2
AIR/GROUND WATER/ONSITE EXPOSURE PATHWAYS:
TOXICITY FACTOR VALUES
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-3
SURFACE WATER PATHWAY:
DRINKING WATER/ENVIRONMENTAL THREATS - TOXICITY FACTOR VALUES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

TABLE 3-1
PERCENTAGE OF SITES RECEIVING MAXIMUM TOXICITY, MOBILITY, OR PERSISTENCE FACTOR VALUES
(Based on Field Test Sites)

Pathway or Threat	Toxicity	Mobility or Persistence
Air	57%	75%
Ground water	79%	83%
Surface water drinking water	78%	96%
Surface water human food chain	57%	83%
Surface water human recreation	43%	65%
Surface water environmental	43%	87%
Onsite exposure	82%	-

Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

The proposed air and ground water pathways combine toxicity ratings for individual substances with mobility factor values. Over 75 percent of the sites tested received the maximum mobility factor value (3 points) for either the proposed air or ground water pathways (Figure 3-4). The proposed surface water pathway combines toxicity ratings with persistence factor values. Each of the four surface water threats receives a specific persistence value. Persistence is assessed in terms of half-lives for hazardous substances and the type of water body (e.g., river, ocean, lake) adjacent to targets. Over 95 percent of the sites recorded a maximum persistence factor value for the proposed drinking water threat (Figure 3-5).

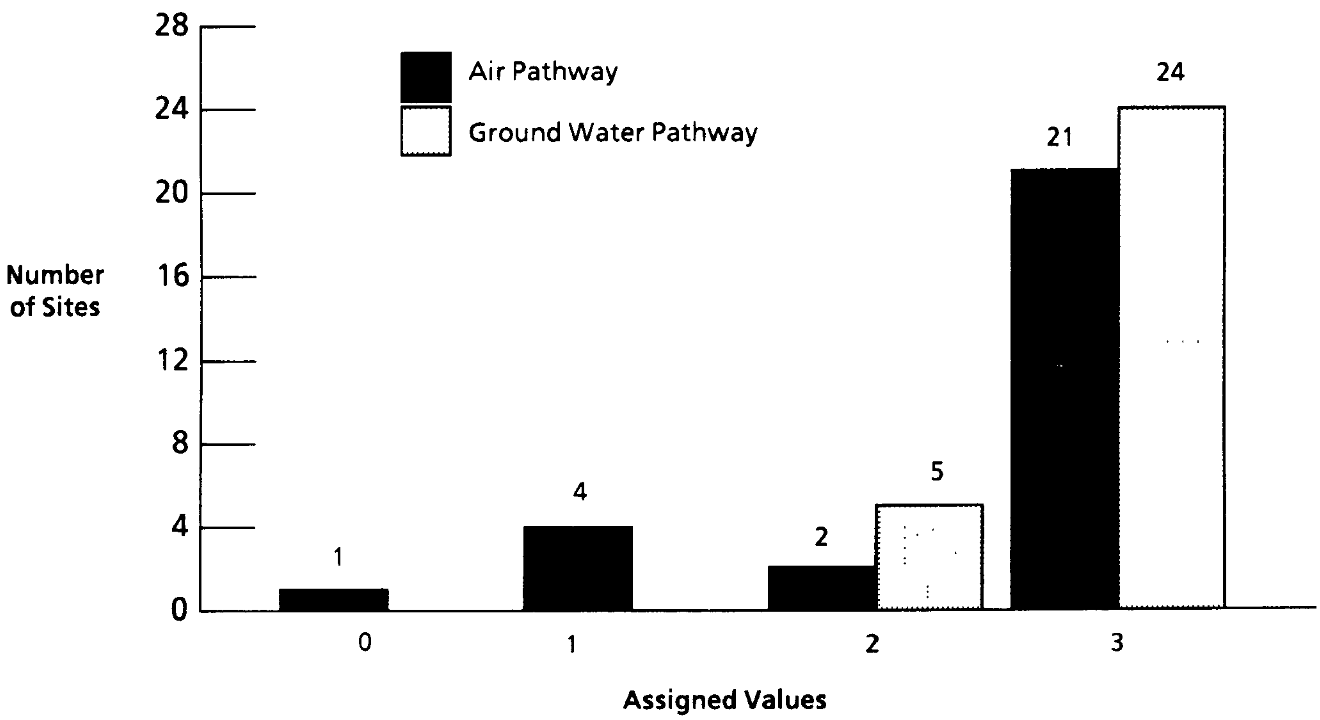
The percentage of sites recording maximum combined toxicity/persistence or toxicity/mobility factor values among the various proposed pathways and surface water threats is given in Table 3-2. A larger percentage of the sites received maximum toxicity/persistence factor values for the surface water drinking water threat than for any of the other surface water threats (Figures 3-6 and 3-7). At least 60 percent of the sites tested received maximum toxicity/mobility factor values for the proposed ground water pathway (Figure 3-8).

3.2.2 Use of the Proposed HRS Hazardous Substance Reference Table

During the early stages of the field test, a hazardous substance reference table was developed for use in evaluating the various waste characteristics factors in the proposed HRS. The table included look-up values for approximately 130 hazardous substances selected because they were frequently detected at NPL sites.

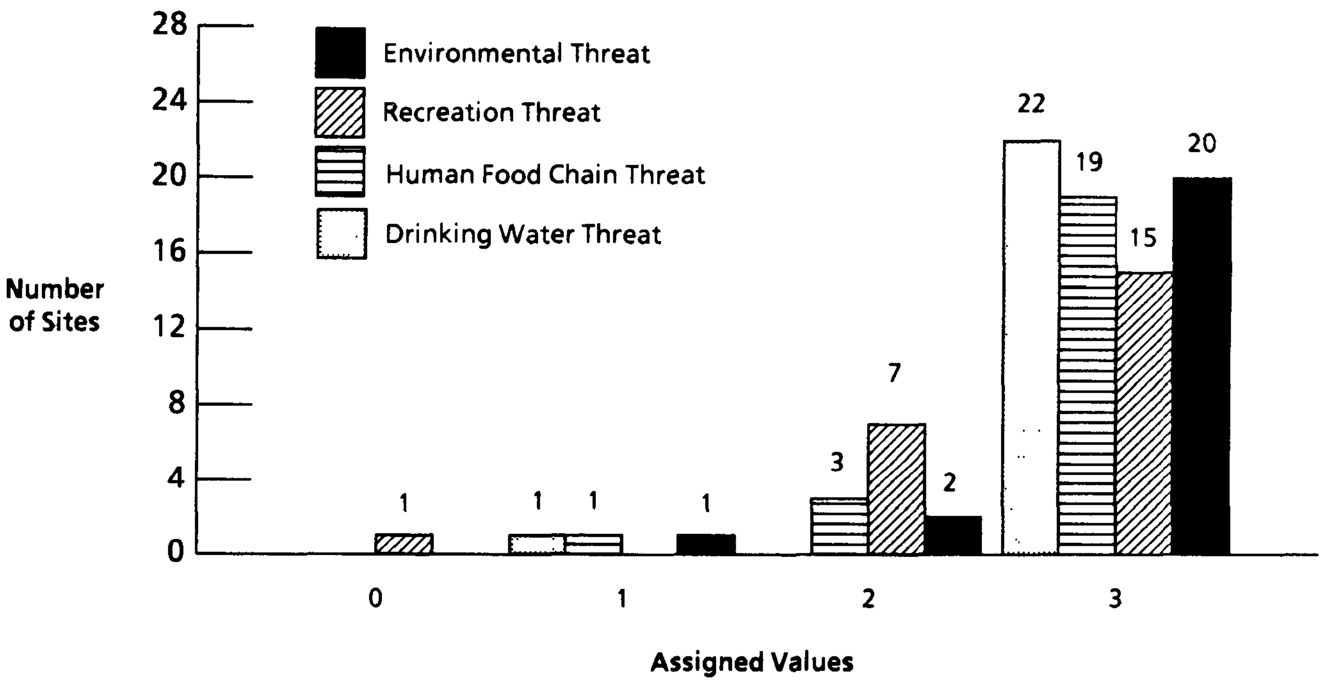
Project participants noted that a number of data gaps exist in the table, particularly with respect to health- and ecological-based benchmarks. A few substances found at the sites tested were not contained in the table, including munitions/explosives, brand-name pesticides, and isomers of PCBs. Also, infectious materials were not included. Finally, some participants remarked that the assignment of waste characteristics values throughout the proposed HRS was time consuming.

FIGURE 3-4
AIR/GROUND WATER PATHWAYS:
MOBILITY FACTOR VALUES
(Based on Field Test Sites)



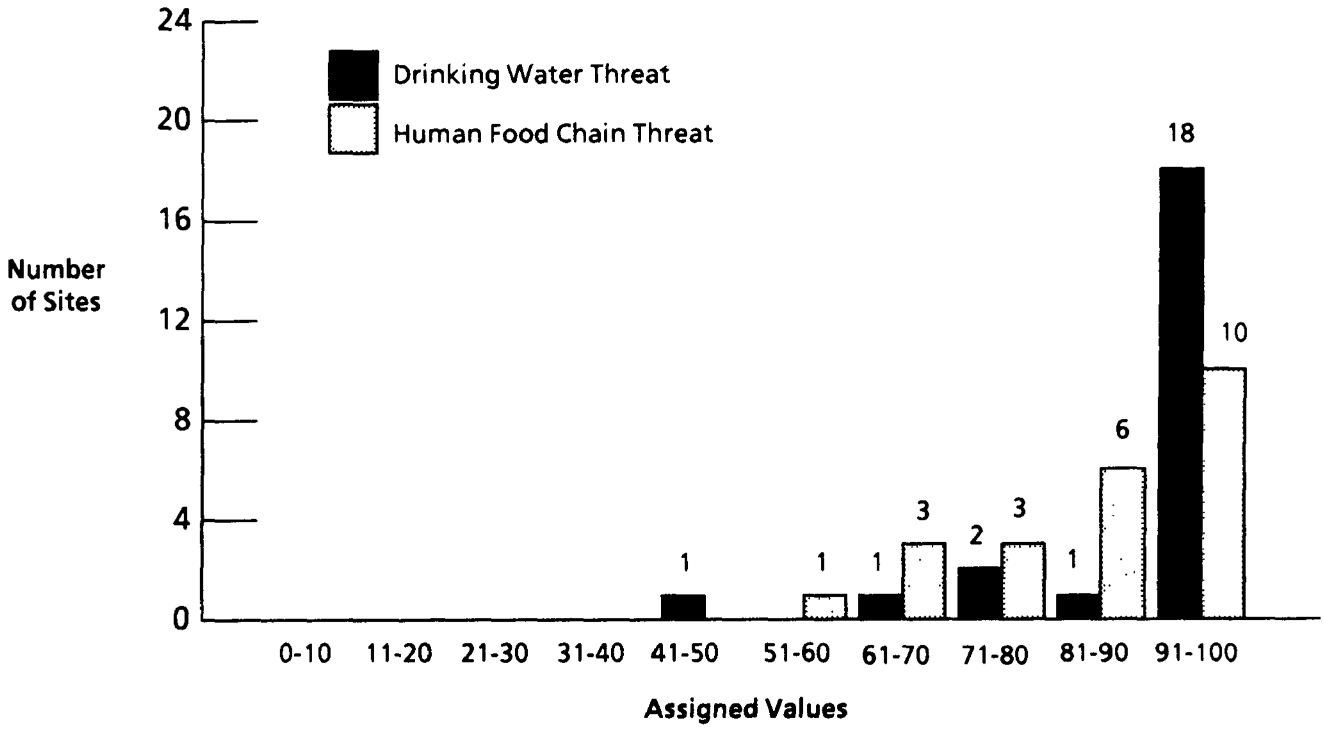
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-5
SURFACE WATER PATHWAY:
PERSISTENCE FACTOR VALUES
(Based on 23 Field Test Sites)



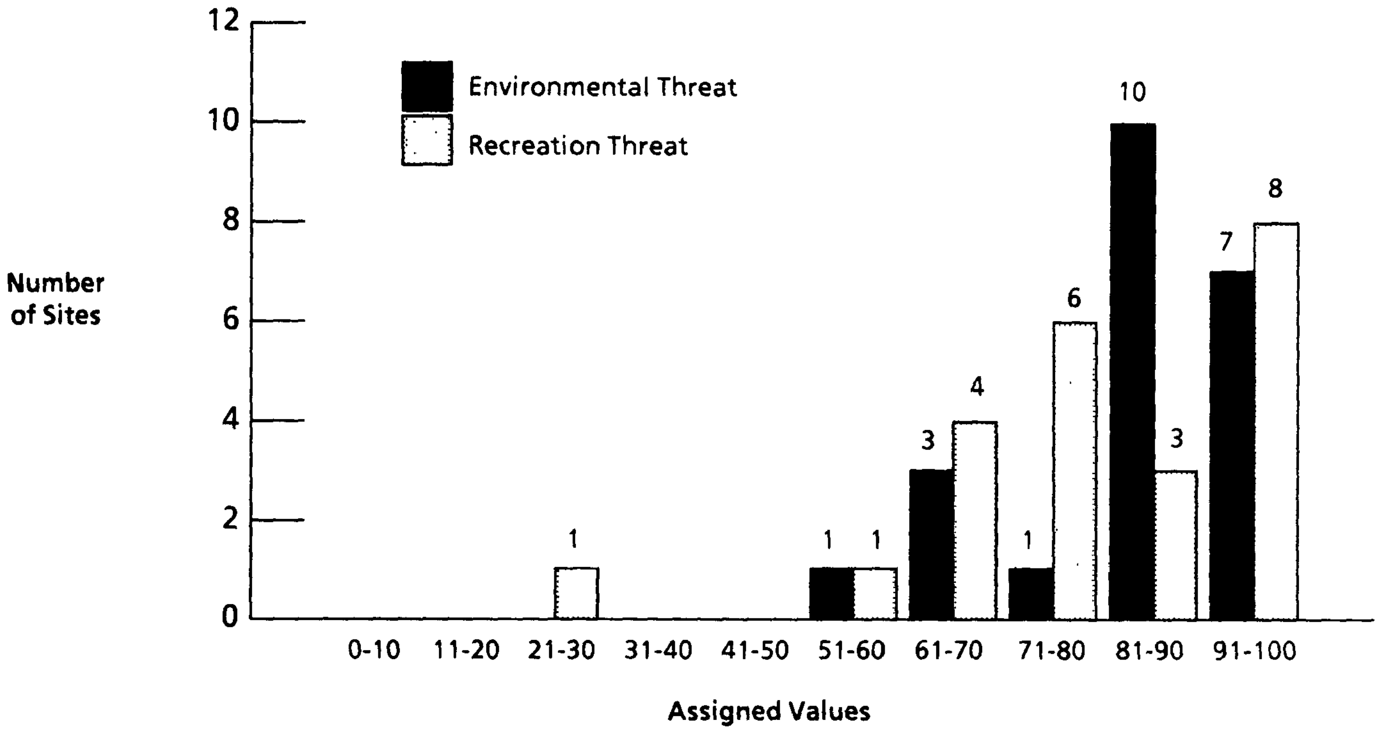
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-6
SURFACE WATER PATHWAY:
DRINKING WATER/HUMAN FOOD CHAIN THREATS - TOXICITY/PERSISTENCE FACTOR VALUES
(Based on 23 Field Test Sites)



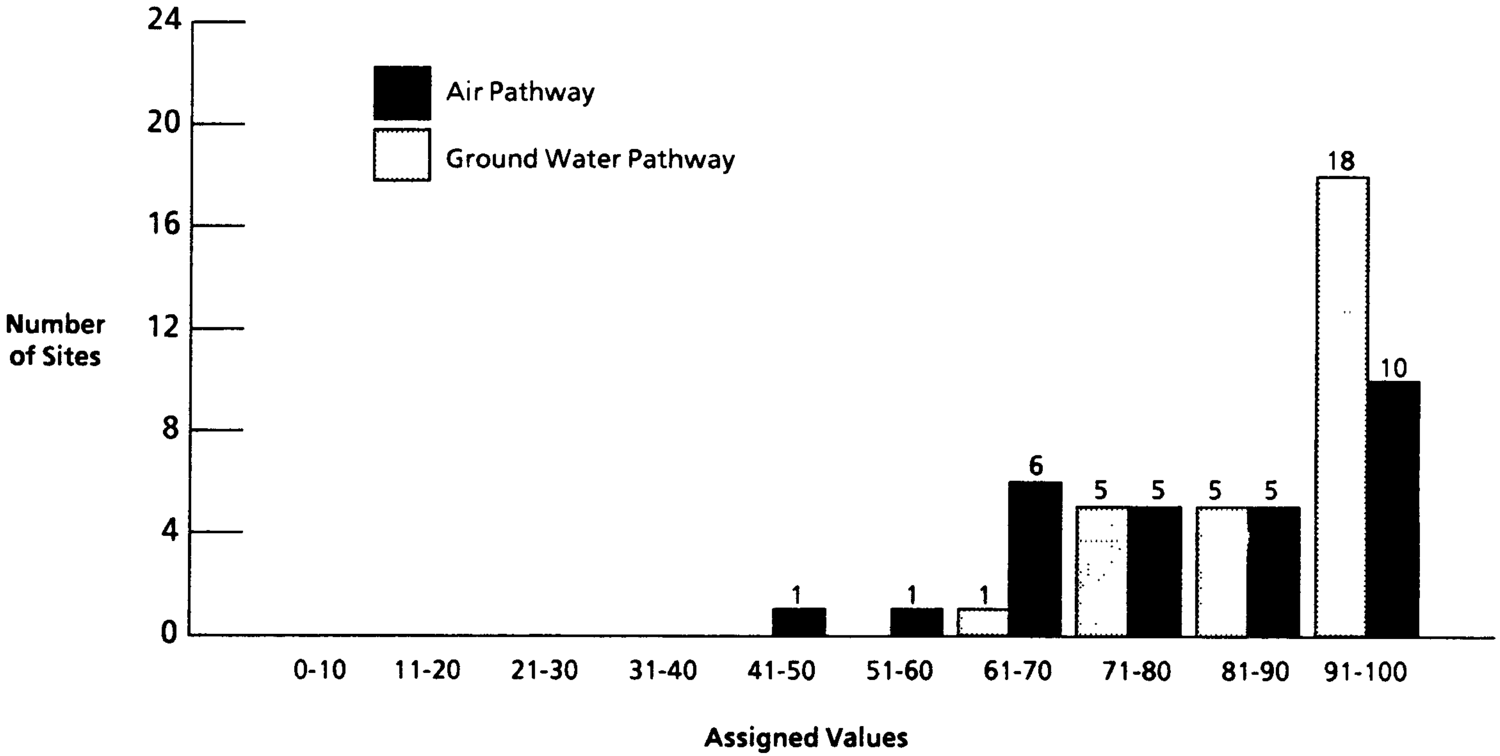
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-7
SURFACE WATER PATHWAY:
RECREATION/ENVIRONMENTAL THREATS - TOXICITY/PERSISTENCE FACTOR VALUES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-8
AIR/GROUND WATER PATHWAYS:
TOXICITY/MOBILITY FACTOR VALUES
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

TABLE 3-2
PERCENTAGE OF SITES RECEIVING MAXIMUM COMBINED TOXICITY/PERSISTENCE OR TOXICITY/MOBILITY FACTOR VALUES
(Based on Field Test Sites)

Pathway or Threat	Toxicity/Mobility	Toxicity/Persistence
Air	34%	-
Ground water	62%	-
Surface water drinking water	-	78%
Surface water human food chain	-	43%
Surface water human recreation	-	35%
Surface water environmental	-	30%

Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

3.3 HAZARDOUS WASTE QUANTITY

The current HRS evaluates the hazardous waste quantity factor based on the total amount of hazardous substances, pollutants, and contaminants at the facility, excluding any wastes associated with totally contained sources (i.e., those having a containment value of zero for the pathway being evaluated). The proposed HRS establishes a tiered approach involving three subsidiary factors:

- Hazardous constituent quantity.
- Site wastestream quantity.
- Site disposal capacity.

The three factors are then evaluated based on some or all of the following measures:

- Quantity of CERCLA hazardous substances deposited.
- Quantity of wastes deposited containing hazardous substances.
- Source volume.
- Source area.

Nearly all project participants felt that hazardous waste quantity was the most difficult factor to evaluate in the proposed HRS. Some found the instructions confusing while others noted the increased effort necessary to evaluate the factor. However, most participants remarked that the tiered approach is a significant improvement over the current HRS. They felt that it permitted a more thorough evaluation of waste quantities and provided new mechanisms for estimating hazardous waste quantity using the volume or area of sources in the absence of other information on hazardous waste quantity.

Three significant items related to hazardous waste quantity were identified during testing:

- Analytic requirements for estimating waste quantity.
- Nonanalytic data collection for documenting waste quantity.
- Distribution of hazardous waste quantity factor values.

3.3.1 Analytic Requirements for Estimating Hazardous Waste Quantity

The proposed HRS differs from the current HRS in the way that analytic evidence (e.g., sampling results) may be utilized to evaluate the hazardous waste quantity factor. For example, concentration data can now be used to estimate the quantity of hazardous constituents present. Furthermore, if information concerning the quantity of waste containing hazardous substances deposited at a facility is inadequate, the sizes of the sources identified can be used to determine the amount of hazardous substances potentially deposited. In some cases, samples may be collected to document the source volume or area. However, some project participants commented that the type, number, and distribution of samples necessary to document these calculations required further explanation.

For several sites, it was unclear whether analyses of subsurface samples could be used to calculate the depth of a source. If available, this depth could be multiplied by the surficial area of the waste-disposal location to determine source volume. At some test sites, subsurface samples were collected at various intervals from boreholes and during the installation of monitoring wells. The uncertainty with this approach is whether the resulting subsurface contamination represents the waste as deposited or the extent of vertical migration. Also, not all samples analyzed indicated the presence of contamination.

Another issue involved delineation of surficial contamination. In the onsite exposure pathway, the total extent of areal contamination at the site, including the migration of wastes, is used in evaluating likelihood of exposure. In all other proposed pathways, source area without including the areal extent of contamination is used to evaluate the hazardous waste quantity factor, providing no better information is available. At several project sites, field test personnel collected shallow soil samples in an attempt to establish the size of the contaminated source area. Difficulties with this approach included the following:

- The number and distribution of samples necessary for defining the extent of contamination.
- The criteria for inferring contamination between sampling locations.
- The high cost of collecting and analyzing a large number of samples.
- The attribution of the detected contaminants to site operations.
- The criteria for establishing concentrations significantly above background.

Project participants were also uncertain about the data needed to calculate hazardous constituent quantities. The tiered approach allows the use of analytic data to estimate hazardous substance concentrations. Most field testing personnel felt that obtaining such data would be difficult, costly, and beyond the scope of a site inspection, and would not be available on a routine basis. Others commented that data from a single sampling event would provide only a "snapshot" of current conditions. However, several field test personnel collected source samples (or used previous analytic results) at their sites in an attempt to determine the concentration of hazardous constituents. This approach worked best when wastes in a source were relatively homogeneous, or when detailed records and comprehensive analytic results were available for a specific wastestream over the operational history of the site.

3.3.2 Nonanalytic Data Collection for Documenting Hazardous Waste Quantity

Data collection not involving analysis of samples can be used to assist in documenting the hazardous waste quantity factor. At some of the sites tested, data collection methodologies were used that were not often employed for the current HRS. For example, disturbed areas were identified at several project sites by reviewing aerial photographs. Historical photos were particularly helpful in reconstructing the sizes and types of sources originally present. These photos assisted field teams in developing sampling strategies to meet the analytic requirements for calculating waste quantity. Several field test personnel commented that it is unclear if aerial photography alone would provide sufficient information to evaluate the hazardous waste quantity factor.

Geophysical investigations -- including electromagnetics, magnetometer surveys, electrical resistivity, and seismic refraction -- were also performed at several test sites. Much of the geophysical work was conducted to identify subsurface anomalies prior to drilling. Other project participants used geophysical techniques in attempts to delineate areas of subsurface waste disposal, although they were uncertain whether this approach provided adequate documentation for the hazardous waste quantity factor.

3.3.3 Distribution of Hazardous Waste Quantity Factor Values

In the proposed HRS, the hazardous waste quantity factor is assigned a value between 10 and 100 for all pathways except onsite exposure (where it is a measure of likelihood of exposure), and except in cases where complete data are available for the hazardous constituent quantity subsidiary factor. For these exceptions, the hazardous waste quantity factor is assigned a value between zero and 100.

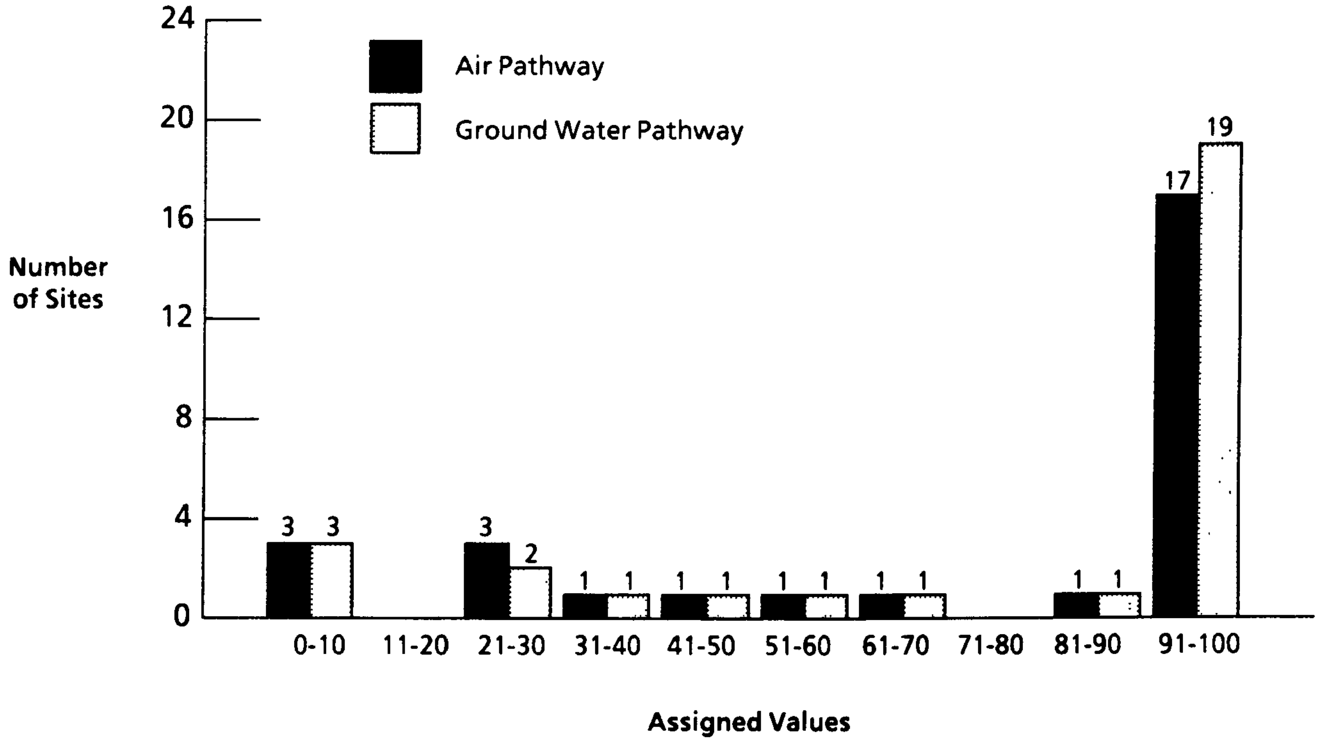
About 60 percent of the sites tested received maximum hazardous waste quantity factor values for the proposed air, ground water, and surface water pathways, versus approximately 40 percent for the onsite exposure pathway (Figures 3-9 and 3-10).

All four measures (hazardous substances quantity, waste quantity as deposited, source volume, and source area) were evaluated to determine the hazardous waste quantity factor (Table 3-3). The most frequent waste quantity measures actually used for scoring sites were source volume (38 percent) and hazardous substances quantity (31 percent). The waste quantity as deposited and source volume measures resulted in the greatest range of hazardous waste quantity factor values. For all field test sites using the site or wastestream hazardous substances quantity factors, the maximum value of 100 was assigned. Three sites received the default value of 10 for the hazardous waste quantity factor. As a general rule, sites where actual information was available on the amount of wastes deposited scored higher than sites where source volume or source area was used to evaluate the hazardous waste quantity factor.

3.3.4 Other Comments

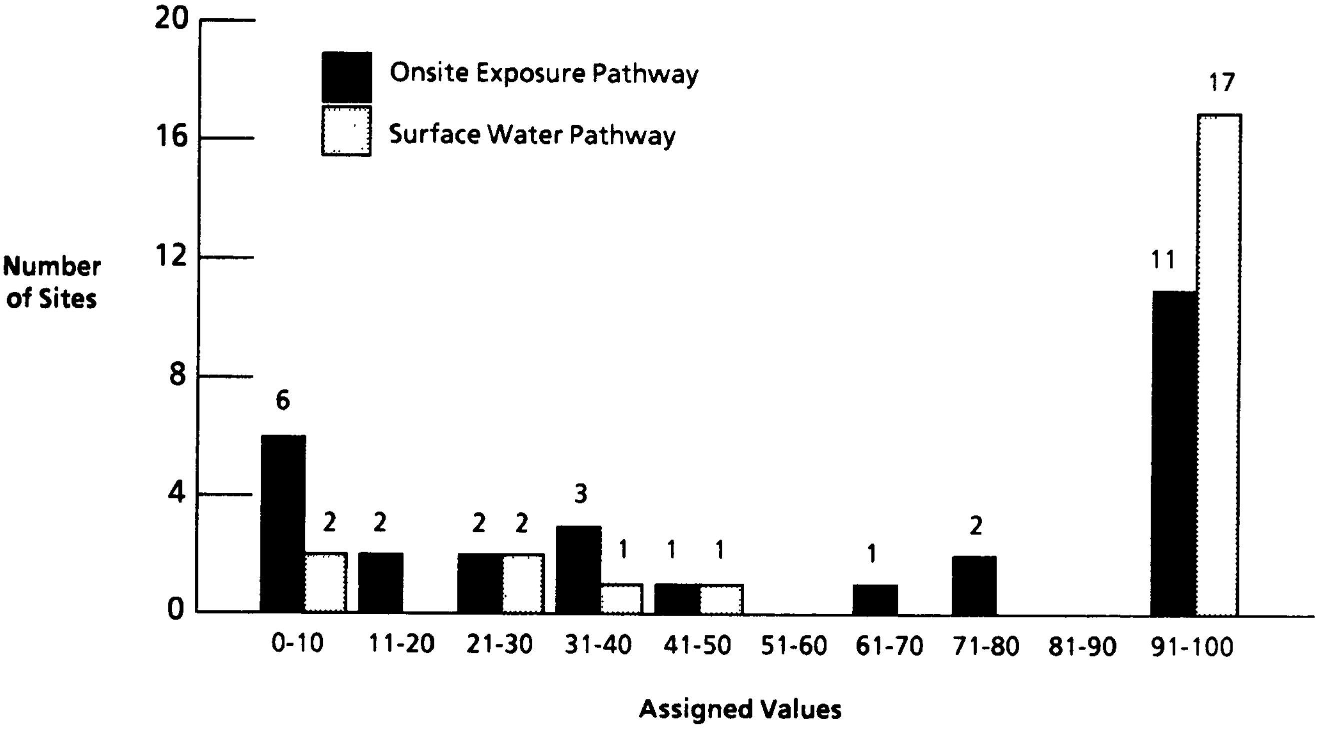
Other comments were made regarding the evaluation of the hazardous waste quantity factor and the establishment of criteria to avoid possible double counting of the quantity of waste present. Also, field test personnel pointed out that some divisors (Table 2-14 in the proposed HRS) used in the equations for evaluating the hazardous waste quantity factor may require adjustment. Some participants felt that the divisors for calculating source area and source volume are unreasonably large for some source types. For example, approximately 80 acres of contaminated soil must be documented at a site in order for the site to receive a hazardous waste quantity factor value higher than the default value of 10.

FIGURE 3-9
AIR/GROUND WATER PATHWAYS:
HAZARDOUS WASTE QUANTITY FACTOR VALUES
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-10
SURFACE WATER/ONSITE EXPOSURE PATHWAYS:
HAZARDOUS WASTE QUANTITY FACTOR VALUES
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

TABLE 3-3
HAZARDOUS WASTE QUANTITY MEASURES
USED AT FIELD TEST SITES

Measure	Frequency Used	Average Value	Range of Values
Hazardous substances quantity (site, wastestream, or source)	31%	95	52 - 100
Waste quantity as deposited (wastestream or source)	14%	47	0 - 100
Source volume	38%	80	0 - 100
Source area	17%	69	28 - 100

Note: At some sites tested, more than one hazardous waste quantity measure was used to evaluate the hazardous waste quantity factor. In these cases, the measure that contributed most significantly to the hazardous waste quantity factor value is portrayed in this table. The use of measures that resulted in values less than 10 have been given the default value of 10 for the purpose of developing average values where appropriate. Note also that these values are based upon findings from field test sites that were selected primarily to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

3.4 SAMPLING STRATEGY

The collection of environmental samples (e.g., air, ground water, surface water, soil) was an important part of the site inspections performed during testing. In the current HRS, sampling is generally limited to documenting observed releases, identifying hazardous substances of concern, and determining locations from which to measure target distances. The proposed HRS provides more opportunities for using analytic data to help characterize the degree of risk associated with sites. For example, analytic evidence may be utilized to evaluate the hazardous waste quantity factor and to document targets actually exposed to contamination. However, Contract Laboratory Program (CLP) sample analyses are costly (averaging $1,000 or more per sample) and project participants were unclear as to requirements for determining data quality and numbers of samples, alternative analytic approaches (e.g., field screening), and the appropriateness of sampling for scoring purposes.

During field testing, several sampling techniques were used to document observed releases or observed contamination for each proposed HRS pathway. In addition to detecting contaminant releases, sampling was used to help document:

- Location, size, and contents of sources.
- Waste quantity.
- Actual contamination at targets.

This section discusses significant implementation issues and other limitations relating to sampling to document observed releases that were encountered during the field test.

3.4.1 Sampling to Document Observed Releases

Both the current and proposed HRS encourage sampling when hazardous substance releases can likely be attributed to the site. An observed release can be scored under either of the following conditions:

- Concentrations of contaminants in a media (e.g., ground water, surface water) that are attributable to the site significantly exceed background concentrations in that media.
- Substances that are observed being discharged directly into pathway media from the facility can be demonstrated to contain hazardous constituents.

The criteria for documenting observed releases were a significant issue during field testing and are discussed in Section 3.5. Sampling plans were generally designed to collect analytic data for all pathways of concern. For the proposed air pathway, samples were collected upwind and downwind in the breathing zone near a suspected source. For the proposed ground water pathway, samples collected from monitoring wells, residential wells, or municipal wells were compared with other samples collected in areas believed to be relatively free of contaminants. Samples were collected at the probable point of entry and at upstream and downstream locations for the proposed surface water pathway. The addition of the onsite exposure pathway to the proposed HRS requires sampling to document surficial contamination; this pathway is only evaluated when actual contamination is observed to be present.

3.4.1.1 Proposed Air Pathway

Direct air sampling was conducted at 10 of 29 sites tested. Field teams used planning criteria common to all sampling approaches: background samples were chosen to establish the concentration of hazardous substances in the atmosphere exclusive of any possible releases from the site; samples were taken under the same meteorological conditions (i.e., wind speed and direction, relative humidity, atmospheric pressure, and temperature); and samples were collected in the "breathing" zone. Equipment utilized during testing included: high volume samplers, PM-10 samplers, polyurethane foam (PUF) samplers, low volume personal air samplers, and Fourier-transform Infrared (FTIR) samplers.

One limitation related to air sampling was recorded during the field test and this involved seasonal weather conditions. Several project participants opted not to sample because of low probability for detecting releases under less than ideal conditions (e.g., cold temperatures and snow cover). Additionally, it was not clear that all sampling equipment utilized would provide data of sufficient precision to support a documented air release

3.4.1.2 Proposed Ground Water Pathway

Field teams employed both traditional and innovative ground water sampling techniques during testing, and used planning criteria common to all approaches: when available, known localized ground water flow conditions were considered in the selection of sample locations; potential aquifer interconnections were evaluated to decide which aquifers were "threatened"; density of contaminants of concern (e.g., floaters or sinkers) was considered in deciding which aquifer intervals to sample; and permanent or temporary wells were installed only if existing monitoring or residential wells were deemed unusable for sampling, in terms of location or distance from the site.

Two limitations related to ground water sampling were recorded during the field test. First, some project participants were concerned with contaminating underlying aquifers when using portable drills or power augers to install temporary wells. Second, some field test personnel identified situations where shallow ground water was possibly being released to nearby surface water bodies. Participants were unclear as to how to develop sampling strategies to document such releases.

3.4.1.3 Proposed Surface Water Pathway

In the current HRS, surface water sampling is generally limited to documenting observed releases, identifying hazardous substances of concern, and determining locations from which to measure target distances. In the proposed HRS, more opportunities are available to use analytic data from surface waters as a result of modifications to the surface water pathway. For example, proposed surface water targets may be evaluated based on actual or potential contamination. Therefore, opportunities may exist to sample drinking water intakes, as well as fisheries, recreational areas, and sensitive environments suspected of showing actual contamination.

Surface water sampling approaches utilized during the field test consisted of collecting grab samples at the probable point of entry to surface water, target samples along the in-water surface water migration path, and downstream sediment samples. Other samples that were collected included:

- Shallow well point samples/seepage meter samples. At some sites, project participants were unable to identify an overland flow segment to surface water. However, potential ground water discharges to surface water were felt to be possible in several cases. Therefore, some field teams attempted to document actual contamination across the ground water/surface water interface using well points or seepage meters.

- Biological samples. Some field test personnel conducted sampling of aquatic species to document either an observed release to surface water or actual human food chain contamination. Electroshocking techniques were used to collect fish for tissue analysis at several sites. Crabs were collected in traps at one site; and oysters, mussels, and shrimp were sampled at another.

Two limitations regarding surface water sampling were identified during testing:

- Use of health- and ecological-based benchmarks. Participants noted that these benchmarks are usually based on aqueous concentrations of contaminants. Therefore, some felt that sediment and aqueous samples should always be collected in pairs to maximize data usefulness.

- Use of Food and Drug Administration (FDA) action levels. The proposed HRS requires comparison of sample results with published FDA action levels in order to document actual human food chain contamination. However, several field test personnel remarked that these criteria are not available for most hazardous substances.

3.4.1.4 Proposed Onsite Exposure Pathway

In the proposed HRS, the onsite exposure pathway can be scored only if contamination is observed; therefore, sampling is essential to confirm surficial contamination and to determine the boundaries for evaluating the resident and nearby population threat target populations. Field teams used conventional sampling techniques to characterize surficial contamination. For example, several project participants used sample grids to define the area of onsite contamination and to determine waste quantity for the nearby population threat. Shelby tube samplers were used to collect samples to depths of two feet. Hand-held or power augers were found to be useful at sites with hardened surface soils. Composite samples were sometimes taken for large areas of expected contamination, particularly where grab samples at numerous grid points would be cost-prohibitive.

Field teams also used field analytical screening analyses to define the extent of surficial contamination, evaluate waste quantity, and document the presence or absence of contamination on nearby properties. Screening samples were not solely relied on for scoring; however, these samples were used to select sample locations for subsequent CLP analyses.

Project participants identified several significant implementation issues or limitations regarding onsite exposure sampling strategies:

- Areal extent of surficial contamination. Many field test personnel felt that the data obtained from their site inspections did not provide a high level of confidence in establishing the areal extent of contamination. Several participants were uncertain as to how to determine the areas of surficial contamination (e.g., how many samples must be taken). This is important because the area of surficial contamination is the primary means of differentiating between onsite/resident targets and offsite/nearby targets.

- Depth of surficial contamination. Project participants were uncertain as to what sampling strategies to use when only portions of a source contained hazardous substances within two feet of the surface. Several sites had partially buried sources, and inferring contamination between "positive" sample points in these situations could result in erroneous waste quantity and target calculations.

- Inferred contamination for resident population threat. The proposed HRS implies that it is unnecessary to sample each residence, school, or day care facility suspected of being contaminated. Points of contamination established through direct sampling, combined with transport mechanisms and topography or surface conditions which indicate that these sampling points are connected, should be adequate. However, several project participants were unclear as to how to connect sample points to infer contamination for resident target populations.

3.5 DATA SIGNIFICANCE

In the current HRS, specific guidance is not provided as to what constitutes a "significantly higher than background" hazardous substance release. In the proposed HRS, however, several conditions are provided through which detected concentrations of hazardous substances can be considered "significantly" above background (Table 3-4). The detection limit is defined to include the CLP contract-required detection limit (CRDL) or quantitation limit (CRQL), the laboratory instrument detection limit (IDL), and the analytical method-specific detection limit (MDL).

Some project participants felt the conditions for documenting "significance" may be unrealistic. They questioned whether these conditions could adequately address the following uncertainties associated with all measured concentrations:

- Uncertainty associated with sampling procedures.
- Uncertainty associated with the natural background variability of metals.
- Uncertainty associated with laboratory analytical procedures.

As an alternative, some project participants suggested comparison of concentration data with health-based levels. However, health-based levels are not available for all media for many hazardous substances. In addition, not all routine analytical services (RAS) CRDLs are below health-based standards (e.g., maximum contaminant levels (MCLs) under the Safe Drinking Water Act). Field test personnel also remarked that based on the limited sampling performed during the site inspections, concentrations detected may not be representative of concentrations that would be detected at other times or at other sampling locations.

TABLE 3-4
CONDITIONS NECESSARY TO DOCUMENT AN OBSERVED RELEASE

If background concentration is:	Observed release occurs if detected concentration is:
Not detected.	Greater than or equal to 3 times the detection limit.
Greater than or equal to the detection limit, but less than 2 times the detection limit.	Greater than or equal to 3 times the applicable background concentration or greater than or equal to 4 times the detection limit, whichever is less.
Greater than or equal to 2 times the detection limit.	Greater than or equal to 2 times the applicable background concentration.

Several field test personnel suggested the need for careful review of laboratory data. The range of precision of sample values should be considered rather than the strict comparison of absolute values. Also, some personnel felt that the range of allowable precision for CLP analysis may preclude scoring a 2x release, especially near the detection limit.

3.6 EVALUATION OF ACTUAL AND POTENTIAL PROPOSED HRS TARGETS

Both the current and proposed HRS include a targets factor category for the air, ground water, and surface water pathways. The proposed HRS adds an onsite exposure pathway which also includes a targets factor category. For each pathway in the proposed HRS, all or most of the following factors are evaluated for the targets factor category: human populations, maximally exposed individuals (MEI), sensitive environments, and resource uses (e.g., land, ground water, fishery).

This section addresses general issues and findings relating to the proposed HRS targets factor category. Three factors -- population, sensitive environments, and resource use -- are discussed for each proposed pathway as appropriate. Significant issues and findings for other target factors (i.e., surface water human food chain threat and human recreation threat targets, onsite exposure pathway target populations) are presented in Section 4.

3.6.1 Target Population Factors

Several target population factors primarily related to human health are evaluated in the proposed HRS. The proposed air and ground water pathways each include one target population factor; the surface water pathway contains three -- for the drinking water, food chain, and recreation threats. Three factors are also included in the onsite exposure pathway -- high-risk resident population, total resident population, and nearby population. Each pathway has a prescribed target distance within which target populations are evaluated. (The proposed HRS also adds human health factors to the proposed air, ground water, and surface water pathways reflecting risks to the MEI; that is, those individuals likely to be exposed to the highest concentrations of hazardous substances.) Five significant issues or findings were identified regarding the various population factors:

- Quality of demographic information needed to document target populations.
- Evaluation of onsite human target populations for the proposed air and onsite exposure pathways.
- Use of distance weighting factors.

- Use of distance weighting factors.

- Use of health-based benchmarks for populations actually exposed to contamination when evaluating target populations.

- Distribution of target population factor values.

3.6.1.1 Quality of Demographic Information

In the context of demographic information for documenting target population factors in the proposed HRS, "quality" primarily reflects the ability to calculate relatively accurate population estimates. A variety of methods -- including topographic maps, aerial photographs, general census data, automated databases, visual surveys, specialized U.S. Bureau of Census information, and contacts with state and local planning agencies -- were utilized to estimate target populations during field testing. For each method, field test personnel identified concerns that could potentially result in a loss of accuracy when calculating target populations. For example, house counts from topographic maps were not feasible for some urban sites and were outdated for other sites tested. Project participants also were concerned with using general census tract data. Census tracts sometimes were located within multiple target distances (e.g., 1/4 - 1/2 miles and 1/2 - 1 mile), and participants needed to make assumptions as to how to apportion populations between these intervals; uniform distribution of populations within census tracts was generally assumed.

Project participants generally remarked that documenting target populations for the proposed HRS was very time consuming compared to the current HRS, particularly for the air population factor and the surface water recreation target population factor. For example, in the proposed air pathway, the total number of residents, students, and workers residing within the various target distance categories are all counted. Some field test personnel were unable to determine student and worker populations due to a lack of available information. Others expressed uncertainties about possible double-counting of individuals who both lived and worked within the prescribed target distance. For the proposed surface water recreation threat, the target population may be evaluated up to a maximum distance of 125 miles. Most project participants felt that there was no reasonable way to determine this population except through the use of automated databases.

The current HRS assumes a multiplier of 3.8 persons per residence as a default when calculating target populations. In the proposed HRS, the default multiplier is based on the most recent U.S. Census factor for the number of persons per residence for the county in which target populations are located. Nearly all project participants considered this an improvement.

Several national automated databases (Table 3-5) were searched to support the determination of various proposed HRS factors (including target populations) as part of field testing. The Graphical Exposure Modeling System (GEMS) provided target population estimates for the proposed air, onsite exposure, and surface water recreation threat pathways. Developed by EPA's Office of Toxic Substances, GEMS contains procedures for manipulating 1980 census data geographically. Population data are graphically displayed over user-specified circular distances. Populations are assigned to the centroid of each census district.

Project participants noted that the GEMS population estimates developed for sites tested had several limitations. First, GEMS was relatively unsuccessful in providing accurate data for close-in distances (less than one mile from the site). Because populations closest to the site are weighted more heavily than those farther away, this limitation is important. Second, GEMS was not helpful in determining populations in rural or sparsely populated areas, where census districts are larger than in urban areas. Because the centroid of a larger district may not fall within the appropriate distance category, GEMS often overstated populations or indicated no resident population when in fact there was a population.

TABLE 3-5
AUTOMATED DATABASES USED TO SUPPORT REVISED HRS FACTORS

Reference Database Link Programs	Reference Databases	HRS Factors Database May Support
Air Pathway		
GEMS (Graphical Exposure Modeling System)	Census Bureau	MEI, population
Ground Water Pathway		
NAWDEX (NAtional Water Data EXchange)	GWSI (Ground Water Site Inventory)	MEI, well depth, water use, karst aquifer, depth to aquifer, aquifer thickness, hydraulic conductivity, sorptive capacity
----	FRDS (Federal Reporting Data System)	MEI
----	Wellfax	Population
Surface Water Pathway		
GEMS	Census Bureau	Recreation population
PATHSCAN	WSDB (Water Supply Data Base) IFD Plot (Industrial Facility Discharge Plot) GAGE file REACH file	MEI, stream flow rates, water use
STORET (STOrage and RETrieval)	Bios Survey File Fish Kill File	Fishery use
Onsite Exposure Pathway		
GEMS	Census Bureau	Population

Note: GEMS, FRDS, PATHSCAN, WSDB, IFD Plot, GAGE File, REACH File, STORET, Bios Survey File, and Fish Kill File are maintained by the U.S. Environmental Protection Agency; NAWDEX and GWSI are maintained by the U.S. Geological Survey; Wellfax is maintained by the National Water Well Association.

However, GEMS did provide some advantages over the other data collection methods. GEMS proved more useful for estimating populations in urban areas compared to other methods, and was a quick and reasonable method for estimating the recreation target population in the proposed surface water pathway.

For the proposed ground water pathway, the Ground Water Site Inventory (GWSI) and Federal Reporting Data System (FRDS) databases were searched to support the target population factor. Project participants generally remarked that the data provided on well locations (both domestic and public-supply) were often outdated and inaccurate. For example, GWSI listed some inactive wells and failed to identify many active wells within the ground water target distance. FRDS data were not current, and locations sometimes were not provided for municipal wells.

The PATHSCAN database was utilized to identify the target population for the proposed surface water drinking water threat target population. The database was helpful in locating public water-supply intakes along the surface water migration path. However, project participants usually had to verify the drinking water target population associated with these intakes.

Overall, most field test personnel were uncertain about the quality of demographic information from automated databases. While these databases may be useful in identifying potential target populations, further analyses are being conducted to determine whether estimates from these databases are adequate for scoring sites.

3.6.1.2 Evaluation of Onsite Human Target Populations

The proposed HRS evaluates onsite human target populations in the air and onsite exposure pathways. (This section restricts discussion to these specific pathways; the proposed ground water and surface water pathways also evaluate onsite drinking water populations.) Onsite populations are generally weighted more heavily than populations farther away. For the proposed air pathway, the onsite population consists of residents, students, workers, and other persons who are regularly present. For the onsite exposure pathway, the onsite population is evaluated as the resident population -- that is, people living or attending school or day care centers where there is observed contamination. Two groups are counted in this pathway: high-risk population (children under seven years of age) and total resident population (all others).

Project participants raised several issues regarding documentation of onsite populations. For example, the criteria for defining onsite target populations for the air pathway were unclear. At some sites, an active manufacturing facility was located adjacent to an area of soil contaminated from the plant's waste management procedures. Field test personnel questioned whether the plant's employees should be considered as an onsite population.

Another issue raised by project participants involved exclusion of onsite workers from total resident population in the onsite exposure pathway. The participants noted that this is the only proposed pathway that does not consider worker populations. The final difficulty pointed out was that documenting resident populations required increased community relations, as well as the collection of specific information on the occupants of each household (ages of children) with observed property contamination.

3.6.1.3 Use of Distance-Weighting Factors

The current HRS weights the population factor by distance only in the air pathway. The proposed HRS incorporates dilution/distance-weighting in several target population factors to account for the attenuation of hazardous substances in the environment. The proposed air and ground water pathways use distance-weighting factors to evaluate targets potentially at risk from releases of hazardous substances from a site. These factors are intended to represent the reduced concentrations of contaminants as distance from the site increases. For the onsite exposure pathway, resident target populations are more heavily weighted than nearby target populations, which are distance-weighted. The proposed surface water pathway evaluates potentially exposed targets using dilution-weighting factors based on the flow characteristics of the water available for dilution. Dilution-weighting factors are discussed further in Section 4.3.

Several project participants felt that the distance-weighting of target populations improved the relative accuracy of the proposed HRS. Some participants also noted that the distance-weighting factors resulted in proposed ground water target population values being lower than values under the current HRS. In addition, the distance-weighting factors used for the proposed air target population factor are such that, for distances beyond one mile, very large populations must be present to significantly contribute to target values.

Some project participants remarked that the distance-weighting factors used for the nearby target population factor (onsite exposure pathway) were too high, possibly resulting in overestimated factor values. This observation may relate in part to the unattractiveness of these sites to draw nearby populations.

3.6.1.4 Use of Health-Based Benchmarks

The current HRS does not consider whether specific concentrations of hazardous substances in drinking water supplies are above health-based benchmarks, but only whether the contaminants are significantly above background levels. As a result, populations known to be exposed to hazardous substances and those potentially exposed are treated in the same way in the current HRS. In the proposed HRS, the ground water pathway and surface water drinking water threat give greater weight to target populations whose drinking water wells or intakes are contaminated by hazardous substances attributable to the site. The evaluation of these target populations includes a factor based on the Federal primary drinking water regulations, or on some other health-based benchmark if no standard exists.

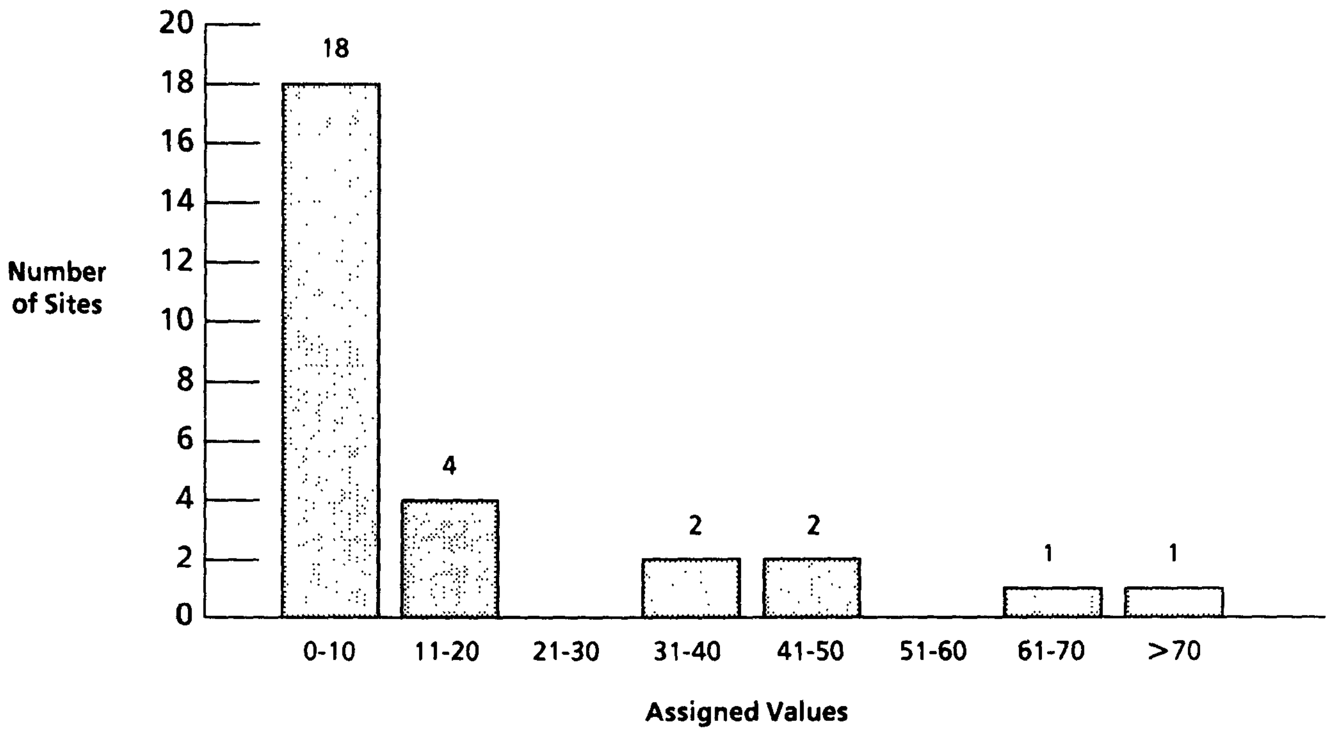
During the site inspections performed in the field test, a few instances were identified where people were drinking water from contaminated wells, but no surface water drinking water intakes were found to be contaminated above health-based benchmarks. Most project participants commented that the scope of the site inspection permitted only limited sampling of nearby drinking water-supply wells. Therefore, the target population identified as exposed above health-based benchmarks was not expected to be very large, unless associated with contaminated municipal water-supply wells.

Participants commented that health-based benchmarks do not exist for several hazardous substances (e.g., cyanide, naphthalene, 1,1-dichloroethane) and that benchmarks are normally not available for sediments.

3.6.1.5 Distribution of Target Population Factor Values

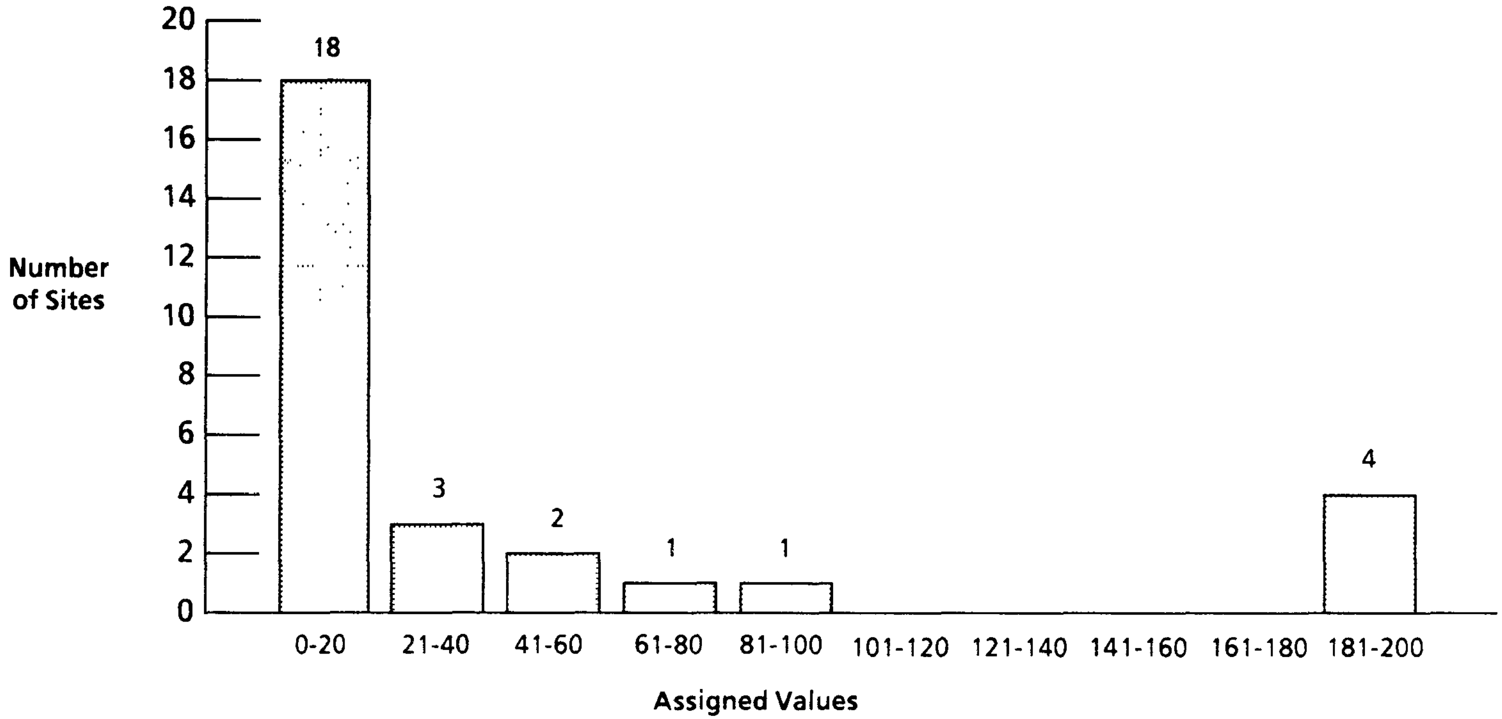
For the sites tested, target population factor values are generally clustered at the low end of the scale (Figures 3-11 through 3-15). Exceptions are the nearby target population factor for the onsite exposure pathway (Figure 3-16) and the target population factor of the food chain threat for the

FIGURE 3-11
AIR PATHWAY:
TARGETS POPULATION FACTOR VALUES
(Based on 28 Field Test Sites)



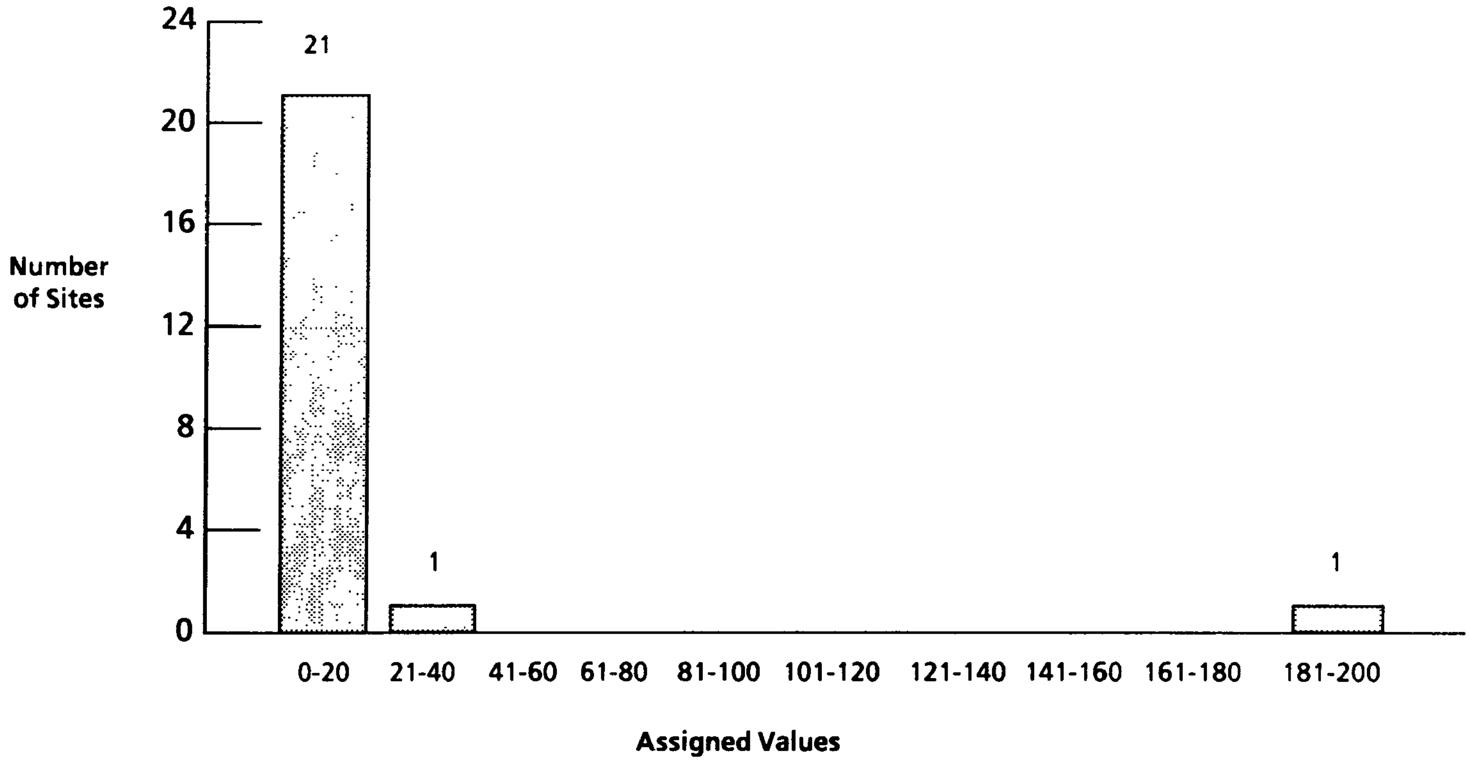
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-12
GROUND WATER PATHWAY:
TARGETS POPULATION FACTOR VALUES
(Based on 29 Field Test Sites)



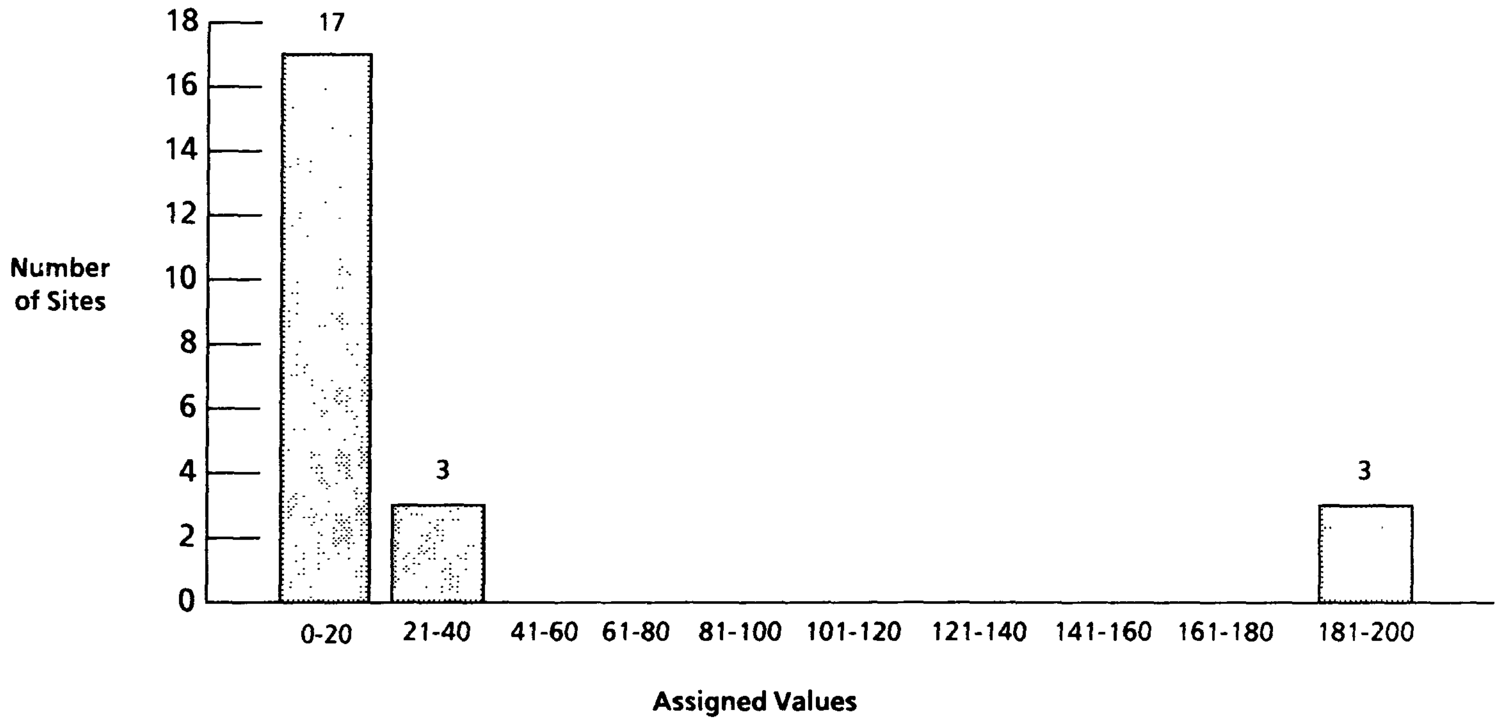
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-13
SURFACE WATER PATHWAY:
DRINKING WATER THREAT - TARGETS POPULATION FACTOR VALUES
(Based on 23 Field Test Sites)



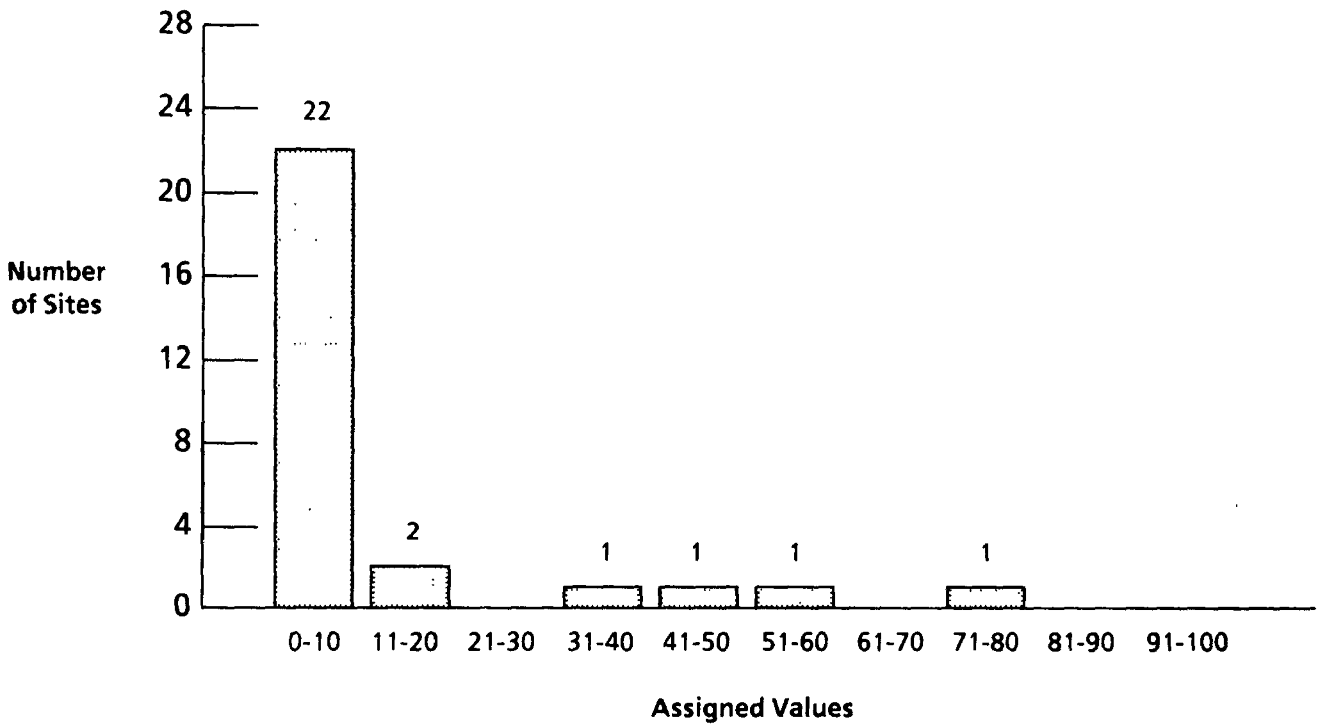
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-14
SURFACE WATER PATHWAY:
RECREATION THREAT - TARGETS POPULATION FACTOR VALUES
(Based on 23 Field Test Sites)



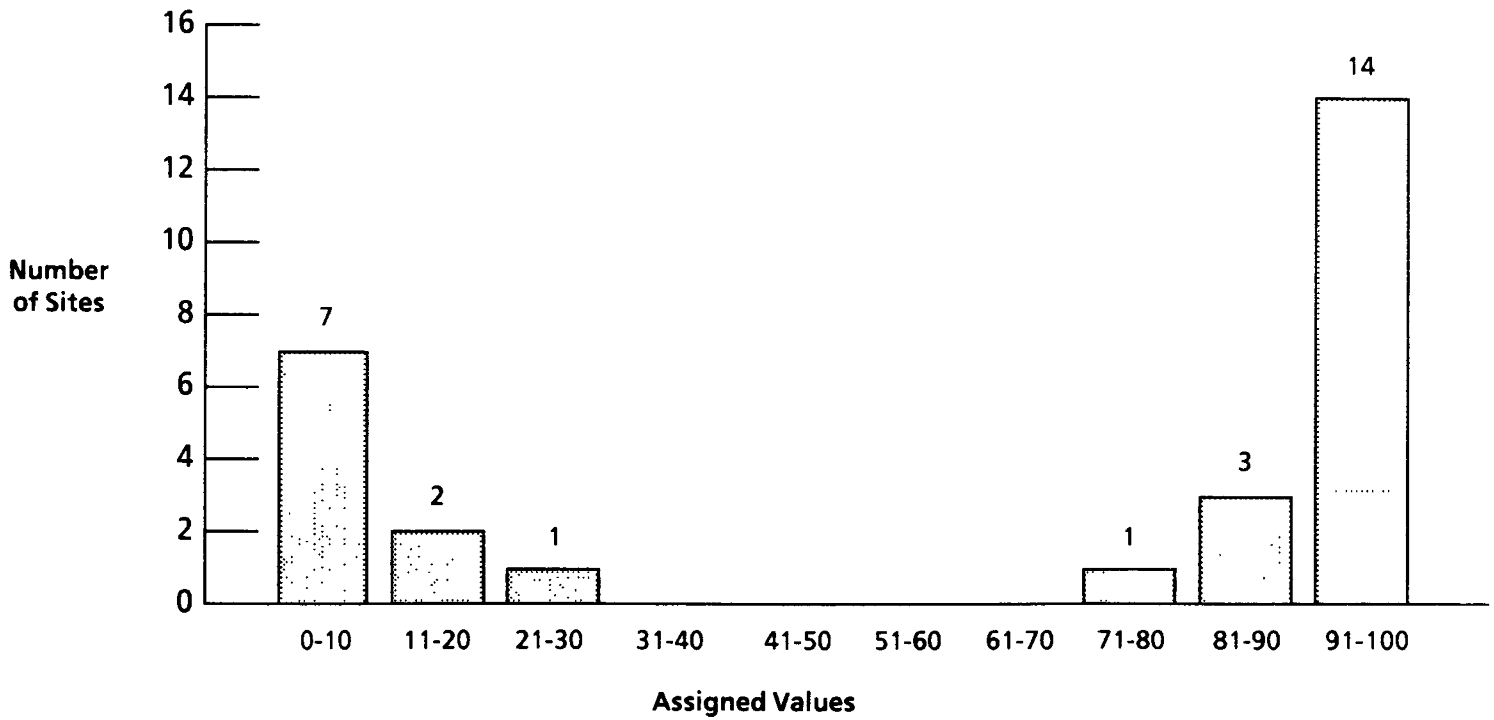
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-15
ONSITE EXPOSURE PATHWAY:
RESIDENT POPULATION THREAT - TARGETS FACTOR VALUES
(Based on 28 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-16
ONSITE EXPOSURE PATHWAY:
NEARBY POPULATION THREAT - TARGETS FACTOR VALUES
(Based on 28 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

surface water pathway (discussed in Section 4.3.4). These results may primarily relate to the use of distance-weighting factors, along with a general lack of target populations for some sites.

3.6.2 Sensitive Environment Factors

Sensitive environment factors are evaluated in each proposed HRS pathway except ground water. The current HRS includes only the highest-scoring sensitive ecosystem when more than one exists within the appropriate target distance, while the proposed HRS sums values for all ecosystems within the target distance, and most environments are weighted for distance or dilution. The types of sensitive environments considered for each proposed pathway have been substantially expanded as well.

Three significant issues or findings were identified regarding the sensitive environment factors during testing:

- Definition and evaluation of sensitive environments.
- Use of Natural Heritage Program rankings.
- Distribution of sensitive environment factor values.

3.6.2.1 Definition and Evaluation of Sensitive Environments

Given the expanded types of sensitive environments considered in the proposed HRS, several project participants were unclear as to how to define and evaluate sensitive environments within the target distances of the sites. The types of sensitive environments that often presented difficulties were:

- Wetlands.
- Critical habitats for Federally designated endangered or threatened species.
- Spawning/feeding areas and migratory pathways critical for maintenance of a fish species.
- Fish hatcheries.
- Other areas administered by national and state agencies (e.g., forests, memorials, parks).

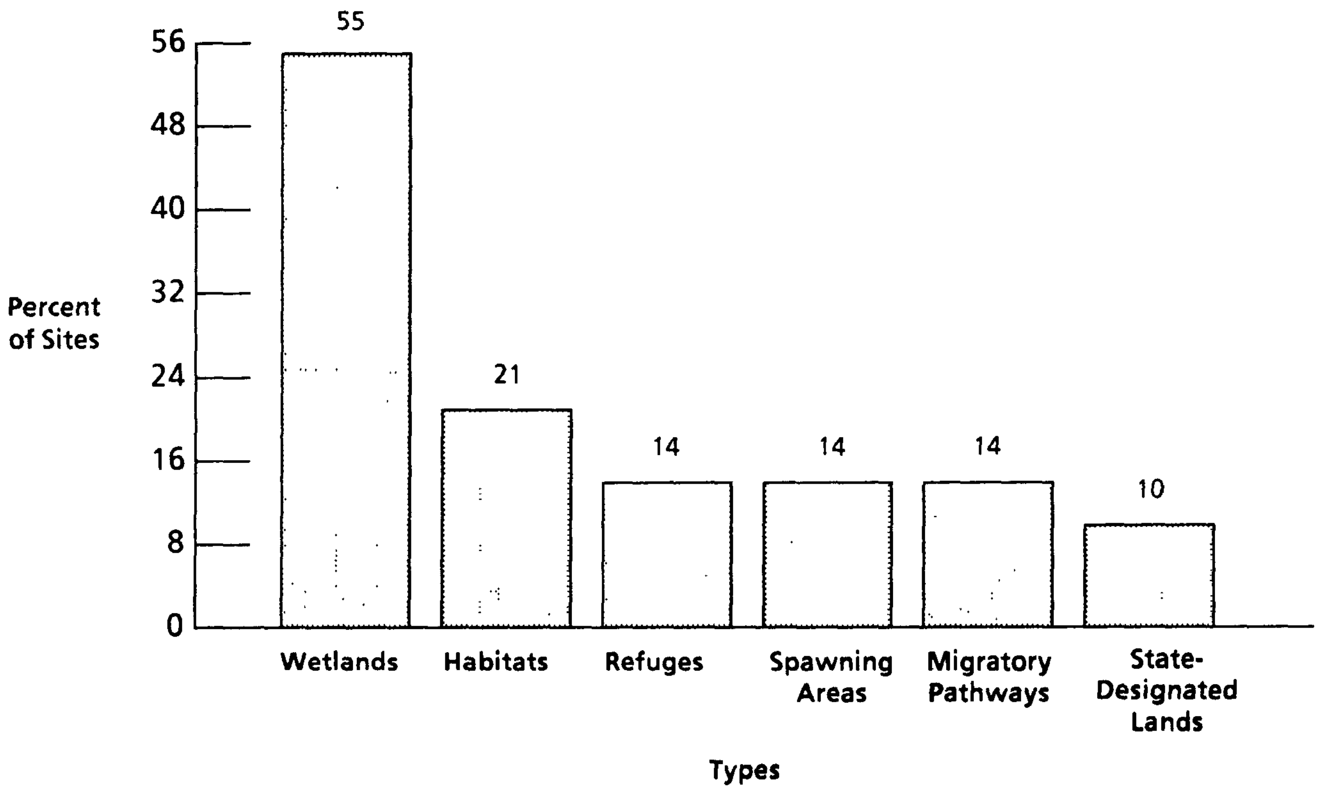
Figure 3-17 displays the types of sensitive environments that occurred most frequently at sites tested.

A variety of data collection methods were utilized to identify sensitive environments, including topographic maps, National Wetlands Inventory maps, visual surveys, Natural Heritage Program rankings, and contacts with Federal, state, and local agencies. Field test personnel noted that classifying and analyzing sensitive environments is more time-consuming with the proposed HRS than with the current HRS.

Project participants also had difficulty evaluating some sensitive environments identified within the target distances. For example, for the proposed air pathway, sensitive environments are weighted based on their distance from any onsite emission source. At some sites, contiguous wetlands were scattered over more than one distance category, raising the question of evaluating these wetlands for each distance interval or only for the interval closest to the site.

Finally, project participants had difficulty defining sensitive environment boundaries. For the proposed surface water environmental threat, field test personnel were unclear as to how to determine boundaries between wetlands. During field testing, it was also sometimes difficult to document the actual locations of sensitive ecosystems, particularly ones without fixed geographical positions (e.g., the range used by endangered or threatened species, as well as nesting locations). Some environmental agencies (e.g., U.S. Fish and Wildlife Service) were reluctant to provide specific locations of sensitive environments for fear of compromising the welfare of these environments.

FIGURE 3-17
FREQUENCY OF SENSITIVE ENVIRONMENT TYPES
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

3.6.2.2 Natural Heritage Program Rankings

The proposed HRS incorporates the use of the Nature Conservancy's Natural Heritage Program (NHP) rankings to assist in evaluating sensitive environments. The NHP was established to provide precise scientific information in support of preserving biological diversity. In cooperation with state governments, the Nature Conservancy maintains ecological inventories of plants, animals, and communities that are uncommon and threatened on a state or national basis. These inventories classify "elements of diversity" which are individual species or communities of species and their habitats. The elements are ranked by a system in which such factors as rarity and vulnerability are considered.

Many project participants accessed NHP information in evaluating sensitive environments. However, NHP rankings were used to support scoring for only 20 percent of the sites tested. Some NHP data are partially based on "sightings" that occurred many years ago. Therefore, additional investigation was required to verify old information. Project participants also noted that the NHP databases are not entirely consistent among the states, primarily due to the length of time that the various state databases have been maintained.

Two other issues were raised during field testing. First, NHP normally does not identify the range of a species' habitat. Therefore, while NHP may locate part of the species' habitat, it generally cannot establish the geographic boundaries of the entire range. Second, some states do not normally assign national rankings to species found in the United States, but rather only to distinguish species that are rare in other parts of the Western Hemisphere.

3.6.2.3 Distribution of Sensitive Environment Factor Values

The air targets sensitive environment factor values are clustered at the low end of the scale (Figure 3-18). These results primarily relate to the distance-weighting factors, along with the general lack of sensitive environment targets for some sites.

For the proposed surface water pathway, most environmental threat targets factor values were also relatively low (Figure 3-19). Higher assigned values were recorded for those sensitive environments subject to actual contamination. Actual contamination (i.e., concentrations exceeding ecological-based benchmarks based on ambient water quality criteria) of one or more types of sensitive environments occurred for approximately 20 percent of the sites tested.

For the onsite exposure pathway, no terrestrial sensitive environments were identified during field testing.

3.6.3 Resource Use Factors

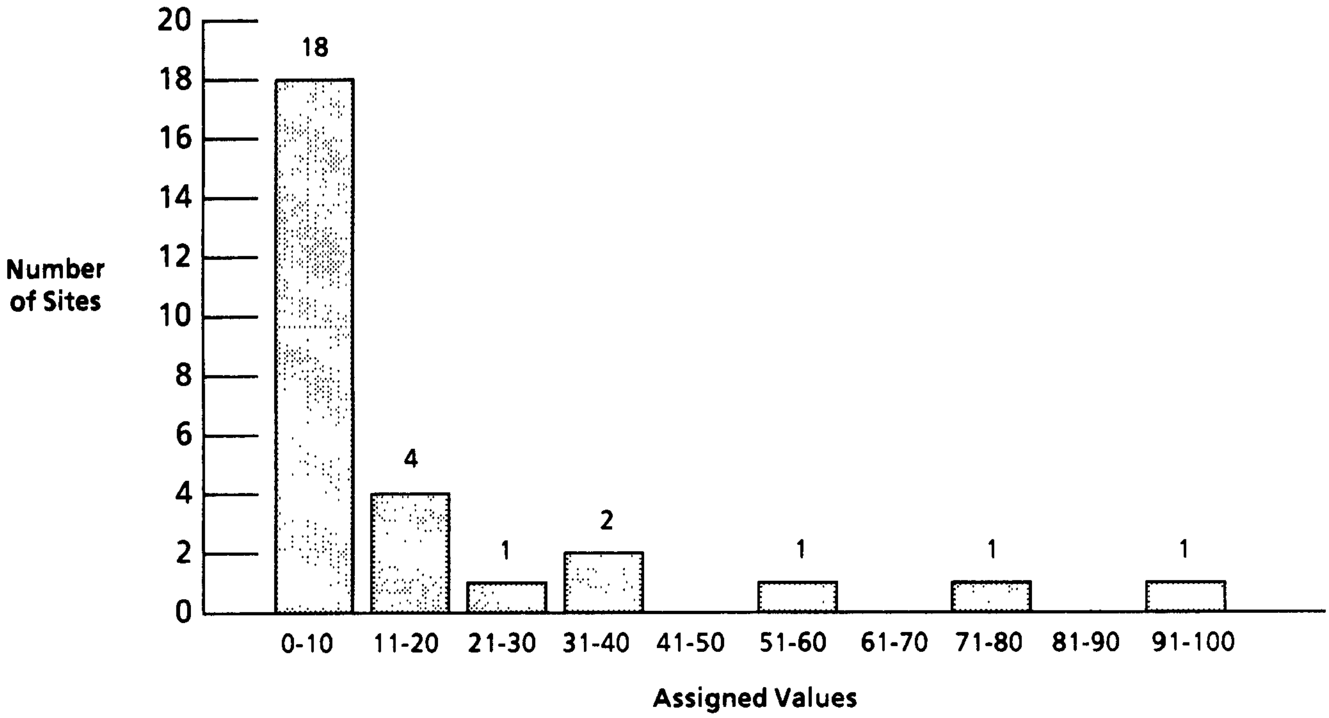
The proposed HRS evaluates four resource use factors. The proposed air and ground water pathways each include one factor; the surface water pathway includes a resource use factor for both the drinking water threat and human food chain threat. Each pathway has a prescribed target distance within which resource uses are evaluated. Two significant issues or findings were identified regarding the resource use factors during testing:

- Definition and evaluation of resource use types for each use factor.
- Distribution of resource use factor values.

3.6.3.1 Definition and Evaluation of Resource Use Types

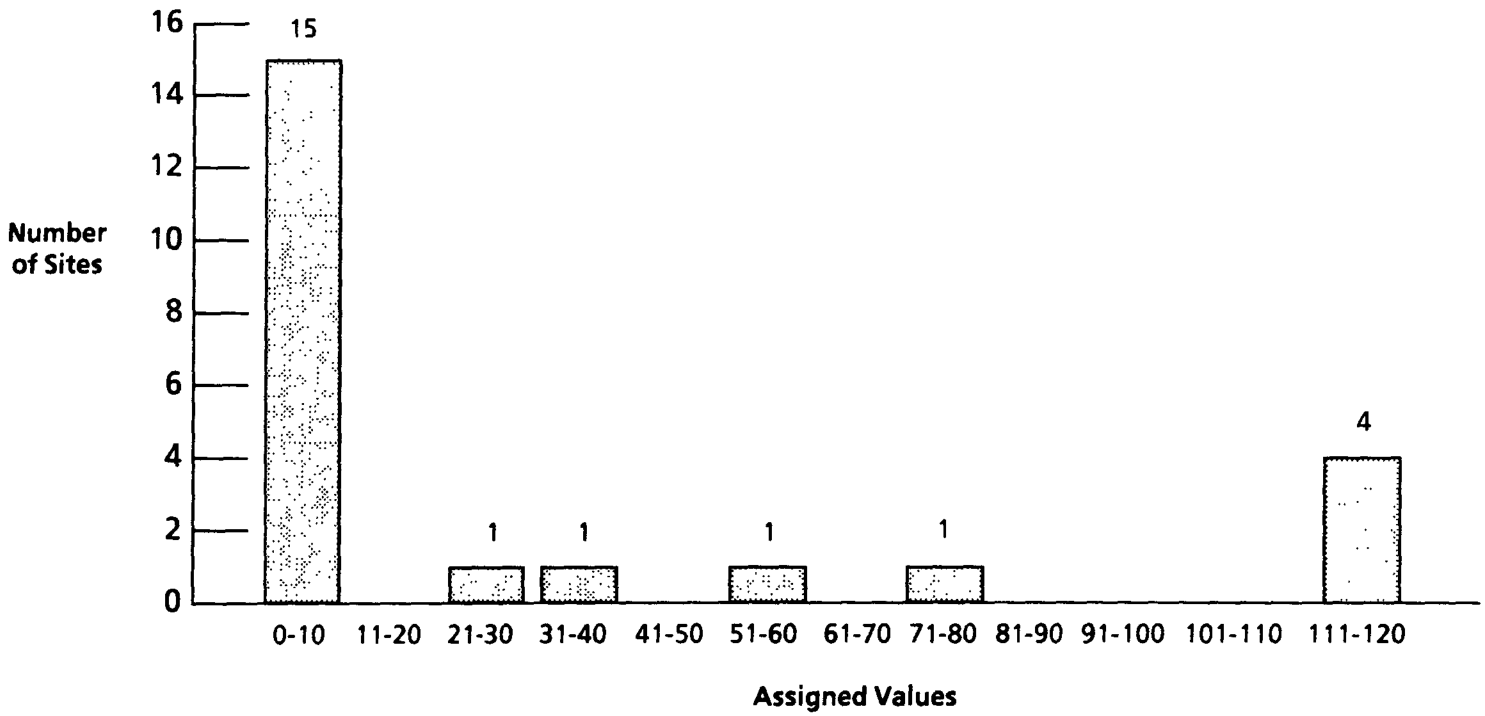
Several project participants were uncertain as to how to define and evaluate resource use types within the target distances. For the proposed air pathway, it was unclear whether the site itself

FIGURE 3-18
AIR PATHWAY:
TARGETS SENSITIVE ENVIRONMENT FACTOR VALUES
(Based on 28 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-19
SURFACE WATER PATHWAY:
ENVIRONMENTAL THREAT - TARGETS FACTOR VALUES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

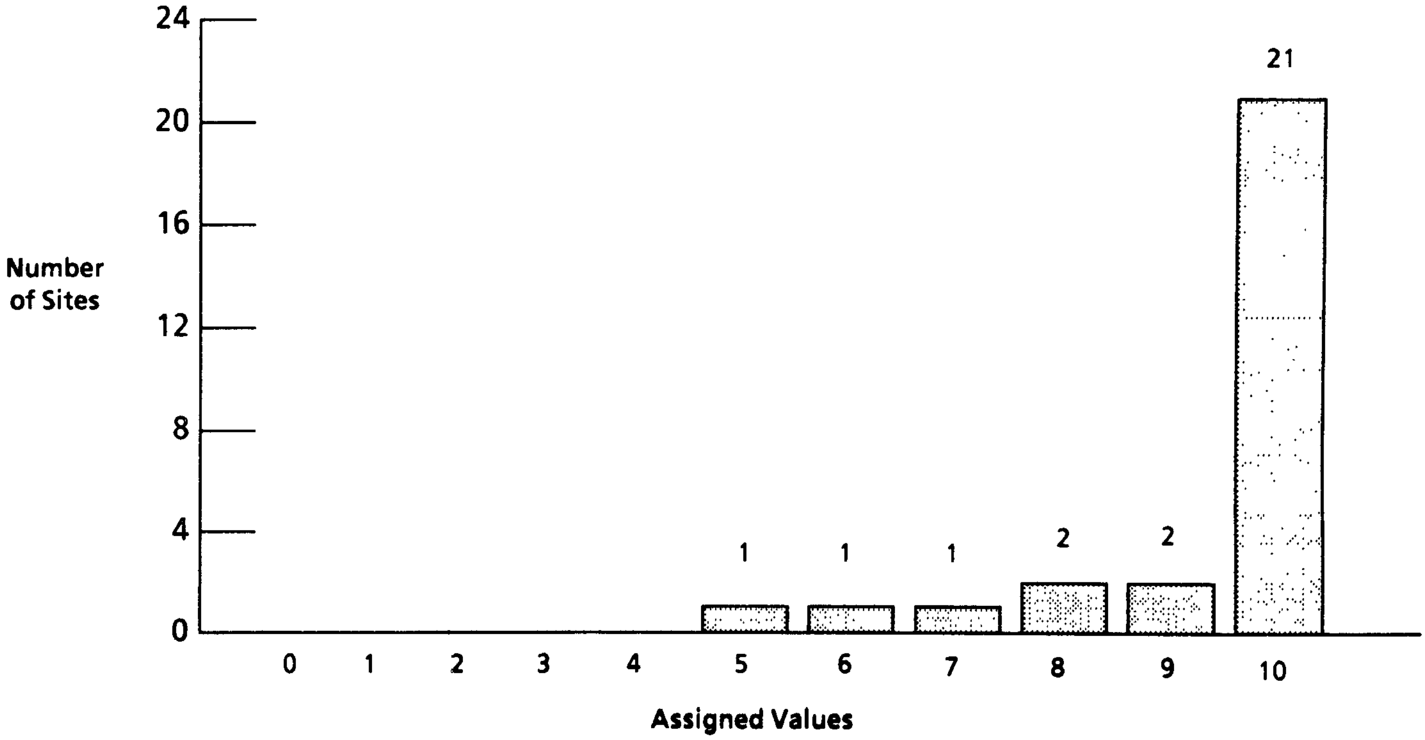
should be assigned a land use value. Some participants encountered prime agricultural land (based on Soil Conservation Service soil surveys) that was no longer used for agricultural purposes. Generally, the definitions of the land use types required subjective interpretation on the part of field test personnel.

In the proposed ground water pathway and surface water drinking water threat, the resource use factors are divided into two subcomponents -- drinking water use and "other" water use. For drinking water use, project participants requested clarification of minimum hook-up requirements. For "other" water use, some personnel encountered situations where wells or intakes supplied water for fish hatcheries. It was unclear whether this use should be evaluated as a resource use. Uncertainties also existed for the fishery use factor in the proposed surface water human food chain threat, where field test personnel were generally unable to distinguish between subsistence fishing and recreation/sport fishing.

3.6.3.2 Distribution of Resource Use Factor Values

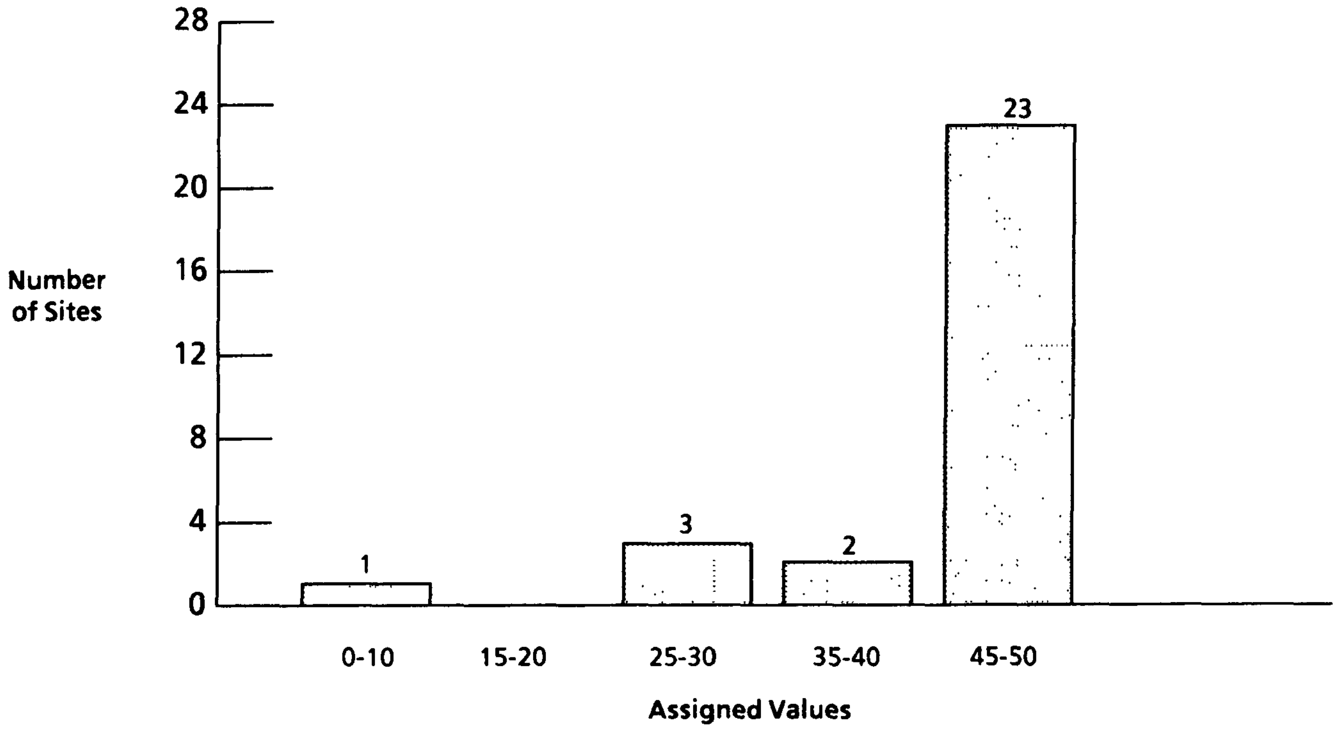
For the proposed air and ground water pathways, resource use factor values for the sites tested are clustered at the high end of the scale (Figures 3-20 and 3-21). For the proposed surface water pathway, there is a somewhat broader distribution of resource use factor values (Figures 3-22 and 3-23). This may be due in part to instructions in the proposed HRS that require at least one of the two surface water use factors for a watershed to be given a value of zero.

FIGURE 3-20
AIR PATHWAY:
TARGETS USE FACTOR VALUES
(Based on 28 Field Test Sites)



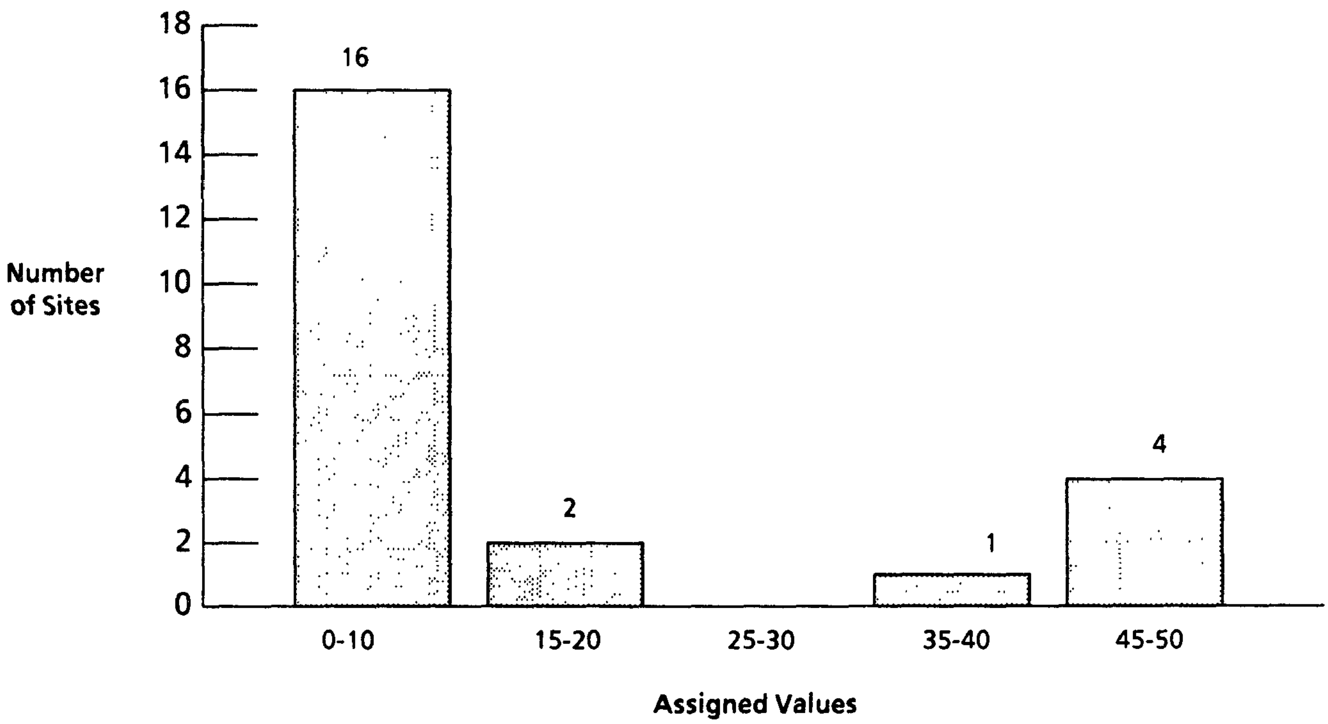
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-21
GROUND WATER PATHWAY:
TARGETS USE FACTOR VALUES
(Based on 29 Field Test Sites)



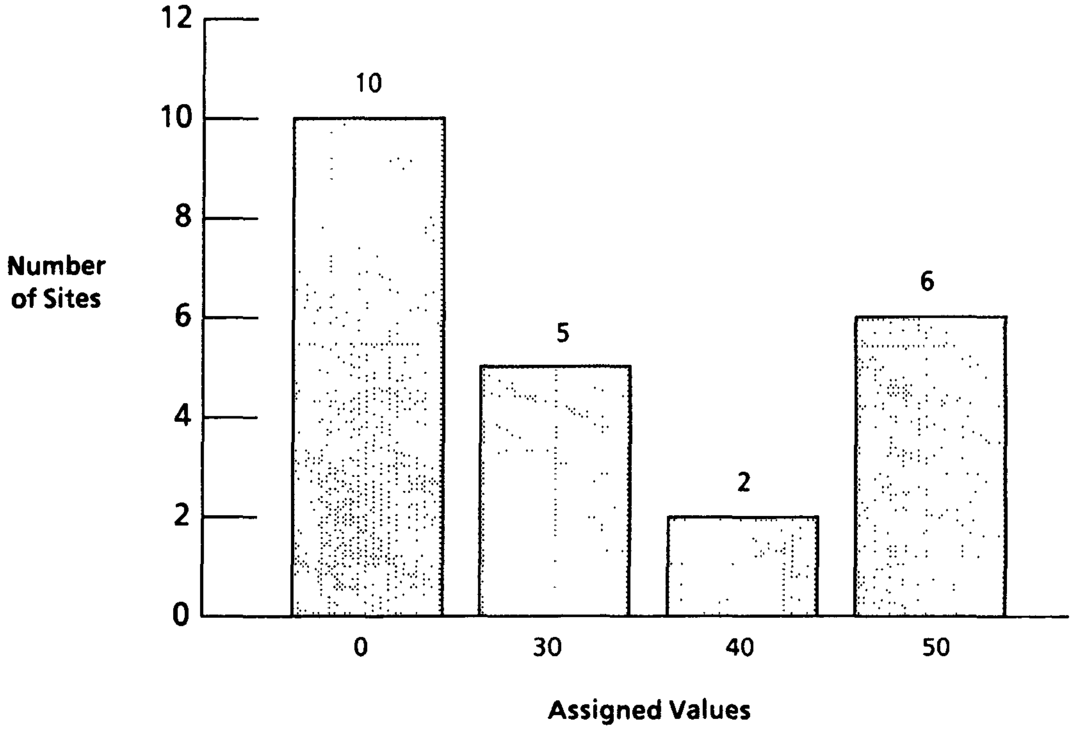
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-22
SURFACE WATER PATHWAY:
DRINKING WATER THREAT - TARGETS USE FACTOR VALUES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 3-23
SURFACE WATER PATHWAY:
HUMAN FOOD CHAIN THREAT - TARGETS USE FACTOR VALUES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

SECTION 4

INDIVIDUAL PATHWAY ISSUES AND FINDINGS

4.0 INTRODUCTION

Project participants identified several pathway-specific issues while gathering information to support the proposed HRS. These issues, which represent a combination of implementation concerns and model development items, are generally exclusive of those items discussed in Section 3. The issues or items include:

- Selected potential to release factors within each proposed HRS pathway (likelihood of release factor category).
- General considerations unique to each proposed pathway (e.g., aquifer boundaries, streamflow estimations, delineation of the hazardous substance migration path for surface water, surface water persistence values).
- Evaluation of surface water human food chain threat and human recreation threat targets.
- Evaluation of onsite exposure pathway target populations.

This section describes significant findings and results for issues relating to the proposed air, ground water, surface water, and onsite exposure pathways. Specific examples are provided where appropriate. Some of these issues were unresolved during the field test and are the subject for ongoing Agency studies, including the development of revised HRS guidance as well as other analyses and considerations to further improve the accuracy and implementation of the model.

4.1 PROPOSED AIR PATHWAY

In the current HRS, the air pathway is evaluated only if an observed release of hazardous substances to the atmosphere can be established; otherwise, the pathway score is zero. As mandated by CERCLA Section 105(a)(8)(A), as amended by SARA, the proposed air pathway is to consider, to the extent possible, factors to evaluate potential air contamination in the absence of data to support an observed release. The proposed factors are dependent on the type of source (source type factor), the physical/chemical properties of the hazardous substances at the source (source mobility factor), and the degree to which the release of hazardous substances is inhibited (source containment factor). The source mobility and source containment factors are evaluated based on the potential for the release of either gaseous or particulate hazardous substances emissions.

Nearly all project participants favored the proposed air pathway's mechanism for evaluating potential to release. Some remarked that this revision allows a more accurate assessment of the relative degree of risk that a site presents. Few comments were recorded for the potential to release factors; most field test personnel found these factors to be straightforward and relatively simple to evaluate. However, two issues were identified regarding the potential to release factors during testing:

- Definition of minimum size requirements for sources.
- Evaluation of potential releases.

4.1.1 Minimum Size Requirements for Sources

Under the potential to release section of the proposed air pathway, each source on the site which meets minimum size requirements is assigned a nonzero factor value for source type. Minimum size requirements are based on the quantity of hazardous substances potentially deposited on the site. As a result, some participants had difficulties evaluating minimum size requirements. These difficulties were similar to those associated with the hazardous waste quantity factor evaluation (Section 3.3).

Others also commented that minimum size requirements should not be based on the amount of waste present within a source. Some noted that small quantities of highly toxic hazardous substances can cause adverse effects, including acute as well as long-term impacts.

4.1.2 Potential Releases

The source mobility factor included under the proposed air pathway's potential to release section reflects the relative tendency of hazardous substances to be released as gases or particulates from a source. The gas and particulate mobility factors are evaluated independently and then combined to produce the source mobility factor value for each source at the site. The gas and particulate containment factors are also assigned separate values, with the higher value serving as the source containment factor value. Some project participants noted that this approach may not be as accurate as separate evaluations for potential gaseous and particulate releases. Others emphasized that the potential to release factors should reflect the different characteristics associated with gaseous and particulate emissions and should not be combined in this manner.

In the proposed air pathway, the Thornthwaite precipitation effectiveness (P-E) index is utilized to rate particulate mobility. This index is a surrogate for the antecedent moisture content of surface material which, in turn, is used as a measure of the relative mobility of particulates. However, some field test personnel commented that both wind speed and particle size at the surface may be important considerations for potential particulate releases. Others noted that particulates may be released via indiscriminate burning or spontaneous combustion; the source mobility factor does not account for these types of situations.

Another issue regarding potential particulate releases involved the distance-weighting factors used to evaluate population and sensitive environments for the proposed air targets factor category. Some project participants remarked that these distance weights are based on gaseous releases and may not be appropriate for sources that contain only particulate hazardous substances.

4.2 PROPOSED GROUND WATER PATHWAY

As in the current HRS, the proposed HRS considers both an observed release or a potential to release for the ground water pathway. An observed release to ground water for both the current and proposed HRS is demonstrated when direct deposition of material containing hazardous substances into ground water is observed, or when ground water samples show a significant increase in contaminant concentrations over background levels and those contaminants can be attributed to the site.

The proposed ground water potential to release factor category is comparable to the combined route characteristics/containment factor categories in the current HRS. For the proposed HRS, however, the potential to release evaluation encompasses a number of new or modified scoring factors. Major revisions to the current HRS approach to evaluating potential ground water releases, which have been incorporated in the proposed HRS, can be summarized as follows:

- Annual net precipitation is calculated based on the sum of monthly values, with a monthly net precipitation value of zero assigned for negative months.

- Geologic data for scoring potential to release factors can generally be collected only within two miles of the site, rather than within three miles as under the current HRS.

- The depth to aquifer factor assigns a value greater than zero to all aquifers, not just to aquifers within 150 feet of the ground surface.

- Thickness-weighted hydraulic conductivity for the entire geologic interval is used as opposed to the hydraulic conductivity of the single layer with the lowest hydraulic conductivity in that interval.

- Depth to aquifer and hydraulic conductivity are combined in a matrix to produce a single factor value.

- A sorptive capacity factor has been added.

- Factors in both the potential to release and targets factor categories have been modified to account for special properties of karst aquifers.

- The containment factor has been revised and expanded.

Several significant issues regarding the proposed ground water pathway were raised during field testing:

- Evaluation of potential ground water releases (i.e., thickness-weighted hydraulic conductivity and sorptive capacity).

- Evaluation of site geologic setting.

- Determination of aquifer boundaries.

- Identification of karst aquifers.

- Consideration of ground water flow direction.

4.2.1 Evaluation of Potential Ground Water Releases

Evaluation of thickness-weighted hydraulic conductivity (T/HC) and sorptive capacity (SC) are new factors under the proposed HRS. Look-up tables for permeability and clay/carbon content of different soil/rock types are provided in the proposed rule for scoring these factors. At several sites, field teams collected core samples for laboratory analysis of T/HC and SC. Lab results and the table values generally produced the same factor values.

Several project participants commented that the least permeable layer in a stratigraphic interval apparently dominated the T/HC value. Similarly, the least permeable layer sometimes appeared to influence the SC factor (e.g., low permeability silt and clay layers have a high clay and carbon content). Thus, some participants noted that the thickness-weighted approach in the proposed HRS may not provide enhanced discrimination over the current HRS approach (which evaluates only the lowest hydraulic conductivity layer in a given stratigraphic sequence).

Finally, a number of project participants commented on the poor quality of well logs available for evaluating ground water potential to release factors. Stratigraphic descriptions from residential drinking well or monitoring well logs in the vicinity of the site being evaluated were often judged inadequate to accurately assess depth to aquifer, thickness-weighted hydraulic conductivity, and sorptive capacity. This deficiency prompted several project managers to propose site-specific boring programs.

4.2.2 Evaluation of the Site Geologic Setting

The majority of the proposed HRS potential to release factors (e.g., depth to aquifer, thickness-weighted hydraulic conductivity, and sorptive capacity) require geologic information representative of site conditions. The proposed rule allows for subsurface conditions within two miles of the site to be evaluated when scoring potential to release. A number of project participants felt, however, that "regional" or "desktop" geologic data (e.g., Federal/state geologic reports) may not be adequate at many sites for scoring purposes, and it may be necessary to gather site-specific data through drilling/soil boring programs.

Several sites tested had "complex" structural geology in the form of tilted bedrock layers and pervasive jointing and faulting. Stratigraphic thicknesses, rock types, and depths to aquifers varied significantly over short distances. At these sites, project participants stressed the need for site-specific geologic data to evaluate potential to release. In areas of relatively "simple" layer-cake geology, exhibiting uniform stratigraphic thicknesses and continuous formations over large distances, project participants pointed out that regional geologic data would generally be adequate for scoring release potential.

Site-specific geologic and hydrogeologic investigations are costly in terms of drilling subcontract dollars and field investigation team resources to oversee drilling operations (see Section 5.3.4). When drilling was justified during testing, project participants employed field sample screening analyses and surface geophysical techniques to select appropriate boring/monitoring well locations and to minimize the total number of sample locations required. This phased data collection approach was generally successful.

4.2.3 Determination of Aquifer Boundaries

Neither the current nor proposed HRS provide specific criteria for the evaluation of aquifer boundaries such as interconnections and discontinuities. Under the proposed HRS, however, some guidance is provided to assist in identifying interconnections. Interconnections may exist when the following apply:

- Geologic data do not demonstrate the presence of low hydraulic conductivity layers (e.g., two orders of magnitude lower than the overlying layer) or confining layers between aquifers.
- Withdrawals of water from one aquifer affect water levels in the other aquifer.
- Migration of constituents from one aquifer to another aquifer has been observed.

These conditions are generally evaluated within a two-mile radius of the site. Most project participants felt that proposed HRS criteria for evaluating interconnection are an improvement, though unequivocal data to support the specified conditions were rarely available for the sites tested. Several field test personnel suggested employing pump tests at sites where interconnection is uncertain, but could be critical to scoring; however, costs could be prohibitive. In areas with multiple NPL-candidate sites, participants felt the benefits of regional pump test data could be worth the cost and effort.

Several project participants suggested the need for more complete and better definition of the terms "aquifer" and "aquifer discontinuity." One issue is how thick a layer of low hydraulic conductivity must be in order to constitute a discontinuity. Participants commented that this type of information would rarely be available without a detailed hydrogeologic investigation. Another is whether a stratigraphic interval that appears to contain significant low permeability layers is a single aquifer or multiple aquifers when wells in the vicinity appear to be drawing water across those layers. A third is whether aquifer and aquitard distinctions should be based on use rather than on hydrostratigraphy. Better definitions, and a more thorough discussion of aquifer conditions, might limit the subjectivity involved in documenting aquifer interconnections and discontinuities. Correctly documenting communication between aquifers can have a significant impact on the calculation of target populations. In the proposed HRS, targets are evaluated based on multiple aquifers, where appropriate, rather than on a single aquifer as with the current HRS.

4.2.4 Identification of Karst Aquifers

The current HRS does not provide a separate approach in the ground water pathway for evaluating sites in karst terrain. Under the proposed HRS, however, factors in both the potential to release and target factor categories are modified to account for the rapid transport and low contaminant attenuation properties of karst. Most participants favored this approach; however, many felt that the proposed rule is unclear as to the circumstances under which an aquifer can be considered karst. Uncertainties are associated with whether karst terrain (e.g., caverns, springs, sinkholes) must be present to assume a karst aquifer, as well as with what constitutes sufficient documentation of karst conditions (e.g., the number of karst terrain features within a four-mile radius of the site) and how dissolutioned limestone/dolomite/gypsum aquifers lacking surface expressions of karst topography should be treated. Two sites tested involved underlying karst aquifers.

4.2.5 Consideration of Ground Water Flow Direction

Neither the current nor proposed HRS directly considers the direction of ground water flow in determining and differentiating among populations that may be affected by the migration of hazardous substances. If available, information regarding the direction of ground water flow near the site can be used to identify sampling locations (e.g., placement of monitoring wells or sampling of existing wells) and to help determine whether hazardous substances detected in ground water can be attributed to the site being evaluated. However, the proposed HRS indirectly considers flow direction in evaluating target populations by including a mechanism that accounts for direction of substance migration in ground water. This is accomplished by assigning higher weights to those populations exposed to drinking water contamination either above or below health-based benchmarks (Section 3.6.1.4). Some project participants remarked that this mechanism was an improvement for the proposed ground water pathway.

Although the site inspections performed during the field test were not designed to determine the direction of ground water flow, measurements of ground water levels were normally made from monitoring wells that existed in the vicinity of the field test sites. Permanent monitoring wells were available for 18 of the 29 sites tested. The number of wells installed generally ranged from three to nine; the average was about four or five wells. For many sites, although more data concerning site-specific hydrogeology were collected during the field test than would be gathered under a typical site inspection conducted for the current HRS, several project participants commented that one-time measurements of ground water levels did not provide an accurate interpretation of the general direction of ground water flow. For example, some participants pointed out that ground water may flow in several directions from a site (e.g., due to mounded ground water beneath landfills) and that the flow direction near a site may differ from the general flow direction throughout the ground water target distance limit (e.g., due to pumping effects of other wells). Others noted that this uncertainty would be compounded where multiple aquifers existed beneath a site. Finally, several field test personnel felt that accurately determining flow direction would be beyond the scope of a typical site inspection without expending the additional time and cost necessary to document direction with some level of confidence.

4.3 PROPOSED SURFACE WATER PATHWAY

The proposed HRS divides the surface water pathway into four evaluations representing threats to human health through drinking water, the human food chain, and recreational water use, as well as threats to the environment. As in the current HRS, the likelihood of release category is evaluated as an observed release or as a potential to release. For the proposed HRS, potential to release has two components: overland flow and flooding. The flooding component is new and the overland flow component has been significantly revised. Each proposed surface water threat is analyzed separately for waste characteristics (except hazardous waste quantity) and targets. The target distance for these threats has been extended to 15 miles downstream for both flowing and static water. Targets exposed to actual contamination are assigned higher values than those potentially exposed; targets that are potentially exposed are dilution-weighted based on the flow characteristics of the water available for dilution.

These major changes included in the proposed surface water pathway raised several significant issues during field testing:

- Delineation of the surface water migration path (i.e., use of the target distance limit).
- Use of dilution-weighting factors.
- Use of surface water persistence values.
- Evaluation of human food chain threat targets.
- Evaluation of human recreation threat targets.

4.3.1 Delineation of the Surface Water Migration Path

The surface water migration path includes an overland flow segment and an in-water segment that hazardous substances would travel as they migrate away from the site. In most cases, the distance limit for evaluating proposed surface water targets begins at the probable point of entry to surface water and extends for 15 miles along the in-water segment. For surface waters such as lakes, oceans, and bays, no flow direction is presumed and the distance limit is applied as an arc.

Project participants identified several issues relating to delineation of the surface water migration path. For some sites, it was unclear whether storm sewers and other man-made drainage systems should be included as part of the overland flow segment. Other participants encountered cases where no apparent overland flow segment was present; however, ground water discharges to surface water potentially existed. This type of discharge may occur in situations where the depth to ground water is relatively shallow. Field test personnel commented that the proposed surface water pathway does not address this potential release to surface water. A number of project participants saw this as a deficiency and suggested that criteria for potential horizontal migration of ground water could be added to the proposed surface water pathway. The threat associated with ground water plumes that have not yet reached surface water was felt to be significant at several sites tested.

Project participants also raised issues concerning the in-water segment of the surface water migration path. For sites located near tidally influenced areas, it was difficult to document tidal reversals for evaluating upstream targets (e.g., sensitive environments, fishery resources). Field test personnel were unclear as to how to determine the extent of the tidal run in these situations. In addition, some participants commented that the 15-mile target distance may be too long for linking possible surface water contamination to a site, particularly in coastal settings. Others remarked that assessing targets along the entire in-water segment was time consuming and did not have a significant impact on surface water target factor values when larger bodies of water were involved. Several participants suggested the target distance should be shorter if an observed surface water release cannot be established.

4.3.2 Dilution-Weighting Factors

The proposed surface water pathway uses dilution-weighting factors to evaluate targets; these factors reflect the expected decreased concentration as hazardous substances are diluted in surface waters. Values for potentially exposed targets are multiplied by dilution factors assigned according to the average annual flow of surface water at the target. Seven flow categories (e.g., minimum perennial stream, major river, ocean) are available from which to choose a dilution-weighting factor.

Field test personnel identified several difficulties regarding the estimation of streamflow and the selection of dilution-weighting factors. For several sites, gauging station information was not available to establish streamflow. Project participants were unsure whether field techniques or visual observations could reliably be used to estimate average annual flow. Some commented that these approaches were not very precise and questioned the level of accuracy needed; others felt that such estimates could often be made within the order-of-magnitude range of the factor. Other difficulties in determining flow occurred with:

- Intermittent water bodies.
- Reservoirs, lakes, and ponds.
- Water bodies controlled by engineered structures (e.g., dams, spillways).
- Tidally-influenced systems (e.g., estuaries, marshes, and other waters near coastal areas).

Project participants also remarked that perhaps another flow category should be included in the list of dilution-weighting factors. They felt the dilution-weighting factor for very large rivers such as the Mississippi and Columbia, which have average discharges in excess of 250,000 cubic feet per second (cfs), should be numerically lower than the 0.001 factor given for "major rivers," which is based on flows greater than 10,000 cfs.

Several field test personnel felt that surface water targets closer to the site should receive higher values (i.e., that targets should be weighted by distance as well as by dilution). At some sites, the dilution-weighting factors resulted in targets receiving the same value regardless of whether they were located 1 mile or 15 miles from the probable point of entry to surface water. In addition, the dilution weights used in the proposed surface water pathway to evaluate targets located along major rivers and the oceans generally resulted in these targets receiving relatively low factor values. For example, 50 critical habitats subject to potential contamination must be located along the in-water segment of such surface water bodies for the factor to be assigned at least 1 point.

4.3.3 Use of Surface Water Persistence Values

The current HRS evaluates the persistence of a hazardous substance based on biodegradation. In the proposed HRS, persistence is based not only on biodegration but also on four additional decay processes: hydrolysis, photolysis, volatilization, and free-radical oxidation. The rate of decay for each process is defined by the half-life of the substance. The persistence value is assigned based on this half-life and on the type of water body (e.g., river, lake, ocean) between the probable point of entry and surface water threat targets (i.e., drinking water intakes, fisheries, recreation areas, and sensitive environments).

Several project participants felt that the persistence values assigned to certain hazardous substances were inaccurate. Examples of such persistence values, derived through the proposed HRS evaluation procedures, are given in Table 4-1. For the substances listed in the table, participants expected maximum persistence values for both types of water categories since these compounds are generally considered to be highly persistent in sediments. Some field test personnel commented that the evaluation of persistence for hazardous substances in the proposed HRS tends to be associated with laboratory processes (e.g., free-radical oxidation, photolysis) rather than the fate of chemicals in the surface water environment. For example, sorption of substances onto particulates, and subsequent sedimentation, is a mechanism that may result in the availability of contaminants to surface waters for a much greater period of time than would be predicted using the proposed HRS approach. This type of mechanism is not addressed by persistence under the proposed HRS.

TABLE 4-1
PERSISTENCE VALUES

Substance	Persistence Values by Water Category	
	Rivers/Oceans/Great Lakes	Lakes
PCBs (Aroclor)	3	2
TCDD (Dioxin)	2	1
Chlordane	3	2

4.3.4 Evaluation of Human Food Chain Threat Targets

The current HRS addresses human health risks associated with the food chain through several factors in the target categories of the ground water, surface water, and air pathways. However, none of these factors explicitly evaluates effects to humans via the aquatic food chain. The proposed surface water pathway includes a separate threat evaluation to assess risks from consumption of fish and shellfish taken from surface waters within the migration path. This evaluation consists of three factor categories: likelihood of release, waste characteristics, and targets. The targets category includes two factors -- population and fishery use (the fishery use factor is discussed in Section 3.6.3.1). The population factor consists of two components: actual and potential food chain contamination. The human food chain population value is based on human food chain production (i.e., the annual harvest or yield (in pounds) of human food chain organisms from each fishery under evaluation) and a bioaccumulation potential factor. Production is calculated by estimating the quantity of food chain organisms harvested from fisheries along the surface water migration path. Dilution-weighting factors are used to determine the potential human food chain contamination component of population. Actual and potential contamination populations are added to assign the target population factor value.

Nearly all project participants felt that food chain population was one of the more difficult factors to evaluate in the proposed HRS. Some were unable to obtain actual data on human food chain production and pointed out that the standing crop default values (Table I-5 in the proposed HRS) were incomplete. Others had difficulties with regard to the definition and characterization of fisheries, particularly for tidally-influenced systems. However, several field test personnel remarked that the evaluation of human food chain risks is a significant improvement over the current HRS. Previously, most sites located near coastal areas received low surface water pathway scores because of the emphasis of the current HRS on drinking water. The inclusion of the human food chain threat in the proposed HRS generally increased surface water pathway scores for coastal sites involved in the field test.

Four significant issues relating to the human food chain threat were identified during testing:

- Definition and characterization of fisheries.
- Evaluation of human food chain production.
- Criteria for actual human food chain contamination.
- Possibly high values associated with the human food chain target population.

Project participants encountered situations where the definition and characterization of fisheries along the surface water migration path were difficult. For example, several hatcheries were withdrawing surface water within the target distance for use in propagating and raising fish. In some cases, these fish were not released to nearby surface water but were transported elsewhere for release. Participants questioned whether fish hatcheries met the definition of a fishery for scoring purposes. Others had difficulty with delineating fishery boundaries, particularly for migratory fish such as salmon.

Another issue raised during testing involved the evaluation of human food chain production. A variety of data collection methods were utilized to estimate productivity. These methods included actual catch or harvest information, historical stocking rate data, landings data, standing crop information, and default values for standing crop. For each of these methods, participants encountered difficulties that could potentially result in a loss of accuracy when calculating annual human food chain production. For example, some productivity data consisted of all food chain species, including fish not normally consumed by humans (e.g., menhaden, alewives). Other participants were uncertain about using landings data for commercial catch because the actual harvest locations may be outside the target distance limit.

In the absence of actual data on yield or productivity (including stocking rate data), the revised HRS includes standing crop default values to estimate human food chain production. These values were used for approximately 50 percent of the sites tested that had fishery evaluations. Several field test personnel commented that the table of standing crop default values was incomplete. For example, values were not available for specific fishery habitats (e.g., ponds, streams, lakes) within some states. For other fisheries, several values were available. In such situations, participants were unclear as to which value should be selected for human food chain production. Others had difficulty when a range of values (e.g., 200-300 pounds per acre) was provided. Overall, most field test personnel favored simplifying the table of standing crop default values.

The third issue involved the criteria for documenting actual human food chain contamination. In the proposed HRS, actual contamination may be demonstrated for fisheries along the surface water migration path based on either of the following conditions:

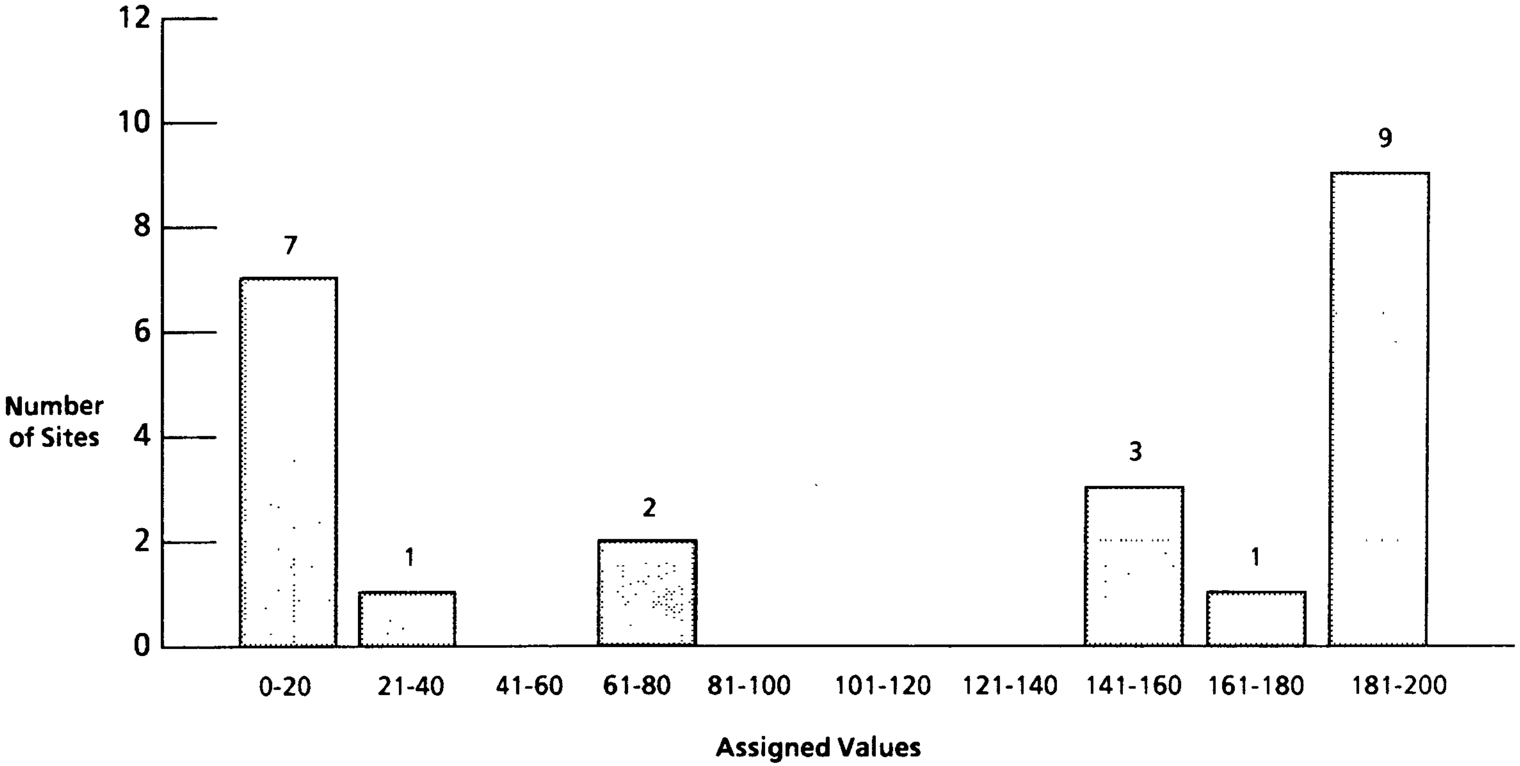
- There is attributable contamination in fish tissue above Food and Drug Administration (FDA) action level standards, and the hazardous substance that exceeds the FDA action level has been documented in an observed release from the site.

- A fishery has been closed and the hazardous substance that caused the closing has been documented in an observed release from the site.

Several participants felt these criteria were too restrictive for documenting actual human food chain contamination. For example, FDA action levels were available for very few of the hazardous substances included in the proposed HRS hazardous substance reference table. Other field test personnel encountered fisheries that were closed due to problems unrelated to hazardous substances (e.g., high bacterial counts). Some suggested the use of state benchmarks, ambient water quality standards, or observed release criteria to demonstrate actual human food chain contamination. Participants also proposed the inclusion of additional levels of food chain contamination similar to those used in the proposed ground water (population factor) and surface water (sensitive environments factor) pathways. These levels could, for example, be applied to situations where fisheries are located between the probable point of entry to surface water and downstream contaminated sediments.

The fourth issue identified during testing involved frequent high values associated with the human food chain target population. Over 50 percent of the sites with fishery evaluations received maximum or near-maximum human food chain population factor values (200 points) (Figure 4-1).

FIGURE 4-1
SURFACE WATER PATHWAY:
FOOD CHAIN THREAT - TARGETS POPULATION FACTOR VALUES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

Population values were generally high for sites near coastal areas or near water bodies with low average annual flows. Several possible mechanisms were suggested as contributing to these high values:

- Target distance that is too extensive for coastal areas.

- Use of the dilution-weighting factors specified for large water bodies, which may not adequately account for the extent of dilution expected.

- Use of the standing crop default values.

- Use of the single highest bioaccumulation potential factor (e.g., bioconcentration factor).

4.3.5 Evaluation of Human Recreation Threat Targets

The current HRS does not evaluate threats to human health through recreational water use except as a subfactor of surface water use. The proposed surface water pathway includes a separate threat evaluation to assess the risk from dermal contact, inhalation, and ingestion during recreational activities in surface water (i.e., swimming or fishing). This evaluation consists of three factor categories: likelihood of release, waste characteristics, and targets. The targets category includes one factor, population, which is dose adjusted for each recreation area within the target distance limit. The population factor consists of two components:

- The estimated number of visits to a recreation area that is actually contaminated. This number is based on the distribution of populations around the area, an accessibility/attractiveness factor (i.e., the type of area present, such as a boat ramp, marina, or beach), and a dose adjusting factor.

- The estimated number of visits to a recreation area threatened by contamination. This number is derived as above, and is adjusted by a dilution-weighting factor.

The value for the highest scoring recreation area is used as the population factor value for the recreation threat.

Project participants commented that the human recreation target population was a difficult factor to evaluate in the proposed HRS. Many felt that the approach for determining population was inaccurate and time consuming. Others noted that, even though considerable effort was required to collect the data to evaluate recreation target population, factor values were assigned low scores for most sites tested (Figure 4-2), and the result contributed little to pathway and overall site scores. Still others commented that the target distances were too long. Some participants remarked that the population factor did not provide meaningful discrimination among recreation areas. The most significant issues included:

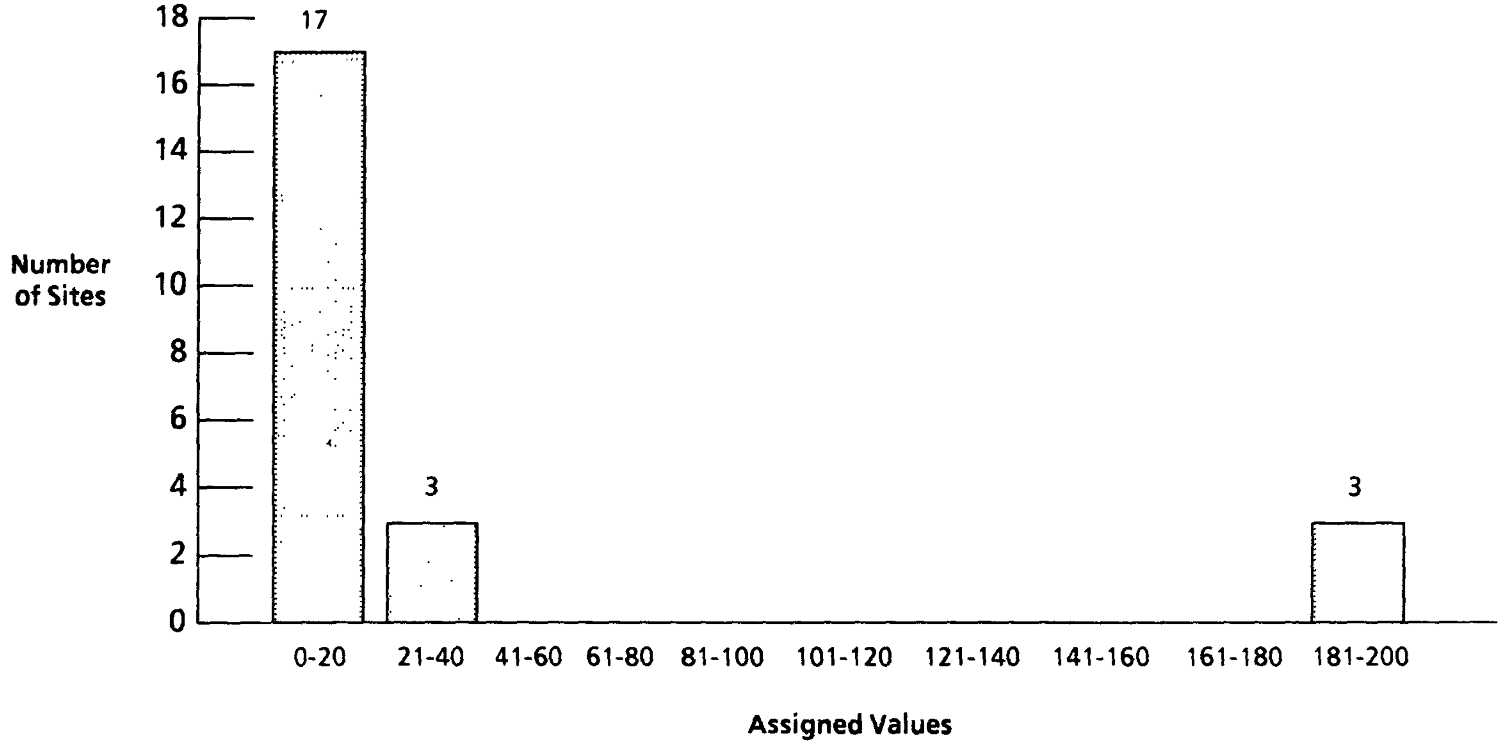
- Definition and characterization of recreation areas.

- Use of the accessibility/attractiveness factor to provide relative differentiation among recreation areas.

- Use of actual recreation population data (e.g., number of visitors per year).

Several field test personnel encountered situations where the definition and characterization of recreation areas within the target distance were difficult. For some sites, recreation activities were identified along the in-water segment that did not meet the strict definition of a recreation activity. Project participants pointed out that the proposed HRS does not consider recreation involving

FIGURE 4-2
SURFACE WATER PATHWAY:
RECREATION THREAT - TARGETS POPULATION FACTOR VALUES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

canoeists, boaters, sailors, or outdoorsmen (i.e., the definition is restricted to fishing and swimming). Other participants had difficulties with delineating recreation area boundaries and determining the access point from which to measure target populations, particularly when several miles of surface water were used for recreation/sport fishing. Finally, some participants were unclear as to the definition of a recreation area subject to actual contamination. For example, difficulties arose in cases where the recreation area was located between the probable point of entry to surface water and downstream contaminated sediments.

The second issue regarding recreation population involved the use of the accessibility/attractiveness factor. In the proposed HRS, the accessibility/attractiveness factor determines the distance over which the target population is estimated for each recreation area. Project participants commented that the accessibility/attractiveness factor does not reflect the relative attractiveness of the actual surface water body, but is generally based on capital use and access improvements for specific types of recreation areas. For example, a recreation area could be defined by a bridge crossing a river, if waterfront access to the public is provided. Some field test personnel remarked that this definition may be unreasonable if only limited recreation activities occur in the vicinity of the bridge. Others noted that the number of access points to the water body should be considered because greater accessibility provides more opportunities for recreational water use.

As mentioned previously for the human food chain threat, project participants felt that target distances for estimating the recreation population were too long. These distances range from 10 to 125 miles, depending on the type of recreation area identified along the surface water migration path. Some commented that it is not realistic to assume that a waterfront picnic area will attract populations from a 125-mile radius, especially when more attractive recreation areas are present within the radius. As a result, several field test personnel suggested using actual visitor data (when available) to determine the recreation threat target population. For many private and public recreation areas, this information was readily available and provided a more accurate assessment of the population at risk. Other participants remarked that perhaps a population default value could be developed for areas where no visitor data could be obtained, such as locations used for sport fishing and local swimming holes.

4.4 PROPOSED ONSITE EXPOSURE PATHWAY

The new onsite exposure pathway evaluates threats to human health and the environment through direct, physical contact with hazardous wastes or contaminated soil. These threats include the resident population -- those targets (people or terrestrial sensitive environments) within the boundaries of a contaminated property -- and the nearby population -- those people living within a one-mile travel distance of the site. Both evaluations consist of three factor categories: likelihood of exposure, waste characteristics, and targets.

A number of project participants felt the onsite exposure pathway was the easiest to evaluate among the four proposed HRS pathways. Several issues associated with this pathway have been discussed in other sections of this report. These issues include:

- Definition of onsite (or resident) target populations (Section 3.6.1.2).

- Analytic requirements for calculating waste quantity (i.e., delineation of the area of surficial contamination) (Section 3.3.1).

Two other significant issues and findings were identified during field testing:

- Evaluation of likelihood of exposure.
- Evaluation of resident and nearby target populations.

4.4.1 Evaluation of Likelihood of Exposure

Field test personnel made several comments regarding the evaluation of the likelihood of exposure factor category. For the resident population threat, likelihood of exposure is evaluated based only on the presence of observed contamination, not on potential to release. The criteria for observed contamination require analytic evidence of hazardous substances in soils or sources containing shallow wastes (i.e., on or above the surface, or not more than two feet below the surface). In addition, contamination may be inferred for areas between the site and the locations used to provide the analytic evidence. Based on these criteria, project participants questioned whether leachate, sediment, or seepage samples could be used to document observed contamination. Others commented that the criteria for contamination do not include a containment factor. At one test site, a thin layer of asphalt covered shallow contaminated soils; participants felt that this situation was not representative of observed contamination.

For the nearby population threat, likelihood of exposure is based on the quantity of hazardous waste on the site and the site's accessibility/frequency of use. The quantity of hazardous waste is primarily expressed as the total areal extent of contamination; areal extent serves as an indicator of the probability of human contact with shallow wastes. As discussed in Section 3.3.1, participants encountered several difficulties in determining the extent of contamination. Other additional uncertainties involved:

- Definition of the contaminated area to be included for determining waste quantity.
- Treatment of sources where only a portion of the source contains wastes within two feet of the surface (e.g., thickness of cover material varies across the surface of a landfill).

The accessibility/frequency of use factor is evaluated based on the physical characteristics of the site, along with the type of property (e.g., park, playground, school) exhibiting contamination. Some participants commented that there was no assigned value for observed contamination found solely on residential property. In addition, others remarked that this factor does not account for contaminated property or land used heavily for recreation but not formally designated for public use. Some project participants felt this factor should be more related to the characteristics of the contaminated land in attracting neighboring populations.

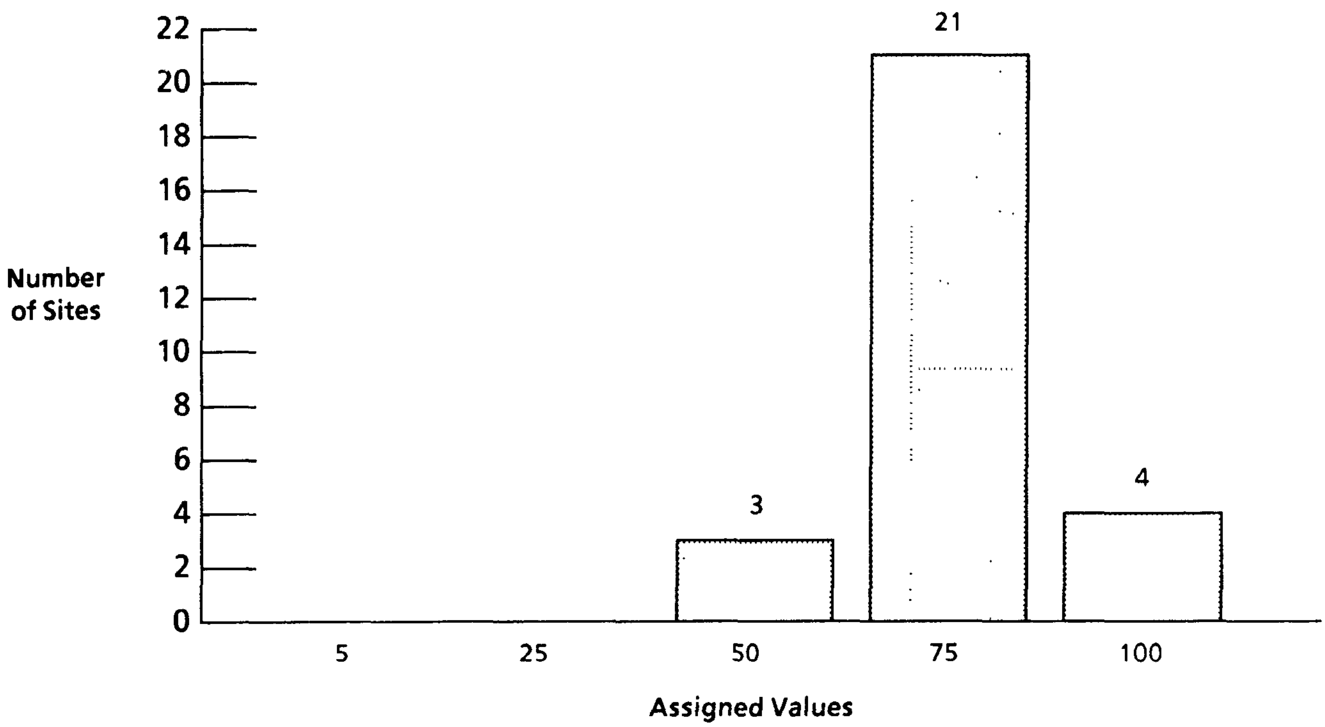
The accessibility/frequency of use factor values for sites tested are generally clustered at the high end of the scale of values (Figure 4-3).

4.4.2 Evaluation of Resident and Nearby Target Populations

The second significant issue regarding the proposed onsite exposure pathway was the evaluation of resident and nearby target populations. Some field test personnel had difficulty with the definition of terrestrial sensitive environments which are assessed under the resident population threat. For example, participants were unclear whether areas associated with Federally designated endangered species such as waterfowl met the eligibility criteria for terrestrial sensitive environments. At two sites, endangered birds were nesting or flying in locations above the areal extent of contamination but were not actually seen on the ground. For these cases, field test personnel questioned whether these areas should be evaluated as terrestrial sensitive environments.

Project participants also had difficulties regarding the evaluation of resident human target populations. At some sites, field test personnel encountered obstacles in obtaining access to nearby potentially contaminated properties, particularly residences. Without such access, documenting the presence of additional observed contamination for these properties was difficult. In addition, participants sometimes did not have enough information prior to the site inspection to assume that nearby properties might be contaminated. Consequently, sampling plans for several sites tested did

FIGURE 4-3
ONSITE EXPOSURE PATHWAY:
NEARBY POPULATION THREAT - USE FACTOR VALUES
(Based on 28 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

not include the collection of samples from nearby properties, and resident human target populations were not always evaluated. Finally, some project participants highlighted a difficulty associated with inferring contamination of properties located between sample "hits." These participants noted that, due to the potentially large impact of the resident population target factor on pathway and overall site scores, scores could be overestimated unless each target property that is scored as contaminated is documented based on analytic results.

Under the nearby population threat, the target factor is evaluated based on the population within a one-mile travel distance from the site. The travel distance is measured along a straight line unless natural barriers, such as rivers, are present. Some participants were unclear as to the definition of natural barriers to travel; others were in favor of possibly including physical or man-made barriers to travel (e.g., highways, topographic features, elevated railroads).

SECTION 5

COST ANALYSIS

5.0 INTRODUCTION

This section provides an analysis of the cost data generated from the field test sites. The principal objective of the analysis is to identify a "best estimate" of the average and range of costs incurred to support the data requirements of the proposed HRS at the field test sites. Costs are defined in terms of dollars, FIT technical level of effort (LOE) hours, and number of analytic samples. Subsidiary objectives include the identification of specific cost categories and cost elements that contributed most significantly to overall costs at these sites and may, therefore, be candidates for the formulation of cost reduction strategies. However, no attempt has been made to evaluate the cost effectiveness of individual data elements in terms of their relative contribution to scoring requirements, or the cost effectiveness of different approaches to collecting equivalent data. These are considerations that might also influence the development of cost reduction strategies.

During the field test, FIT personnel tracked and recorded the costs associated with their site inspections. A standardized cost reporting form was used for this purpose, requesting specific costs for over 200 individual data elements at a level of detail corresponding to proposed HRS factors and subfactors. A uniform charge rate for FIT technical LOE was assumed at $50 per hour. This rate includes direct labor, equipment, travel and living expenses, expendables, and overhead. Not included in this rate are subcontract charges, which were reported on an actual cost basis. Contract Laboratory Program (CLP) charges for full Target Compound List (TCL) sample analysis were assumed to be $1,000 per sample (i.e., full organic and inorganic fraction analyses) and special analytical services (SAS) were assumed at $1,500 per sample (e.g., very low detection limits; high concentration samples; analysis for special, non-TCL substances). (SAS charges also include full organic and inorganic fraction analyses.) These figures approximate the current (1989) average costs experienced nationwide under the CLP. In cases where something less than full TCL analysis was performed, and/or actual analytic costs were readily accessible, the actual costs were used. Note that SAS charges for fast turnaround were not included.

5.1 METHODOLOGY

Prior to analysis, the cost data submitted by FIT were subjected to a data refinement process. Several factors made the development and application of such a process necessary. These factors, and associated data refinement objectives, are described below.

- Persons responsible for tracking and reporting costs associated with a site (usually the site manager) tended to have different ideas as to what specific cost data should be reported and where on the form these data should be placed. There was a need, therefore, to improve the uniformity of reporting and the assumptions employed, both within and between individual cost packages.

- The field test was, in fact, a test of the proposed HRS itself, its data requirements, and the means available to satisfy those requirements. As such, FIT personnel were encouraged to test new sources of information, innovative methods of acquiring data, and even duplicative means of obtaining the same data. In many cases, the reported costs thus included elements that would not likely be a part of future site inspection activities in support of the proposed HRS, but were performed primarily for testing purposes. Such elements were isolated and excluded from the analysis.

- Sites had different levels of available information pre-dating the field test. For some sites, extensive investigations had already been performed by FIT, EPA's Technical Assistance Teams (TATs), state agencies, or potentially responsible parties (PRPs). At these sites, the availability of existing analytic data and in-place monitoring wells often had a substantial effect in reducing FIT cost expenditures during the field test. By contrast, other sites had very little data available prior to the field test. In order to normalize costs, it was thus necessary to establish a common "starting point" for all sites. For this purpose, the cost of developing previously available data which were useful to FIT and were consistent with FIT data needs in support of proposed HRS scoring (whether such data had been previously developed by FIT or by other entities) were estimated and included in overall site costs. In this way, all sites were costed as if FIT had been the sole investigatory entity, all sites were costed from a common "starting point" (of little available pre-existing data), and the reported costs better reflect the true total cost of data acquisition to support proposed HRS scoring. Pre-existing data which were not representative of the type of data that FIT would develop, or were not consistent with the data requirements of the proposed HRS, were not costed for inclusion in the analysis.

- At some sites, inspections may have been constrained by time and/or weather limitations. For example, some project participants felt that air sampling would have been conducted at their sites at any other time of the year (most of the field test site inspections, by necessity, occurred during the winter). For these sites, the costs of air sampling programs were estimated and included in the analysis, again, in order to better reflect the true total cost of data acquisition. At other sites, time and weather conspired to cut short sampling or well installation programs. In such cases, the full cost of planned activities was estimated and used for the analysis.

- Most of the personnel involved in the field test felt that, as a result of the field test experience, they had learned a great deal about the proposed HRS, how it operates, and what its data requirements are. In some cases, project participants felt that, given this higher level of experience and comfort with the model, some aspects of their site inspections might have been conducted differently. For such sites, these considerations were reflected in the reported costs in order to establish a common "ending point" among sites that represents, as much as possible, a level of data availability and quality that is representative of the requirements for site scoring with the proposed HRS.

The data refinement process consisted of a detailed examination and evaluation of the raw, "as reported" data, followed by an in-depth discussion with the project participants responsible for reporting site costs. These discussions covered the full range of cost elements and included evaluation of cost reasonableness or typicality; data collection methodologies; and sampling strategies, alternatives, and lessons learned. On the basis of these discussions, the dollars, LOE hours, and/or number of samples associated with some specific cost elements were adjusted, within the context of the objectives outlined above, and with the concurrence of the FIT representative. While this data refinement process served to "normalize" costs and establish a common framework for cost reporting, the process should not be construed as one of "optimization." The resultant costs reflect the views of individual FIT personnel as to appropriate data collection and evaluation procedures for their individual sites; "real world" delays and inefficiencies occasionally occurred and are reflected in the reported costs; and least cost methodologies were not always employed.

5.2 DATABASE DEVELOPMENT

Following the refinement process, all data were entered into a computerized database. The database was built from data elements corresponding, or analogous, to proposed HRS factors and subfactors. These were used to build costs to the factor category, pathway, and site levels. Pathway-level data totals consist of the four proposed HRS pathways (air, ground water, surface water, and onsite exposure) plus two other categories which have been defined for analytical purposes: general tasks; and site, source, and waste characterization.

The general tasks category consists of cost elements that tend to be non-pathway-specific and non-data-generating. These include project planning and management; mobilization, demobilization, and travel; data validation; preparation of the proposed HRS scoring package and documentation; and collection of QA/QC samples (blanks and duplicates, which tend to be media-specific rather than pathway-specific).

The components of the site, source, and waste characterization category are cost elements that are data-generating but also tend to be non-pathway-specific. These data elements tend to be collected and evaluated within the context of site/source/waste characterization rather than within the context of individual pathway evaluation. Included are: identifying and evaluating sources and source containment; identifying site hazardous substances; evaluating hazardous waste quantity and other pathway-specific waste characteristics factors; and collecting non-pathway-specific, multipurpose samples (such as soil or source samples which can be applied to the identification of hazardous substances, establishment of near-surface contamination, and evaluation of hazardous waste quantity).

Totals for the four proposed HRS pathways include the costs associated with pathway-specific subcontracts, likelihood of release, targets evaluation, and pathway-specific environmental samples (those associated with observed release and targets).

5.3 DISCUSSION

The following subsections present and discuss the results of the cost analysis, which is based on 24 field test sites (five sites were not included in the analysis due to data constraints). Costs are examined on the basis of site and pathway totals, and include technical LOE hours, dollar expenditures, and number of analytic samples. LOE hours represent the time involved in planning and conducting the site inspection, acquiring and evaluating data, scoring the site and preparing the initial scoring package and documentation record, and internal FIT review and revision. Not included are EPA reviews and FIT response to such reviews. Dollar totals include the costs of FIT LOE, subcontracted work, and CLP analysis. In the discussions of proposed HRS costs that follow, the actual range and average values derived from the refined cost data for the 24 sites are given, though LOE has been rounded to the nearest ten hours and dollar costs are generally rounded to the nearest thousand. These figures are discussed in the following subsections and summarized in Section 5.4 below.

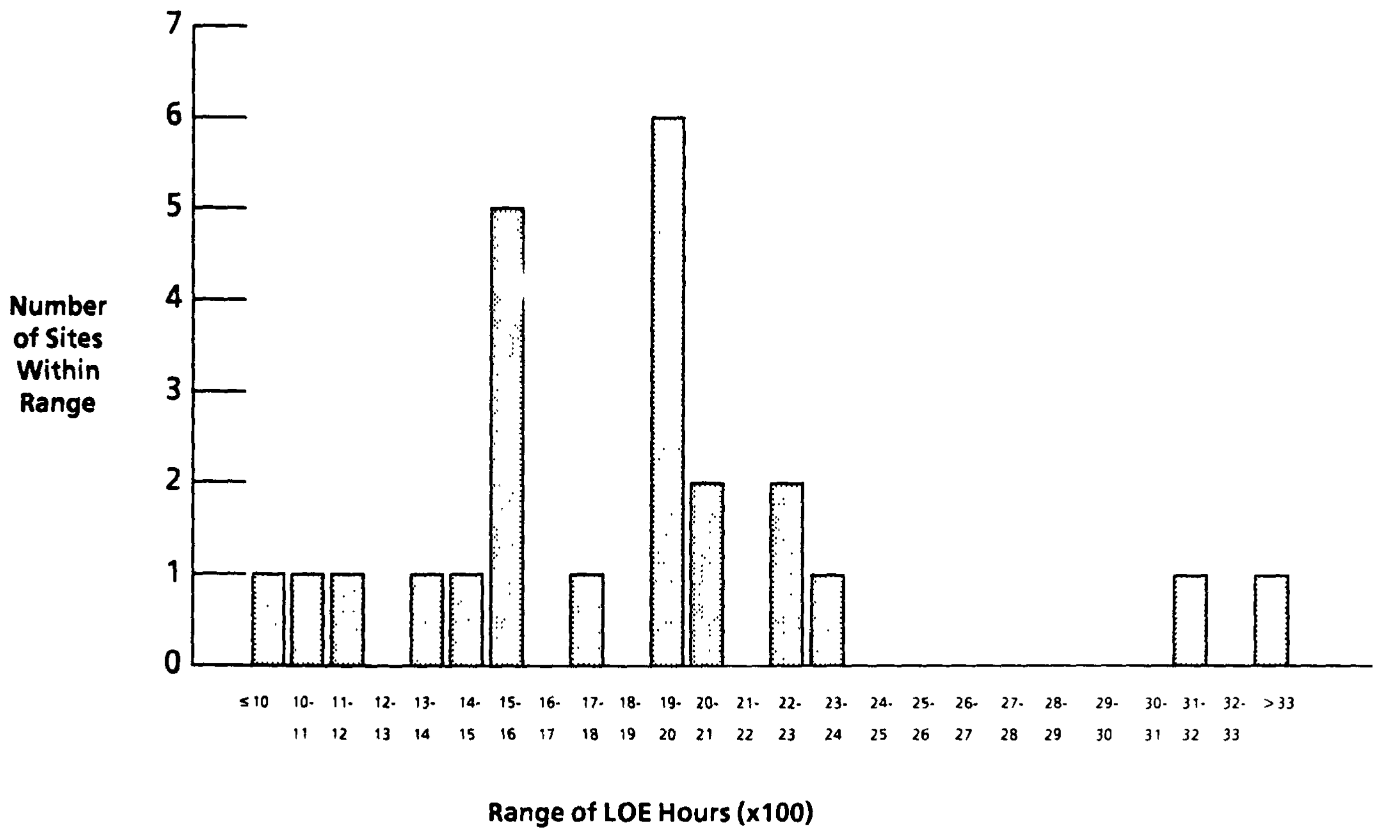
5.3.1 Total Site Costs

The range of total site LOE was 970 to 3,310 hours, with an average of 1,860 hours. Only two sites, however, were in excess of 2,320 hours and three sites were at or below 1,120 hours; most sites fell in the range of 1,320 to 2,320 hours. The distribution of site LOE is shown in Figure 5-1.

The dollar cost ranged from $100,000 to $311,000 (Figure 5-2), and averaged $176,000. Only two sites were in the range above $220,000 and three sites were below $120,000; most sites were within the range of $130,000 to $220,000.

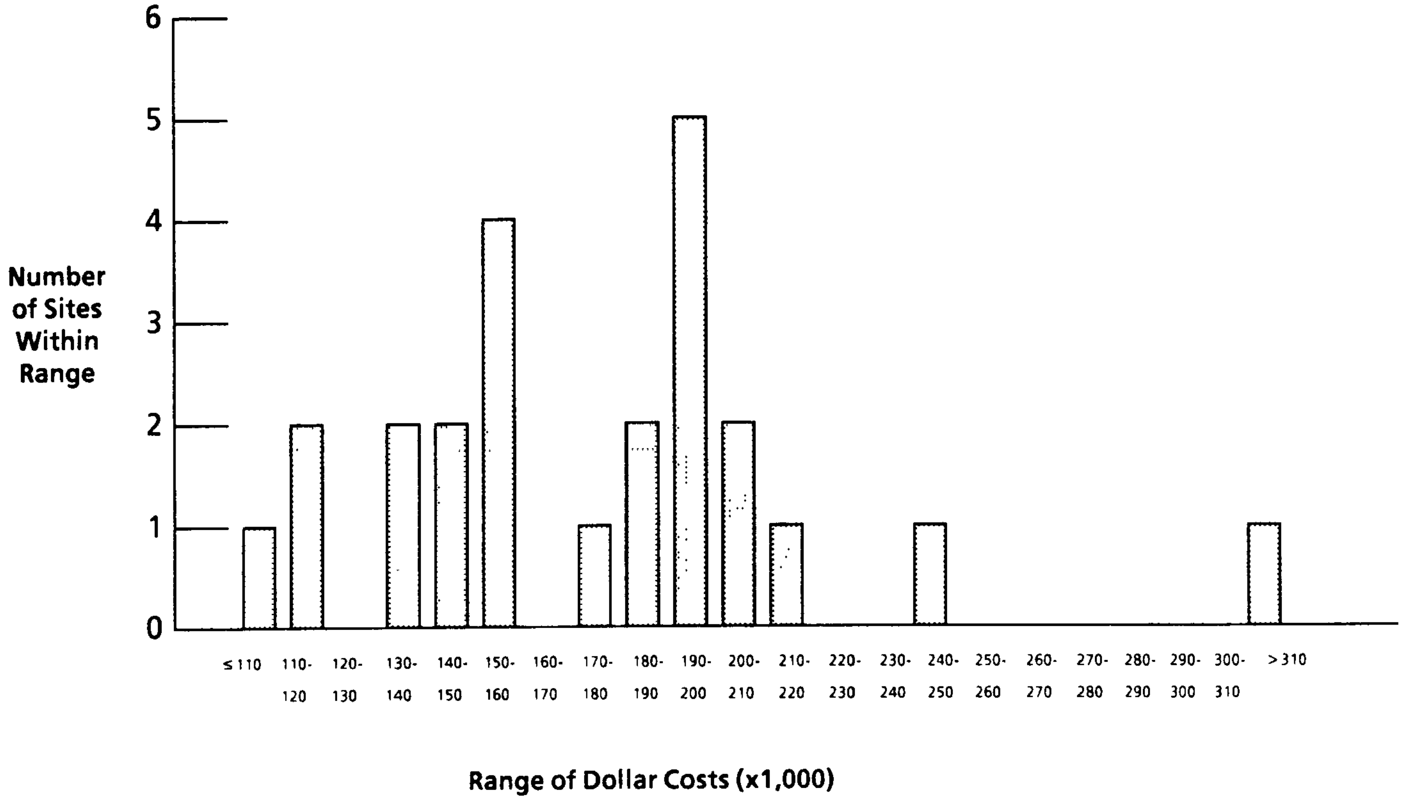
The number of CLP samples costed at field test sites ranged from 34 to 98 (Figure 5-3) and averaged 63. Field screening (FASP) was conducted at nine sites. Theoretically, FASP should reduce the number of samples requiring CLP analysis by providing in-field identification of samples that are in fact contaminated. One might expect the sites where FASP techniques were used to be among those with the lowest number of CLP samples. However, this was not always the case: four of the FASP sites (employing 11 to 46 FASP samples) required fewer than the average number of CLP samples (a range

FIGURE 5-1
TOTAL SITE LOE HOURS
(Based on Field Test Sites)



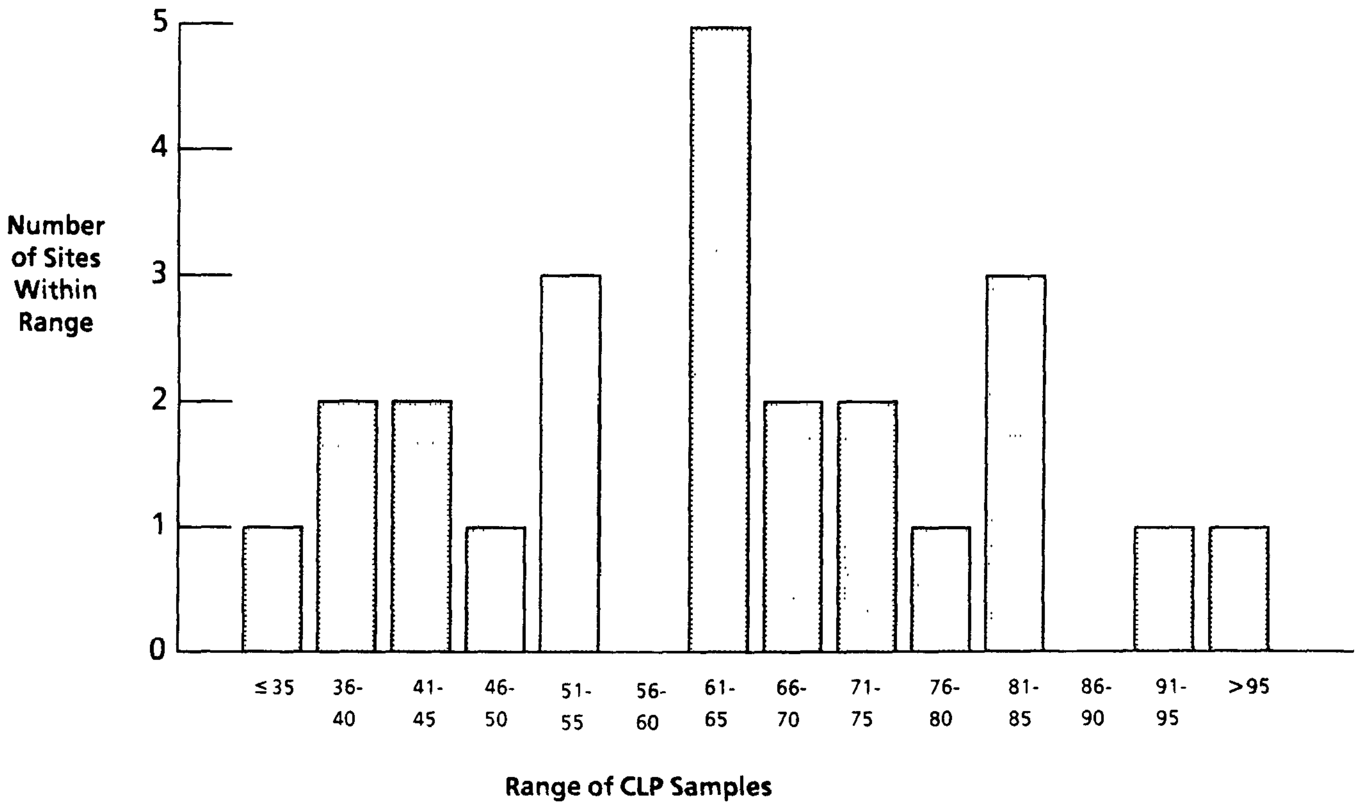
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-2
TOTAL SITE DOLLAR COST
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-3
TOTAL SITE CLP SAMPLES
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

of 38 to 44); two of the FASP sites (with 26 and 57 FASP samples) had about average numbers of CLP samples (64 and 65); and three of the FASP sites (having 22 to 81 FASP samples) involved higher than average CLP sampling (77 to 91). These results may be attributable to unfamiliarity with the field screening concept and its implementation, since this is a relatively new technique being employed at sites and full implementation of FASP in terms of equipment and capabilities has not yet been realized.

Figures 5-4 through 5-6 show the average proportion of total site LOE, total site dollars, and CLP samples contributed by each of the six cost categories. Note that, while all sites included samples for site, source, and waste characterization, and for QA/QC (general tasks) purposes, not all sites involved sampling within all four proposed HRS pathways. The percentages illustrated in Figure 5-6 do not reflect this subtlety but, rather, show the proportionate representation, by category, of all CLP samples collected during the field test.

It is of interest to note that, combined, the two categories of general tasks and site, source, and waste characterization constituted the majority of average total site costs for all three types of costs:

	LOE (% of Total)	Dollars (% of Total)	CLP Samples (% of Total)
General Tasks	52	35	17
Site, Source, and Waste Characterization	15	23	37
	67	58	54

5.3.2 General Tasks

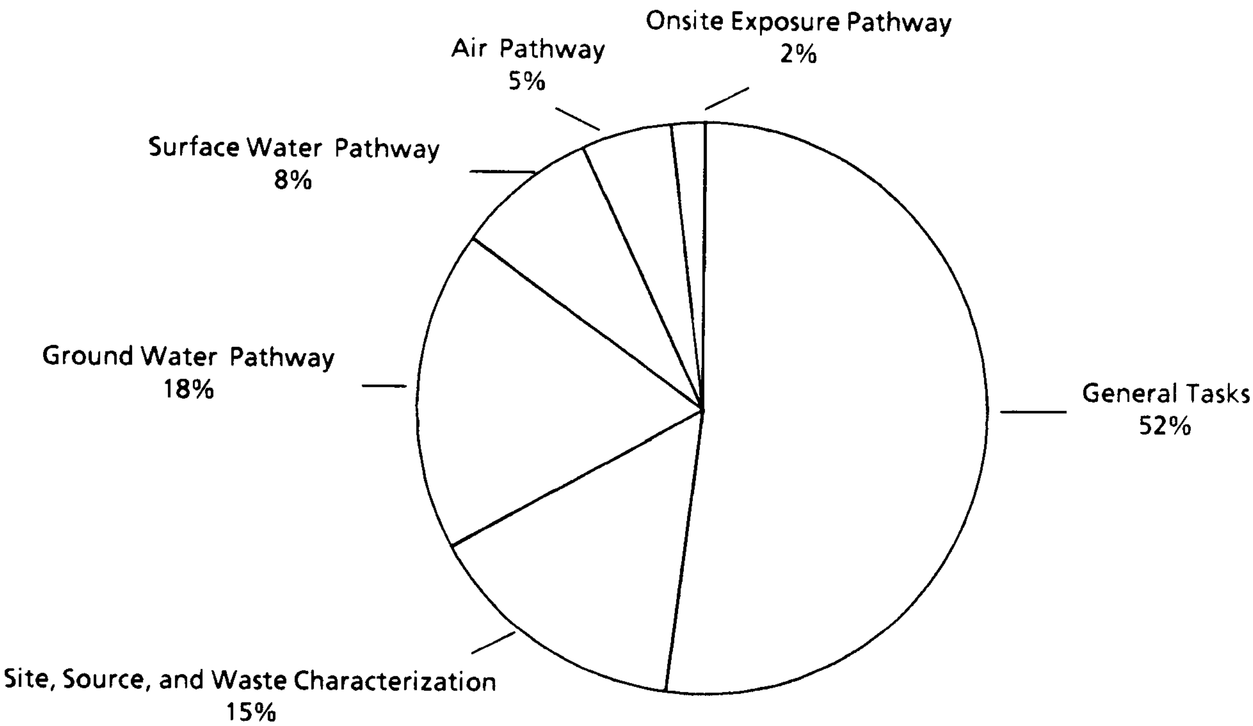
Among the six reporting categories, general tasks was the most costly in terms of both LOE and dollars. LOE ranged from 480 to 1,500 hours (Figure 5-7), and averaged 960 hours. Most sites fell within the range of 600 to 1,300 hours; only one was below this range and two were above. In relative terms, as noted above, general tasks accounted for fully one-half (52 percent) of average total site LOE, ranging from 39 to as much as 70 percent.

The dollar cost of general tasks ranged from $39,000 to $84,000, and averaged $59,000. Figure 5-8 shows the distribution of sites over this range. General tasks accounted for about one-third of average total site dollars.

Among the components of general tasks, project planning and management was the largest source of both LOE and dollar costs. LOE for this element ranged from 100 to 870 hours, with all but one site within the range of 100 to 600 hours. The average was 340 hours, which is 36 percent of average total general tasks LOE and 18 percent of average total site LOE. In dollar terms, the range was $5,000 to $43,000, with all but one site in the range of $5,000 to $30,000. The 24 sites averaged $17,000, or 29 percent of average total general tasks and 10 percent of average total site dollars. During the data refinement discussions with FIT personnel, almost all of the project participants interviewed felt that a significant "learning curve" associated with the proposed HRS was attached to the cost of project management, and the raw figures for individual sites were accordingly adjusted downward through further discussion. The figures reported here are the lower, "refined" figures.

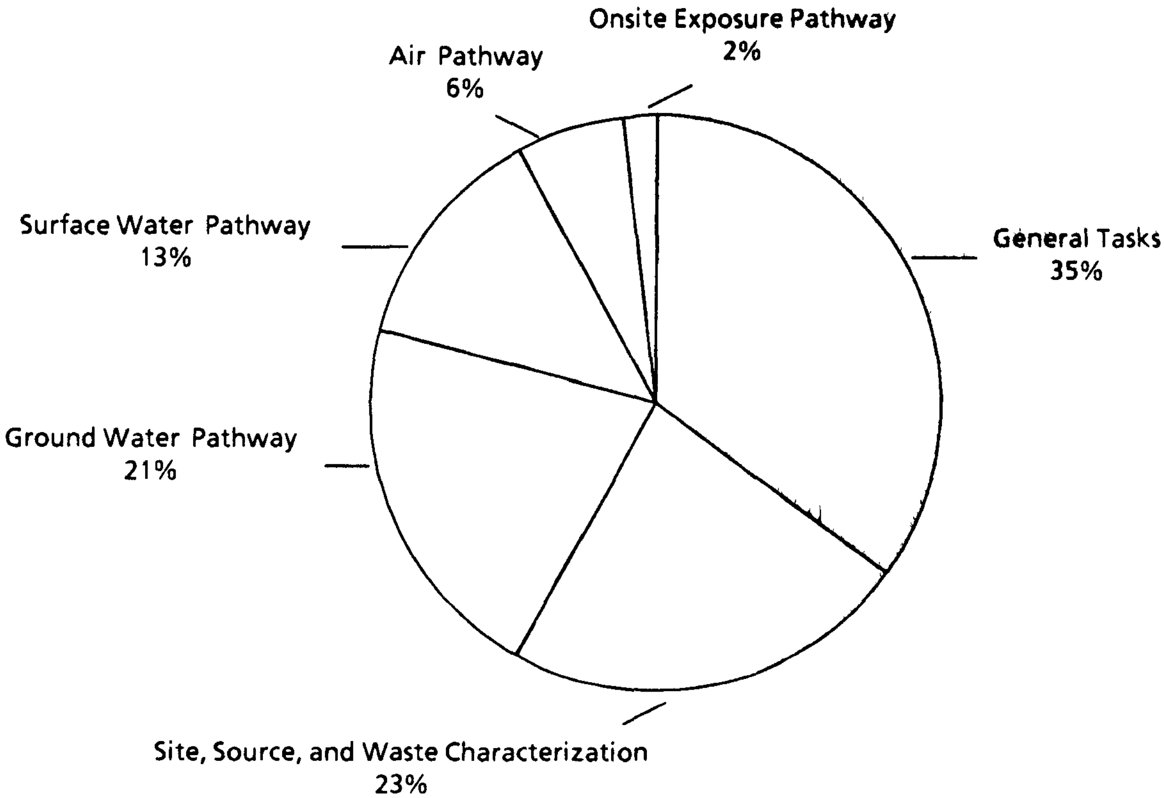
Mobilization, demobilization, and travel ranged from 90 to as much as 700 hours, though all but one site fell into the range of 90 to about 420 hours. The average was 240 hours. This cost element was highly variable between sites and is a function not only of distance of the site from the FIT office, but also of team size and the number of field trips made to the site.

FIGURE 5-4
PROPORTION OF TOTAL SITE LOE, BY CATEGORY
(Based on Field Test Sites)



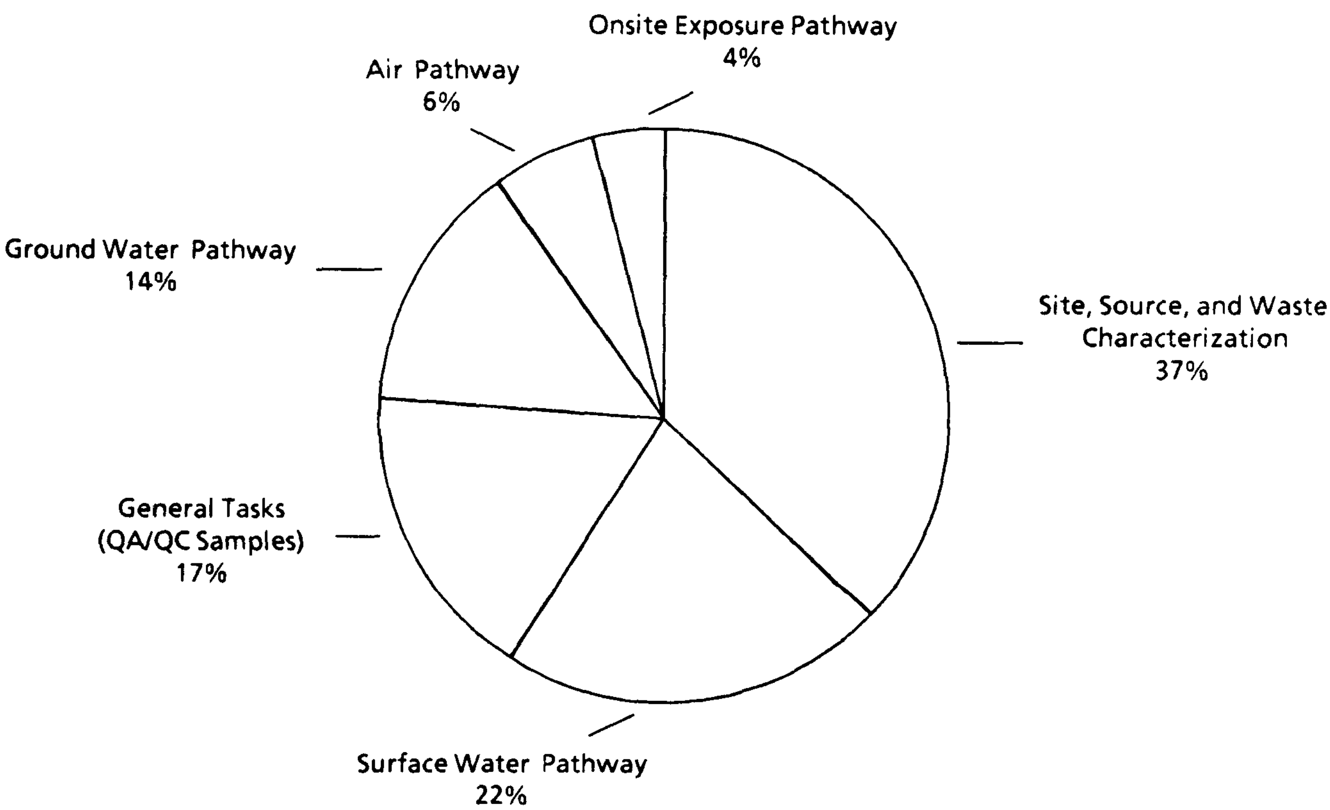
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-5
PROPORTION OF TOTAL SITE DOLLARS, BY CATEGORY
(Based on Field Test Sites)



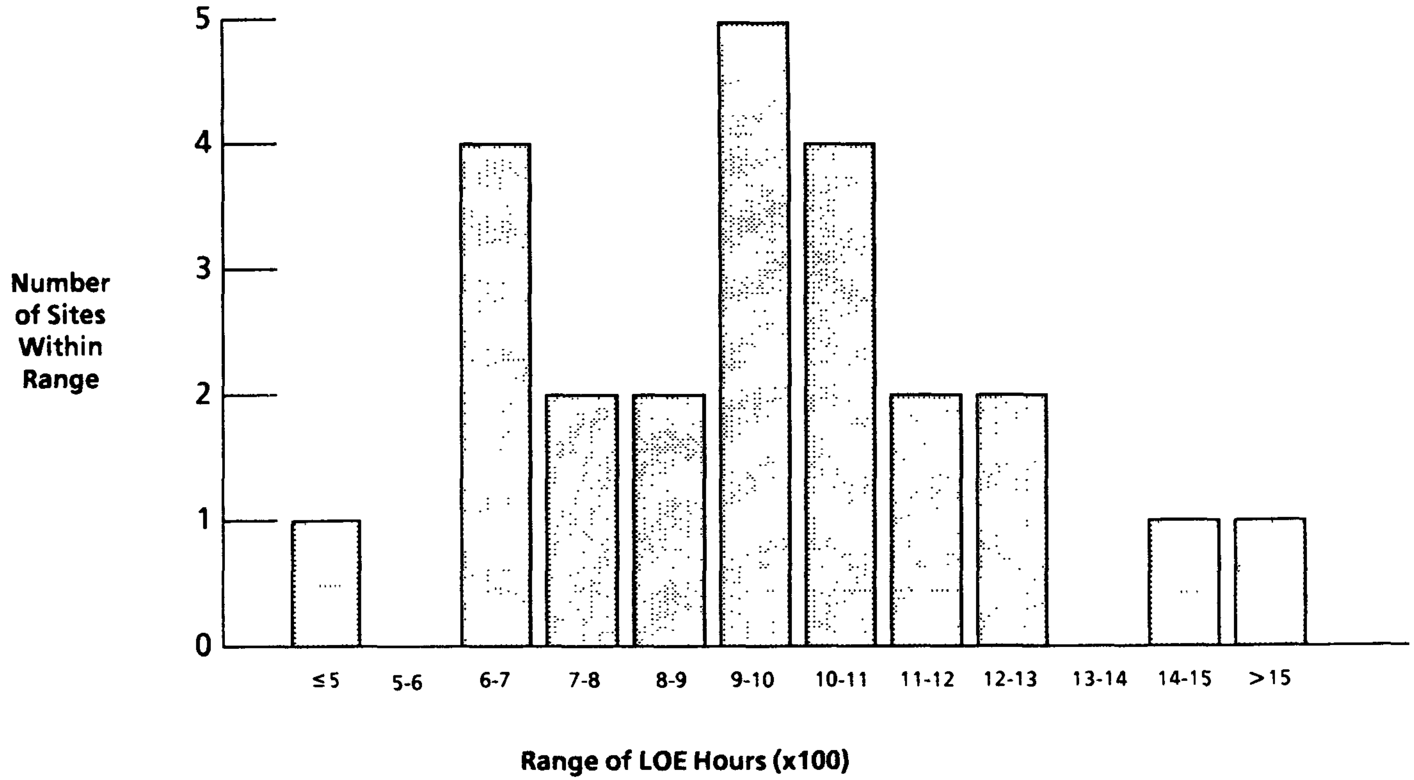
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-6
PROPORTIONATE DISTRIBUTION OF CLP SAMPLES
(Based on Field Test Sites)



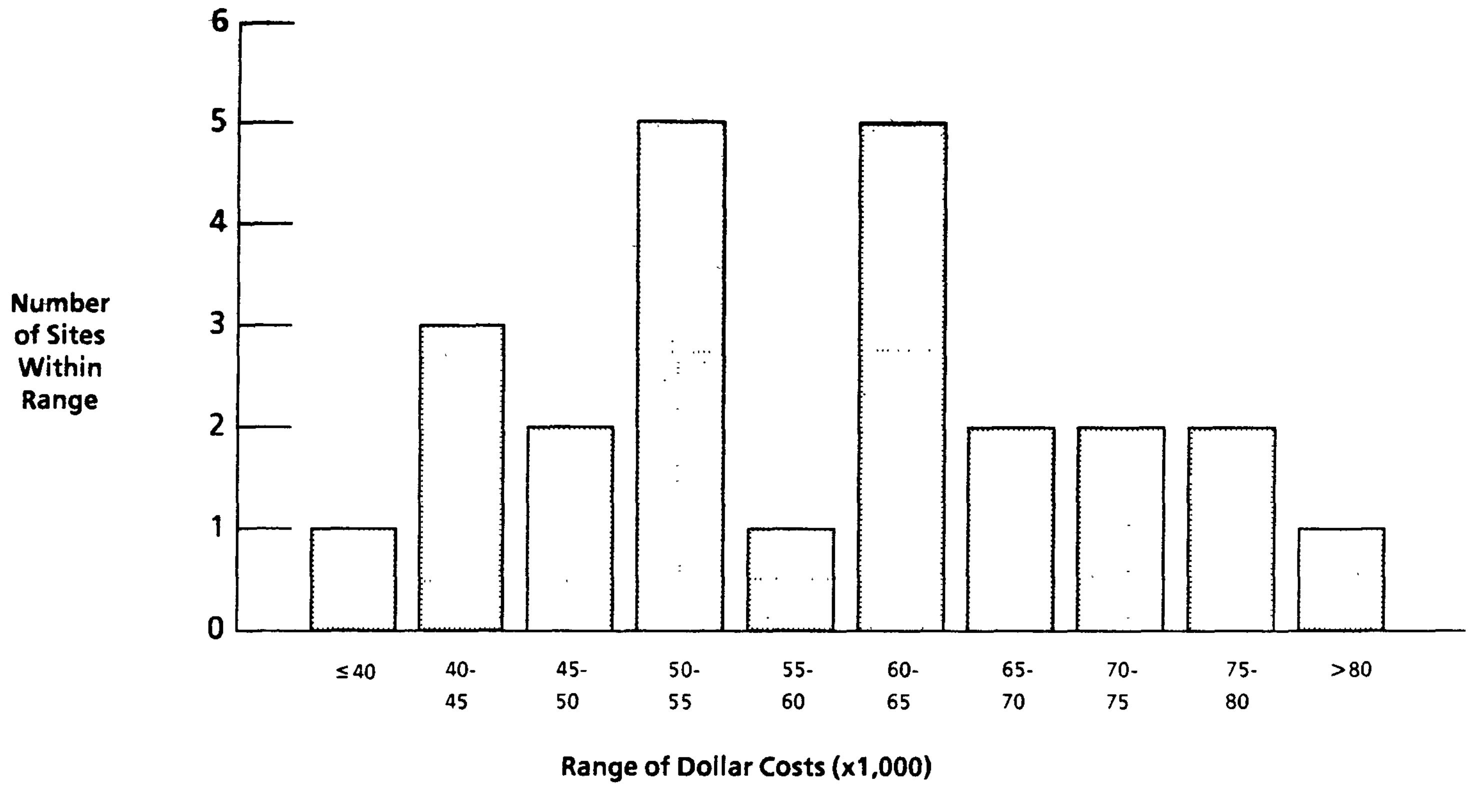
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-7
GENERAL TASKS LOE HOURS
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-8
GENERAL TASKS DOLLAR COST
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

Data validation costs were found to vary by the number of samples and analytic fractions involved, and by Regional differences in data validation requirements. In some Regions, data validation is performed directly by FIT; in other Regions it is performed by EPA's Environmental Services Division (ESD) or is subcontracted to a third party. To normalize these differences, data validation was costed, in all cases, at a rate estimated as that which would be required if the work were performed by FIT. In most cases, FIT was able to supply such estimates based on previous data validation experience. For the field test sites, data validation ranged from 50 to 380 hours and averaged about 180 hours. Most sites required between 100 and 300 hours.

Preparation of the proposed HRS documentation and scoring package for tested sites ranged from 60 to 400 hours (though only two sites were above 250 hours), with an average of 150 hours. These hours represent the development of scores from collected data and the preparation of documentation. They do not include the acquisition of data necessary to support factor scores; data acquisition LOE is reflected within the individual pathway factors. Nor do they include EPA Regional and Headquarters review of submitted packages or FIT response to such reviews. Like project planning and management, most project participants interviewed felt that there was a significant learning curve involved here and that the experience of having learned the proposed HRS during the course of the field test would result in more efficient site scoring at future sites. The figures reported here reflect this view.

The final element within general tasks is QA/QC samples, and LOE for these was generally modest. LOE ranged from less than 10 to 150 hours, though only one site involved more than 65 hours. The range of dollar costs was $5,000 to $24,000, and this was keyed directly to the number of QA/QC samples undergoing CLP analysis (a range of 3 to 17, average of 11).

5.3.3 Site, Source, and Waste Characterization

The LOE required for the site, source, and waste characterization category at the 24 sites represented, on average, 15 percent of total site LOE. The range was 80 to 530 hours with an average of 280 hours (Figure 5-9). Only one site required less than 130 hours. Collection of CLP samples required about one-third of the LOE expended in this category, while all other activities accounted for two-thirds.

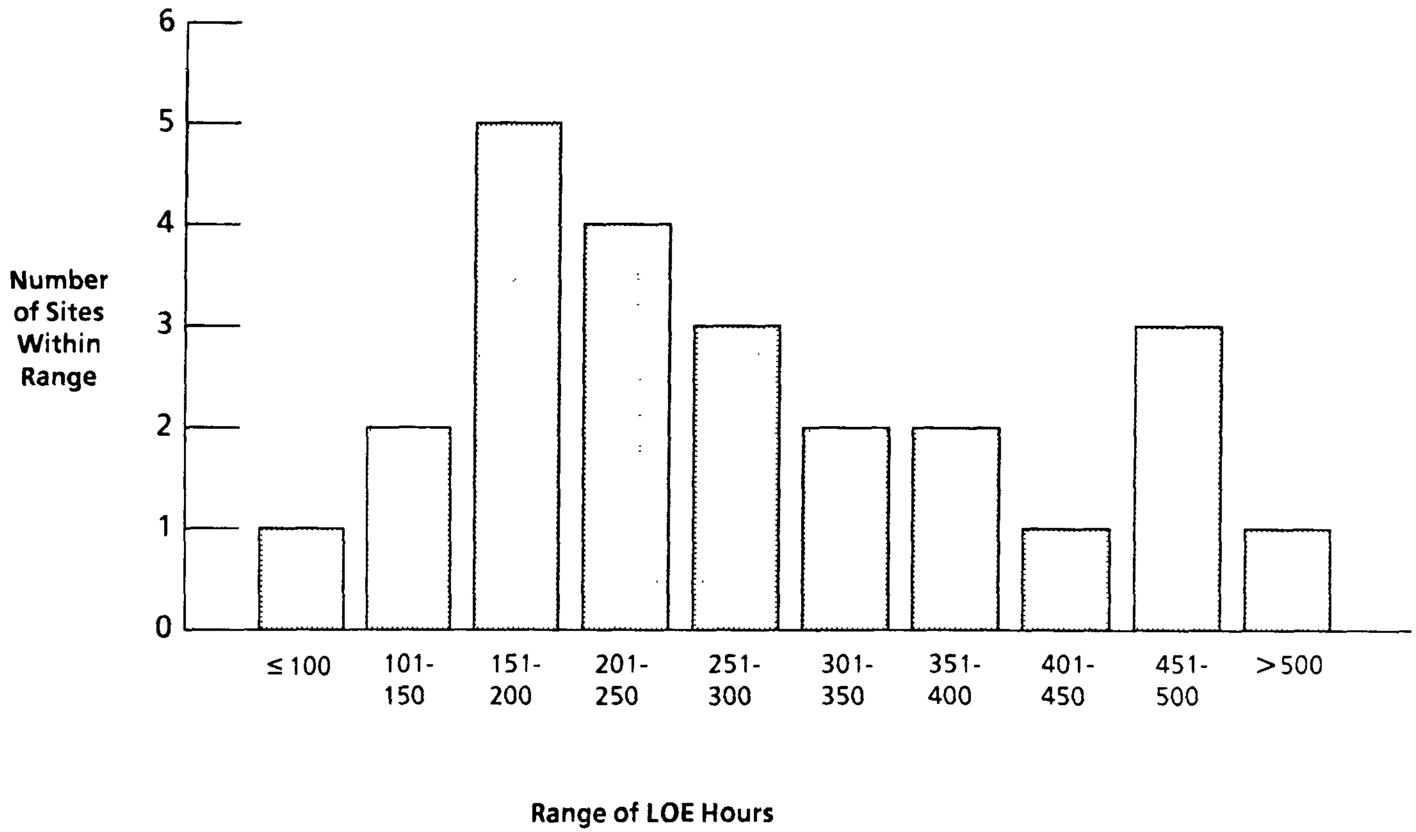
Among the six cost categories, site, source, and waste characterization was second highest in terms of dollar cost, representing nearly one-quarter of average total site dollars. Figure 5-10 shows the cost distribution which ranged from about $20,000 to $79,000, averaging $40,000. Only one site involved more than $64,000. Costs associated with CLP samples (LOE and analytic charges) in this category accounted for 76 percent of average total dollar cost; the number of samples ranged from 10 to 46 and averaged 24. All but two sites involved 32 or fewer samples for site, source, and waste characterization.

5.3.4 Proposed Ground Water Pathway

While all of the proposed HRS pathways may require environmental sampling, the ground water pathway also often required the installation of monitoring wells or boreholes at field test sites. As a result, among the proposed HRS pathways, ground water was by far the largest contributor to total site LOE, representing 18 percent of average total site LOE -- which is more than the other three pathways combined. Dollar costs were also considerably higher than those of the other pathways and, at 21 percent of the site total, were about equivalent to the other three pathways combined. Total ground water pathway LOE ranged from a low of 50 to a high of 1,360 hours (Figure 5-11). Dollar costs ranged from under $3,000 to $156,000 (Figure 5-12). The inclusion and extent of drilling programs were a major factor in these wide ranges of costs.

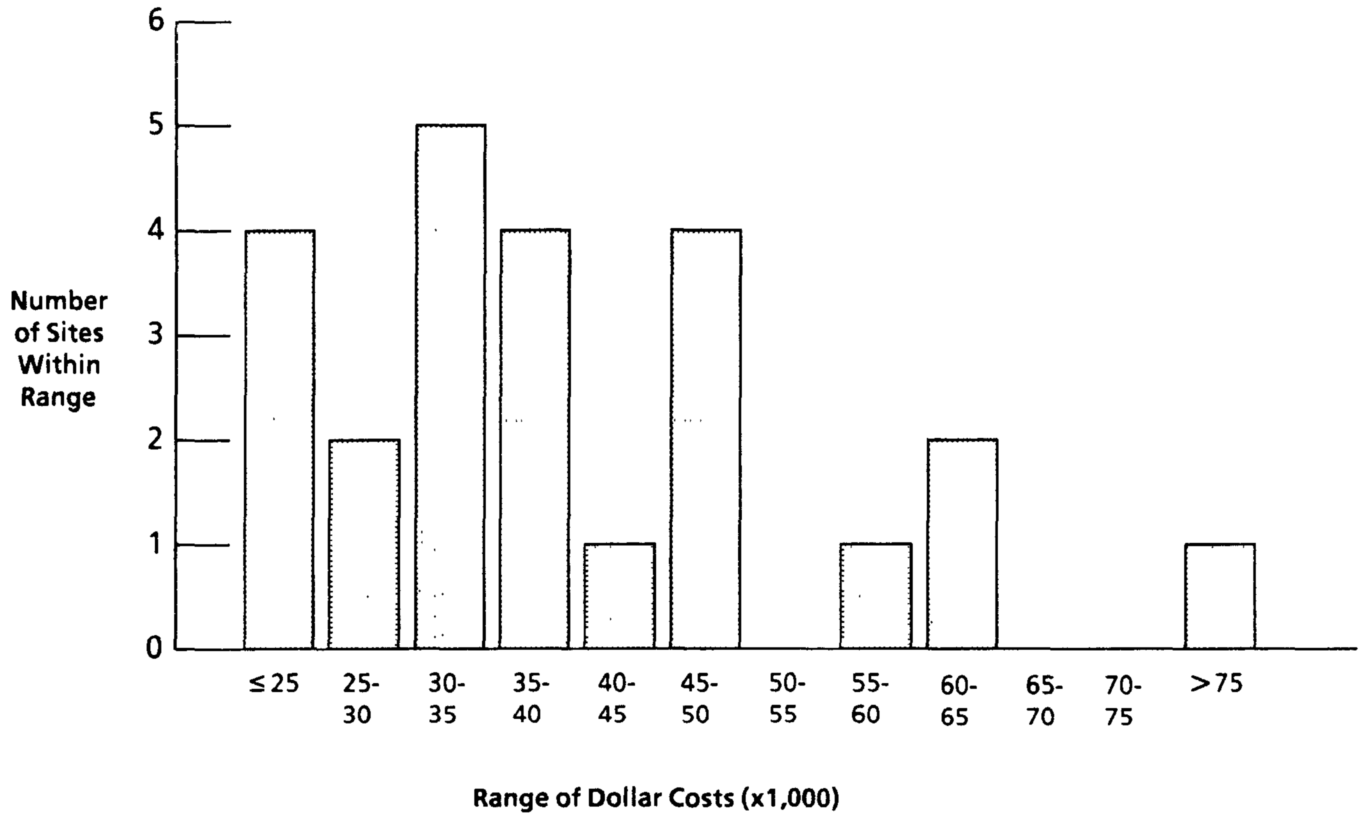
Drilling programs were costed at 15 of the 24 sites. Monitoring wells were involved at 13 sites, boreholes at two sites, and one site had both. The number of wells installed generally ranged from

FIGURE 5-9
SITE, SOURCE, AND WASTE CHARACTERISTICS LOE HOURS
(Based on Field Test Sites)



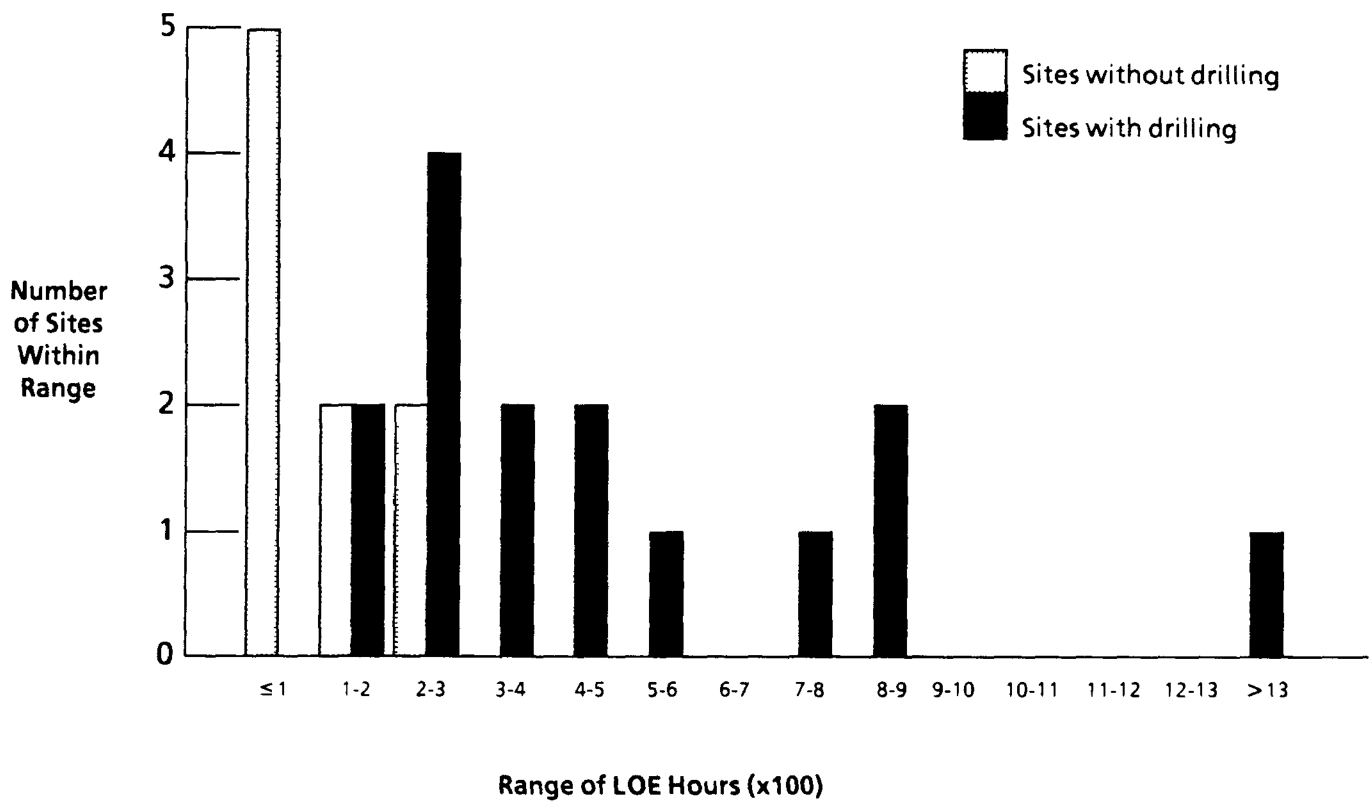
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-10
SITE, SOURCE, AND WASTE CHARACTERISTICS DOLLAR COST
(Based on Field Test Sites)



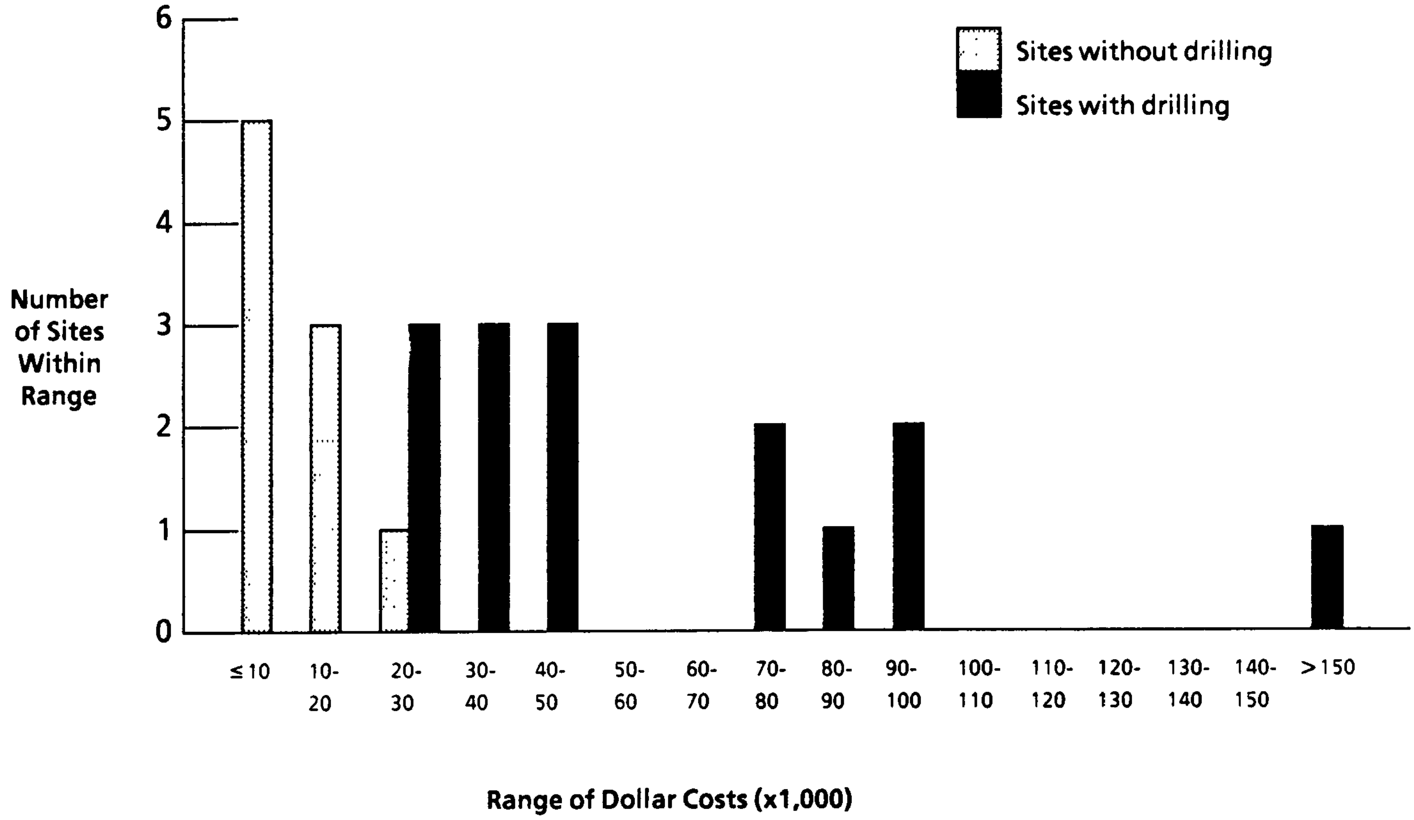
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-11
GROUND WATER PATHWAY LOE HOURS
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-12
GROUND WATER PATHWAY DOLLAR COST
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

three to nine, though one site involved 14 wells. The average was about four or five wells No more than three boreholes were drilled at any one site. For these 15 sites, LOE ranged from 140 to 1,360 hours and averaged 480 hours. The one site involving more than 850 hours included an unusually comprehensive drilling program (the 14 wells). The dollar cost at these sites ranged from $22,000 to $156,000 and averaged $59,000. As shown in Figure 5-12, only the site with the extensive drilling program exceeded $100,000.

For the nine sites where a drilling program was not costed, total ground water pathway LOE ranged from 50 to 240 hours, with an average of 120 hours. Six of these were in the range of 50 to 100 hours. Dollar costs ranged from about $3,000 to $26,000, though all but one site were in the range of $3,000 to $17,000. The average was about $11,000. The higher-cost sites generally involved larger numbers of samples from nearby domestic and/or municipal wells.

The implementation of a drilling program clearly had significant impacts on overall costs, in terms of both LOE and dollars. The sites where drilling occurred required subcontract administration and in-field supervision of the borehole/well installation which involved 40 to 660 LOE hours, along with $5,000 to $73,000 in FIT costs and subcontractor charges. Sites where drilling occurred also tended to have a higher number of ground water samples and associated costs, averaging 11 ground water samples. These ranged from two to 40, with all but two sites having 15 or fewer samples. By comparison, sites without drilling ranged from zero to 16 ground water samples (from municipal and residential wells) and averaged around five or six. All but two of these sites had eight or fewer samples. Dollar costs associated with sample collection and CLP analysis averaged $16,000 at sites with boreholes and/or monitoring wells and $6,000 at sites without.

5.3.5 Proposed Surface Water Pathway

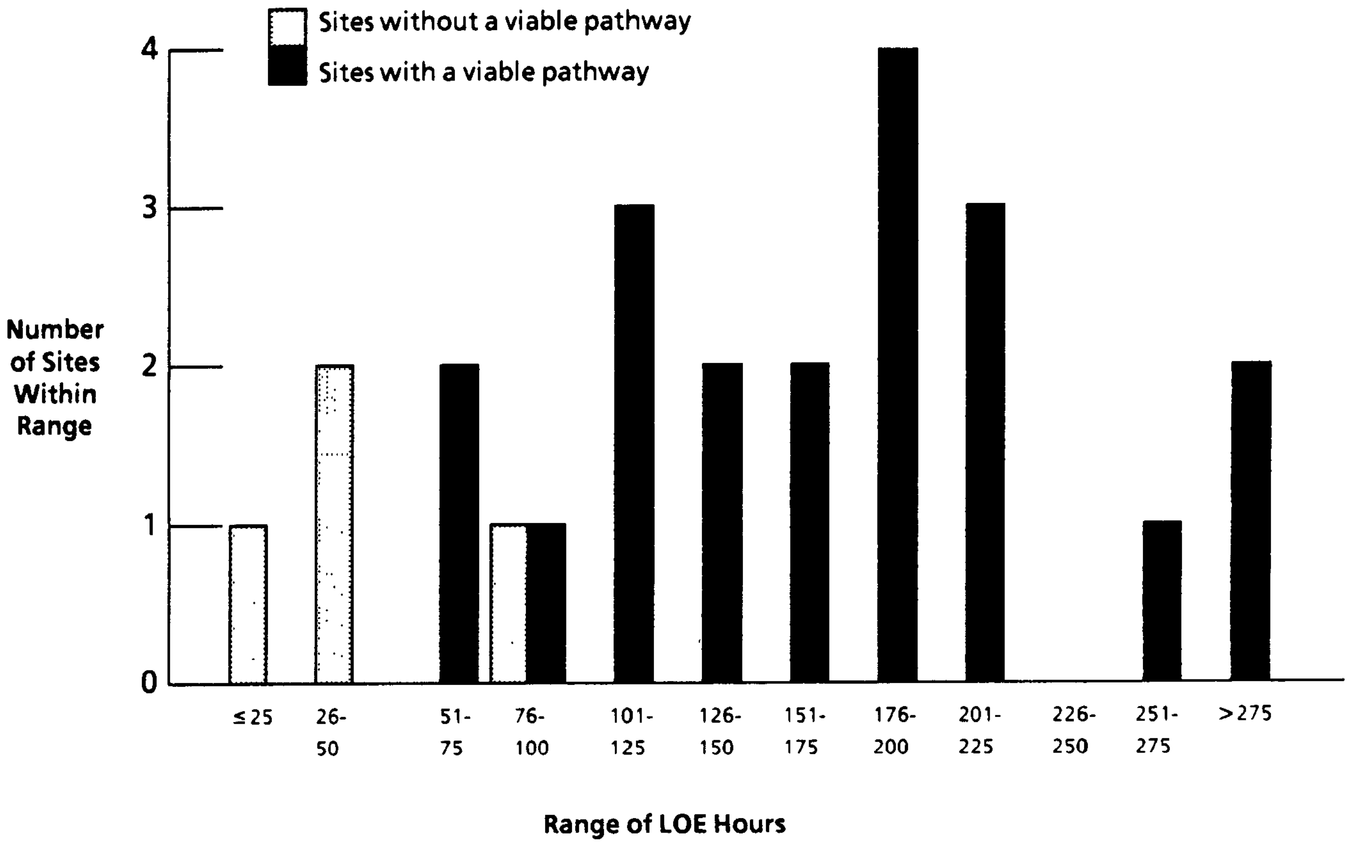
The surface water pathway was next in overall cost, contributing eight percent of average total site LOE and 13 percent of total dollars. Figures 5-13 and 5-14 show the distributions.

Of the 24 sites included in the cost database, four were shown not to have viable surface water pathways (e.g., lack of nearby surface water, no overland flow route or flood potential); one of these nevertheless involved extensive sampling. LOE for these four sites ranged from 10 to 87 hours; the three involving six or fewer samples were all under 50 hours. The dollar cost for the three sites with few samples ranged from $500 to $7,000. The dollar cost at the fourth site was $18,000.

For the 20 sites that did have viable surface water pathways, LOE ranged from 70 to 290 hours and averaged 170 hours. Most sites fell into the range of about 70 to about 220 hours. The dollar cost of these 20 sites showed a range from $10,000 to $42,000 with an average of about $25,000. The broad range of dollar costs is primarily attributable to the range of samples, from a low of six to as many as 28 (average of 15). Sampling to establish an observed release involved the full range of six to 28 samples at these sites. In many cases, the surface water body itself constituted a recreational or environmental target and sampling for observed release served the dual purpose of sampling for potentially contaminated targets. Specific sampling of discrete surface water targets was limited at the field test sites, as illustrated below:

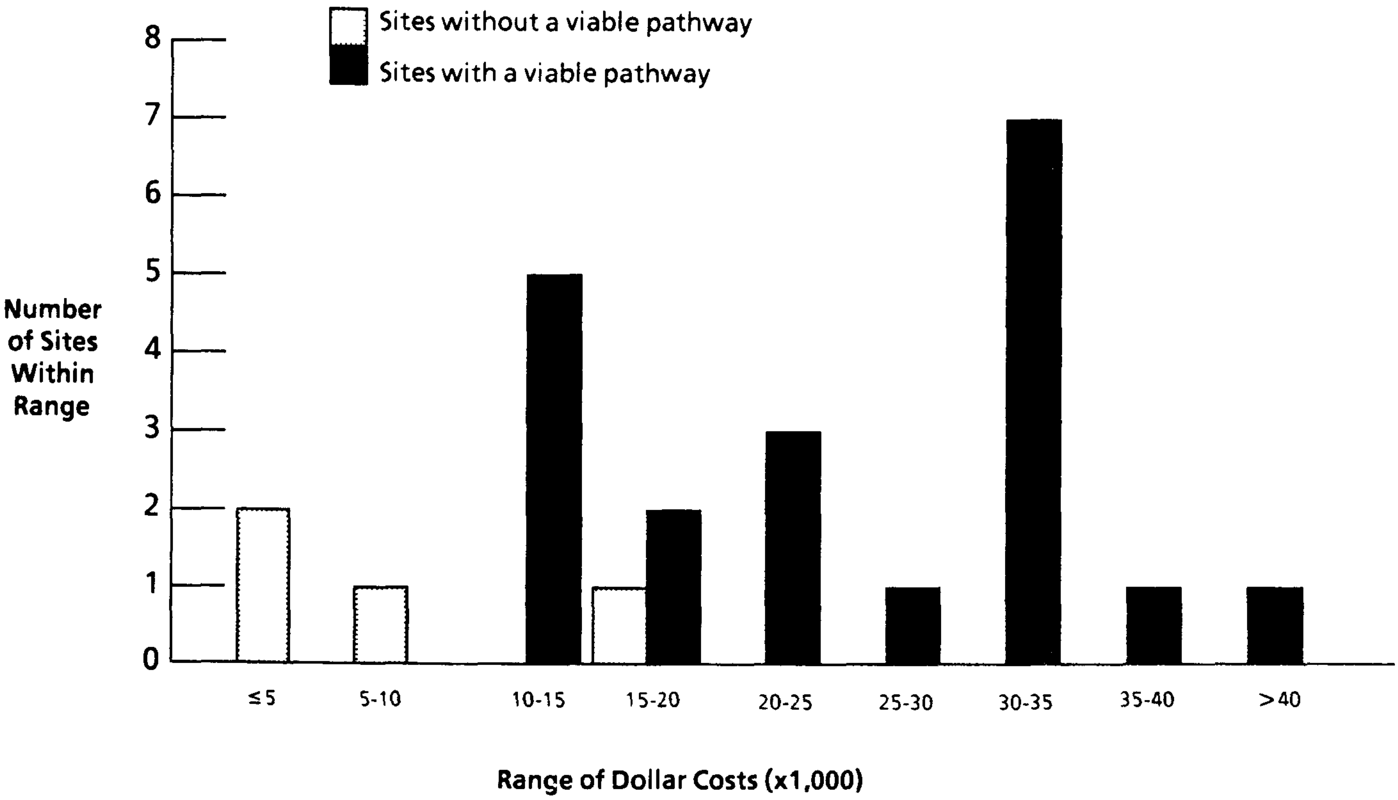
	No. of Sites	Range of Samples	Average No. of Samples
Observed Release	20	6-28	14
Drinking Water Targets	1	2	2
Human Food Chain Targets	2	2-4	3
Recreation Targets	3	2-4	3
Environmental Targets	3	2-5	4

FIGURE 5-13
SURFACE WATER PATHWAY LOE HOURS
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-14
SURFACE WATER PATHWAY DOLLAR COST
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

5.3.6 Proposed Air Pathway

The LOE range for the air pathway was 20 to 270 hours, averaging 90 hours (Figure 5-15). Fifteen sites involved no collection of analytic air samples and these ranged from about 20 to about 90 hours and averaged about 50 hours. Two sites outside of this range involved FASP sampling at 140 and 170 hours. Seven sites involved CLP air sampling and these showed a wide range from 60 to 270 hours with an average of 150 hours. The majority of these, however, were clustered between 110 and 140 hours.

For sites without CLP air sampling and analysis, dollar costs were modest at less than $5,000 for 15 of the 17 sites (averaging less than $3,000); the two sites involving FASP air sampling and analysis had costs between $7,000 and about $8,000. The seven sites with CLP sampling and analysis ranged from $8,000 to $44,000 and averaged $25,000. Five of these, however, were in the range of $8,000 to about $27,000 (Figure 5-16). The primary determinant of the range of dollar costs was the number of samples collected. This ranged from five to 23 and averaged 13; the five sites under $25,000 ranged between five and 16 samples, averaging 10 samples.

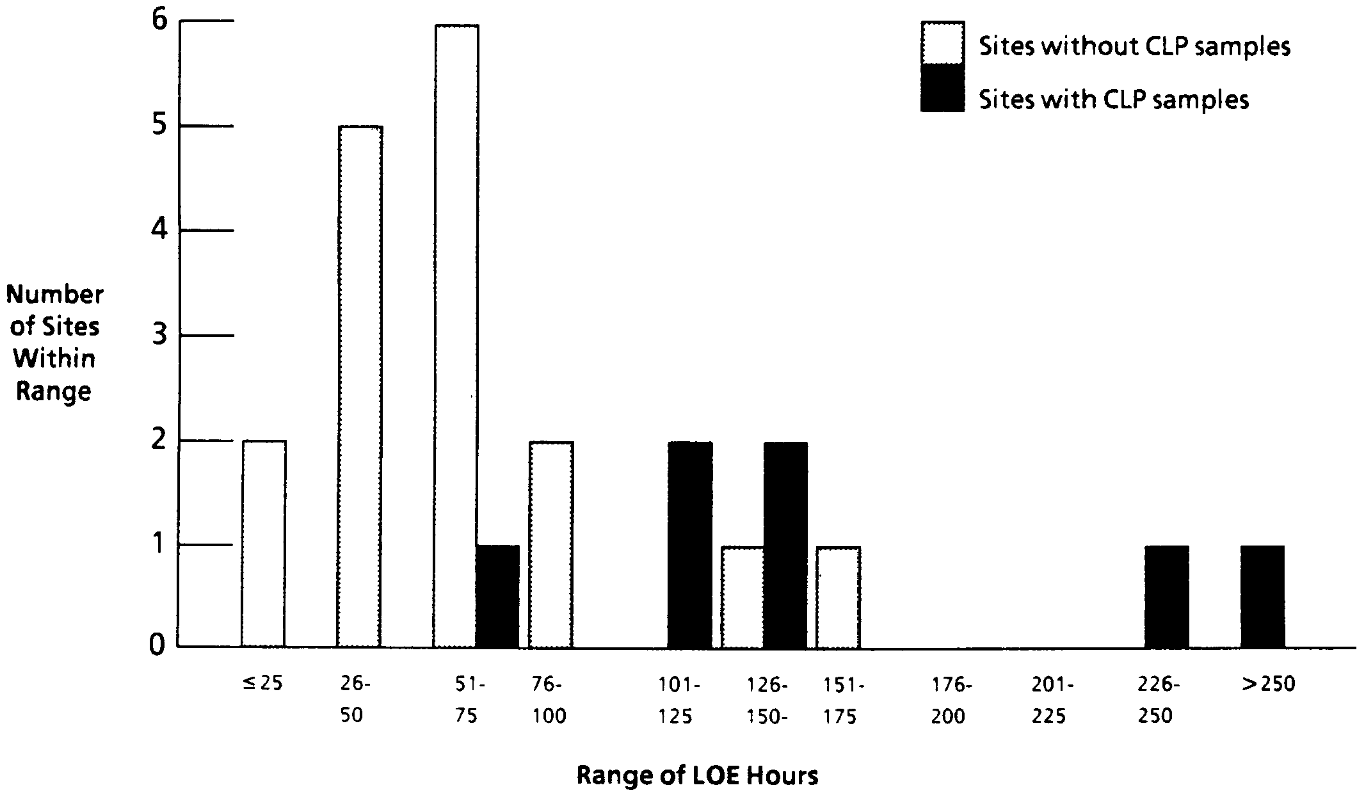
5.3.7 Proposed Onsite Exposure Pathway

At the field test sites, the onsite exposure pathway was generally the least costly of the proposed HRS pathways to evaluate. This observation is at least partly due to the fact that much of the information required to evaluate this pathway could be collected for, or in conjunction with, data collection for other pathways. The attribution of costs was probably somewhat related to the physical structure of the cost reporting form and the means by which project participants kept track of costs. Since the onsite pathway is new to the HRS, is unfamiliar, and was placed at the end of the cost reporting form, much of the cost associated with onsite pathway factors could easily have been attributed to other pathways where that information was also employed. For example, nearby population data were generally derived from air pathway target population data, and accessibility/frequency of use could be assessed during a reconnaissance or via general observations which may have been costed elsewhere. Costs associated with other factors, including onsite pathway-specific waste quantity, toxicity, and sampling to establish onsite observed contamination (with the exception of samples taken from resident population properties) have been aggregated under site, source, and waste characterization. The result is that costs specifically attributable to the onsite exposure pathway were generally quite modest at these sites. LOE and dollar cost distributions for the onsite exposure pathway are shown in Figures 5-17 and 5-18, respectively.

There were some instances where FIT felt that a resident population threat was possible, yet sampling was not conducted due to access problems or community relations concerns. In such cases, the costs of such samples were estimated and added during the data refinement process. For 15 sites, no sampling of adjacent residential, school or day care properties, or terrestrial sensitive environments, was costed; nine sites did include the cost of such sampling. The sites without resident population samples ranged in LOE from less than 10 to about 30 hours. The dollar costs ranged from $300 to $1,700 and averaged $800.

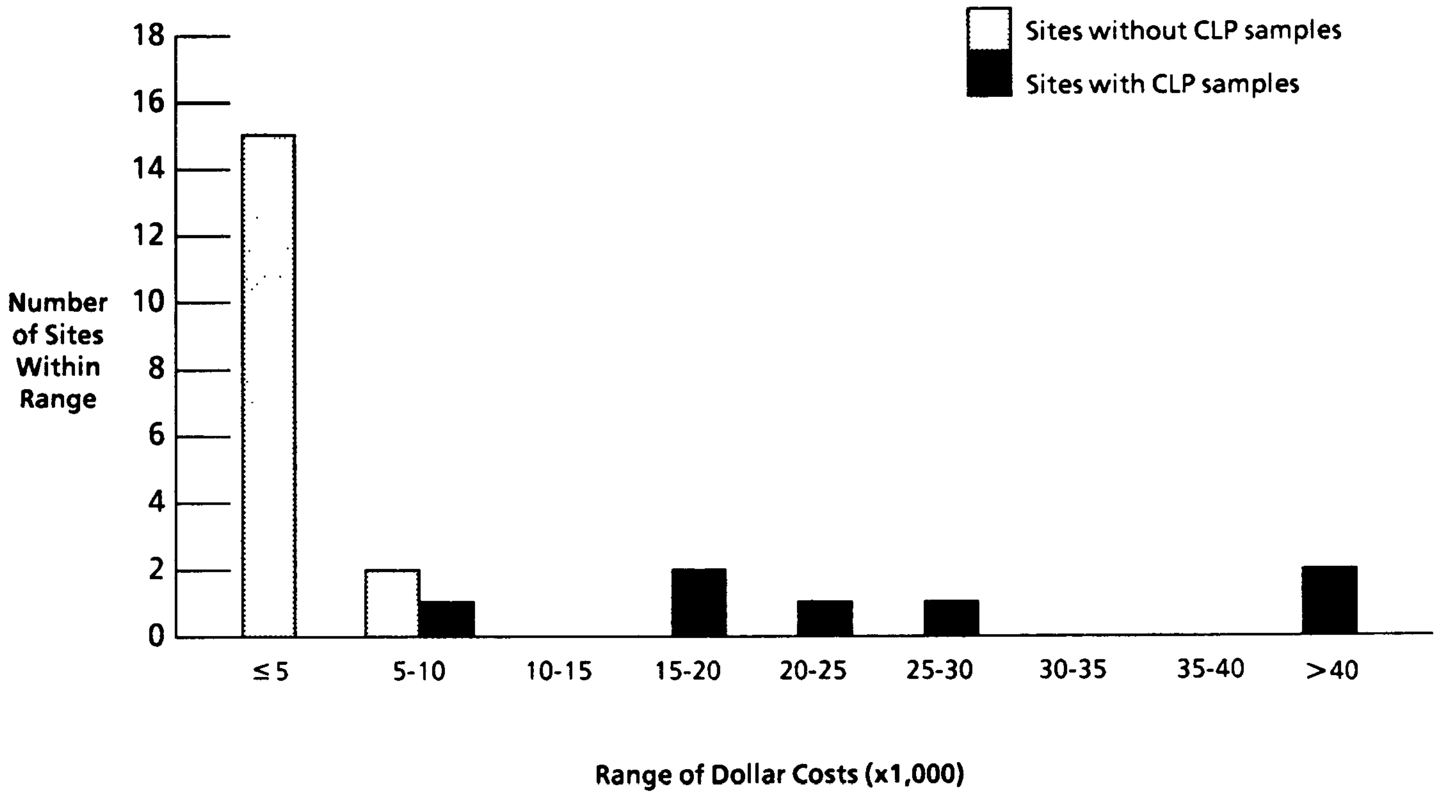
The number of resident population samples costed at the other nine sites ranged from one to 15 and averaged six. LOE ranged from less than 20 to 340 hours and averaged 80 hours. Dollar costs remained proportional to the number of samples and ranged from about $3,000 to $32,000 with an average of $10,000. Most field test sites involved eight or fewer samples, less than 100 hours of LOE, and total dollar costs under $11,000. Only one site -- which had a very high resident population threat, a number of contaminated residential properties, and associated community relations concerns -- involved higher levels of sampling, LOE, and dollar costs.

FIGURE 5-15
AIR PATHWAY LOE HOURS
(Based on Field Test Sites)



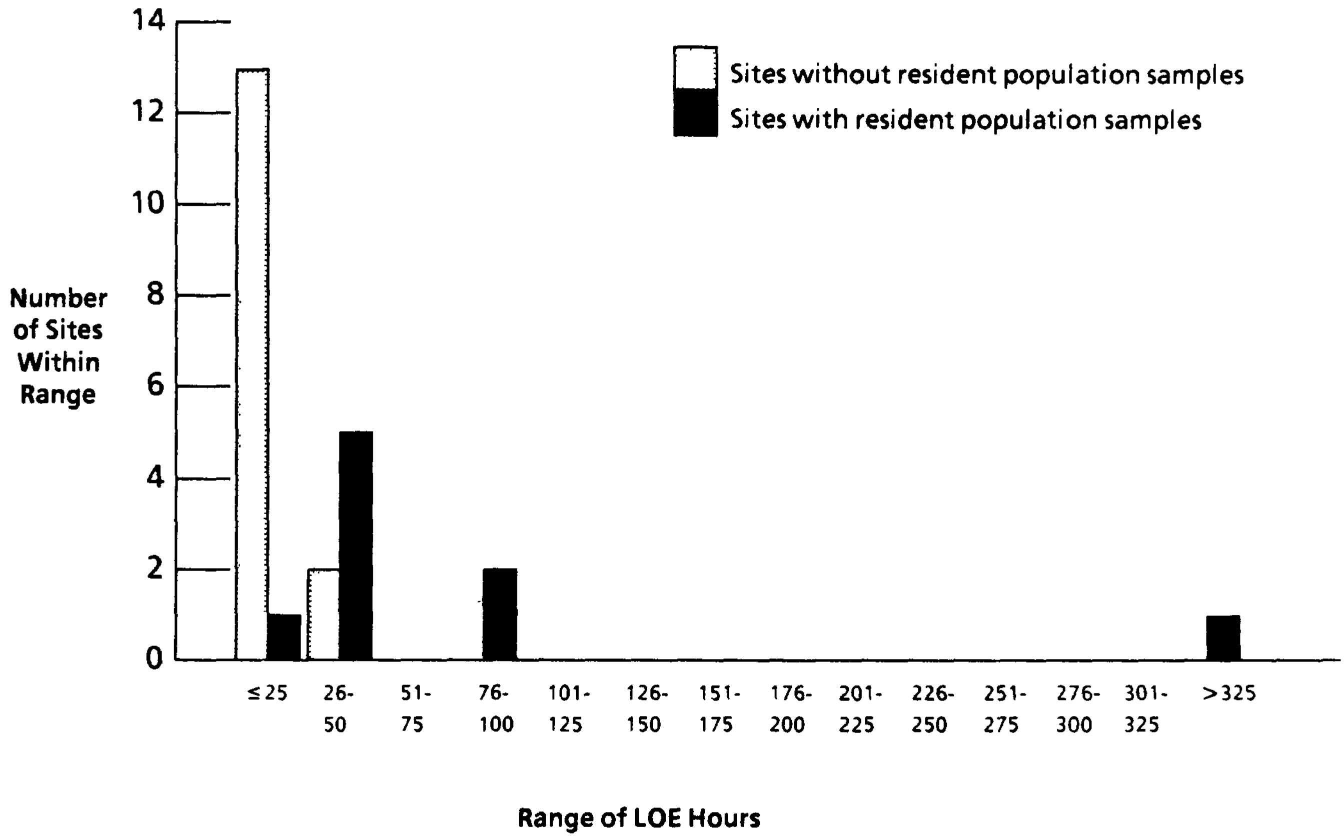
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-16
AIR PATHWAY DOLLAR COST
(Based on Field Test Sites)



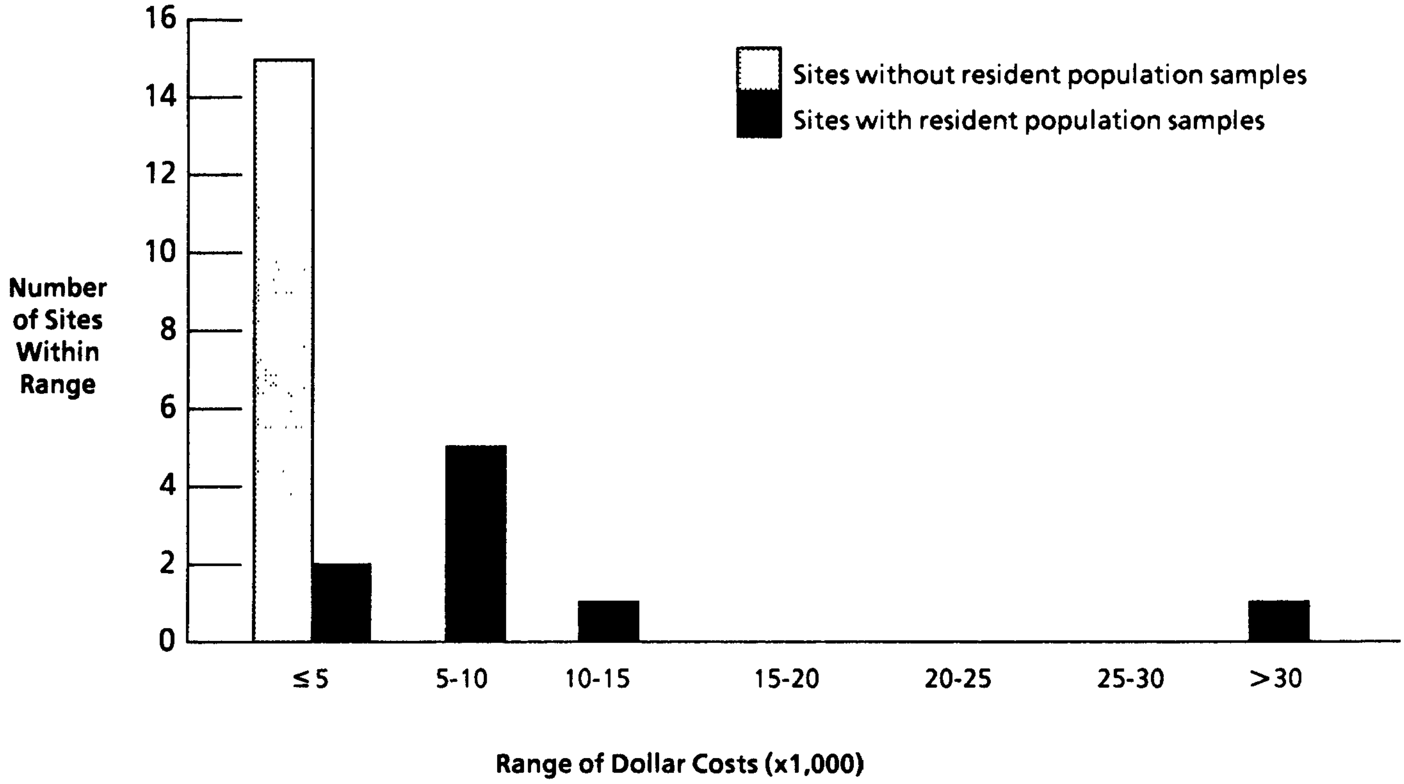
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-17
ONSITE EXPOSURE PATHWAY LOE HOURS
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-18
ONSITE EXPOSURE PATHWAY DOLLAR COST
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

5.4 SUMMARY OF SITE COSTS

Table 5-1 summarizes the range of costs, and their averages, as discussed in preceding sections. The 24 field test sites required between 970 and 3,310 LOE hours, involved 34 to 98 CLP samples, and cost a total of $100,000 to $311,000. Since not all sites required a full evaluation of each pathway, Table 5-1 presents the costs incurred for the common alternatives, i.e., sites with or without: CLP air sampling; monitoring well or borehole installation; a viable surface water pathway; and resident population sampling.

One of the most significant influences on the overall cost of these site inspections was the number of CLP samples collected at a site. While the LOE involved in sample collection and handling (sample management, packaging, chain of custody paperwork, shipping) represents only 16 percent of total site LOE (Figure 5-19), the dollar cost associated with samples (which is mostly CLP analytic charges) represents nearly one-half (48 percent) of average total site dollar cost (Figure 5-20). Any reductions in CLP sample collection within the proposed HRS pathways, and for purposes of site, source, and waste characterization, could have significant impacts on overall site costs.

A second major cost element was the installation of monitoring wells which, as discussed in Section 5.3.4, tends to be very expensive in terms of both dollars and LOE, and also results in greater numbers of CLP samples. This can be readily seen in the comparisons given in Table 5-1. Limiting the number of wells installed could reduce overall costs substantially.

The largest cost center for LOE seems to be concentrated among the non-pathway-specific and non-data-generating elements of the general tasks category, which accounts for one-half of average total site LOE. This cost analysis has attempted to account for the effects of a proposed HRS "learning curve" as it impacts the elements of project planning and management and proposed HRS scoring and documentation; there may or may not be additional efficiencies to be found here as personnel become more accustomed to working with the proposed model. (It should also be pointed out that, while no attempt was made to account for similar learning efficiencies among the individual data elements within the proposed HRS pathways, the possibility of their realization seems likely).

Other factors which bear consideration when interpreting these cost results include the following:

- As has been indicated elsewhere in this report, the sites involved in the field test were not a random selection from among the universe of Superfund sites. Some sites were selected because they had particular characteristics that were of interest from the perspective of proposed HRS testing. It is likely that this particular group of sites is, as a whole, more complex than a random grouping would be.

- The site inspections conducted during the field test were quite comprehensive, and each pathway was fully evaluated at most sites. This may not be necessary at all sites, and early recognition of low scoring potential for a particular pathway or threat could be useful in focusing FIT efforts and controlling costs.

- As explained in Section 5.1, the costs reported here represent all costs incurred for all data development activities that occurred at a site, regardless of source (FIT, TAT, PRPs, state agencies), provided that those data were both representative of the type of data that FIT would develop and were consistent with FIT data needs in support of proposed HRS scoring. Consequently, while the costs reported here are meant to be representative of the total cost of data acquisition at these sites, they may in some cases overstate the direct costs.

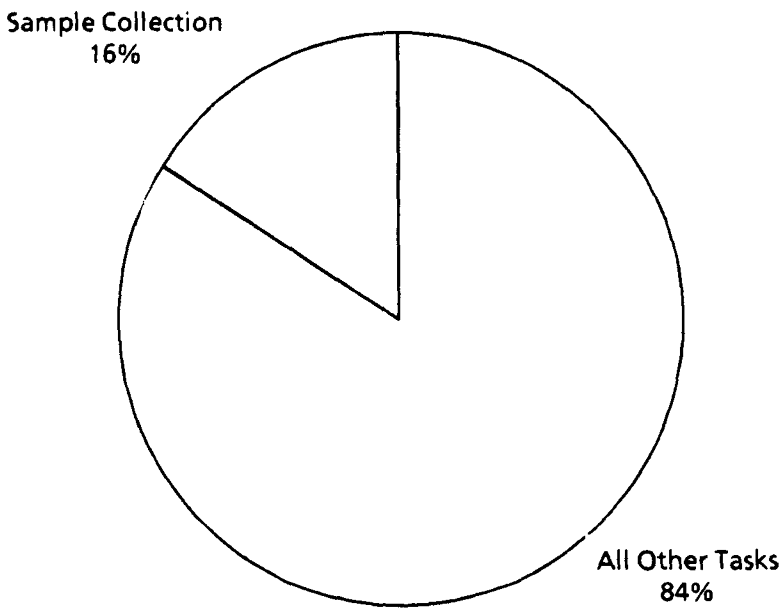
TABLE 5-1
SUMMARY OF SITE COSTS
(Based on Field Test Sites)

	LOE Hours		Dollars		CLP Samples	
	Range	Average	Range	Average	Range	Average
General Tasks	480 - 1,500	960	$39,000 - 84,000	$ 59,000	3 - 17	11
Site/Source/Waste Characterization	80 - 530	280	$20,000 - 79,000	$ 40,000	10 - 46	24
Air Pathway						
w/CLP sampling	60 - 270	150	$8,000 - 44,000	$ 25,000	5 - 23	13
w/o CLP sampling	20 - 170	60	$900 - 8,000	$ 3,000	NA	NA
Ground Water Pathway						
w/drilling	140 - 1,360	480	$22,000 - 156,000	$ 59,000	2 - 40	11
w/o drilling	50 - 240	120	$3,000 - 26,000	$ 11,000	0 - 16	5
Surface Water Pathway						
w/viable pathway	70 - 290	170	$10,000 - 42,000	$ 25,000	6 - 28	15
w/o viable pathway	10 - 90	40	$500 - 18,000	$ 7,000	0 - 14	5
Onsite Exposure Pathway						
w/resident population sampling	20 - 340	80	$3,000 - 32,000	$ 10,000	1 - 15	6
w/o resident population sampling	10 - 30	20	$300 - 1,700	$ 800	NA	NA
Total Site*	970 - 3,310	1,860	$100,000 - 311,000	$176,000	34 - 98	63

* Represents actual total site costs for the 24 sites, not the sum of individual line items.

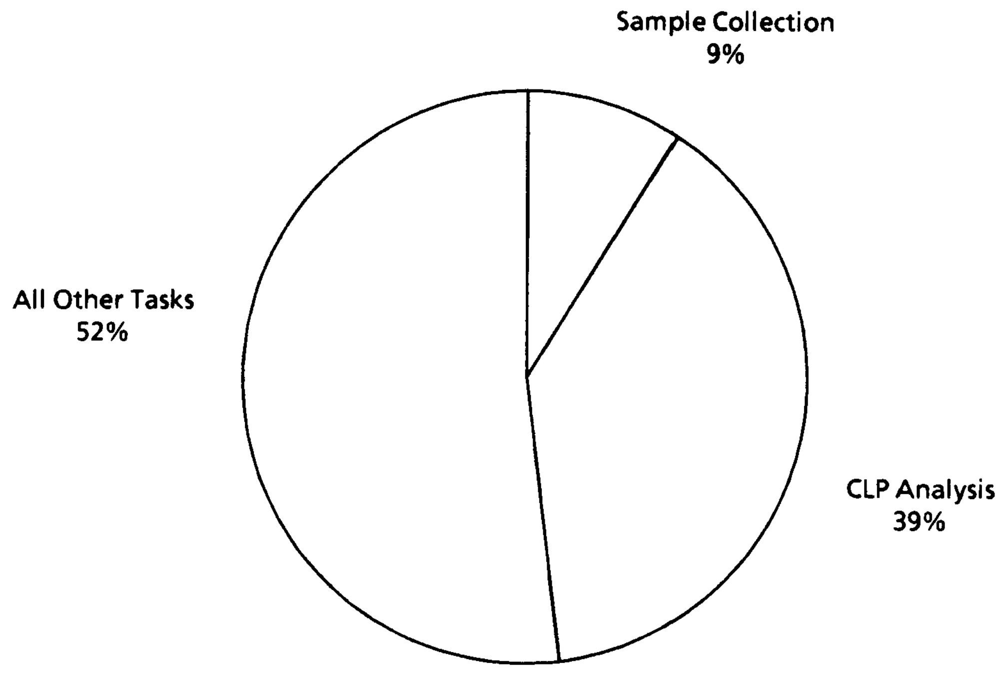
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-19
PROPORTION OF TOTAL SITE LOE
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 5-20
PROPORTION OF TOTAL SITE DOLLARS
(Based on Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

- The process of collecting information and evaluating sites for the purpose of supporting HRS scoring is one that would typically involve a series of increasingly focused investigations. This was not the case with the field test sites, nor was this approach reflected in the cost reporting and refinement process. Rather, the costs discussed here (as has been described above and in Section 5.1) have been normalized to reflect a common framework for comparison which approximates the entire sequential process of site investigation and evaluation (starting from "little available data"). The costs presented here should be viewed within this context.

SECTION 6

FIELD TEST HRS SCORING RESULTS

6.0 INTRODUCTION

This section discusses the HRS scoring results for the 29 sites involved in the field test. Data generated from the site inspections performed during field testing were used to develop both current and proposed HRS scores. Among the sites included in the field test were the following:

- Sites with features not addressed by the current HRS (e.g., human food chain exposures, potential air releases, onsite exposures, human exposures through recreational surface water use).
- Sites with different types of sources (e.g., landfills, surface impoundments, waste piles).
- High-scoring and low-scoring sites under the current HRS.

The initial proposed HRS scoring package for each site was reviewed by the Agency and several of its contractors. Written comments were prepared for each initial scoring package and forwarded to the Regional EPA/FIT office upon conclusion of the respective Regional visit. These comments often consisted of items that were derived from the initial reviews, including scoring package documentation requirements. However, the review process for field test sites was not as extensive (nor as well defined) as the review process for sites being considered for possible placement on the NPL.

Significant highlights regarding the field test HRS scoring results that are presented in this section include:

- The distribution of proposed HRS site scores for the field test sites.
- The distribution of individual pathway scores under the proposed HRS for the field test sites.
- The distribution of surface water threat scores (i.e., drinking water, human food chain, human recreation, and environmental) under the proposed HRS for the field test sites.
- The comparison between current and proposed HRS site scores, as well as individual pathway scores, for the field test sites.
- The general characteristics of those field test sites that scored relatively high or low under individual proposed HRS pathways.

Although the field test results provide the Agency with useful information, there are significant limitations on the conclusions regarding HRS scores that can be drawn from these results. The sites tested were not randomly selected but were in part selected for potential risks to public health and the environment that are not evaluated under the current HRS. Therefore, the proposed HRS scores associated with these sites are not necessarily representative of the scores that other CERCLA sites would generate.

Due to the small number of sites tested and the fact that the sites tested were not randomly selected, the field test results should not be construed to fully reflect the general relationships between proposed HRS scores and current HRS scores.

6.1 FIELD TEST SCORES UNDER THE PROPOSED HRS

The distribution of proposed HRS site scores for sites tested is shown in Figure 6-1. The distributions of the scores for the individual proposed HRS pathways are shown in Figures 6-2 through 6-5. Not all pathways were evaluated for each site due to:

- The absence of nearby surface water or the absence of an overland flow segment to surface water (six sites).
- The lack of observed contamination as defined in the onsite exposure pathway (one site).
- The assignment of a value of zero for the containment factor under a particular pathway (one site).

Overall scores for the 29 sites ranged from 15 to 71, with an average of 46 and a median of 53. Average and median scores for the individual proposed HRS pathways and overall site scores are summarized in Table 6-1.

TABLE 6-1
AVERAGE AND MEDIAN PROPOSED HRS PATHWAY AND SITE SCORES
(Based on Field Test Sites)

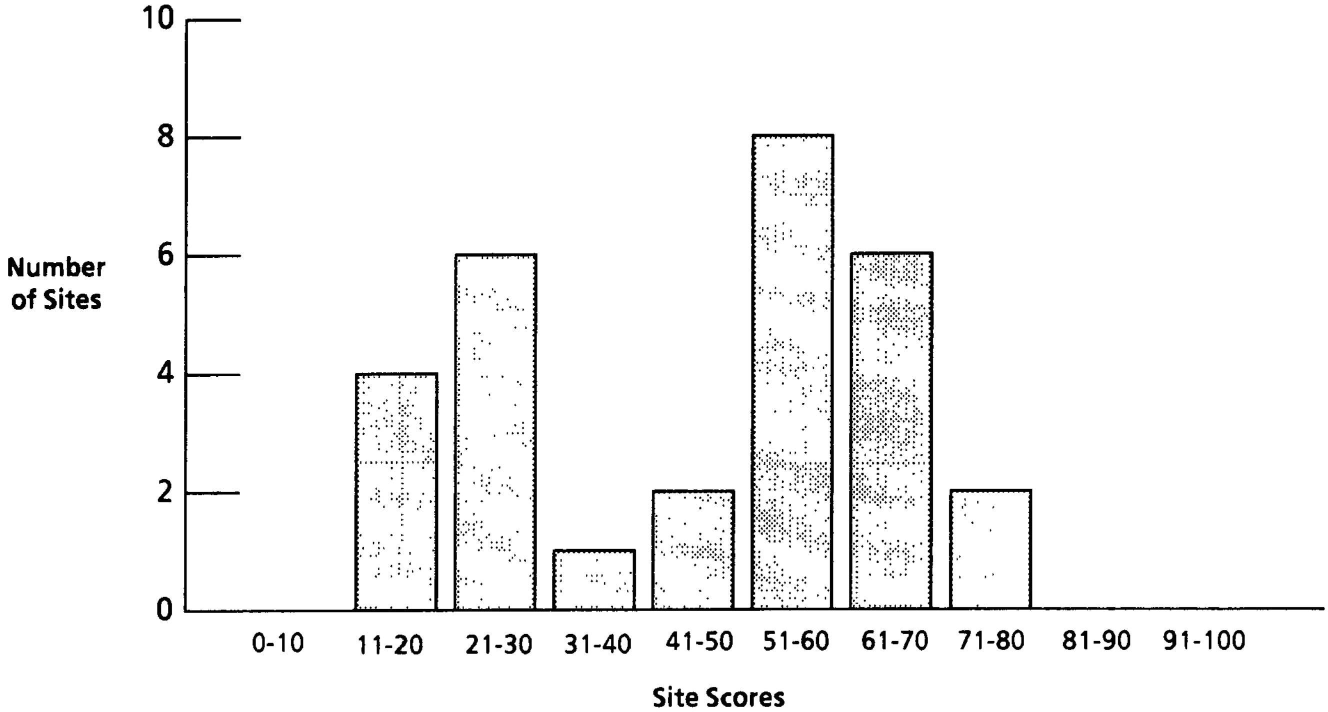
Pathway or Site Score	No. of Sites Tested	Average Score	Median Score	Range of Scores
Air	28	22	22	3 - 47
Ground water	29	40	31	4 - 100
Surface water	23	65	62	13 - 100
Onsite exposure	28	40	25	0 - 100
Overall site score	29	46	53	15 - 71

Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

For the sites tested, the proposed surface water pathway had the highest average and median scores while the proposed air pathway had the lowest average and median scores. The air pathway also had the smallest range of individual pathway scores under the proposed HRS.

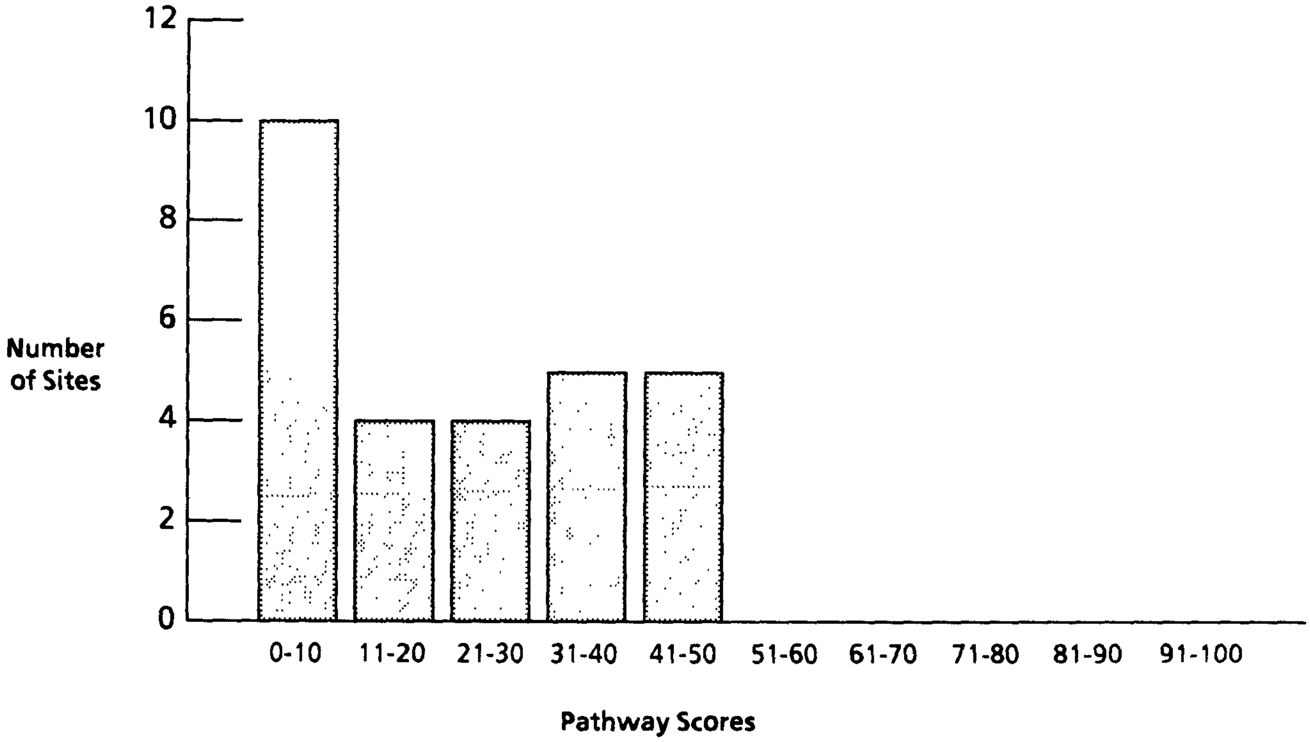
For the proposed surface water pathway, the distributions of scores for each surface water threat among the sites tested are given in Figures 6-6 through 6-9. Average and median scores for the various surface water threats are summarized in Table 6-2. Scores for these threats are normalized to a scale of 0-100 in these figures for the purposes of comparison. Of the 23 sites for which the surface water pathway was evaluated, most scored relatively low for the drinking water, human recreation, and environmental threats; the human food chain threat scores were higher because about 60 percent of the sites tested had significant human food chain target values (Figure 4-1). In nearly all cases, the presence of nearby surface waters resulted in the identification of some human food chain targets since most waters supported aquatic life. Targets were not always present for the other surface water threats. As a result, for sites tested, the remaining surface water threats normally did not have target values that were as high as those target values for the human food chain threat .

FIGURE 6-1
PROPOSED HRS SITE SCORES
(Based on 29 Field Test Sites)



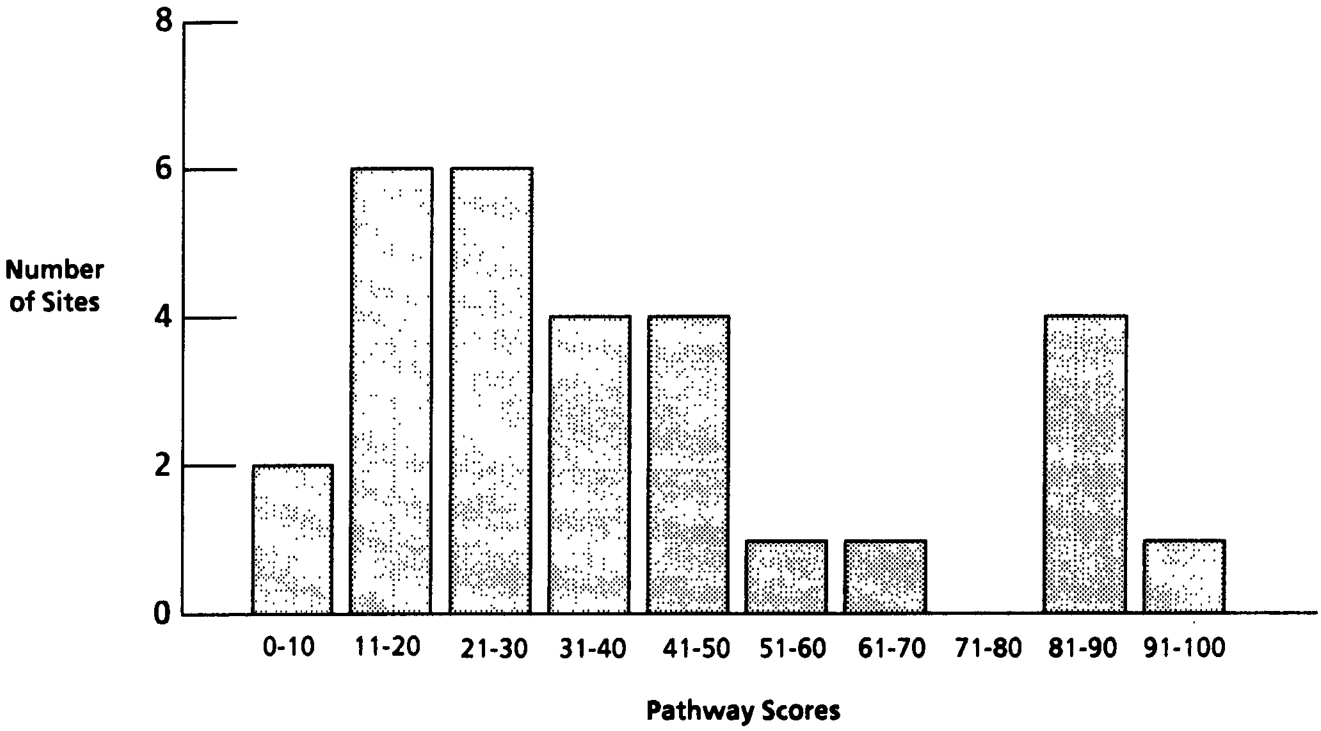
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-2
PROPOSED HRS AIR PATHWAY SCORES
(Based on 28 Field Test Sites)



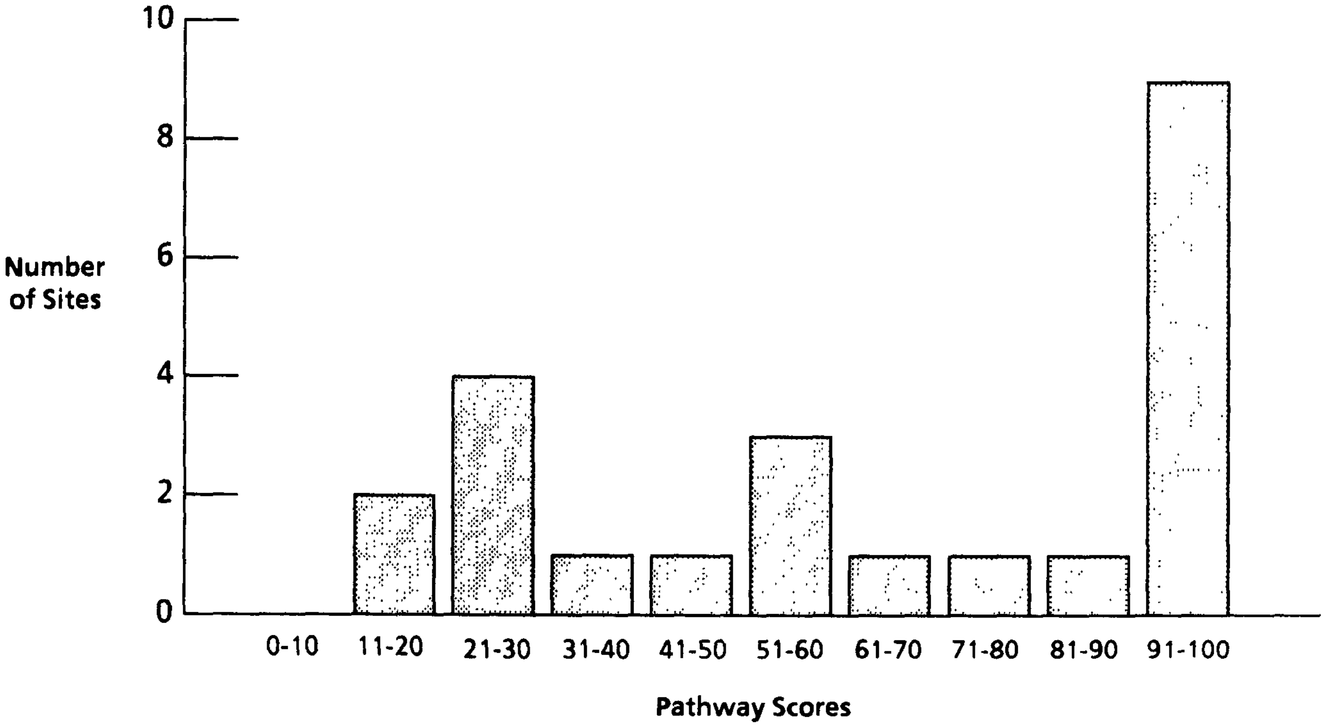
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-3
PROPOSED HRS GROUND WATER PATHWAY SCORES
(Based on 29 Field Test Sites)



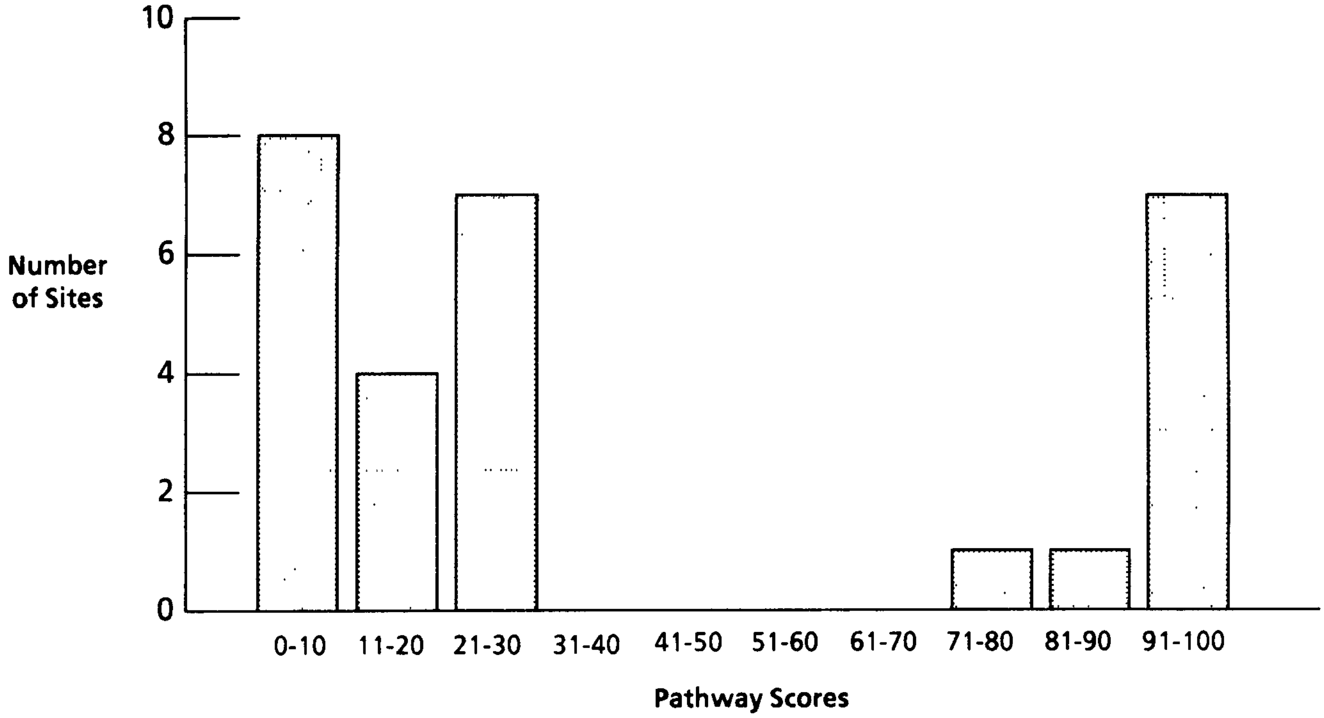
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-4
PROPOSED HRS SURFACE WATER PATHWAY SCORES
(Based on 23 Field Test Sites)



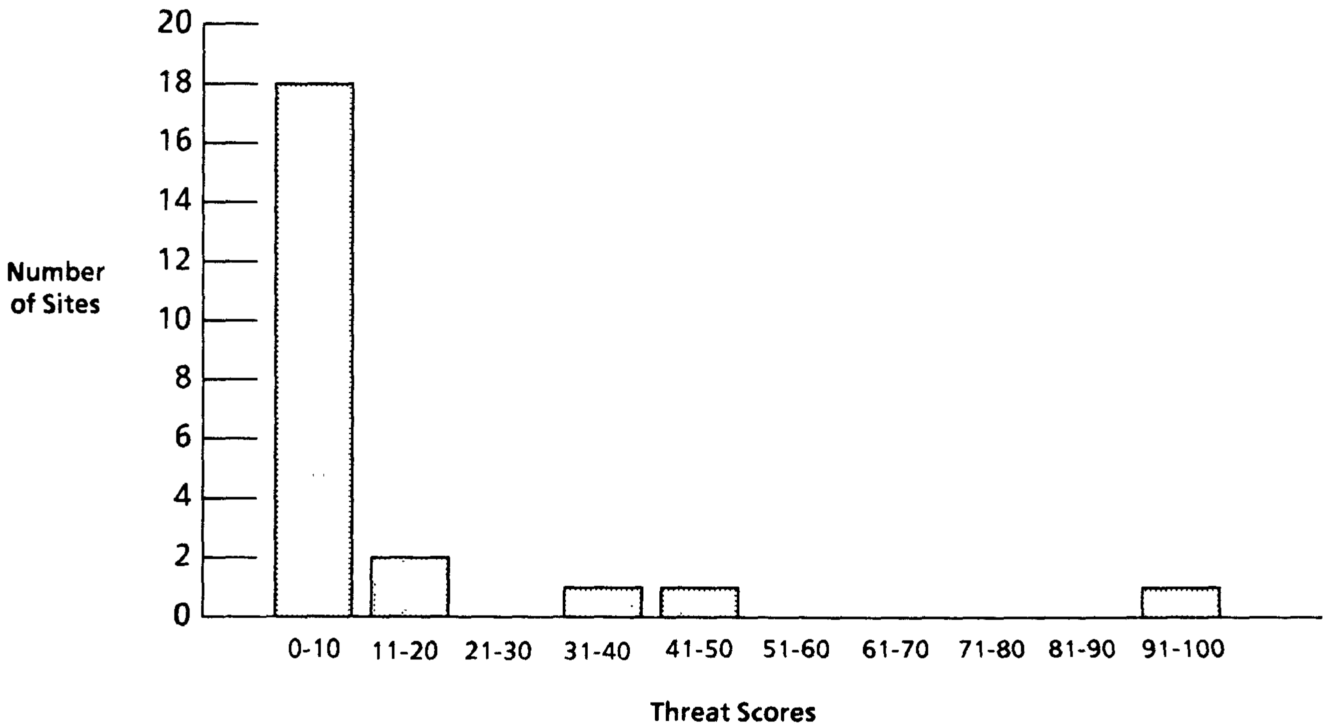
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-5
PROPOSED HRS ONSITE EXPOSURE PATHWAY SCORES
(Based on 28 Field Test Sites)



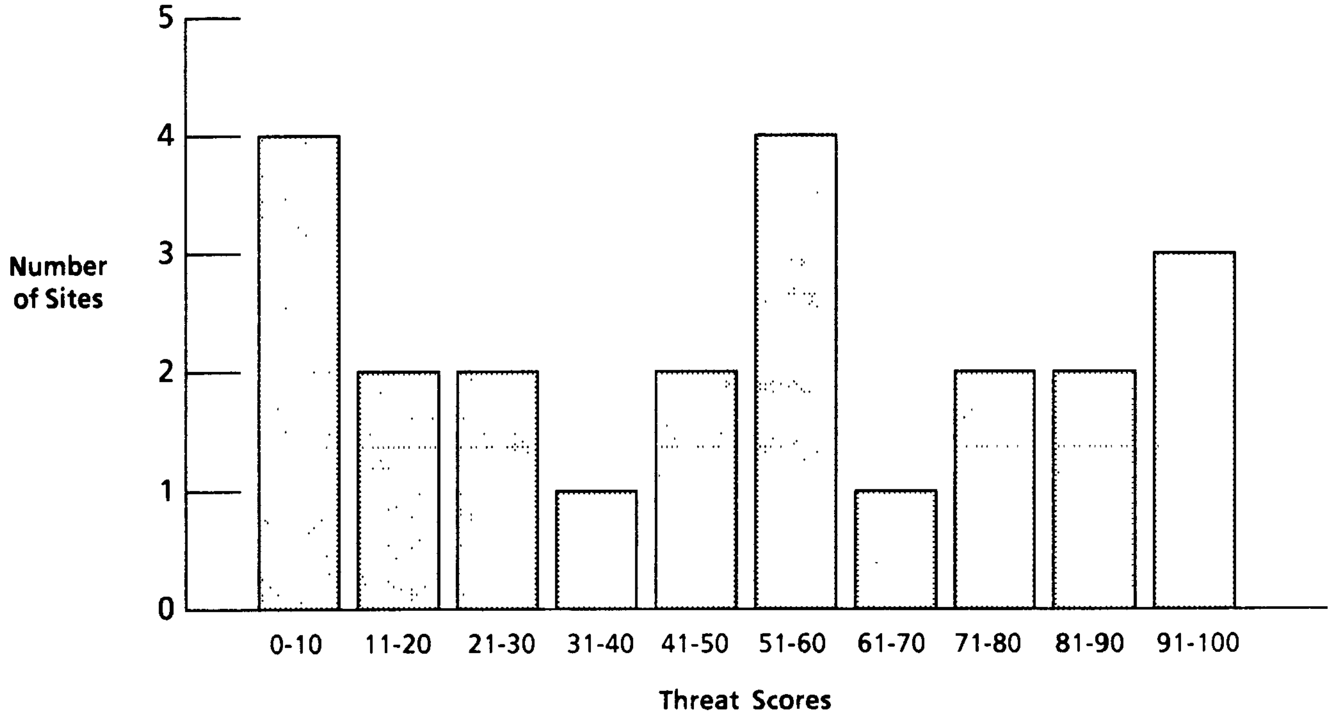
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-6
PROPOSED HRS SURFACE WATER PATHWAY:
DRINKING WATER THREAT SCORES
(Based on 23 Field Test Sites)



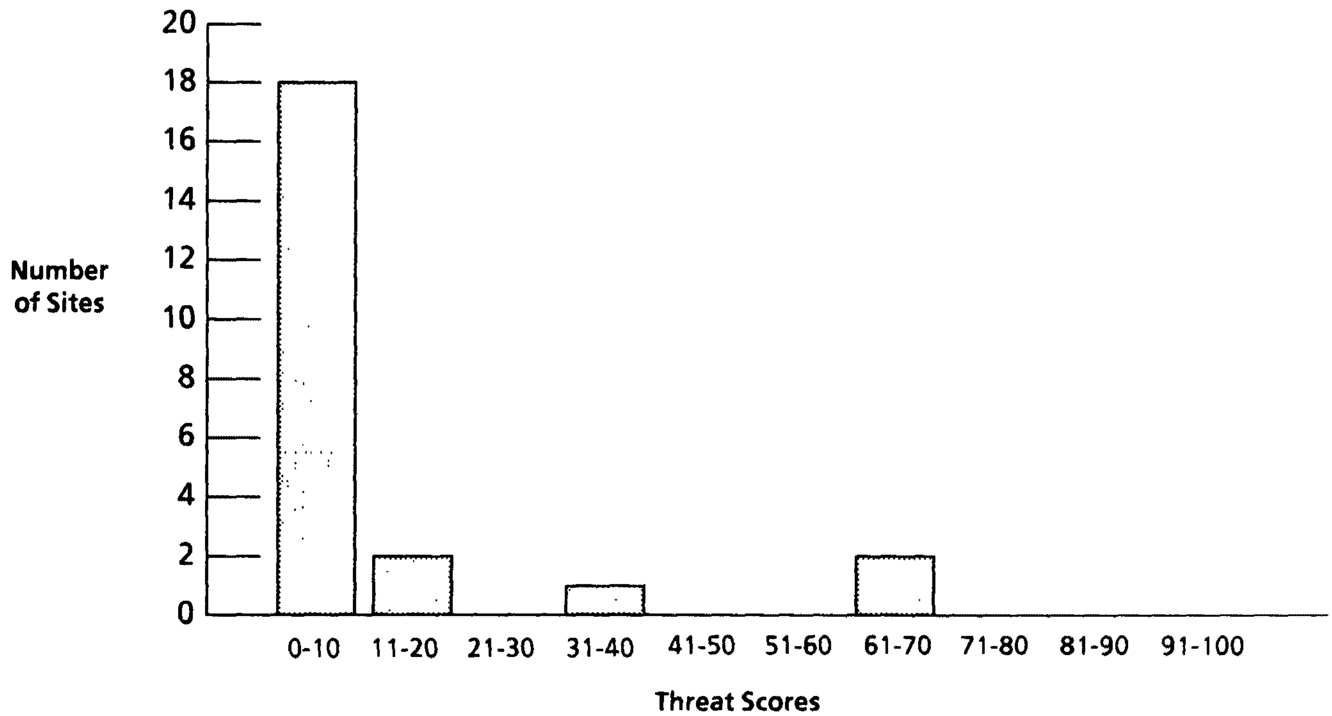
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-7
PROPOSED HRS SURFACE WATER PATHWAY: FOOD CHAIN THREAT SCORES
(Based on 23 Field Test Sites)



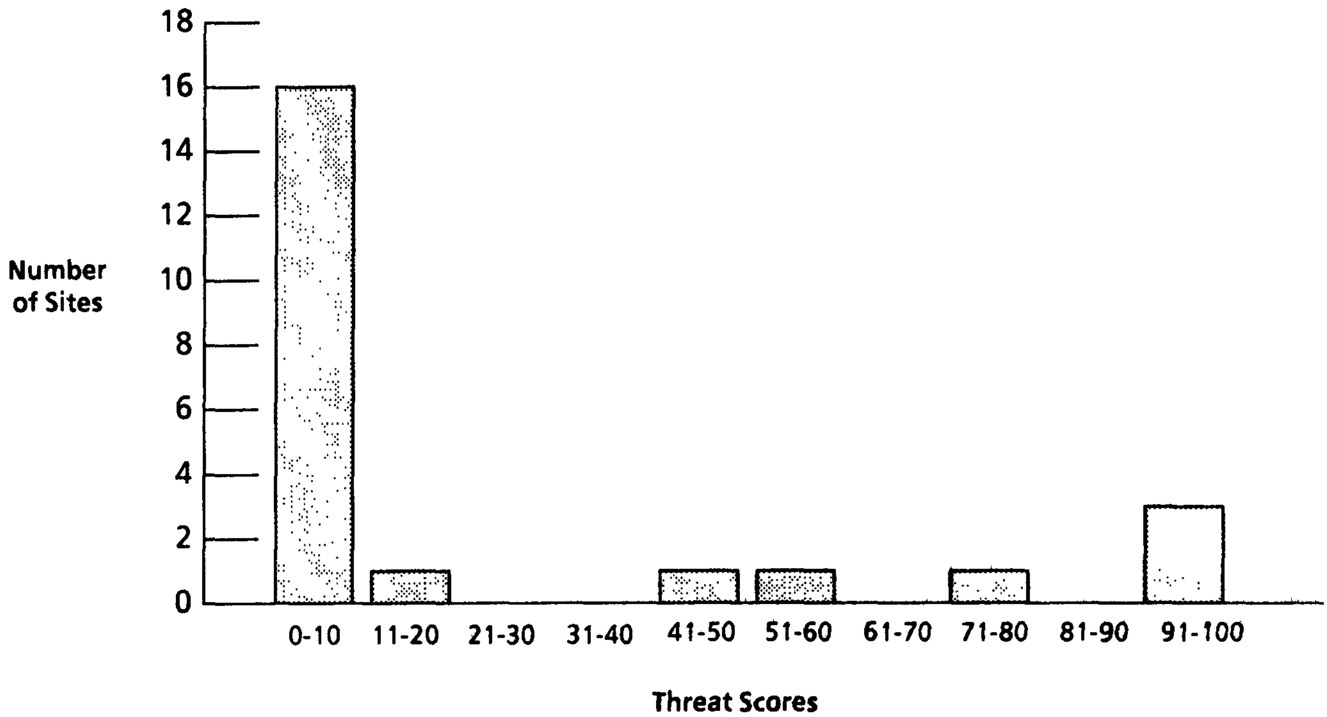
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-8
PROPOSED HRS SURFACE WATER PATHWAY:
RECREATION THREAT SCORES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-9
PROPOSED HRS SURFACE WATER PATHWAY: ENVIRONMENTAL THREAT SCORES
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

TABLE 6-2
AVERAGE AND MEDIAN PROPOSED HRS SURFACE WATER THREAT SCORES
(Based on 23 Field Test Sites)

Threat	Average Score	Median Score	Range of Scores
Drinking water	5	0	0 - 100
Human food chain	49	52	0 - 100
Human recreation	9	1	0 - 67
Environmental	22	3	0 - 100

Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

6.2 COMPARISON OF PROPOSED AND CURRENT HRS SCORES

Under the current HRS, overall scores for the 29 sites ranged from 3 to 51, with an average of 30 and a median of 30. Average and median scores for the individual current HRS pathways and overall site scores are summarized in Table 6-3. For the field test sites, site scores were generally higher under the proposed HRS than under the current HRS. Only two sites scored 51 or above under the current HRS; 16 scored 51 or above under the proposed HRS (Figure 6-10).

TABLE 6-3
AVERAGE AND MEDIAN CURRENT HRS PATHWAY AND SITE SCORES
(Based on Field Test Sites)

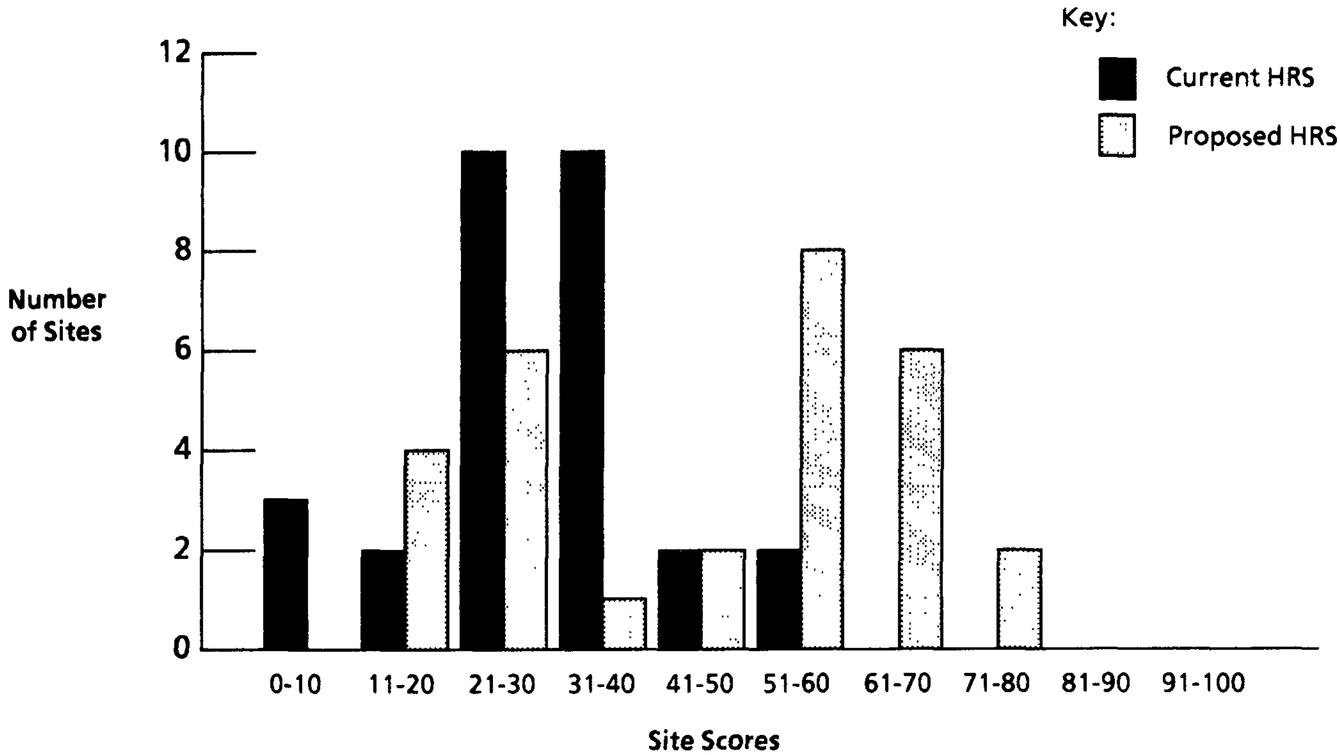
Pathway or Site Score	No. of Sites Tested	Average Score	Median Score	Range of Scores
Air	28	4	0	0 - 42
Ground water	29	48	50	0 - 100
Surface water	23	9	9	0 - 16
Overall site score	29	30	30	3 - 51

Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

For the field test sites, the ground water pathway in the current HRS had the highest average and median scores, while the current HRS air pathway had the lowest average and median scores. The surface water pathway had the smallest range of individual pathway scores under the current HRS.

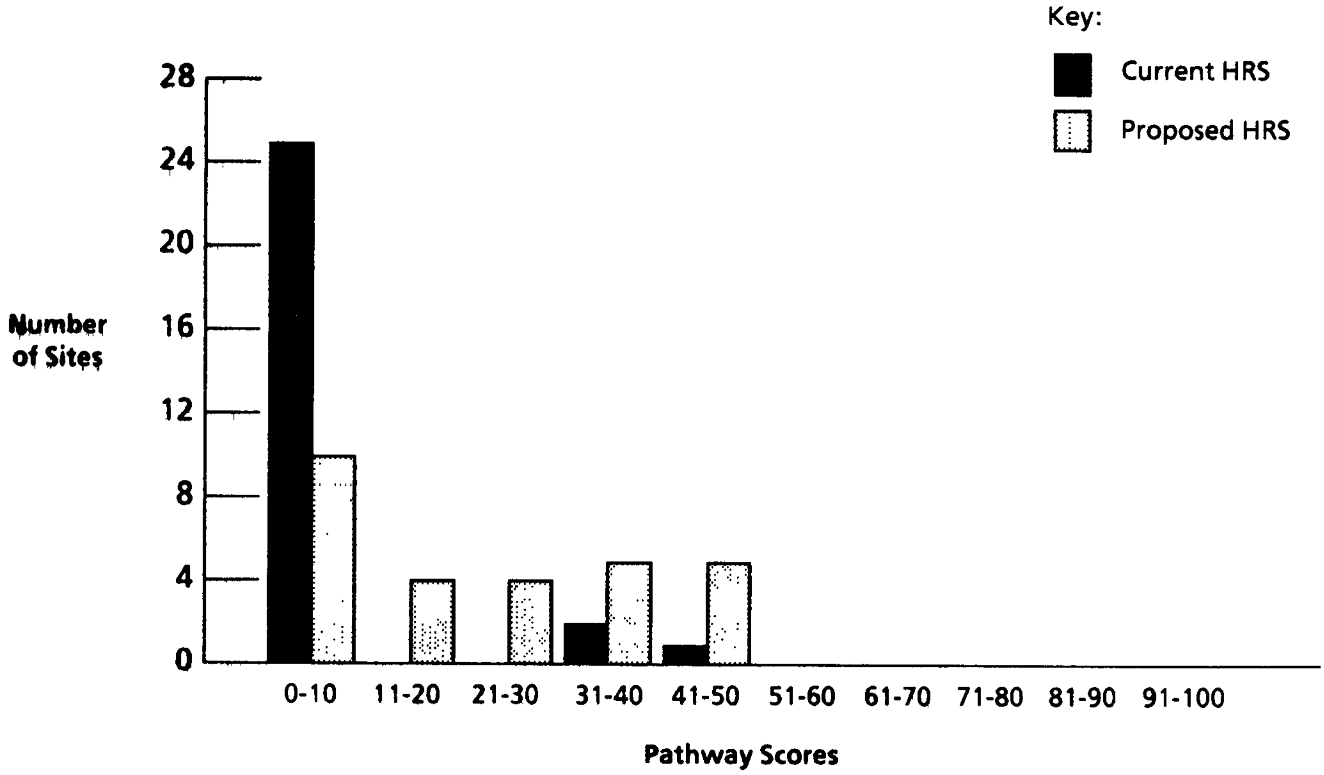
Comparative distributions of current and proposed HRS pathway scores are given in Figures 6-11 through 6-13. Average and median pathway scores as well as overall site scores under the proposed and current HRS are summarized in Table 6-4.

FIGURE 6-10
PROPOSED AND CURRENT HRS SCORES
(Based on 29 Field Test Sites)



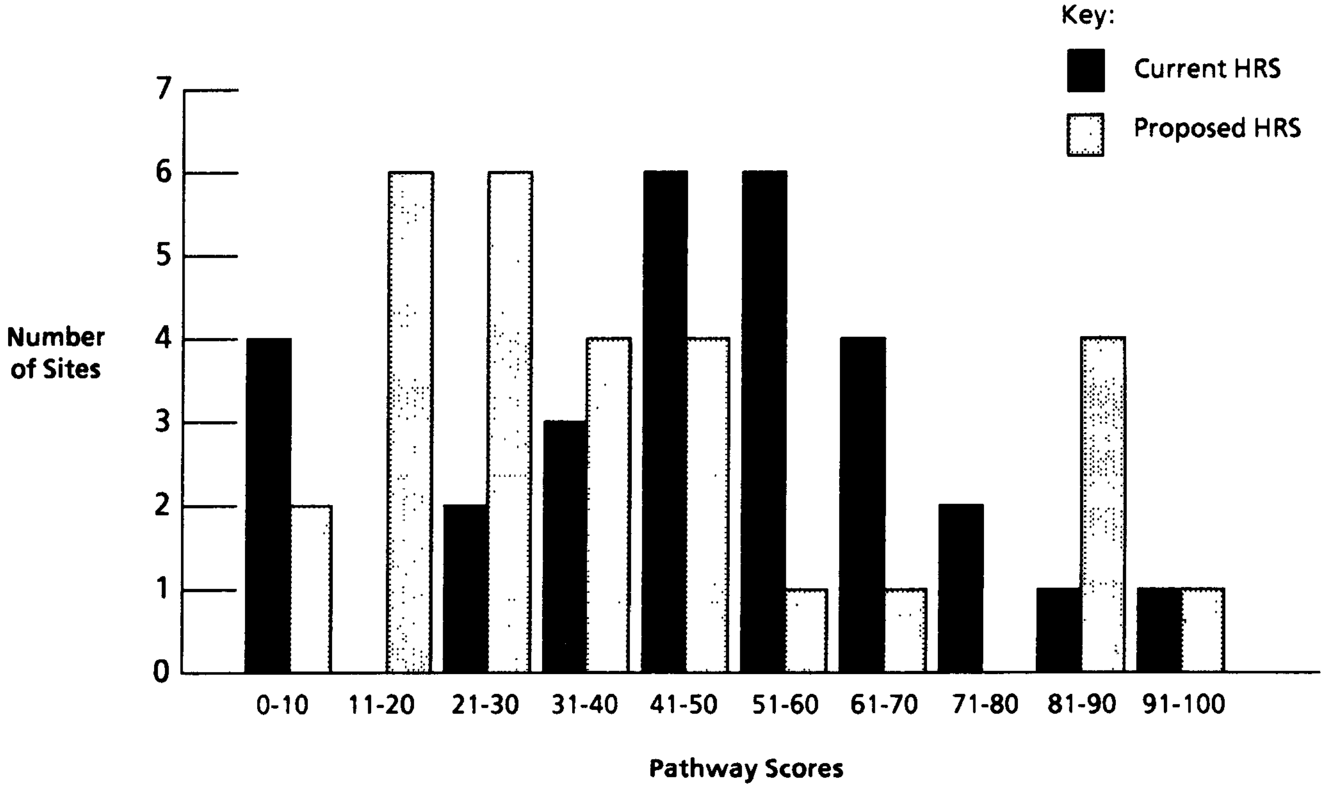
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-11
AIR PATHWAY SCORES:
PROPOSED AND CURRENT HRS
(Based on 28 Field Test Sites)



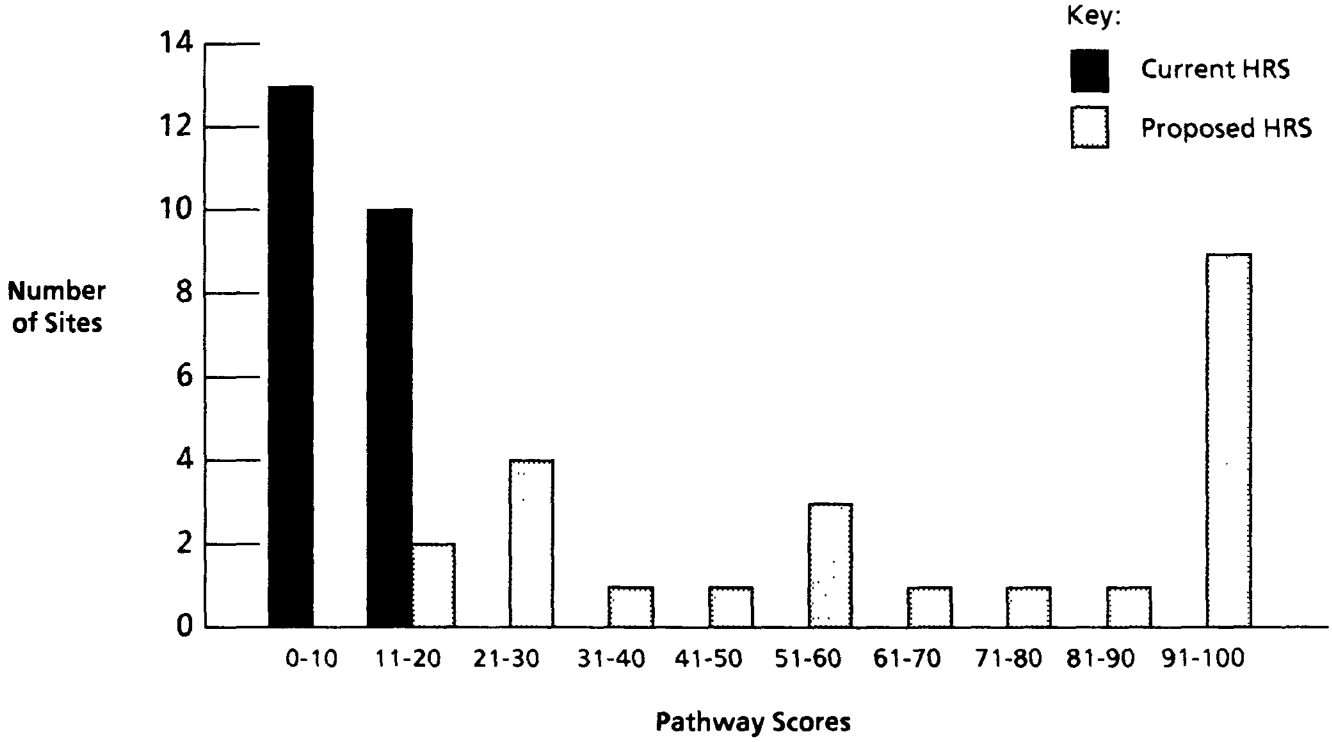
Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-12
GROUND WATER PATHWAY SCORES:
PROPOSED AND CURRENT HRS
(Based on 29 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

FIGURE 6-13
SURFACE WATER PATHWAY SCORES:
PROPOSED AND CURRENT HRS
(Based on 23 Field Test Sites)



Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

TABLE 6-4
AVERAGE AND MEDIAN PATHWAY AND SITE SCORES UNDER THE PROPOSED AND CURRENT HRS
(Based on Field Test Sites)

Pathway or Site Score	Average Scores		Median Scores	
	Proposed HRS	Current HRS	Proposed HRS	Current HRS
Air	22	4	22	0
Ground water	40	48	31	50
Surface water	65	9	62	9
Onsite exposure	40	NA	25	NA
Overall site score	46	30	53	30

Note: These values are based upon findings from field test sites that were primarily selected to test specific features of the proposed HRS. As such, these values are not necessarily representative of the greater universe of CERCLA sites.

6.3 SCORING SUMMARY

This scoring analysis, conducted by comparing HRS scores for sites evaluated under both the current and proposed HRS, is based on the 29 field test sites. For these sites:

- Surface water scores were highest among the individual pathway scores under the proposed HRS while, under the current HRS, ground water scores were highest among the individual pathway scores.
- Proposed surface water pathway scores were, in turn, usually dominated by the human food chain threat.
- Surface water and air pathway scores were generally higher with the proposed HRS than with the current HRS.
- Ground water pathway scores were generally lower with the proposed HRS than with the current HRS.
- Overall site scores were generally higher with the proposed HRS than with the current HRS.

Sites scoring higher than the average and median proposed air pathway scores among the field test sites generally had maximum hazardous waste quantity factor values, significant target population or sensitive environment factor values (but not necessarily both together), and documented observed air releases or maximum gas mobility factor values. Sites scoring lower than the average and median proposed air pathway scores generally had relatively smaller target population or sensitive environment factor values.

For the proposed ground water pathway, sites scoring higher than the average and median pathway scores among the field test sites generally had maximum hazardous waste quantity factor values, significant potential ground water target population or Level I population (i.e., those populations which are drinking water contaminated above health-based benchmarks) factor values, and documented observed ground water releases or maximum depth to aquifer/hydraulic conductivity matrix values. Sites scoring lower than the average and median proposed ground water pathway scores generally had smaller potential target population factor values, lower hydraulic conductivity factor values, or lower MEI factor values.

Field test sites scoring higher than the average and median proposed surface water pathway scores were generally characterized by higher hazardous waste quantity factor values, higher distance to surface water factor values, and documented observed surface water releases. This group of sites also had at least two surface water threats that received significant scores, one of which was always the human food chain threat. The highest scoring surface water threats among the sites tested generally had significant target population (i.e., drinking water or recreation) or sensitive environment factor values specific to those threats. In many cases, these targets also met the proposed HRS criteria for actual contamination (human recreation and environmental threats only).

Sites that scored lower under the proposed surface water pathway generally had at least three surface water threats that received small scores, two of which were usually the human food chain and environmental threats. In most cases, the lack of targets or the small hazardous waste quantity factor values for these threats resulted in lower scores.

For the onsite exposure pathway, the field test sites that scored higher than the average and median pathway scores were generally characterized by significant resident or nearby human target population factor values and higher waste quantity factor values. Sites that scored lower generally had relatively smaller resident or nearby target population factor values.

Because the field test sites were primarily selected to test new components included in the proposed HRS, the ability to extrapolate the field test results to the greater universe of CERCLA sites is limited. Overall site scores in the field test, for example, tended to be higher under the proposed HRS than under the current HRS, but this would not necessarily hold true for CERCLA sites in general. However, the scoring results of this study do provide a useful measure of how actual environmental data perform within the framework of the proposed HRS.

SECTION 7

MAJOR SOURCE MATERIALS

U.S. Environmental Protection Agency. 1982. National Contingency Plan. Appendix A; Final Rule. 47 Federal Register 32220. Washington, D.C. July 16.

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