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Part II

**Environmental
Protection Agency**

40 CFR Part 300
Hazard Ranking System; Final Rule

ENVIRONMENTAL PROTECTION
AGENCY

40 CFR Part 300

[FRL-3730-8]

RIN 2050 AB73

Hazard Ranking System

AGENCY: Environmental Protection
Agency.

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is adopting revisions to the Hazard Ranking System (HRS), the principal mechanism for placing sites on the National Priorities List (NPL). The revisions change the way EPA evaluates potential threats to human health and the environment from hazardous waste sites and make the HRS more accurate in assessing relative potential risk. These revisions comply with other statutory requirements in the Superfund Amendments and Reauthorization Act of 1986 (SARA).

DATES: Effective date March 14, 1991. As discussed in Section III H of this preamble, comments are invited on the addition of specific benchmarks in the air and soil exposure pathways until January 14, 1991.

ADDRESSES: Documents related to this rulemaking are available at and comments on the specific benchmarks in the air and soil exposure pathways may be mailed to the CERCLA Docket Office, OS-245, U.S. Environmental Protection Agency, Waterside Mall, 401 M Street, SW, Washington, DC 20460, phone 202-382-3046. Please send four copies of comments. The docket is available for viewing by appointment only from 9:00 am to 4:00 pm, Monday through Friday, excluding Federal holidays. The docket number is 105NCP-HRS.

FOR FURTHER INFORMATION CONTACT: Steve Caldwell or Agnes Ortiz, Hazardous Site Evaluation Division, Office of Emergency and Remedial Response, OS-230, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460, or the Superfund Hotline at 800-424-9346 (in the Washington, DC area, 202-382-3000).

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I. Background

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. 9601 *et seq.*), commonly called the Superfund, in response to the dangers posed by uncontrolled releases of hazardous substances, contaminants, and pollutants. To implement section 105(8)(A) of CERCLA and Executive Order 12316 (46 FR 42237, August 20, 1981), the U.S. Environmental Protection Agency (EPA) revised the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR part 300, on July 16, 1982 (47 FR 31180), with later revisions on September 18, 1985 (50 FR 37624), November 20, 1985 (50 FR 47912), and March 8, 1990 (55 FR 8666). The NCP sets forth guidelines and procedures for responding to releases or potential release of hazardous substances, pollutants, or contaminants.

Section 105(8)(A) of CERCLA (now section 105(a)(8)(A)) requires 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 the 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 the 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 adopted the Hazard Ranking System (HRS) as appendix A to the NCP (47 FR 31180, July 16, 1982). The HRS is a scoring system used to assess the relative threat associated with actual or potential releases of hazardous

substances at sites. The HRS is the primary way of determining whether a site is to be included on the National Priorities List (NPL), the Agency's list of sites that are priorities for long-term evaluation and remedial response, and is a crucial part of the Agency's program to address the identification of actual and potential releases. (Each State can nominate one site to the NPL as a State top priority regardless of its HRS score; sites may also be added in response to a health advisory from the Agency for Toxic Substances and Disease Registry (see NCP, 40 CFR 300.425(c)(3).) Under the original HRS, a score was determined for a site by evaluating three migration pathways—ground water, surface water, and air. Direct contact and fire and explosion threats were also evaluated to determine the need for emergency actions, but did not enter into the decision on whether to place a site on the NPL.

In 1986, Congress enacted the Superfund Amendments and Reauthorization Act of 1986 (SARA) (Pub. L. 99-499), which added section 105(c)(1) to CERCLA, requiring EPA to amend the HRS to assure "to the maximum extent feasible, that the hazard ranking system accurately assesses the relative degree of risk to human health and the environment posed by sites and facilities subject to review." Congress, in its Conference Report on SARA, stated the substantive standard against which HRS revisions could be assessed:

This standard is to be applied within the context of the purpose for the National Priorities List; i.e., identifying for the States and the public those facilities and sites which appear to warrant remedial actions. . . . This standard does not, however, require the Hazard Ranking System to be equivalent to detailed risk assessments, quantitative or qualitative, such as might be performed as part of remedial actions. The standard requires the Hazard Ranking System to rank sites as accurately as the Agency believes is feasible using information from preliminary assessments and site inspections . . . Meeting this standard does not require long-term monitoring or an accurate determination of the full nature and extent of contamination at sites or the projected levels of exposure such as might be done during remedial investigations and feasibility studies. This provision is intended to ensure that the Hazard Ranking System performs with a degree of accuracy appropriate to its role in expeditiously identifying candidates for response actions. [H.R. Rep. No. 962, 99th Cong., 2nd Sess. at 199-200 [1986]]

Section 105(c)(2) further specifies that the HRS appropriately assess the human health risks associated with actual or potential contamination of surface waters used for recreation or drinking

water and that this assessment should take into account the potential migration of any hazardous substance through surface water to downstream sources of drinking water.

SARA added two criteria for evaluating sites under section 105(a)(8)(A): Actual or potential contamination of the ambient air and threats through the human food chain. In addition, CERCLA section 118, added by SARA, requires EPA to give a high priority to facilities where the release of hazardous substances has resulted in the closing of drinking water wells or has contaminated a principal drinking water supply. Finally, CERCLA section 125, added by SARA, requires revisions to the HRS to address facilities that contain substantial volumes of wastes specified in section 3001(b)(3)(A)(i) of the Solid Waste Disposal Act, commonly referred to as the Resource Conservation and Recovery Act (RCRA). These wastes include fly ash wastes, bottom ash wastes, slag wastes, and flue gas emission control wastes generated primarily from the combustion of coal or other fossil fuels. Specifically, section 125 requires EPA to revise the HRS to assure the appropriate consideration of each of the following site-specific characteristics of such facilities:

- The quantity, toxicity, and concentrations of hazardous constituents that are present in such waste and a comparison with other wastes;
- The extent of, and potential for, release of such hazardous constituents into the environment; and
- The degree of risk to human health and the environment posed by such constituents.

EPA published an advance notice of proposed rulemaking (ANPRM) on April 9, 1987 (52 FR 11513), announcing its intention to revise the HRS and requesting comments on a number of issues. After a comprehensive review of the original HRS, including consideration of alternative models and Science Advisory Board review, EPA published a notice of proposed rulemaking (NPRM) for HRS revisions on December 23, 1988 (53 FR 51962). The NPRM contains a detailed preamble, which should be consulted for a more extensive discussion of CERCLA, SARA, the HRS, and the proposed changes to the HRS.

Today, EPA is publishing the revised HRS, which will supersede the HRS previously in effect as appendix A to the NCP. CERCLA section 105(c)(1) states that the revised HRS shall be applied to any site newly listed on the NPL after its effective date; as specified in section

105(c)(3), sites scored with the original HRS prior to that effective date need not be reevaluated.

The HRS is a scoring system based on factors grouped into three factor categories. The factor categories are multiplied and then normalized to 100 points to obtain a pathway score (e.g., the ground water migration pathway score). The final HRS score is obtained by combining the pathway scores using a root-mean-square method. The proposed HRS revised every factor to some extent. A few factors were replaced, and several new factors were added. The major proposed changes included:

- (1) Consideration of potential as well as actual releases to air;
- (2) Addition of mobility factors;
- (3) Addition of dilution and distance weightings for the water migration pathways and modification of distance weighting in the air migration pathway;
- (4) Revisions to the toxicity factor;
- (5) Additions to the list of covered sensitive environments;
- (6) Addition of human food chain and recreation threats to the surface water migration pathway;
- (7) Revision of the hazardous waste quantity factor to allow a tiered approach;
- (8) Addition of health-based benchmarks for evaluating population factors and ecological-based benchmarks for evaluating sensitive environments;
- (9) Addition of factors for evaluating the maximally exposed individual; and
- (10) Inclusion of a new onsite exposure pathway.

EPA conducted a field test of the proposed HRS to assess the feasibility of implementing the proposed HRS factors, to determine resources required for specific tasks, to assess the availability of information needed for evaluation of sites, and to identify difficulties with the use of the proposed revisions. To meet the objectives, site inspections were performed at 29 sites nationwide. The sites were selected either because work was already planned at the site or because the sites had specific features EPA wanted to test using the proposed revisions to the HRS. The major results of the field test were summarized on September 14, 1989 (54 FR 37949), when the field test report was made available for public review and comment.

II. Overview of the Final Rule

The rule being promulgated today incorporates substantial changes to revisions proposed in December 1988. EPA has changed the rule for three reasons: (1) To respond to the general

comment submitted by many commenters that the factor categories and pathways need to be consistent with each other; (2) to respond to specific recommendations made by commenters; and (3) to respond to problems identified during the field test and discussed in the field test report. Major changes affecting multiple pathways include:

- Multiplication of hazardous waste quantity factor, toxicity, and other waste characteristics factors;
- Uncapping of population factors (i.e., no limit is placed on maximum value);
- Revised criteria for establishing an observed release;
- Capping of potential to release at a value less than observed release;
- Revision of the toxicity evaluation to select carcinogenic and non-cancer chronic values in preference to acute toxicity values;
- Elimination of Level III concentrations and extension of weighting based on levels of exposure to nearest individual (well/intake; formerly maximally exposed individual) factors;
- Modification of the weights assigned to Level I and Level II concentrations;
- Revisions to the benchmarks used and methods for determining exceedance of benchmarks;
- Use of ranges to assign values for potentially exposed populations;
- Inclusion of factors assessing exposures of the nearest individual in all pathways;
- Revisions to distance and dilution weights in all pathways except ground water migration;
- Replacement of the use factors with less heavily weighted resources factors;
- Evaluation of wetlands based on size or surface water frontage; and
- Specific instructions for the evaluation of radionuclides at radioactive waste sites and sites with radioactive and other hazardous substances wastes.

The major changes in the ground water migration pathway include:

- Replacement of depth to aquifer/hydraulic conductivity and sorptive capacity factors with travel time and depth to aquifer factors; and
- Revision of the mobility factor, including consideration of distribution coefficients.

In the surface water migration pathways, the major changes include:

- Elimination of the separate recreational use threat;
- Addition of a ground water to surface water component;

- Incorporation of bioaccumulation into the waste characteristics factor category rather than the targets factor category for the human food chain threat;
- Revision to allow use of additional tissue samples in establishing Level I concentrations for the human food chain threat; and
- Addition of ecosystem bioaccumulation potential factor for sensitive environments.

The major changes in the soil exposure pathway (formerly the onsite exposure pathway) include:

- Elimination of separate consideration of the high risk population;
- Inclusion of hazardous waste quantity in the waste characteristics factor category;
- Consideration of workers in the resident threat's targets factor category; and

- Revisions to scoring of terrestrial sensitive environments.

The major changes in the air migration pathway include:

- Separate evaluation of gas and particulate potential to release; and
- Consideration of actual contamination in evaluating sensitive environments.

Figures 1 to 4 show the differences between the pathways in the original HRS and in the final rule.

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Figure 1

Ground Water Migration Pathway

ORIGINAL HRS

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

FINAL HRS

| Likelihood of Release | X | Waste Characteristics | X | Targets |
|--|---|---|---|---|
| Observed Release or Potential to Release | | Toxicity/Mobility Hazardous Waste Quantity | | Nearest Well Population Resources Wellhead Protection Area |
| Containment | | | | |
| Net Precipitation | | | | |
| Depth to Aquifer | | | | |
| Travel Time | | | | |

Surface Water Migration Pathway

ORIGINAL HRS

| | | |
|---|--|--|
| <p>Likelihood of Release X</p> <p>Observed Release</p> <p>or</p> <p>Route Characteristics</p> <p> Facility Slope/Intervening Terrain</p> <p> 1-Year, 24-Hour Rainfall</p> <p> Distance to Nearest Surface Water</p> <p> Physical State</p> <p> Containment</p> | <p>Waste Characteristics X</p> <p>Toxicity/Persistence</p> <p>Hazardous Waste Quantity</p> | <p>Targets</p> <p>Surface Water Use</p> <p>Distance to Sensitive Environment</p> <p>Population Served/Distance to Nearest Intake Downstream</p> |
|---|--|--|

Surface Water Migration Pathway (continued)

FINAL HRS

Likelihood of Release:

Overland Flow/Flood Component

Observed Release
or
Potential to Release

By Overland Flow
Containment
Runoff
Distance to Surface
Water
By Flood
Containment
Flood Frequency

or

Likelihood of Release:

**Ground Water to Surface
Water Component**

Observed Release
or
Potential to Release
Containment
Net Precipitation
Depth to Aquifer
Travel Time

X

Drinking Water Threat

| | | |
|---|----------|----------------|
| Waste Characteristics | x | Targets |
| Toxicity/Mobility ¹ /Persistence | | Nearest Intake |
| Hazardous Waste Quantity | | Population |
| | | Resources |

+

Human Food Chain Threat

| | | |
|----------------------------------|----------|-----------------------|
| Waste Characteristics | x | Targets |
| Toxicity/Mobility ¹ / | | Food Chain Individual |
| Persistence/Bioaccumulation | | Population |
| Hazardous Waste Quantity | | |

+

Environmental Threat

| | | |
|--|----------|------------------------|
| Waste Characteristics | x | Targets |
| Ecosystem Toxicity/Mobility ¹ / | | Sensitive Environments |
| Persistence/Bioaccumulation | | |
| Hazardous Waste Quantity | | |

¹ Mobility is only applicable to the Ground Water to Surface Water Component.

Figure 3

Soil Exposure Pathway¹

FINAL HRS

Resident Population Threat

| Likelihood of Exposure | X | Waste Characteristics | X | Targets |
|------------------------|---|--------------------------------------|---|---|
| Observed Contamination | | Toxicity Hazardous Waste Quantity | | Resident Individual Resident Population Workers Resources Terrestrial Sensitive Environments |

+

Nearby Population Threat

| Likelihood of Exposure | X | Waste Characteristics | X | Targets |
|---|---|--------------------------------------|---|---|
| Attractiveness/Accessibility Area of Contamination | | Toxicity Hazardous Waste Quantity | | Population Within 1 Mile Nearby Individual |

¹ New pathway.

Figure 4

Air Migration Pathway

ORIGINAL HRS

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

FINAL HRS

| Likelihood of Release | X | Waste Characteristics | X | Targets |
|--|---|---|---|---|
| Observed Release or Potential to Release | | Toxicity/Mobility Hazardous Waste Quantity | | Nearest Individual Population Resources Sensitive Environments |
| Gas | | | | |
| Gas Containment | | | | |
| Gas Source Type | | | | |
| Gas Migration Potential | | | | |
| Particulate | | | | |
| Particulate Containment | | | | |
| Particulate Source Type | | | | |
| Particulate Migration Potential | | | | |

Section III of this preamble summarizes and responds to major issues raised by commenters. These issues are organized so that issues that affect multiple pathways are covered first, followed by discussions of individual pathway issues. Section IV provides a section-by-section discussion of the final rule. All substantive changes not discussed in section III are identified in section IV. Because the rule has been substantially rewritten to clarify the requirements, editorial changes are not generally noted.

III. Discussion of Comments

About 100 groups and individuals submitted comments on the ANPRM and NPRM. Nineteen of these also submitted comments on the field test report; two other groups submitted comments only on the field test report. The commenters included more than 20 State agencies, several Federal agencies, companies, trade associations, Indian tribes, environmental groups, technical consultants, and individuals. This section summarizes and responds to the major issues raised by commenters. A description of the comments and EPA's response to each issue raised in the comments are available in *Responses to Comments on Revisions to the Hazard Ranking System (HRS)* in the EPA CERCLA docket (see ADDRESSES section above).

1. Simplification

In response to SARA, EPA proposed revisions to the HRS so that, to the maximum extent feasible, it accurately assesses the relative risks posed by hazardous waste sites to human health and the environment. Consequently, the proposed rule required more data than did the original HRS.

A number of commenters stated that the data collection requirements of the proposed rule were excessive given its purpose as a screening tool. These commenters expressed concern that the data requirements were too extensive for a screening process; specifically, that the data requirements would lengthen the time needed to score sites with the HRS, increase the cost of listing sites, and, therefore, limit the money available for remedial actions. Most commenters—even those who considered that the revisions increased the accuracy of the model—stated that the resources required to evaluate sites under the proposed HRS were excessive.

One commenter suggested the proposed HRS would be so expensive to implement that EPA would need to develop a new screening tool to determine whether a site should undergo

an HRS evaluation. Another commenter suggested that because of the complexity of the proposed revisions, preliminary scoring of a site during the site assessment process would be impractical because sites would advance too far in the site assessment process before they were determined not to be NPL candidates. Several commenters stated that, with the additional requirements, the proposed HRS is more of a quantitative risk-assessment tool than the screening tool it is supposed to be. Another suggested that the increased accuracy of the proposed rule over the original HRS is of marginal value relative to the amount of time and money involved, and that the HRS is no longer a quick and inexpensive method of assessing relative risks associated with sites.

Several commenters expressed concern that the increased data requirements of the proposed HRS would affect the schedule of the entire site assessment process. They suggested that these requirements would create a backlog of sites to be evaluated, slow the process of listing sites, and delay cleanup. Some noted that this would be contrary to the goal of identifying and evaluating sites expeditiously.

In response, the Agency believes the requirements of the final rule are within the scope of the site assessment process, and that a new screening tool to determine whether a site should undergo an HRS evaluation will not be needed. To assist in screening sites, the site assessment process is divided into two stages:

- A preliminary assessment (PA), which focuses on a visual inspection, collection of available local, State, and Federal permitting data, site-specific information (e.g., topography, population), and historical industrial activity; and
- A site inspection (SI), where PA data are augmented by additional data collection, including sampling of appropriate environmental media and wastes, to determine the likelihood of a site receiving a high enough HRS score to be considered for the NPL.

The field test identified a best estimate of the average and range of costs incurred to support the data requirements of the proposed HRS. These cost estimates represented the entire site assessment process from PA to SI, and comprehensive evaluations for all pathways at most sites. As such, the Agency believes these cost estimates overstate the costs associated with site assessments occurring on the greater universe of CERCLA sites. The amount of data collected during an SI varies from site to site depending on the

complexity of the site and the number of environmental media believed to be contaminated. Some SIs may be limited in scope if data are easy to obtain, while others require more substantial resource commitments. The most important factors in determining costliness of an SI are (1) the presence or absence of ground water monitoring wells in situations where ground water is affected, and (2) the number of affected media, which determines the number of samples taken and analyzed. The Agency believes the greater universe of CERCLA sites will not require the more substantial resource commitments.

Finally, EPA does not agree that the requirements of the final rule will delay the listing of sites. The site assessment process screens sites at each stage, thereby limiting the number of sites that require evaluation for scoring. The Agency believes that it will be possible to score sites expeditiously with the revised HRS.

The Agency believes the additional data requirements of the final rule will make it more accurately reflect the relative risks posed by sites, but also that the HRS should be as simple as possible to make it easier to implement and to retain its usefulness as a screening device. This approach responds to the majority of commenters who recommended that EPA simplify the proposed HRS to make it easier and less expensive to implement. In response to these comments, the rule adopted today includes a number of changes from the proposed rule that simplify the HRS. These simplifying changes were based largely on EPA's field test of the proposed rule, sensitivity studies, and issue analyses undertaken by EPA in response to comments.

- In the surface water migration pathway, the proposed recreation threat has been eliminated as a separate threat. Instead of requiring a separate set of detailed calculations and data, the final rule accounts for recreational use exposures through resources factors, where points may be added for recreation use.

- In the ground water migration pathway, the proposed potential to release has been simplified by dropping "sorptive capacity," by revising "depth to aquifer" and making it a separate factor, and by eliminating the requirement to consider all geological layers between the hazardous substance and the aquifer in evaluating travel time to the aquifer. The "travel time" factor (the depth to aquifer/hydraulic conductivity factor in the proposed rule)

is now based on the layer(s) with the lowest hydraulic conductivity.

- In the three migration pathways (i.e., ground water, surface water, and air), the use factors in the proposed rule—"land use" in the air migration pathway, "drinking water use" and "other water use" in the ground water migration pathway, and "drinking water use" and "other water use" in the surface water migration pathway—have been replaced by "resources" factors. The "fishery use" factor has been dropped from the surface water migration pathway. A resources factor has been added to the soil exposure pathway.

- In the soil exposure pathway, the requirement that children under seven be counted as a separate population has been dropped. The "accessibility/frequency of use" factor has been replaced by a simpler "attractiveness/accessibility" factor.

- In the surface water migration pathway, the "runoff curve number," which required determining the predominant land use within the drainage area, has been replaced by a simpler factor, "soil group," which only requires classifying the predominant soil group in the drainage area into one of our categories.

- In the air migration pathway, the maps used to assign values of particulate migration potential (formerly particulate mobility under potential to release) have been simplified.

- In all pathways, potentially exposed populations are assigned values based on ranges rather than exact counts, reducing documentation requirements.

- In the surface water and ground water migration pathways, Level III benchmarks have been dropped.

- In all pathways, hazardous waste quantity values are based on ranges, which will reduce documentation requirements. The methodology and explanation for evaluating the hazardous waste quantity factor have been simplified.

- Containment tables have been simplified in the air, ground water, and surface water migration pathways.

A number of the simplifications, such as the changes to the travel time and hazardous waste quantity factors, better reflect the uncertainty of the underlying site data and, therefore, do not generally affect the accuracy of the HRS. In addition, EPA notes that some revisions that may appear to make the HRS more complex actually make it more flexible. For example, the hierarchy for determining hazardous waste quantity allows using data on the quantity of hazardous constituents if they are available or can be determined;

additionally, data on the quantity of hazardous wastestreams, source volume, and source area can be used, depending on the completeness of data within the hierarchy. The hierarchy allows a site to be scored at the most precise level for which data are reasonably available, but does not require extensive data collection where available data are less precise.

In response to comments on the complexity of the rule language, the presentation of the HRS has been reorganized and clarified. Factors that are evaluated in more than one pathway are explained in a separate section of the final rule (§ 2) to eliminate the repetition of instructions. The proposed HRS included descriptive background material that, while useful, made the HRS difficult to read. Much of this descriptive material has been removed from the rule.

B. HRS Structure Issues

Although the proposed rule retained the basic structure of the original HRS, a number of commenters felt that the HRS should provide results consistent with the results of a quantitative risk assessment. Several commenters identified this issue explicitly, while others identified specific aspects of the proposed rule that they believed to be inconsistent with basic risk assessment principles. The commenters maintained that if the HRS is to reflect relative risks to the extent feasible, as required by the statute, its structure should be modified to better reflect the methods employed in quantitative risk assessments. Commenters stressed the need for EPA to follow the advice of the EPA Science Advisory Board (SAB) as expressed in the SAB review of the HRS:

Revisions to the HRS should begin with the development of a chain of logic, without regard for the ease or difficulty of collecting data, that would lead to a risk assessment for each site. This framework, but not the underlying logic, would be simplified to account for the very real difficulties of data collection.

This chain of logic . . . should lead to a situation in which an increased score reflects an increased risk presented by a site.

In response to the structural issues raised by commenters and to the statutory mandate to reflect relative risk to the extent feasible, EPA made a number of changes to the final rule. These structural changes affect how various factors are scored and how scores are combined, but do not involve changes in the types or amount of data required to score a site with the HRS. The Agency stresses that the limited data generated at the SI stage are designed to support site screening, and

are not intended to provide support for a quantitative risk assessment.

General structural changes. While the final rule retains the basic structure of the proposed rule in that three factor categories (likelihood of release, waste characteristics, and targets) continue to be multiplied together to obtain pathway scores, the structure has been changed in certain respects to make the underlying logic of the HRS more consistent with risk assessment principles.

The key structural changes to the waste characteristics factor category were to make use of consistent scales and to multiply the hazardous waste quantity and toxicity (or, depending on the pathway and threat, toxicity/mobility, toxicity/persistence, or toxicity/persistence/bioaccumulation) factors. Within the waste characteristics factor category, factors have been modified so they are on linear scales. These modifications make the functional relationships between the HRS factors more consistent with the toxicity and exposure parameters evaluated in risk assessments.

Where possible, the final rule assigns similar maximum point values to factor categories across pathways. The likelihood of release (likelihood of exposure) factor category is assigned a maximum value of 550; the waste characteristics factor category is assigned a maximum value of 100 (except for the human food chain and environmental threats of the surface water migration pathway); the targets factor category is not assigned a maximum. EPA determined that in general targets should be a key determinant of site threat because the data on which the targets factors are based are relatively more reliable than most other data available at the SI stage.

Likelihood of release. Except in the air migration pathway, the proposed rule assigned the same maximum value to observed release and potential to release. In the final rule, an observed release is assigned a value of 550 points and potential to release has a maximum value of 500 in all pathways. This relative weighting of values reflects the greater confidence (the association of risks with targets) when reporting an observed release as opposed to a potential release. As a result of this change in point values at the factor category level, as well as the new maximums for most pathways, the values assigned to individual potential to release factors have been adjusted.

Waste characteristics. The proposed rule assigned a maximum point value to

hazardous substance quantities of 1,000 pounds. Because some sites have hazardous substance quantities far in excess of that amount and because it is reasonable to assume that these sites present some additional risk, all else being equal, the final rule elevates the maximum value to quantities in excess of 1,000,000 pounds. Even when hazardous waste quantity is documented with precision, EPA concluded that there are diminishing returns in considering quantities above this amount.

Although the HRS does not employ the same type and quality of information that would be used to support a risk assessment (e.g., pounds of waste and nobility are combined in the ground water pathway as a surrogate for long-term magnitude of releases), as waste characteristics values rise, contamination resulting from conditions at the sites in general should be worse. As a result of using linear scales and incorporation of a multiplicative relationship between hazardous waste quantity, toxicity, and other waste characteristics factors, the influence of the waste characteristics factor category could be disproportionately large relative to the likelihood of release and targets factor categories in determining overall pathway scores. Therefore, EPA is limiting—through use of a scale transformation—the values assigned to the waste characteristics factor category, shown in Table 2-7 of the final HRS, to limit the effect of waste characteristics on the pathway scores.

While the waste characteristics factor values are limited to values of 0 to 100 in most cases, the waste characteristics factor category may reach values of up to 1,000 for both the human food chain and environmental threats in the surface water migration pathway. These exceptions have been made to accommodate the bioaccumulation factor (or ecosystem bioaccumulation factor), applied in these threats but not in other pathways or threats, which can add up to four orders of magnitude to the waste characteristics factor values before reduction to the scale values of 0 to 1,000.

Targets. The final rule includes two major structural changes to the targets factor category. Population factor values are not capped as they were in the proposed rule. This change allows a site with a large population but a low waste characteristics value to receive scores similar to a site with a smaller population but larger waste characteristics value (as would be done in a risk assessment). A second change to the targets factors involves the

nearest individual (or intake or well) factors (i.e., the maximally exposed individual factors in the proposed rule). These factors are now assigned values based on exposure to Level I and Level II contamination (50 and 45 points, respectively). Potentially exposed nearest individuals are assigned a maximum of 20 points in all pathways. EPA changed the assigned values for these factors to give more relative weight to individuals that are exposed to documented contamination.

C. Hazardous Waste Quantity

In the NPRM, EPA proposed to change the hazardous waste quantity factor to allow the use of four levels of data depending on what data are available and how complete they are. Hazardous waste quantity for a source could be based on (a) hazardous constituent quantity, (b) the total quantity of hazardous wastes in the source, (c) the volume of the source, or (d) the area of the source. Each source at the site would be evaluated separately, based on data available for the source.

EPA received numerous comments relating to changes in the hazardous waste quantity factor. Several commenters agreed that allowing use of waste constituent data, when available, was an improvement over the original HRS. Several also supported the tiered approach to scoring hazardous waste quantity when constituent data were incomplete or unavailable.

Two commenters stated that the emphasis on hazardous constituent data will require more extensive and expensive site investigations. These commenters have misunderstood the revisions. The rule does not require the scorer to determine hazardous constituent quantities in all instances, but simply encourages use of those data when they are available. This approach allows a scorer the flexibility to use different types of available data for scoring hazardous waste quantity. At a minimum, the scorer need only determine the area of a source (or the area of observed contamination), which is routinely done in site inspections. Where better data are available, they may be used in scoring the factor. This approach is in keeping with the intent of Congress that the HRS should act as a screening tool for identifying sites warranting further investigation.

Several commenters stated that the methodology for determining hazardous waste quantity was too complex and time consuming, and that its administrative costs outweighed its benefits. Others found the proposed rule instructions and tables confusing and hard to follow.

EPA strongly disagrees with the claim that the costs of the revised approach to scoring waste quantity outweigh its benefits. The amount of hazardous substances present at a site is an important indicator of the potential threat the site poses. At the same time, EPA recognizes that cost is an important consideration. In revising the hazardous waste quantity factor, however, the Agency believes it has established an appropriate balance between time and cost required for scoring this factor and the degree of accuracy needed to evaluate the relative risk of the site properly.

In response to comments, EPA has modified the hazardous waste quantity scoring methodology to make it easier to understand and to use. The changes include elimination of proposed rule Table 2-13, Hazardous Waste Quantity Factor Evaluation Methodology and Worksheet. In addition, the scale for the hazardous waste quantity factor has been divided into ranges that span two orders of magnitude (100x) to reflect the uncertainty inherent in estimates of hazardous waste quantities at typical sites. The practical effect of this scale change is to reduce the data collection and documentation requirements. See §§ 2.4.2-2.4.2.2. The final rule also clarifies the treatment of wastes classified as hazardous under RCRA. Under CERCLA, any RCRA hazardous waste stream is considered a hazardous substance. If this definition were strictly applied in evaluating hazardous waste quantity of RCRA hazardous wastestreams, hazardous constituent quantity and hazardous wastestream quantity would be the same because the entire wastestream would be considered a hazardous substance. The final rule makes clear that only the constituents in a RCRA wastestream that are CERCLA hazardous substances should be evaluated for determining hazardous constituent quantity; for the other three tiers, however, the entire RCRA wastestream is considered as is any other wastestream.

As discussed in section III Q, EPA will consider removal actions when calculating waste quantities. EPA believes consideration of removal actions is likely to increase incentives for rapid actions. If there has been a removal at a site, and the hazardous constituent quantity for all sources and associated releases is adequately determined, the hazardous waste quantity factor value will be based only on the amount remaining after the removal. This will result in lowering some hazardous waste quantity factor values.

Where an adequate determination of the hazardous constituent quantity remaining after the removal cannot be made, EPA has established minimum hazardous waste quantity factor values in order to ensure that the HRS score reflects any continuing risks at the sites. In this case, the assigned hazardous waste quantity factor value will be the current hazardous waste quantity factor value (as derived in Table 2-6), or the minimum value, whichever is greater.

The proposed rule assigned a minimum hazardous waste quantity factor value of 10 when data on hazardous constituent quantity was not complete. In the final rule, for migration pathways (i.e., not the soil exposure pathway), if the hazardous constituent quantity is not adequately determined, and if any target is subject to Level I or II contamination, the minimum hazardous waste quantity factor value will be 100.

If the hazardous constituent quantity for all sources is not adequately determined, and none of the targets are subject to Level I or II contamination, the minimum factor value assigned for hazardous waste quantity depends on whether there has been a removal action, and what the hazardous waste quantity factor value would have been without consideration of the removal action. If there has not been a removal action, the minimum hazardous waste quantity factor value will be 10. If there has been a removal action and if a factor value of 100 or greater would have been assigned without consideration of the removal action, a minimum hazardous waste quantity factor value of 100 will be assigned. If the hazardous waste quantity factor value was less than 100 prior to consideration of the removal action, a minimum hazardous waste quantity factor value of 10 will be assigned. This will ensure that the Agency provides an incentive for removal actions and that in no case will consideration of removal actions result in an increased hazardous waste quantity factor value score.

D. Toxicity

The proposed HRS substantially changed the basis for evaluating toxicity. The major change was that hazardous substance toxicity would be based on carcinogenicity, chronic non-cancer toxicity, and acute toxicity. For each migration pathway and each surface water threat except human food chain and recreation, toxicity was combined with mobility or persistence factors to select the hazardous substance with the highest combined value for toxicity and the applicable mobility or persistence factor. For the

human food chain threat, only substances with the highest bioaccumulation values were evaluated for toxicity/persistence. For the recreation threat, only substances with the highest dose adjusting factor values were evaluated for toxicity/persistence. In addition, ecosystem toxicity rather than human toxicity was evaluated for the environmental threat of the surface water migration pathway.

Several commenters expressed concern about or opposition to using the single most hazardous substance at a site to score toxicity, stating that the approach seems overly conservative and unlikely to distinguish sites on the basis of hazard. Some commenters suggested that EPA allow flexibility in weighting the toxicity values of multiple substances either by concentration, waste quantity, or proportion information, whenever such information is available. One commenter suggested basing toxicity on a fixed percentage of the hazardous substances known to be present at a site.

The Agency agrees that, for purposes of accurately assessing the risk to human health and the environment posed by a site, it would be preferable to evaluate the overall toxicity by considering all hazardous substances present, based on some type of dose- (or concentration-) weighted toxicity approach. EPA believes, however, that this approach is not feasible because the data requirements would be excessive. Such an approach would be feasible only when relative exposure levels of multiple substances are known or can reasonably be estimated; however, these data can be obtained only by conducting a comprehensive risk assessment. Extensive concentration data would be required to be confident that comparable concentrations are being used for the various substances, and that the multi-substance toxicity of the contaminants is not, in fact, being underestimated. Use of inadequate data could result in underestimating or overestimating the toxicity of substances in a pathway.

EPA considered a number of alternatives to the use of a single hazardous substance to score toxicity (mobility/persistence) and tested some of these on several real and hypothetical sites. The analyses included comparisons between the single most toxic substance and the average toxicity value for all substances, the average toxicity value for the 10 most toxic substances, and the concentration-weighted average value of all substances. These alternatives were also tested using toxicity/mobility

values. The results of these analyses showed that using a single substance approach usually resulted in an assigned value (either toxicity or toxicity/mobility) that was within one interval in the scale of values of the alternatives tested; for example, the single substance approach would assign a value of 1,000 for toxicity whereas averaging the toxicities would assign a value of 1,000 or 100, the next lower scale value. (The final rule uses linear scales to assign values for toxicity, mobility, and persistence. The scales for toxicity now range from 0 to 10,000 rather than 0 to 5; consequently, the default value for toxicity is now 100 rather than 3.) The Agency recognizes the uncertainty in the use of the single substance approach, but concludes that it is a reasonable approach for a screening model, especially given the general unavailability of information to support alternatives. In making this judgment, the Agency notes that the single substance approach to evaluating the toxicity factor was not identified in SARA as a portion of the HRS requiring further examination, even though it had been used in the original HRS and EPA had received criticism similar to the above comments prior to the enactment of SARA.

Several commenters suggested that additive, synergistic, or antagonistic effects among substances be considered in scoring toxicity when several substances are found at a site. In particular, one commenter suggested increasing the scores for sites with a large number of hazardous substances to account for additive or synergistic effects.

As noted in EPA's 1988 *Technical Support Document for the Proposed Revisions to the Hazard Ranking System*, quantitative consideration of synergistic/antagonistic effects between hazardous substances is generally not possible even in RI/FS risk assessments because appropriate data are lacking for most combinations of substances. Interactive effects have been documented for only a few substance mixtures, and the Agency's risk assessment guidelines for mixtures (51 FR 34014, September 24, 1986) emphasize that although additivity is a theoretically sound concept, it is best applied for assessing mixtures of similar acting components that do not interact. Thus, the Agency believes that consideration of interactive effects in evaluating toxicity in the HRS is not feasible, nor is it necessary to allow use of the HRS as a screening model. The Agency rejects the suggestion that scores should simply be raised for sites

with numerous substances because this approach ignores the technical complexities related to interactions (i.e., the possibility of antagonistic effects.)

One commenter suggested that a waste's toxicity should be assessed in terms of its "degree of risk," and that this could be measured by comparing constituent concentrations at the point of exposure to appropriate toxicity reference levels. Two commenters stated that toxicity should be measured at a likely point of human exposure rather than at the waste site.

The toxicity of a substance, as used in the HRS, is an inherent property, often expressed quantitatively as a dose or exposure concentration associated with a specific response (i.e., a dose-response relationship). These toxicity values, in general, are independent of expected environmental exposure levels; many are based on laboratory tests on animals. Risk, on the other hand, is a function of toxicity, the concentration of a substance in environmental media to which humans may be exposed, and the likelihood of exposure to that medium (and the population likely to be exposed). The toxicity factor in the waste characteristics factor category of the HRS is intended to reflect only the inherent toxicity (i.e., the basic dose-response relationship) of substances found at the site. The HRS as a whole is intended to evaluate, to the extent feasible, relative risks posed by sites by including factors for likelihood of release, waste quantity, toxicity, and the proximity of potentially exposed populations. If actual contamination (for example, of drinking water) has been detected at a site, the measured environmental concentration of each substance is compared with its appropriate health-based or ecological-based concentration limit (i.e., its benchmark). If these environmental concentrations equal or exceed a benchmark, certain target factors are assigned higher values than if environmental concentrations are less than benchmarks.

Two commenters suggested using Cancer Potency Factors to score toxicity only for Class A and B1 carcinogens, and using reference doses (RfDs) for scoring Class B2 and C carcinogens (i.e., substances for which there is inadequate or no direct human evidence of carcinogenicity).

In response, EPA believes that because the HRS is a screening tool, it should maintain a conservative (i.e., protective) approach to evaluation of potential cancer risks. EPA's 1986 *Guidelines for Carcinogen Risk Assessment* (51 FR 34014, September 24, 1986) provide for substances in Class A

and Class B (both B1 and B2) to be regarded as suitable for quantitative human risk assessment. In general, according to EPA's 1989 *Risk Assessment Guidance for Superfund: Human Health Evaluation Manual*, Class C substances are evaluated for cancer risks within the Superfund risk assessment process. Thus, the use of cancer risk information for Class B2 and C substances in the HRS is consistent with the objective of maintaining a conservative approach and with other Agency and Superfund program risk assessment guidelines.

In response to comments that the best available data should be used to score sites, that accepted Agency practices be relied on, and that consistency across pathways be encouraged, the Agency has modified slightly the way the toxicity value for a substance is selected. The final rule requires the use of carcinogenicity and chronic toxicity data, when available, over acute toxicity data. If both slope factors and RfDs are available, the higher of the values assigned for these types of toxicity parameters is used. If neither is available, but acute toxicity data are available, the acute toxicity data are used to assign toxicity factor values. EPA decided to give preference to slope factors and RfD values because these undergo more extensive Agency review and are based on long-term exposure studies.

E. Radionuclides

The proposed HRS assigned radionuclides a maximum toxicity value, but included no other procedures specific to radionuclides.

One commenter, the U.S. Department of Energy (DOE), asserted that the proposed HRS "contains an inequitable bias regarding radionuclides." DOE specifically criticized assigning maximum toxicity factor values to radionuclides, "where, in fact, the health impact associated with radionuclides is associated with the type of decay, the level of decay energy, the half-life, the mobility, the concentration of the radionuclide, internal biological factors, and external pathway factors." DOE proposed using concepts for evaluating radionuclides that were included in its Modified Hazard Ranking System (mHRS). In its subsequent comments on the HRS field test report, DOE stated that it considered the "method of handling radionuclides in the proposed revised HRS to be a serious flaw in the evaluation system."

In the final rule, EPA has clarified and significantly changed how radionuclides are evaluated. Instead of using or

adapting the mHRS directly, however, EPA modified the proposed HRS to account more fully for radionuclides based on EPA's own methods for evaluating them, which are similar to and generally consistent with the radiation analysis concepts underlying the mHRS.

The final rule evaluates radionuclides within the same basic structure as other hazardous substances, and the evaluation of many individual HRS factors is the same whether radionuclides are present or not. Table 7-1 of the final rule lists HRS factors and indicates which are evaluated differently for radionuclides. Essentially, radionuclides are simply treated as additional hazardous substances with certain special characteristics that are accounted for by separate scoring rules for some HRS factors. For sites containing only radionuclides, the scoring process is very similar to the process at other hazardous substance sites, except that different scoring rules are applied to a number of substance-specific factors and a few other factors. For sites containing both radionuclides and other hazardous substances, both types of substances are scored for all HRS factors that are substance-specific, with overall factor values based either on combined values or the higher of the values, as appropriate.

EPA notes that, although some radioactive substances are statutorily excluded from the definition of "hazardous waste" in both CERCLA and RCRA (specifically, source, special nuclear, and byproduct material as defined in the Atomic Energy Act of 1954), such substances may be, and generally are, "hazardous substances" as defined in section 101(14) of CERCLA and therefore may be addressed under CERCLA. Radioactive substances should be included in HRS scoring and section 7 of the final rule is intended to facilitate that analysis. It also should be noted that two narrow categories of releases (either from "nuclear incidents" or from sites designated under the Uranium Mill Tailings Radiation Control Act of 1978) are excluded from CERCLA's definition of the term "release" (CERCLA section 101(22)), and such releases should not be scored using the HRS.

The major changes to the HRS in the evaluation of radionuclides apply to establishing observed releases, to factors in the waste characteristics category, and to determining the level of actual contamination in the targets factor category. The HRS components that have been modified are briefly described below.

The criteria for establishing an observed release through analysis of samples for radionuclides differ considerably from the criteria used for other hazardous substances. These criteria are divided into three groups: radionuclides that occur naturally or are ubiquitous in the environment; manmade radionuclides that are not ubiquitous in the environment; and gamma radiation (soil exposure pathway only). (See § 7.1.1.)

The hazardous waste quantity factor for sources (and areas of observed contamination) containing radionuclides has been modified to reflect the different units used to measure the amount of radiation (curies, a measure of activity) versus the units used for other hazardous substances (pounds, a measure of mass). EPA believes it is preferable to use activity units rather than mass units because activity is the standard measure of radiation quantity and is a better indicator of energy released and potential to cause human health damage than is mass. In addition, the hierarchy for evaluating the waste quantity factor for sources (and areas of observed contamination) containing radionuclides is limited to Tiers A and B, Tiers C and D, based on source

volume and source area, respectively, are not used because adequate data to derive their quantitative relationship to Tier A were unavailable. Thus, the waste quantity factor is based either on radionuclide constituent quantity (Tier A) or radionuclide wastestream quantity (Tier B).

For sites containing only radionuclides, hazardous waste quantity is calculated based on the activity content of the radionuclides or radionuclide wastestreams associated with each source. For sites with both radionuclides and other hazardous substances, hazardous waste quantity is evaluated separately for the two types of hazardous substance for each source, and the values are then summed in determining the hazardous waste quantity value. The scale for scoring radionuclide waste quantity was derived based on concepts of risk equivalence between radionuclides and other hazardous substances.

In the proposed rule, all radionuclides were automatically assigned a maximum default value for the toxicity factor. The final rule evaluates radionuclides individually on the basis of human toxicity, across a range of factor values based on the potential to cause cancer (i.e., cancer slope factors). Non-cancer effects are not considered for radionuclides because cancer is generally the most significant toxic

effect. Incorporated in the development of cancer slope factors are the type of radioactive decay; energy emitted during decay; biological uptake, distribution, and retention; and radiation dose-response relationship. Thus, across the set of scoring ranges used, radionuclides that are more potent carcinogens per unit activity now receive higher toxicity factor values than those that are less potent. The new toxicity scoring scale for radionuclides was derived in a manner consistent with the derivation of the existing carcinogenicity scale for other hazardous substances. Taken together, the new toxicity and hazardous waste quantity scales for radionuclides result in a risk equivalence between radionuclides and other hazardous substances.

Mobility of radionuclides in both the air and ground water migration pathways is evaluated in the same way as mobility for other hazardous substances; that is, on the basis of the chemical and physical characteristics of the radionuclide. Similarly, the bioaccumulation (and ecosystem bioaccumulation) potential factor is evaluated in the same way for radionuclides as for other hazardous substances. The final rule clarifies that radionuclides should be scored for these factors in all relevant pathways.

The persistence factor in the surface water migration pathway has been modified so that radionuclides are evaluated solely on the basis of half-life, which for HRS purposes is based on both radioactive half-life and volatilization half-life. Sorption to sediments is not considered, nor are hydrolysis, photolysis, or biodegradation. Other than this change in the processes considered to estimate surface water half-life, the scoring of the persistence factor is the same for radionuclides as for other hazardous substances.

The final rule extends to radionuclides the benchmark concept used throughout the HRS for weighting certain targets factor values. Measured levels of specific radionuclides at potential exposure points are compared to benchmark levels, and additional weight is given to targets subject to actual contamination (Levels I and II). This approach for weighting target factors using benchmarks is similar for radionuclides and for other hazardous substances, although both the specific benchmark values used for radionuclides and the methods for deriving the values are different. Benchmarks for evaluating radionuclide contamination parallel those used for

other hazardous substances in that available Federal standards and screening concentrations are used when applicable. At sites with both radionuclides and other hazardous substances, each radionuclide and other substance is evaluated separately. If no individual substance equals or exceeds its benchmark, the ratios of the measured concentrations to the screening concentrations for cancer for radionuclides and other hazardous substances are added. Radionuclides are not evaluated using screening concentrations for non-cancer effects.

Specific benchmark values for radionuclides are in activity units instead of mass units, however, to reflect the appropriate measurement units for the level of radionuclide contamination. Radionuclide benchmarks include drinking water maximum contaminant levels (MCLs) for both the ground water and the surface water/drinking water threat pathways; Uranium Mill Tailings Radiation Control Act (UMTRCA) standards for the soil exposure pathway; and screening levels corresponding to 10^{-6} individual cancer risk for inhalation or oral exposures, as derived from cancer slope factors, for all pathways and threats incorporating human health benchmarks. The radionuclide benchmarks are consistent with EPA's radionuclide risk assessment methods in that they incorporate standard data or assumptions about contact/consumption rates for various environmental media and radiation dose-response, as well as the specific radionuclide's type of decay, decay energy, biological absorption, and biological half-life. Furthermore, radionuclide benchmarks for the soil exposure pathway account for external exposure (i.e., exposure to radiation originating outside the human body) from gamma-emitting radioactive materials in surficial material as well as from ingestion, which is the sole basis for non-radioactive hazardous substance benchmarks for the soil exposure pathway, because external exposure from gamma-emitting radionuclides can be an extremely important exposure route.

F. Mobility/Persistence

The proposed rule added mobility factors to both the ground water and air migration pathways and modified the persistence factor in the surface water migration pathway to consider a greater number of potential degradation mechanisms.

The Agency received a large number of comments critical of several aspects

of the ground water mobility factor. The most common issues included:

- Concern about the use of coefficients of aqueous migration to establish mobility values for inorganic cations and anions;
- Suggestions that solubility values, distribution coefficients, and other measures be used to establish mobility values for anions and cations; and
- Requests that the same measures of mobility be used for organics and inorganics.

Criticism of the use of the coefficients of aqueous migration focused on its obscurity; except for geochemists, few scientists are familiar with the measure. In response to these comments and because coefficients of aqueous migration are not available for all hazardous substances and radionuclides, the Agency decided to replace coefficients of aqueous migration.

The majority of commenters stated a preference for using parameters related either to hazardous substance release (solubility) or to transport (distribution coefficients) as measures of mobility. The ground water mobility factor is intended to reflect the fraction of a hazardous substance expected to be released from sources, migrate through porous media, and contaminate aquifers and the drinking water wells that draw from them. Because mobility is concerned with both release and transport, the Agency concluded that mobility for all hazardous substances in ground water will be evaluated using both solubility and distribution coefficient values. A default value is assigned when none of the hazardous substances eligible to be evaluated can be assigned a mobility factor value based on available data.

A number of commenters raised questions about the persistence factor in the surface water migration pathway. In general, the commenters were divided between those who wanted more degradation mechanisms considered and those who believed the equation in the proposed rule for calculating half-lives was too complex. Several commenters suggested including sorption of substances by sediments.

In response to these comments, EPA has made several changes to the persistence factor. The free-radical oxidation half-life has been dropped from the equation used to calculate half-life because the data on which its half-life values are based are typically derived from ideal, laboratory conditions that differ greatly from conditions found in nature; few field validation studies have been conducted to provide a basis for extrapolating

these laboratory values to natural environments. Thus, EPA concluded that including free-radical oxidation in the persistence equation resulted in an overemphasis of the influence of free-radical oxidation as a degradation mechanism. For hazardous substances that sorb readily to particulates found in natural water bodies, the persistence equation as proposed overemphasized the importance of degradation mechanisms that occur in the liquid phase. $\log K_{ow}$, the logarithm of the n-octanol-water partition coefficient, has been added to account for sorption to sediments.

The Agency received several comments concerning the mobility factors in the air migration pathway. The most significant of the issues raised by commenters were:

- Whether consideration of mobility in both the likelihood of release factor category and the waste characteristics factor category counts mobility twice;
- Whether the approach used in the proposed rule properly reflected the dynamics of releases of gases from sources into the atmosphere; and
- Whether the Thomthwaite P-E Index was sufficient as the sole measure of particulate mobility and whether particle size should be included.

In response to these and other related structural and air migration pathway comments, the Agency thoroughly reassessed the adequacy of the mobility factors in the likelihood of release and waste characteristics factor categories. Based on this review, EPA has made several changes to the mobility factors in the final rule. In response to the "double counting" issue, the Agency believes there are differences between mobility in the context of likelihood of release and mobility in the context of waste characteristics. The potential to release mobility factor is a measure of the likelihood that a source at a site will release a substance to the air; the waste characteristics mobility factor, together with the hazardous waste quantity factor, is a measure of the magnitude of release. To highlight these differences, the names of the likelihood of release mobility factors have been changed to gas (or particulate) migration potential.

In response to comments on air migration pathway mobility and structure, EPA reviewed gas and particulate release rate models to develop revised mobility factors that improve evaluations of release magnitude and duration. The gas and particulate mobility factors in the final rule are a result of that review. The gas mobility factor is based on a simplified release model and is determined by the vapor pressure of the most toxic/mobile

hazardous substance available for migration to the atmosphere at the site. The particulate mobility factor is based on a simplified fine-particle wind-erosion model and reflects the combined effects of differing wind speeds and soil moisture. Analyses indicated that soil moisture was dominant over both wind speed and particle size, which are essentially equal in effect. Because of the comparative difficulty of determining particle sizes in an SI, a single particle size was assumed to apply to all sites. This constant particle size value was factored into the simplified model yielding the factor in the final rule.

G. Observed Release

The proposed HRS described how to determine whether an observed release was significantly above background levels based on multiples of detection limits and background concentrations.

Some commenters stated that the proposed revisions treated observed release in an overly complex manner. A number of commenters, primarily from the mining industries, were concerned about the consideration of background concentration in determining an observed release. (See Section III P below for a summary of their concerns and EPA's response.)

As in the proposed rule, observed releases may be established based on either direct observation or chemical analysis of samples. In the case of direct observation, material (e.g., particulate matter) containing hazardous substances must be seen entering the medium directly or must have been deposited in the medium.

EPA has replaced the proposed rule criteria for establishing an observed release by chemical analysis with simpler criteria. In the final HRS, an observed release is established when a sample measurement equals or exceeds the sample quantitation limit (SQL) and is at least three times above the background level, and available information attributes some portion of the release of the hazardous substance to the site. (The SQL is the quantity of a hazardous substance that can be reasonably quantified, given the limits of detection for the methods of analysis and sample characteristics that may affect quantitation (e.g., dilution, concentration).) When a background concentration is not detected (i.e., below detection limits), an observed release is established when the sample measurement equals or exceeds the SQL. Any time the sample measurement is less than the SQL, no observed release is established. Table 2-3 of the

final rule provides the criteria for determining when analytic sampling information is sufficient for establishing an observed release (or observed contamination in the soil exposure pathway). The final rule also provides procedures to be followed when the SQL is unavailable and defines various types of detection and quantitation limits in the context of the HRS. (See § 2.3 of the final rule.)

H. Benchmarks

SARA requires that EPA give high-priority to sites that have led to closing of drinking water wells or contamination of principal drinking water supplies. To respond to this mandate, the proposed rule added health-based benchmarks to the ground water and surface water migration pathways; in addition, ecological-based benchmarks were added to evaluate sensitive environments targets in surface water. In the proposed rule, population factors were evaluated at Level I if a health-based benchmark had been exceeded. If actual contamination was present, but the benchmark was not exceeded, populations were evaluated based on two levels of contamination (i.e., Level II and Level III). Sensitive environments in the surface water migration pathway were evaluated based on two levels of actual contamination (exceeding benchmark or not exceeding benchmark). Where several hazardous substances were present below benchmarks, the percentages of their concentrations relative to their benchmarks were added to determine which level was used to assign values.

Of the commenters on this issue, most supported EPA's proposal to give extra weighting to sites where measured exposure-point concentrations exceed benchmarks. One commenter who dissented suggested giving extra weighting to sites where actual contamination is documented; documentation of an observed release (or observed contamination) would be the only criterion for assigning higher values to target factors, and the relationship of the concentration of hazardous substances to benchmarks would not be used. The other dissenting commenter suggested that EPA re-evaluate the role of health-based benchmarks in the HRS because common sense, and other laws, will discourage people from drinking water contaminated above benchmark levels, and because evaluating this factor will entail large resource expenditures for marginal gains in discrimination.

The final rule weights most targets based on actual and potential exposure

to contamination across all pathways and threats, including those for which benchmarks were not originally proposed, because EPA believes that this approach both improves the ability of the HRS to identify sites that pose the greatest threat to human health and the environment and increases the internal consistency of the HRS. (See §§ 2.5, 2.5.1, 2.5.2, 3.3.1, 3.3.2, 4.1.2.3.1, 4.1.2.3.2, 4.1.3.3.1, 4.1.3.3.2, 4.1.4.3.1, 4.2.2.3.1, 4.2.2.3.2, 4.2.3.3.1, 4.2.3.3.2, 4.2.4.3.1, 5.1.3.1, 5.1.3.2, 6.3.1, 6.3.2, 6.3.4, 7.3.1, 7.3.2.) In the final rule, both the population factors and the factors reflecting the hazard to the nearest individual (or well or intake) are evaluated in relation to health-based benchmarks in all pathways. The sensitive environment factor in the surface water environmental threat is weighted in relation to ecological-based benchmarks; however, in the soil exposure and air migration pathways, the sensitive environment factor is weighted simply on the basis of exposure to actual contamination, and no benchmarks are used.

The Agency chose to use benchmarks in all pathways in response to comments that specifically suggested such a change; it is also responding to comments that the HRS should better reflect relative risks and that the approaches in all pathways should be consistent. The Agency has concluded that the concerns expressed by commenters outweigh the concerns about uncertainties in the evaluation of samples collected in air and soil and about the lack of regulatory standards and criteria on which to base soil or air benchmarks that led the Agency not to include benchmarks for those pathways in the proposed rule. In short, EPA carefully considered this point and concluded that the consistent application of benchmarks across all pathways provides for the most reasonable use of data given the purpose of the HRS as a screening tool.

EPA generally selected specific criteria based on applicable or relevant and appropriate requirements (ARARs), excluding State standards, that have been selected for the protection of public health and the environment as outlined in the NCP (55 FR 8666, March 8, 1990). In the HRS NPRM, EPA proposed to use MCLs, maximum contaminant level goals (MCLGs), and screening concentrations (SCs) based on cancer slope factors as drinking water benchmarks, and Food and Drug Administration (FDA) Action Levels as benchmarks for the human food chain threat. EPA also proposed to use Ambient Water Quality Criteria

(AWQC) as ecological-based benchmarks for the environmental threat. EPA received 21 comments from 12 commenters on which benchmarks the HRS should use and whether additional information should be considered in establishing benchmarks. Opinion was divided on the use of specific types of benchmarks: three commenters supported the use of MCLs; three did not. Two commenters supported the use of MCLGs, two opposed such use, and one suggested that EPA consider the economic impact of using the value of 0 (i.e., the MCLG for a carcinogen) as a health-based benchmark. Two commenters suggested including relevant State drinking water standards, and one suggested including concentrations based on RfDs. One commenter expressed concern that the current lack of water quality standards for many substances might make the benchmark system ineffective in identifying sites that pose a significant threat to human health. Two commenters suggested that carcinogen weight of evidence should be used in establishing SCs (e.g., the individual risk level should be lower for a Class A carcinogen than for a Class B2 carcinogen). Two commenters suggested considering other important routes of exposure (e.g., inhalation of hazardous substances volatilized from water, or dermal contact with contaminated water) in establishing drinking water benchmarks.

EPA conducted a number of analyses on specific benchmarks and on the modification of factors to consider in establishing HRS benchmarks. As a result of public comments and these analyses, EPA has concluded that the HRS is improved by including concentrations based on nationally uniform standards, criteria, or toxicity values as health-based or ecological-based benchmarks in all pathways and threats. EPA's conclusion is based on several considerations. First, the addition of benchmarks across all pathways and the use of ARARs for those benchmarks improves linkages with the RI/FS process. That is, the HRS benchmarks will be those used most frequently during RI/FSs, and the additional points provided by equalling or exceeding a benchmark will aid in identifying areas requiring follow-up in the RI/FS. Second, the internal consistency of the HRS is improved by using benchmarks because concentrations measured at or above benchmark levels are treated in a parallel manner across all pathways, allowing more consistent and fuller use of the relatively costly sampling data

collected during the SI. Third, the number of hazardous substances for which at least one health-based or ecological-based benchmark is available is increased, allowing for more uniform assessment of sites nationwide.

The benchmark criteria that the Agency has concluded are most appropriate for each pathway and threat are listed below. As discussed above, EPA agrees with comments suggesting that benchmarks also be used in the soil exposure and air migration pathways and has selected criteria for these pathways based upon the kinds of factors discussed above. While EPA believes the criteria for the soil exposure and air migration pathways in the final rule are appropriate, it is open to any comments that members of the public may wish to submit regarding these criteria and specifically solicits such comments at this time. EPA asks that any such comments be submitted on or before (30 days after the date of publication in the Federal Register).

For the final rule, EPA has selected the following types of benchmarks in each pathway and threat, subject to any revisions in the criteria for air and soil exposure that may be made in response to comments. (Benchmarks for radionuclides are discussed in Section I E of this preamble.)

- Benchmarks in the ground water migration pathway and the surface water drinking water threat include MCLs, non-zero MCLGs, screening concentrations (SCs) for non-cancer effects based on RfDs for oral exposures, and SCs for cancer based on slope factors for oral exposures and 10^{-6} individual cancer risk (see Table 3-10). Because SCs based on RfDs and slope factors are used as drinking water benchmarks, MCLGs with a value of 0 have been dropped as HRS benchmarks.
- Benchmarks in the surface water human food chain threat include FDA Action Levels for fish or shellfish, SCs for non-cancer effects based on RfDs for oral exposures, and SCs for cancer based on slope factors for oral exposures and 10^{-6} individual cancer risk (see Table 4-17).
- Benchmarks in the surface water environmental threat include AWQC and Ambient Aquatic Life Advisory Concentrations (AALACs); AALACs will be considered as they become available (see Table 4-22).
- Benchmarks in the soil exposure pathway include SCs for non-cancer effects based on RfDs for oral exposures, and SCs for cancer based on slope factors for oral exposures and 10^{-6} individual cancer risk (see Table 5-3).
- Benchmarks in the air migration pathway include National Ambient Air

Quality Standards, National Emission Standards for Hazardous Air Pollutants (NESHAPs) that are expressed in ambient concentration units, SCs for non-cancer effects based on RfDs for inhalation exposures, and SCs for cancer based on slope factors for inhalation exposures and 10^{-6} individual cancer risk (see Table 6-14).

Several commenters suggested technical refinements for deriving health-based benchmarks. Although qualifying information is useful and important and is, in fact, used extensively in the RI/FS process, the benefits of including such information in the HRS must be balanced against its limited scope and purpose as well as the limited data available to determine concentration at the point of exposure. Consequently, in the final rule:

- All health-based benchmarks are set in reference to the major exposure concern for each pathway or threat (e.g., benchmarks in the air migration pathway are set in reference to inhalation only; benchmarks in drinking water, the human food chain threat, and the soil exposure pathway are set in reference to ingestion), except for radionuclides for which external exposure is also considered in the soil exposure pathway;
- All benchmarks are set in reference to uniform exposure assumptions that are consistent with RI/FS procedures (e.g., water consumption is assumed to be two liters per day; body weight is assumed to be 70 kg);
- State water quality standards and other State or local regulations are not included as benchmarks because they would introduce regional variation in the HRS;
- A hierarchy has been developed to provide a single benchmark concentration for each hazardous substance by pathway and threat; and
- Qualitative weight-of-evidence is not used in deriving SCs for carcinogens.

In the NPRM, EPA requested comments on how many tiers (levels) of actual contamination to consider when weighting populations relative to benchmarks (i.e., which of three alternative methods presented should be adopted). EPA received two comments on this issue and three related comments regarding the weighting factors for each level. One commenter supported Alternative 2 (i.e., use of two levels of observed contamination and one level of potential contamination). Another commenter suggested that Level II and Level III concentrations be combined to include the range of contaminant levels above background, but below health-based benchmarks. A third commenter suggested that the

weighting factors for each level be reconsidered. A fourth commenter suggested that $1/1000$ of a benchmark factor is inappropriate because it is excessively conservative and difficult to detect. The fifth commenter suggested that because Level III represents concentrations with cancer risks below 10^{-7} , populations exposed to Level III concentrations should not be considered in the population category of drinking water threats.

EPA conducted a number of analyses on the subject of benchmark tiers and has dropped Level III contamination. In the final rule, Level I contamination is defined as concentration levels for targets which meet the criteria for actual contamination (see § 2.5 of the final rule) and are at or above media-specific benchmark levels; Level II contamination is defined as concentration levels for targets which either meet the criteria for actual contamination but are less than media-specific benchmarks, or meet the criteria for actual contamination based on direct observation; and potential contamination is defined as targets that are potentially subject to releases (i.e., targets that are not associated with actual contamination for that pathway or threat). These three tiers are used to assign values to both the nearest individual (or well or intake) and the population factors. As a result of EPA's analyses of benchmark issues, the weighting assigned to Level I and Level II contamination has been changed and made consistent across pathways. For example, Level I populations are now multiplied by a factor of 10 in all pathways. As in the proposed rule, potentially contaminated populations and nearest individuals (or wells or intakes) are distance or dilution weighted.

The proposed rule summed the ratios of all hazardous substances to their individual benchmarks as a means of defining the level of actual contamination, and EPA requested comments on the appropriateness of this approach to scoring multiple substances detected in drinking water. Of the 10 comments in response to this proposal, nine strongly opposed the proposed approach, particularly when applied to drinking water standards (i.e., MCLs), MCLGs, and noncarcinogens. One commenter supported the proposed approach.

EPA has decided to retain the summing of ratios of hazardous substances to their individual benchmarks, but in a modified form. The final rule sums measures of carcinogenic and noncarcinogenic effects separately;

concentrations specified in regulatory limits (e.g., NAAQS, MCLs, or FDA Action Levels) are not included in the summing algorithm. EPA recognizes that a more precise estimate of relative risk would be obtained by summing the ratios of hazardous substances to their individual RfD-based concentrations by segregating substances according to major effect, target organ, and mechanism of action. In fact, such a segregation is recommended during the RI/FS. However, health-based benchmarks are used in the HRS to provide a higher weight to populations exposed to hazardous substances at levels that might result in adverse health effects. As a consequence, EPA believes that use of the summed ratios of hazardous substances within pathways and threats to their individual RfD-based benchmark levels is appropriate for the screening purpose of the HRS.

EPA proposed and solicited comments on a range of 10^{-4} to 10^{-7} for individual cancer risk levels of concern in establishing levels of actual contamination with respect to health-based benchmarks. EPA received eight comments concerning this risk range. Four commenters suggested restricting the range to 10^{-4} to 10^{-6} , primarily because this range would be consistent with risk levels identified in the NCP and used by other EPA regulatory programs. Three commenters said the SCs for carcinogens should be the 10^{-6} individual cancer risk level. One commenter stated that 10^{-4} to 10^{-7} generally is the risk range considered for Superfund response. The final rule defines only two levels of actual contamination: significantly above background and equal to or above benchmark, and significantly above background but less than benchmark. When an applicable or relevant and appropriate requirement does not exist for a carcinogen, EPA selects remedies resulting in cumulative risks that fall within a range of 10^{-4} to 10^{-6} incremental individual lifetime cancer risk based on the use of reliable cancer potency information. EPA has selected the 10^{-6} screening risk level in defining the HRS benchmark level for cancer risk because it is the lower end of the cancer risk range (i.e., 10^{-4} to 10^{-9}) identified in the NCP and used by other EPA regulatory programs.

Two commenters objected to assigning releases of substances with no benchmarks to Level II as a default value. One suggested assigning unknowns to Level III because substances that are frequently released or are known or suspected to cause health problems are studied before

those that are not. The other objected because "the absence of data is not data."

Because EPA has decided to adopt a benchmark system incorporating only two levels of actual contamination, the default level is Level II. If none of the hazardous substances eligible to be evaluated at a sampling location has an applicable benchmark, but actual contamination has been established, the actual contamination at the location is assigned to Level II.

I. Use Factors

The proposed HRS included factors to assign values to uses of potentially affected resources in the three migration pathways: ground water use (drinking water and other) in the ground water migration pathway, drinking water and other use and fishery use in the surface water migration pathway, and land use in the air migration pathway.

EPA received a number of comments on each of these factors. The commenters raised specific objections to distinctions drawn among various potential uses and to the weights assigned to those uses. For example, for the ground water use factor, some commenters asserted that the HRS should not delineate between private and public water supply contamination. For the surface water use factors, a commenter recommended a range of assigned values for irrigation of commercial food or forage crops because of variations in rates of uptake of hazardous substances. For the land use factor, two commenters urged giving greater consideration to institutional land use because of the sensitive populations that would be exposed.

Partly in response to these comments, and in an effort to simplify the HRS, EPA has substantially revised the method of incorporating resource use information in targets factor categories. The field test indicated that collecting data on each of the use factors involved considerable effort at many sites. In addition, because of weighting factors applied to potentially contaminated populations, at sites with no actual contamination, use factors were contributing more to the targets value than were large populations. As some commenters pointed out, the use factors mixed concerns about human health with concerns about the value of the resource and, therefore, were partially redundant with population factors. To avoid redundancy with human health concerns as evaluated through the population factor, EPA has made major changes in how resource uses are evaluated and scored in the final rule.

In each migration pathway, the use factors have been replaced by a resources factor that assigns values to resources appropriate for the pathway. In addition, a resources factor has been added to the soil exposure pathway. The resources factor for a pathway is assigned a maximum of five points if any of the resource uses for that pathway exists within the target distance limit in the ground water or surface water migration pathway, within one-half mile of a source in the air migration pathway, or within an area of observed contamination in the soil exposure pathway. If none of the uses exists, the factor is assigned a value of 0.

The resources factor in the ground water migration pathway assigns a value of 5 for wells supplying water for irrigation of commercial food or commercial forage crops (five-acre minimum), watering of commercial livestock, as an ingredient in commercial food preparation, or as a supply for commercial aquaculture or for a major or designated water recreation area (excluding drinking water use)—for example, water parks (see § 3.3.3). A value of 5 is also assigned if the water in the aquifer is usable for drinking water, but not used.

The resources factor in the drinking water threat of the surface water migration pathway assigns a value of 5 if the surface water is designated by a State for drinking water use but not used, or is usable but not used for drinking water. In addition, points may be assigned for intakes supplying water for irrigation of commercial food or commercial forage crops (five-acre minimum), watering of commercial livestock, as an ingredient in commercial food preparation, or if the water body is used as a major or designated water recreation area (see § 4.1.2.3.3). The fishery use factor has been deleted to avoid double-counting of fisheries.

In the air migration pathway, the resources factor is assigned a value of 5 if there is commercial agriculture or commercial silviculture, or a major or designated recreation area within a half mile of a source (see § 6.3.3). The distance of one-half mile for the agricultural, silvicultural, and recreational areas was determined by the distance weighting factors for the air migration pathway, which reflect the rapid diminishing of air contaminant concentrations beyond one-half mile from a source. Therefore, resources beyond this distance are not considered in this pathway.

A resources factor has also been added to the resident population threat of the soil exposure pathway. The factor is assigned a value of 5 if there is commercial agriculture, commercial silviculture, or commercial livestock production or grazing on an area of observed contamination at the site.

J. Sensitive Environments

The proposed rule expanded the list of sensitive environments considerably and, for the surface water and air pathways, counted all sensitive environments within the target distance limit, rather than just the one with the highest assigned value; for the soil exposure pathway, only the sensitive environment assigned the highest value was counted. Potentially contaminated sensitive environments were distance/dilution weighted; in the surface water environmental threat, actual contamination of sensitive environments was evaluated on the basis of ecological-based benchmarks.

EPA received relatively few comments on issues related to sensitive environments. However, participants in the field test requested clarification of three categories of sensitive environments involving spawning areas, migratory pathways, and feeding areas critical for the maintenance of a fish species within a river system, coastal embayment, or estuary. In particular, critical migratory pathways and feeding areas were difficult to identify and seemed to provide little discrimination among surface waters in some areas of the country.

EPA has redefined critical spawning areas to include shellfish beds, and has limited the areas to those used for intense or concentrated spawning by a given species. Critical migratory pathways and feeding areas have been combined into a single category and limited to anadromous fish (i.e., fish that ascend from the ocean to spawn), which face special problems in migrating substantial distances between the ocean and their spawning areas. These feeding areas are further restricted to only those areas in which the fish spend extended periods of time. Examples include areas where juveniles of anadromous species feed for prolonged periods (e.g., weeks) as they prepare to migrate from fresh water to the ocean, and holding areas along the adult migratory pathways.

Terrestrial areas used for breeding by large or dense aggregations of vertebrates (e.g., heron rookery, sea lion breeding beach) have been added to the list of sensitive environments to parallel the spawning areas listed for fish species. Water segments designated by a State as not attaining toxic water

quality standards have been removed because these environments are already degraded and thus are not analogous to the other sensitive environments listed. Also, the assigned value for State designated areas for protection or maintenance of aquatic life has been changed from 50 points to 5 points (see Table 4-23 in final rule) to be consistent with the points assigned under the resources factor for State designated areas for drinking water use.

In response to public comment, National Monuments have been added to the 100-point category on the list of terrestrial sensitive environments considered under the soil exposure pathway. "State designated natural areas" and "particular areas, relatively small in size, important to the maintenance of unique biotic communities" were also added to the list of terrestrial sensitive environments in response to public comment. These latter two categories were already considered in the air and surface water pathway evaluation of sensitive environments. (See Table 5-5.)

The method for evaluating wetlands has been revised, partially because participants in the field test had difficulty identifying discrete wetlands. Some wetlands were patchy and could be classified as one large or many small wetlands. Other wetlands were divided by rivers or roads, or changed from one type of wetland to another, making it unclear whether more than one wetland should be counted. To eliminate these difficulties, wetlands are now evaluated on the basis of size and level of contamination. In the air migration pathway, wetlands are evaluated based on acreage and level of contamination (see § 8.3.4); in the surface water migration pathway, wetlands are evaluated by linear frontage along the surface water hazardous substance migration path and level of contamination (see § 4.1.4.3.1). Distinguishing among wetlands on the basis of size and level of contamination should improve the discriminating ability of the sensitive environments factor. In the drier portions of the country, where even small wetlands (e.g., prairie potholes) are very important, small wetlands may also qualify as "particular areas, relatively small in size, important to the maintenance of unique biotic communities."

Sensitive environments other than wetlands are not evaluated on the basis of size for several reasons. Most other HRS sensitive environments tend to be less common and less widely distributed nationally than wetlands (e.g., see EPA's 1989 *Field Test of the Proposed Revised*

HRS) and, therefore, their numbers and boundaries tend to be easier to identify. In addition, the value of many sensitive environments is independent of size; for example, the size of a critical habitat of an endangered species may vary solely due to the type of species present. Furthermore, potential or actual contamination of even a small portion of many sensitive environments—for example, a wildlife refuge—tends to be viewed as unacceptable.

An ecosystem bioaccumulation potential factor has been added to the waste characteristics factor category of the surface water environmental threat in response to comments that hazardous substances that demonstrate an ability to bind to sediments and/or to bioaccumulate (e.g., PCBs, mercury) tend to pose the greatest long-term threats to aquatic organisms. The accumulation of hazardous substances in the aquatic food chain can result in adverse effects in aquatic species and in other animals that ingest aquatic species (e.g., waterfowl). The ecosystem bioaccumulation potential factor differs slightly from the bioaccumulation potential factor in the human food chain threat, primarily in that all BCF data are considered in deriving it and not just BCF data for human food chain organisms.

The EPA ambient aquatic life advisory concentrations (AALACs) have been added to the data hierarchy used to assign the ecosystem toxicity value (see § 4.1.4.2.1.1). The Natural Heritage Program alternative sensitive environment rating factors have been removed from the rule because of problems that arose during the field tests: field test participants found that the availability of information varied substantially among States. However, a Natural Heritage Program Data Center can assist in identifying many of the sensitive environment types listed in Tables 4-23 and 5-5.

K. Use of Available Data

A number of commenters stated that all available data should be used when scoring a site. Several cited the tiered approach to hazardous waste quantity as a model that could be applied to other factors. Under this method, where data are available, they would be used; where data are not available, defaults or more generalized approaches would be applied. Several commenters specifically suggested using this approach for ground water flow direction and for scoring mining sites. These commenters argued that it would be less expensive and time-consuming to use available data when scoring a site

than to wait until the remedial investigation to consider the additional information.

EPA considered modifying the HRS to allow the use of additional data, but determined that further expanding the HRS to account for varying levels of data availability is inconsistent with the HRS's role as an initial screening tool. Adding tiers to various factors to accommodate the use of all available data would make the HRS considerably more difficult to apply and could lead to substantial inconsistencies in how sites are investigated and evaluated. EPA Regions and States would have to determine, for each set of data presented, whether the data quality was good enough for the data to be considered. Debates over decisions on data quality could delay scoring and, ultimately, delay cleanup at sites. Therefore, the Agency believes that the limited use of tiers in the final HRS represents a reasonable tradeoff between the need to limit the complexity of the system and the desire to accommodate risk-related information that is generally outside the scope of a site inspection.

L. Ground Water Migration Pathway

The proposed rule included a number of significant changes in the ground water migration pathway: new hydrogeologic factors were added;

populations were distance weighted unless exposed to actual contamination; a maximally exposed individual (MEI) factor was added; the target distance limit was extended; a mobility factor was added and combined with toxicity; and a wellhead protection area factor was added. Figure 5 shows the proposed ground water migration pathway and the final rule pathway.

Ground water flow direction. Neither the original HRS nor the proposed HRS directly considered ground water flow direction in evaluating targets. The proposed HRS indirectly considered ground water flow direction by weighting populations based on actual and potential contamination of drinking water wells.

EPA received 50 letters from 40 commenters on this issue; 27 letters responded to the ANPRM, 21 to the NPRM, and two to the field test report. Commenters included eight States, three Federal agencies, the mining, petroleum, chemical, and cement industries, utilities, and professional engineers. The commenters supported the consideration of ground water flow direction data, at least in some circumstances. Numerous commenters urged the use of ground water flow direction data when they are either available or easily obtained. They suggested several methods to incorporate flow direction, including:

- Considering use of a radial impact area when directional release routes can be determined. Only a half circle with a three-mile radius for the downgradient portion (and a half-mile radius for the rest of the circle) should be considered when scoring;

- Differentiating between upgradient and downgradient areas using topographic maps, evaluating water levels at wells, and noting the presence of major surface water bodies;

- Expending the effort to obtain accurate data and considering selected upgradient locations as a precaution against unanticipated anomalies;

- Excluding drinking water wells where analytical data prove no contamination is present;

- Having a "professional" review available information and conduct a site visit;

- Using available flow direction data and developing regionally based defaults when no data are available;

- Installing piezometers to determine flow direction in the PA/SI phase and when no ground water flow data are available;

- Incorporating ground water flow direction into the "depth to aquifer" and "distance to nearest well/population served" scores; and

- Affording responsible parties the opportunity to determine flow direction.

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Figure 5

Ground Water Migration Pathway

PROPOSED HRS

| Likelihood of Release | X | Waste Characteristics | X | Targets |
|--|---|---|---|--|
| Observed Release or Potential to Release | | Toxicity/Mobility Hazardous Waste Quantity | | Maximally Exposed Individual Population Ground Water Use Wellhead Protection Area |
| Containment Net Precipitation Depth to Aquifer/ Hydraulic Conductivity Sorptive Capacity | | | | |

FINAL HRS

| Likelihood of Release | X | Waste Characteristics | X | Targets |
|---|---|---|---|---|
| Observed Release or Potential to Release | | Toxicity/Mobility Hazardous Waste Quantity | | Nearest Well Population Resources Wellhead Protection Area |
| Containment Net Precipitation Depth to Aquifer Travel Time | | | | |

Commenters suggested that data on ground water flow are either readily available or can be easily obtained at reasonable cost and are no more imprecise than other aspects of the HRS. Some commenters stated that the level of effort required to estimate the direction of ground water flow is no greater than that required to determine other hydrogeologic parameters in the HRS.

EPA reviewed a range of options for considering ground water flow direction in evaluating targets. For the reasons discussed above under "Use of Available Data," the Agency decided that it was not feasible to adopt a tiered approach in the targets factors for evaluating ground water flow direction. EPA does not agree that increased accuracy warrants the increased complexity of accounting for ground water flow direction, because this level of accuracy is not required for a screening tool that is intended to assess relative risk. This level of accuracy, however, is needed to determine the extent of remedial action and, therefore, is appropriate at the time of the RI.

EPA disagrees with the argument that determining ground water flow direction is no more difficult than determining other ground water factors. Aquifer interconnections and discontinuities as well as hydraulic conductivity and depth to aquifer, which are evaluated in the final rule, are geologic features that are unlikely to change over the short-term. In contrast, ground water flow direction can be influenced by factors such as seasonal flows and pumping from well fields. In addition, the ground water flow direction may be different in each aquifer at the site, and the direction of hazardous substance migration is not always the same as the direction of ground water flow. Therefore, data on ground water flow direction would need to be considerably more extensive than would the data required to document the other hydrogeologic factors. EPA notes that in the final rule, many of the other hydrogeologic factors considered have been simplified and the sorptive capacity factor has been dropped. EPA also notes that ground water flow direction was not identified in SARA as a portion of the HRS requiring further examination, even though ground water flow direction was not considered in the original HRS and the Agency had received criticism similar to the above comments prior to enactment of SARA.

Although the final rule does not consider ground water flow direction directly in evaluating targets, it does consider flow direction indirectly in the

method used to evaluate target populations. If wells have not been contaminated by the site, as the commenters assume upgradient wells would not be, the population drawing from those wells is distance weighted and, thus, populations drawing from the wells would have to be substantial before a large number of points could be assigned. Moreover, in addition to providing a measure of the population at risk from the site, the target factors afford a measure of the value of the ground water resources in the area of the site and of the potential need for expanded uses of the ground water.

Aquifer interconnections. Aquifer interconnections facilitate the transfer of ground water or hazardous substances between aquifers. The final rule specifies that if aquifer interconnections occur within two miles of the sources at the site (or within areas of observed ground water contamination attributed to sources at the site that extend beyond two miles from the sources), the interconnected aquifers are treated as a single aquifer for the purposes of scoring the site. Thus, for example, when an observed release to a shallow aquifer has been identified, targets using deeper aquifers interconnected to the shallow aquifer are included in the evaluation of the combined aquifer. This approach is common to the original as well as the revised HRS.

In practice, EPA has found that studies in the field to determine whether aquifers are interconnected in the vicinity of a site will generally require resources more consistent with remedial investigations than SIs, especially where installation of deep wells is necessary to conduct aquifer testing. Thus, EPA has in the past relied largely on existing information to make such determinations and the Agency finds it necessary to continue that approach. Examples of the types of information useful in identifying aquifer interconnections were given in the proposed rule. This information includes literature or well logs indicating that no lower relative hydraulic conductivity layer or confining layer separates the aquifers being assessed (e.g., presence of a layer with a hydraulic conductivity lower by two or more orders of magnitude); literature or well logs indicating that a lower relative hydraulic conductivity layer or confining layer separating the aquifers is not continuous through the two-mile radius (i.e., hydrogeologic interconnections between the aquifers are identified); evidence that withdrawals of water from one aquifer (e.g., pumping tests,

aquifer tests, well tests) affect water levels in another aquifer; and observed migration of any constituents from one aquifer to another within two miles. For this last type of information, the mechanism of vertical migration does not have to be defined, and the constituents do not have to be attributable to the site being evaluated. Other mechanisms that can cause interconnection (e.g., boreholes, mining activities, faults, etc.) will also be considered. While the descriptive text has been removed from the rule, the approaches mentioned in the proposed rule will be used in making aquifer interconnection determinations. In general, EPA will base such determinations on the best information available; in the absence of definitive studies and where costs of field studies are prohibitive, the Agency will rely on expert opinion (e.g., U.S. Geological Survey staff or State geologists). In the absence of such information, EPA assumes that aquifers are not interconnected.

Ground water potential to release factors. EPA proposed replacing the depth to the aquifer of concern and permeability factors of the original HRS with depth to aquifer/hydraulic conductivity and sorptive capacity factors. EPA received more than 75 comments on these factors, in addition to general comments on evaluating ground water potential to release in response to the ANPRM.

Several commenters supported consideration of depth to aquifer in evaluating the ground water migration pathway. One commenter stated that use of a depth to aquifer/hydraulic conductivity matrix, which was intended to reflect travel time to ground water, was an improvement over considering these two parameters individually and additively. Concerns were raised, however, about how to determine depth to aquifer. In addition, commenters stated that the two-mile radius for evaluating hydrogeologic factors should be extended to four miles, while others commented that the distance should be measured from vertical points as near to the source as possible.

Commenters generally supported the proposal to include hydraulic conductivity, although many believed that the proposed method was too complicated; several commenters suggested that the single least conductive layer(s) should be used. Another concern was the lack of data for determining hydraulic conductivity. One commenter stated that unless data can confirm that the geologic strata

extend throughout the entire area of a site, assigning a hydraulic conductivity value is highly questionable.

Some commenters offered alternative approaches to evaluating hydraulic conductivity. These included replacing the proposed method with:

- Assigned "confidence levels" tied to professional estimates based on regional data and judgment;
- Consideration of actual travel time in the unsaturated zone; or
- An assumption of maximum hydraulic conductivity among the various geological layers below the site.

More than 20 comments were received on the sorptive capacity factor, but there was little consensus among the commenters. A number of commenters agreed that the factor should be added, but stated that the approach was not detailed enough and that more waste- and site-specific information should be required. Other commenters agreed that the factor was an improvement, but said that sorptive capacity should be dropped because the waste- and site-specific information needed for an accurate evaluation cannot be collected during a screening process. Others said that it was too complex as proposed and should be dropped.

Based on these comments and the field test results, EPA examined the depth to aquifer/hydraulic conductivity and sorptive capacity factors. The examination showed that the lowest hydraulic conductivity layer(s) accounted for almost all of the travel time to the aquifer if a one-foot or three-foot minimum layer thickness was used. Accordingly, in the final rule, the depth to aquifer/hydraulic conductivity factor has been replaced with a simpler factor, travel time, which is determined using a matrix of the hydraulic conductivity and thickness of the lowest hydraulic conductivity layer(s) with at least a three-foot thickness. (See § 3.1.2.4 and Table 3-7 of the final rule.)

To conform with the change limiting the travel time factor to the least conductive layer(s), and to meet the goal of simplification, a change to the sorptive capacity factor was necessary. The proposed rule evaluated this factor

using all layers between the source and the aquifer. In reexamining this factor, EPA concluded that depth to aquifer is one of the major parameters affecting total sorbent content, at least within the HRS ranges for the factor. Depth to aquifer also indirectly reflects geochemical retardation mechanisms because, all else being equal, the effect of these retardation mechanisms increases as the depth to aquifer increases. At the field test sites, using only the layer(s) of lowest hydraulic conductivity decreased the calculated sorbent content between 10 and 99 percent. For these reasons, EPA has decided to replace the sorptive capacity factor with a depth to aquifer factor. (See § 3.1.2.3 and Table 3-5 of the final rule.)

M. Surface Water Migration Pathway

The proposed rule made major changes to the evaluation of releases or threatened releases to surface water. The pathway was divided into four threats: drinking water, human food chain, recreational use, and environmental. Other changes included consideration of flood potential; revision of potential overland flow; addition of dilution weights for potentially contaminated populations; extension of the target distance limit to 15 miles; revision of the persistence factor to consider more degradation mechanisms; addition of a bioaccumulation factor for evaluation of human food chain toxicity/persistence and populations; addition of ecosystem toxicity to evaluate the environmental threat; and addition of a maximally exposed individual factor (MEI) factor to the drinking water threat. Figure 8 shows the proposed rule and the overland flow/flood migration component of the surface water migration pathway in the final rule.

Recreational use threat. SARA stated that the HRS should consider threats to surface water used for recreation and drinking water, and the proposed HRS included a recreational use threat in the surface water migration pathway. A number of States, several companies and trade associations, and two Federal

agencies identified problems with the proposed recreational use threat. Some commenters objected to weighting it as heavily as the drinking water threat, while others suggested that evaluating the threat was too complicated for use in a screening tool. Many commenters said that proposed methods for assigning values to recreation areas were too broadly drawn and that a limited number of recreation areas should be considered. Two commenters suggested using actual attendance data, and one commenter suggested that recreational uses be considered in other pathways as well.

EPA's field test indicated that the recreational use threat evaluation was too complex for HRS purposes and, at the same time, was not very accurate. Several field test participants commented that the recreation target population was difficult to evaluate and that the approach for determining population was inaccurate and time-consuming. In addition, the population factor did not provide meaningful discrimination among sites. The proposed rule used the physical characteristics (e.g., capital improvements) of a recreational site as the basis for determining the distance limit used to evaluate population, but because major and minor sites may have the same types of capital improvements (e.g., boat ramps, picnic facilities), the same distance limit could be associated with a minor recreation area and a major recreation area. The alternative approach would be to require actual use data to evaluate targets; however, site-specific population data are not available for many recreation areas, making it difficult to obtain accurate estimates of the population at risk. The target distance limits, which ranged from 10 to 125 miles, also contributed to the problems with evaluating targets. The Agency invited comments on refining these calculations; no alternative approaches were suggested, and EPA did not identify viable alternatives.

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Figure 6

Surface Water Migration Pathway

PROPOSED HRS

Likelihood of Release

X

Drinking Water Threat

Observed Release
or
Potential to Release

By Overland Flow
Containment
Runoff
Distance to Surface
Water

By Flood
Containment
Flood Frequency

| | | |
|--------------------------|---|-------------------|
| Waste Characteristics | X | Targets |
| Toxicity/Persistence | | Maximally Exposed |
| Hazardous Waste Quantity | | Individual |
| | | Population |
| | | Surface Water Use |

+

Human Food Chain Threat

| | | |
|--|---|-------------|
| Waste Characteristics | X | Targets |
| Toxicity/Persistence/ Bioaccumulation | | Population |
| Hazardous Waste Quantity | | Fishery Use |

+

Recreational Use Threat

| | | |
|---|---|------------|
| Waste Characteristics | X | Targets |
| Toxicity/Persistence/Dose Adjusting Factor | | Population |
| Hazardous Waste Quantity | | |

+

Environmental Threat

| | | |
|------------------------------------|---|------------------------|
| Waste Characteristics | X | Targets |
| Ecosystem Toxicity/ Persistence | | Sensitive Environments |
| Hazardous Waste Quantity | | |

Figure 6

Surface Water Migration Pathway - Overland Flow/Flood Component

FINAL HRS

Likelihood of Release X

| |
|---|
| Observed Release or Potential to Release By Overland Flow Containment Runoff Distance to Surface Water By Flood Containment Flood Frequency |
|---|

Drinking Water Threat

| | | |
|---|---|--|
| Waste Characteristics Toxicity/Persistence Hazardous Waste Quantity | X | Targets Nearest Intake Population Resources |
|---|---|--|

+

Human Food Chain Threat

| | | |
|---|---|--|
| Waste Characteristics Toxicity/Persistence/ Bioaccumulation Hazardous Waste Quantity | X | Targets Food-Chain Individual Population |
|---|---|--|

+

Environmental Threat

| | | |
|---|---|-----------------------------------|
| Waste Characteristics Ecosystem Toxicity/ Persistence/Bioaccumulation Hazardous Waste Quantity | X | Targets Sensitive Environments |
|---|---|-----------------------------------|

EPA is also concerned that many qualities of recreation areas (e.g., uniqueness, attractiveness, value) cannot be readily quantified or measured, which poses significant problems for a screening tool. Therefore, the recreational use threat has been removed from the final rule. Instead, factors related to recreational use are being included in the assessment of resource factors in the air, surface water, and ground water migration pathways. (See the discussion of resources factors above and §§ 3.3.3, 4.1.2.3.3, 4.2.2.3.3, and 6.3.3 of the rule.) Recreational use is also a major component of the evaluation of the attractiveness/accessibility factor in the soil exposure pathway (see § 5.2.1.1 of the rule).

Human food chain. SARA requires that EPA consider "the damage to natural resources which may affect the human food chain . . ." Accordingly, the surface water migration pathway of the proposed rule included evaluation of threats to human health via the aquatic food chain.

A number of commenters suggested that terrestrial food chain threats should also be evaluated because most of the food eaten in the United States originates on land, and the terrestrial human food chain is, therefore, more important than the aquatic human food chain. Commenters specifically stated that the HRS should account for human food chain threats involving irrigated crops, livestock, and game animals. One commenter stated that the SARA mandate would not be fulfilled if only aquatic human food chain threats were evaluated.

After conducting an investigation into possible methods, EPA determined that it would not be practical to include a separate evaluation of terrestrial human food chain threats in the HRS. The terrestrial food chain is more complex and site-specific and is less understood than the aquatic food chain, and its assessment requires considerably more data. These factors render evaluation of the relative risks associated with the terrestrial human food chain well beyond the capability of a screening system such as the HRS. The final rule, therefore, does not separately evaluate terrestrial human food chain threats. These threats are, however, considered indirectly under the resources target components in the air migration pathway, ground water migration pathway, soil exposure pathway, and drinking water threat portion of the surface water migration pathway.

The proposed rule required the estimation of bioaccumulation potentials for hazardous substances

posing threats via the human food chain. One commenter stated that the estimation of bioaccumulation potentials requires excessive time and resources, and that this step should be dropped from the HRS.

EPA disagrees and considers the bioaccumulation potentials of hazardous substances to be among the most important factors determining the degree of human health threat posed by substances via the human food chain. Substances that do not bioaccumulate pose less of a threat via the human food chain than substances that bioaccumulate, all else being equal. Conversely, substances with high bioaccumulation potentials can pose very significant threats via the human food chain even if they are only moderately toxic, or are present in modest quantities. EPA believes that compiling bioaccumulation potential tables will reduce the effort and resources required to score this factor.

EPA received several comments stating that bioaccumulation potential was not given sufficient weight in the evaluation of human food chain threats. EPA evaluated the use of bioaccumulation potential during the field test and determined that there was considerable uncertainty related to this factor, in part because of major differences in uptake associated with different species in different environments. In addition, bioconcentration values have been computed for only a few species for most substances. In light of this uncertainty, EPA decided that bioaccumulation potential should not be given additional weight in the HRS. In addition, as part of the structural changes discussed in Section III B, the bioaccumulation potential factor was moved from the targets factor category to the waste characteristics factor category so that it is evaluated consistently with the other waste characteristics factors that reflect exposure. As part of these changes, the use of the bioaccumulation potential factor in selecting the substance posing the greatest hazard also has been modified.

The final rule broadens the definition of actual contamination of the human food chain by modifying one criterion and adding a new criterion defining actual contamination. The proposed rule defined a fishery as actually contaminated if (1) the fishery was closed as a result of contamination and a substance for which the fishery was closed had been documented in an observed release from the site, or (2) a tissue sample from a human food chain organism from the fishery was found to

contain a hazardous substance at a concentration level exceeding the FDAAL for that substance in fish tissue and the substance had been documented in an observed release from the site. In both cases, at least a portion of the fishery must be within the boundaries of the observed release.

Under the final rule, the former criterion (closed fishery) remains essentially unchanged. The latter criterion (tissue contamination) has been modified: A fishery is considered actually contaminated if the concentration of a hazardous substance in tissue of an essentially sessile benthic human food chain organism from the watershed is at a level that meets the criteria for an observed release from the site and at least a portion of the fishery is within the boundaries of the observed release. A new criterion has also been added: A fishery is considered actually contaminated if a hazardous substance having a bioaccumulation potential factor value of 500 or greater either is present in an observed release established by direct observation or is present in a surface water or sediment sample at a level that meets the criteria for an observed release from the site and at least a portion of the fishery is within the boundaries of the observed release. Only the portion of a fishery within the boundaries of an observed release is considered actually contaminated.

EPA broadened the definition of actually contaminated fisheries on the basis of field test results. With the more narrow definition in the proposed rule, few actually contaminated fisheries were identified because:

(1) Closed fisheries did not exist at most sites;

(2) Hazardous substance concentration data from tissues of applicable organisms were available for only a small portion of fisheries; and

(3) FDAALs exist for only a relatively small number of hazardous substances.

The final rule also introduces two levels of actually contaminated fisheries or portions of fisheries:

- Level I: Applicable when concentrations of site-related hazardous substances meeting the criteria for actual contamination of the fishery equal or exceed the benchmark concentration levels established in the final rule based on FDAALs, screening concentrations corresponding to elevated cancer risks, and screening concentrations corresponding to elevated chronic, non-cancer toxicity risks via oral exposures. The final rule allows Level I contamination to be established based on hazardous

substance concentrations in tissue samples from "organisms other than essentially sessile benthic organisms" (e.g., fish, lobsters, crabs), even though these organisms cannot be used to establish observed releases or actual contamination.

- **Level II:** Applicable to all actually contaminated fisheries (or portions of actually contaminated fisheries) not meeting Level I criteria.

The final rule assigns human food chain populations associated with Level I concentrations tenfold greater weight than those associated with Level II concentrations. The final rule also describes the procedures for determining, where applicable, the part of a fishery subject to Level I concentrations, the part subject to Level II concentrations, and/or the part subject to potential contamination.

EPA received several comments suggesting that, to be consistent with the other threats, a maximally exposed individual factor should be incorporated into the human food chain threat. The Agency agrees, and to provide this consistency the final rule incorporates a maximally exposed individual factor (the food chain individual) into the human food chain targets factor category. As with similar factors in other pathways and threats, the food chain individual is assigned points according to the level of contamination. Where actual contamination of a fishery is documented, the food chain individual factor is assigned 50 points for Level I and 45 points for Level II concentrations. Where no actual contamination of a fishery is documented, but there is documentation of an observed release of a hazardous substance having a bioaccumulation potential factor value of 500 or greater to a watershed containing a fishery within the target distance limit, the food chain individual is assigned a value of 20 points. Where

there are no observed releases to surface water or no observed release of a hazardous substance with a bioaccumulation potential factor value of 500 or greater, but a fishery is present (i.e., there is a potentially contaminated fishery) within the target distance limit, the food chain individual is assigned points ranging from 0 to 20, depending on the dilution weight assigned to the associated surface water body.

The proposed rule estimated human food chain production of actually contaminated or potentially contaminated fisheries based on harvest data or stocking data for those fisheries, if available. Where such data were not available, production estimates were based on productivity of the surface water body or the estimated standing crop of aquatic biota in the fisheries. The proposed rule included a table of standing crop default values for estimating human food chain production of the fishery.

EPA received numerous comments to the effect that the standing crop default table was difficult to use, provided several different values for some water bodies and none for others, and provided unreliable data. Several commenters stated that standing crop values are not an appropriate basis for estimating aquatic human food chain production. One commenter pointed out that standing crop estimates do not correlate well with harvest for various water body types. Another commenter stated that estimates of harvest from fish and game officials are preferable to standing crop default values because standing crop is a measure of biomass (weight of all edible living organisms in the water body) rather than productivity.

EPA agrees with the commenters. In the final rule, estimates of fishery human food chain production are based on fish harvest data (including stocking

data) as opposed to standing crop data. When site-specific data are not available, harvest rates are to be estimated based on the average harvest per unit area for the particular water body type under assessment and the geographic area in which the water body is located.

Ground water discharge to surface water. A number of commenters and field test participants suggested that the HRS should consider the potential impact of ground water discharges to surface water because contaminated ground water can be a significant source of surface water contamination. Field test participants noted that some sites have no overland flow route, but surface water can be contaminated through ground water discharges.

EPA agrees and has added a ground water to surface water migration component to the surface water migration pathway. Figure 7 shows the structure of this component. The surface water migration pathway, therefore, now includes two components: The overland flow/flood migration component, which retains the structure of the surface water migration pathway as proposed (except for the changes discussed in this preamble), and the new ground water to surface water migration component. Either or both components may be scored; if both are scored, the surface water migration pathway score is the higher of the two scores. EPA selected the higher of the two scores rather than combining them because, if scores were combined, the amount of hazardous substances at the site available to migrate via each component would have to be apportioned between the two components. The site-specific data needed to determine the appropriate apportionment are rarely available.

Figure 7

Surface Water Migration Pathway - Ground Water to Surface Water Component¹

FINAL HRS

Likelihood of Release X

Drinking Water Threat

| |
|----------------------|
| Observed Release |
| or |
| Potential to Release |
| Containment |
| Net Precipitation |
| Depth to Aquifer |
| Travel Time |

| | | |
|-------------------------------|---|----------------|
| Waste Characteristics | X | Targets |
| Toxicity/Mobility/Persistence | | Nearest Intake |
| Hazardous Waste Quantity | | Population |
| | | Resources |

+

Human Food Chain Threat

| | | |
|---|---|-------------------------------------|
| Waste Characteristics | X | Targets |
| Toxicity/Mobility/Persistence/ Bioaccumulation | | Food Chain Individual Population |
| Hazardous Waste Quantity | | |

+

Environmental Threat

| | | |
|---|---|------------------------|
| Waste Characteristics | X | Targets |
| Ecosystem Toxicity/Mobility/ Persistence/Bioaccumulation | | Sensitive Environments |
| Hazardous Waste Quantity | | |

New component.

The ground water to surface water migration component evaluates three threats: drinking water, human food chain, and environmental. The component is scored only if: (1) A portion of the surface water is within one mile of any source at the site that could release to ground water; (2) there is no discontinuity in the uppermost aquifer between the source and the portion of the surface water within one mile of the source; and (3) the bottom of the surface water is at or below the top of the aquifer. The target distance limit for the component is determined the same way as for the overland flow/flood component. For each threat, likelihood of release is based on either observed release or potential to release. An observed release is established if, and only if, there is an observed release to the uppermost aquifer, while potential to release is based on ground water potential to release factors, except that only the uppermost aquifer is considered. (See § 4.2.2.1.2.)

The hazardous waste quantity factor is scored in the same way it is scored for the overland flow/flood migration component, except that only sources that could release to ground water are considered (see § 4.2.2.2.2). Toxicity, ground water mobility, and surface water persistence are considered in selecting the substance potentially posing the greatest hazard in drinking water (see § 4.2.2.2.1). By considering ground water mobility, the final rule reflects the fraction of a hazardous substance expected to be released from the sources and to migrate through ground water to the surface water body. For human food chain and environmental threats, bioaccumulation (or ecosystem bioaccumulation) potential is also considered in selecting the substance potentially posing the greatest hazard (see § 4.2.3.2.1).

The targets factors in this component are evaluated in the same way as targets factors in the overland flow/flood migration component, except that a dilution-weight adjustment is combined with the surface water dilution weights for populations potentially exposed to contamination. The dilution-weight adjustment was added because the HRS assumes that hazardous substances migrate via ground water in all directions from a site. Under this assumption, except in those instances where the surface water body completely surrounds the site, only a portion of the hazardous substances can be assumed to reach the surface water through the ground water. The dilution-weight adjustment accounts for the portion of the hazardous substances

assumed to be available to migrate to surface water through ground water. The probable point of entry is defined as the shortest straight-line distance, within the aquifer boundaries, from the sources at the site to the surface water body. Therefore, the actual targets considered may differ somewhat from targets evaluated in the overland flow/flood migration component because the two probable points of entry may differ. This approach might allow evaluation of intakes, fisheries, and sensitive environments that may be exposed to contamination from a site but are upstream from the point of overland flow entry.

N. Soil Exposure Pathway

The onsite exposure pathway, which was added to the HRS in the proposed rule, has been renamed the soil exposure pathway in the final rule. The pathway was primarily designed to assess the potential threats posed by direct exposure to wastes and contaminated surficial materials at a site. It evaluated two threats—the resident population and the nearby population. In the proposed rule, the resident population threat included three types of targets: High risk population on a property with observed contamination, all other residents and people attending school or day care on a property with observed contamination, and terrestrial sensitive environments in which there is observed contamination. The nearby population was based on people who live or attend school within a one-mile travel distance and who did not meet the criteria for resident population. Figure 8 summarizes the proposed and final rules.

A number of commenters supported the inclusion of the pathway, but raised issues related to its evaluation. For example, commenters objected to evaluating the waste characteristics factor category solely on toxicity. Three commenters objected to limiting the high risk population to children under seven. Other commenters stated that collecting data on the high risk population would be difficult. A number of commenters questioned how the onsite area and area of contamination would be defined and how accessibility of the site was evaluated.

In response to these comments and to the field test results, EPA has made a number of changes to the soil exposure pathway. The name of the pathway has been changed to be more consistent with terminology used in the Superfund human health evaluation process.

As suggested by commenters, the final rule limits the area within which human targets are evaluated for the resident

population threat to locations within property boundaries and within a distance limit of 200 feet from an area of observed contamination. The 200-foot limit accounts for those situations where the property boundary is very large, and exposure to contaminated surficial materials is unlikely or infrequent because of the distance of residences, schools, or work places from an area of observed contamination on the same property.

To make the pathway consistent with the other pathways and in response to comments, the final rule includes hazardous waste quantity in the waste characteristics factor category and multiplies it by the factor value for toxicity. New factors, resident individual and nearby individual, have been added to make the pathway consistent with the other pathways, all of which assign values for the maximally exposed individual (e.g., nearest individual or intake). Population is evaluated using two levels of actual contamination based on health-based benchmarks. Separate consideration of the high risk population (children under seven) has been eliminated because the field test indicated that this factor could greatly add to the time and expense of scoring a site yet resulted in little discrimination among sites. This change also makes the soil exposure pathway more consistent with the other pathways.

In the nearby population threat, the hazardous waste quantity factor in the likelihood of exposure factor category has been renamed "area of contamination" to reflect both the intent of the factor and how it is evaluated. The accessibility/frequency of use factor has been revised and renamed the "attractiveness/accessibility" factor. The revised factor emphasizes recreational uses of areas of observed contamination because they are most likely to result in exposures to contaminated surficial materials. In addition, the weighting of the nearby population relative to the resident population has been reduced to better reflect the relative levels of exposure for those threats.

A number of commenters questioned whether workers should be counted when evaluating target populations in the soil exposure pathway. One commenter suggested that soil exposure scoring should "not include activities at facilities that presently are regulated under the Occupational Safety and Health Administration (OSHA)." Other commenters, however, stated that workers should be counted in the target population. One commenter argued that

not counting a facility's work force is inconsistent with other population counting techniques. Another commenter said that workers should be included in the resident population because the proposed method of calculating soil exposure pathway scores can result in inappropriately low scores when onsite workers are exposed to wastes or contaminated soil.

In response to these comments, the Agency investigated statutory, regulatory, and policy conditions that

might restrict the inclusion of workers in the target population for the soil exposure pathway. This analysis found no broad statutory or regulatory authority for excluding workers covered by OSHA regulations from consideration as targets in the HRS. Although the definition of a release under CERCLA section 101(22) excludes "any release which results in exposure to persons solely within a workplace * * *" it only does so for purposes of claims by workers who are already

covered by State worker compensation laws. The legislative history of section 101(22) specifically anticipated that authority under CERCLA might, in appropriate cases, be used to respond to releases within a workplace. Thus, the Agency concludes that there are no broad statutory or regulatory restrictions against consideration of activities at OSHA-regulated facilities.

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Figure 8
Soil Exposure Pathway

PROPOSED HRS

Resident Population Threat

| | | | | |
|------------------------|---|-----------------------|---|--|
| Likelihood of Exposure | X | Waste Characteristics | X | Targets |
| Observed Contamination | | Toxicity | | High Risk Population Total Resident Population Terrestrial Sensitive Environments |

+

Nearby Population Threat

| | | | | |
|--|---|-----------------------|---|--------------------------|
| Likelihood of Exposure | X | Waste Characteristics | X | Targets |
| Waste Quantity Accessibility/Frequency of Use | | Toxicity | | Population Within 1 Mile |

FINAL HRS

Resident Population Threat

| | | | | |
|------------------------|---|--------------------------------------|---|---|
| Likelihood of Exposure | X | Waste Characteristics | X | Targets |
| Observed Contamination | | Toxicity Hazardous Waste Quantity | | Resident Individual Resident Population Workers Resources Terrestrial Sensitive Environments |

+

Nearby Population Threat

| | | | | |
|---|---|--------------------------------------|---|---|
| Likelihood of Exposure | X | Waste Characteristics | X | Targets |
| Attractiveness/Accessibility Area of Contamination | | Toxicity Hazardous Waste Quantity | | Population Within 1 Mile Nearby Individual |

The soil exposure pathway is designed to account for exposures and health risks resulting from ingestion of contaminated surficial materials. Because ingestion exposures are comparable for some types of workers and residents, the Agency has decided to include workers in the resident population threat. However, substantial variability in the kinds of workers and work activities at sites (e.g., indoor and outdoor) leads to considerable variability in exposure potential. The Agency believes that determining specific categories or types of workers is beyond the scope of HRS data collection. Thus, workers are assigned target points on a prorated basis: 5 points are assigned for sites with up to 100 workers; 10 points for sites with 101 to 1,000 workers, and 15 points for greater than 1,000 workers. Prorating workers will reduce the data collection effort. Evaluation of workers is not affected by health-based benchmarks. (See § 5.1.3.3.) Nearby workers are not counted in the nearby population because the Agency considers it unlikely that workers from nearby workplaces would regularly visit contaminated areas outside the property boundary of their workplace during the workday, and because there is no way to estimate accurately the number of workers who might.

O. Air Migration Pathway

The proposed rule made several significant changes to the air migration pathway in the original HRS. In response to the SARA mandate to consider potential as well as actual releases to air, the proposed rule included an evaluation of the potential to release. The proposed rule also added a mobility factor to the waste characteristics factor category and an MEI factor to the targets category. Finally, the proposed rule added explicit distance weighting factors for evaluating all factors in the targets category. Figure 9 shows the proposed air migration pathway and the final rule pathway.

The public provided numerous comments on these changes and raised new issues as well. The most significant new issue concerned the structural inconsistency in the treatment of gases and particulates in the proposed air migration pathway. For example, commenters observed that in the potential to release evaluation, it was possible to assign a high containment value to a source with good gas containment and poor particulate containment while assigning high source type and mobility values based on the presence of gaseous hazardous substances. This combination would yield an inappropriately high potential

to release value. This concern was also noted in discussions with field test personnel.

The Agency agrees with these commenters and investigated methods to better reflect the differences between gases and particulates. As a result of these analyses, EPA has made several changes to the final rule in both the likelihood of release and waste characteristics factor categories.

In the likelihood of release factor category, the final rule evaluates source potential to release separately for gases and particulates. Only those sources containing gaseous hazardous substances are evaluated for gas potential to release, and only those sources containing hazardous substances that can be released as particulates are evaluated for particulate potential to release. This change in potential to release structure necessitated other changes in the scoring of potential to release including development of separate gas and particulate source type factors and migration potential factors. The names of these latter factors were also changed to highlight the differences between potential to release "mobility" and waste characteristics "mobility." (See §§ 6.1.2.1.3, 6.1.2.2.3.)

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