Figure 9

# Air Migration Pathway

## PROPOSED HRS

| Likelihood of Release | X | Waste Characteristics | X | Targets |
|---|---|---|---|---|
| Observed Release<br>or<br>Potential to Release<br>Source Containment<br>Source Type<br>Source Mobility | | Toxicity/Mobility<br>Hazardous Waste Quantity | | Maximally Exposed Individual<br>Population<br>Land Use<br>Sensitive Environments |

## FINAL HRS

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

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In addition to these changes in the basic structure of the potential to release factors, the final rule includes several additional changes in the source type list, migration potential factors, and containment factors. Based on the experience gained in the field test, EPA added several source types to the source type list. Some of these additions (e.g., surface impoundment (not buried/backfilled); dry) simply clarify classifications that were implied in the proposed source type list. Other additions, such as source types involving biogas release, were considered early in the development of the proposed HRS but were not included originally in the interest of simplicity. Field test experience, however, indicated that their inclusion in the final rule was necessary. Finally, new distinctions within some source types (e.g., the various types of piles) were added partly in response to comments and partly as a result of field test experience. As applicable, source type values were also revised. (See §§ 6.1.2.1.2, 6.1.2.2.2 and Table 6–4.)

The revised gas and particulate migration potential factors are very similar to the proposed likelihood of release gas and particulate mobility factors. Several commenters questioned the need for including dry relative soil volatility in the final gas migration factor. A simplification analysis indicated that dry relative soil volatility was redundant, as it was almost completely determined by vapor pressure. Hence, the final gas migration potential factor includes only vapor pressure and Henry's law constant. The particulate migration potential factor in the final rule is simply the particulate component of the proposed potential to release mobility factor.

The containment factors were also changed as a result of the field test, a review of recent information on covering systems, the examination of air release rate models, and the public comments on the need for simplicity in the final rule. The final list of containment descriptions eliminated many redundant descriptions and changed others, retaining only those distinctions that are necessary based on type of source. (See §§ 6.1.2.1.1, 6.1.2.2.1 and Tables 6–3, 6–9.) As discussed in Section III F above, two new mobility factors were developed for the waste characteristics factor category.

Commenters generally supported the concept of distance weighting target factors. However, several disagreed with the approach used to develop the proposed factor values. Some commenters suggested basing the factor values on long-term meteorology and the size of the site, while others suggested that additional atmospheric phenomena (e.g., particulate deposition) be reflected in the final values. As a result of these comments, EPA has revised the distance weighting factors used in the final rule to reflect long-term atmospheric phenomena. Analyses indicated that particulate deposition and other similar phenomena as well as site size were not sufficiently significant within four miles of a site to warrant their inclusion in the final factor values. EPA also notes that the distance weighting factor values are now incorporated in the population factor value table. (See § 6.3.2.4 and Table 6–17.)

*P. Large Volume Wastes*

*Mining waste sites.* A number of commenters representing mining companies, trade associations, and State and Federal agencies commented on how the proposed HRS would score mining waste sites; commenters representing waste management facilities raised similar issues in regard to their sites. This section summarizes and addresses the major issues addressed by these commenters.

Commenters raised several concerns regarding the appropriate consideration of background levels of metals in documenting direct or indirect releases from mining waste sites. One commenter recommended that in determining direct releases from a mining waste site, EPA should consider the natural characteristics of the site prior to mining and the changes in migration rates resulting from mining. The commenter explained that the concentration of metals in a mining waste pile may be similar to or less than natural concentrations in soil or rocks below and adjacent to the pile. To document indirect releases, the commenter suggested that EPA require collection of detailed information on site geology and hydrological gradients to ensure proper consideration of background levels. Finally, the commenter asserted that although it is appropriate to weight observed releases more heavily than potential releases at sites with synthetic organic hazardous substances, the criteria used to define observed release are not valid at sites with natural sources of metals. Another commenter agreed and suggested that because of background levels of inorganic elements, the proposed HRS could identify as an observed release concentrations unrelated to mining activities.

EPA recognizes that natural background concentrations of metals in soil or rocks can affect the measured concentration necessary to establish an observed release at a mining waste site. This consideration is reflected in the requirement that concentrations significantly above background be shown to establish an observed release. Moreover, EPA has clarified the observed release criteria in the final rule to explain that they specify minimum differences necessary to establish an observed release by chemical analysis.

Several commenters questioned the treatment of metals in the ground water mobility factor. One commenter stated that the proposed HRS is biased against mining waste sites because it gives greater consideration to the accurate assessment of the mobility of organic substances than to that of naturally occurring metals. The commenter noted that the proposed persistence factor for the surface water migration pathway accounts for the degradation of hazardous substances in the environment through four processes. None of these processes, according to the commenter, applies to metallic elements, which received a default value of 3 (the highest possible score for persistence). Another commenter stated that decreased mobility was considered only for organic compounds, even though inorganic compounds are immobile in some situations.

One commenter stated that adding a metals mobility factor, as EPA's Science Advisory Board (SAB) recommended, would allow the HRS to reflect more accurately the potential for metallic elements to migrate in the aqueous phase. Two commenters were concerned that metals would be assigned a "worst-case" default value for mobility. On the other hand, another commenter stated that consideration of the mobility of metals in the revised HRS would at least partially rectify the bias in the current HRS against high-volume, low-concentration mining wastes.

A number of these commenters appear to have misunderstood the proposed rule. Metals were not automatically assigned the maximum value as a default in the ground water mobility factor, but rather were assigned values based on their coefficient of aqueous migration. The final rule automatically assigns the maximum value for mobility only to metals establishing an observed release by chemical analysis, which is the same way organics and nonmetallic inorganics are evaluated. For metals and metal compounds not establishing an observed release by chemical analysis, mobility is based on water solubility and distribution coefficient ($K_d$), the same as for organics and nonmetalli-

inorganics. If none of the hazardous substances (including metals, organics, and nonmetallic inorganics) eligible to be evaluated for the site can be assigned a mobility factor value based on available data, § 3.2.1.2 of the final rule assigns a mobility factor value of 0.002 for all of the hazardous substances. This value was selected based on a review of the range of mobility factor values assigned to those hazardous substances (including metals) for which data were available for assigning mobility factor values. The value of 0.002 is clearly not a worst-case default (which would be 1.0).

EPA believes that the persistence factor is not biased against metals. Elemental metals do not degrade and, therefore, should receive higher scores for persistence than other substances subject to degradation processes.

One commenter claimed that the soil exposure pathway is likely to bias the HRS scores of mining waste sites toward higher values because such sites contain large volumes of waste covering large surface areas, and because of geographic factors, these large areas are seldom secured against direct public access. In addition, according to the commenter, the public may be attracted to mining waste sites. The commenter suggested that the soil exposure pathway incorrectly assumes there is an exposure because there is access to mining waste sites.

EPA does not agree that the soil exposure pathway is biased against mining waste sites. The pathway evaluates exposures of people via contact with surficial hazardous substances. The Agency believes that, all else being equal, large contaminated surface areas with public access, including those associated with mining waste sites, should receive higher scores for the soil exposure pathway than smaller sites with more restricted access. Even sites with large contaminated surface areas are unlikely to be assigned high scores except when they are near residential areas or include a listed sensitive environment. As some commenters representing mining-related activities have noted in the past, most mines are located some distance from inhabited areas.

Three commenters stated that the original HRS was biased against sites such as mining waste sites that are characterized by high volumes of waste with relatively low concentrations of toxic constituents. Two of these commenters suggested that mining wastes would be appropriate for hazardous constituent quantity determination because such wastes are relatively homogeneous (compared to other wastes) and, therefore, have fairly consistent concentrations. One of these two commenters also stated that the hazardous waste quantity factor equations in Table 2–14 of the proposed rule should be revised to be less conservative. The remaining commenter suggested that the proposed HRS was still biased against mining waste sites because they are still scored based on the quantity of waste rather than on the concentration of the waste at the point of exposure.

EPA does not agree that the HRS is biased against high-volume, low-concentration waste sites. The final rule incorporates concentration data in three factors: (1) Likelihood of release (concentration data can be used for establishing an observed release); (2) hazardous waste quantity (concentration data, if available and adequate, can be used for calculating hazardous constituent quantity); and (3) targets (concentrations of hazardous substances present in drinking water wells or at other exposure points can be used to determine weightings for nearest individuals (or wells or intakes), populations, and sensitive environments factors). EPA has not explicitly required concentration data for all sites because of the substantial costs for obtaining these data and the very high degree of uncertainty associated with data collected during SIs.

EPA requested that the SAB review issues related to large-volume waste sites before the NPRM was published. The SAB final report is available in the CERCLA docket. Two commenters stated that the Agency did not adequately consider the SAB's recommendations for revising the HRS, specifically those concerning the use of mobility data.

The SAB, in its review of the original HRS, examined whether large-volume waste sites (e.g., mining waste sites) had been treated differently than other waste sites and concluded that insufficient data were presented to demonstrate that the original HRS was biased against mining waste sites. However, the SAB noted that the original HRS had the potential for such a bias, particularly when scoring potential to release, because the original HRS did not consider mobility, concentration of hazardous constituents, and transport. The SAB suggested several possible modifications to improve the application of the HRS to mining waste sites.

Based in part on the SAB suggestions, EPA proposed several changes to the overall scoring process to make the HRS more accurately reflect risks associated with mining waste sites, notably, addition of a mobility factor to the air and ground water migration pathways, changes in the persistence factor, incorporation of a tiered hazardous waste quantity factor that can account for waste concentration data, and addition of health-based benchmarks for evaluating population. As explained in the NPRM, determining speciation of metals and pH, as the SAB had suggested, is not feasible given the temporal and spatial variations at hazardous waste sites and the limitations on SI data collection. Moreover, determining speciation is not feasible for most substances given EPA's current analytical procedures; requiring speciation analyses would add substantially to the cost of data collection.

Two commenters stated that the proposed HRS can significantly overestimate risks associated with mining waste sites that consist of high-volume, low-concentration wastes. One of these commenters recommended a "preliminary evaluation system" to more accurately reflect the actual risks associated with such sites and remove any bias in the HRS relative to other types of sites. This commenter also suggested that in proposing the HRS revisions, EPA had ignored the results of its own studies under RCRA sections 3001 and 8002, which the commenter believed to be more focused efforts to quantify risks from mining waste sites than the HRS revisions.

EPA does not believe that a separate "preliminary evaluation system" for scoring mining waste sites would be appropriate. A single HRS can be applied uniformly to all sites, allowing the Agency to evaluate sites relative to each other with respect to actual and potential hazards. The Agency examined the RCRA studies cited by the commenter before proposing HRS revisions. Those studies, which focus on the management of wastes at active facilities, concluded that many special study waste sites (e.g., mining) do not present very high risks, while others may present substantial risks. EPA believes that the conclusions of these studies and the Agency's subsequent regulatory determinations (i.e., not to regulate most mining wastes under RCRA Subtitle C) are not inconsistent with a determination that some mining waste releases can require Superfund response actions. Furthermore, the HRS is designed so that it can be applied to closed and abandoned sites as well as active sites.

*Other large volume waste sites.* Several commenters suggested that the proposed HRS did not meet CERCLA section 125 requirements for sites

involving fossil fuel combustion wastes. These commenters generally agreed that section 125 requires EPA to consider the quantity and concentration of hazardous constituents in fossil fuel combustion wastes and that the proposed HRS had not adequately addressed this requirement.

One commenter supported the Agency's proposal to allow consideration of concentration data when such data are available. Three commenters stated that the proposed HRS would often assign fossil fuel combustion waste sites high scores in part because of the worst-case assumptions or "default values" for certain factors (i.e., hazardous waste quantity, toxicity, target populations). The commenters claimed that fossil fuel combustion waste sites receive high scores merely because of the large quantity of waste, although this waste presents no significant adverse environmental effects, and that these high scores are inconsistent with EPA's findings in the RCRA section 8002 study. One of the three commenters suggested that the proposed HRS retained certain deficiencies of the original HRS, such as assuming that all hazardous substances in the waste consist of the single most toxic constituent in the waste.

EPA does not believe that the approach taken in the final rule creates a bias against fossil fuel combustion wastes. Partly because concentration data are considered in the final rule, fossil fuel combustion waste sites are not expected to score disproportionately high when compared with other types of sites. The HRS assumes that it is not possible to determine in a consistent manner the relative contribution to risk of all hazardous substances found at sites. Given this assumption, EPA has determined that basing the toxicity of the combination of substances at a site on the toxicity of the substance posing the greatest hazard is a reasonable and appropriately conservative approach. In many cases, the substance posing the greatest hazard is not several orders of magnitude more toxic than other hazardous substances at the site. Therefore, the effect of this approach on the toxicity factor value—which is evaluated in one order of magnitude scoring categories—is not as great as some commenters have suggested (see also section III D). In addition, as noted above, worst-case defaults are not assigned for mobility; population factors have no default values.

Two commenters suggested that because CERCLA section 125 contains no statutory deadlines, EPA should take as much time as necessary to adequately respond. These commenters recommended that EPA extend the tiered approach of the hazardous waste quantity factor to other factors to take advantage of the extensive data on fossil fuel combustion wastes generated by the electric utility industry.

The Agency does not agree that the tiered approach used in the hazardous waste quantity factor should be extended to other factors for fossil fuel combustion waste sites (see also section III K). EPA believes that creating a separate HRS to score certain types of sites would not allow the Agency to provide a uniform measure of relative risk at a wide variety of sites, as Congress intended.

One commenter recommended that EPA consider using fate and transport models currently under development to incorporate quantitative representations of specific processes and mechanisms into the HRS. EPA carefully examined this possibility and concluded that although the use of fate and transport models could conceivably increase the accuracy of the HRS for some pathways, collection of the required site-specific data would be far too complex and costly. Fate and transport models are appropriate for a comprehensive risk assessment, but not for a screening tool such as the HRS. In addition, EPA's review suggested that it would be more difficult to achieve consistent results among users of such models than with the HRS. EPA points out that it used fate and transport models to develop the distance weighting factors used in the HRS target calculations, and also that the HRS incorporates several hazardous substance parameters (e.g., mobility) and site parameters (e.g., travel time) that are components of fate and transport models.

Two commenters expressed concern that the proposed HRS fails to account for the leachability of hazardous constituents as required by CERCLA section 125. According to the commenters, some hazardous constituents pose no risk via ground water because they will never be released to that medium. Thus, even if hazardous waste quantity and concentration are considered adequately, hazardous waste quantity scores for fossil fuel combustion sites will be erroneously high unless leachability is considered as well.

EPA examined the availability of leachate data and the feasibility of using such data for calculating hazardous substance quantity for all types of sources and wastes. The Agency decided against using leachate concentrations because:

- Leachate data are not available for all sources and wastes, and available leachate data on high-volume wastes and some landfills have limited applicability for estimating the quantity of leachable hazardous substances;
- Leachate data derived from lab studies are limited and do not realistically represent the universe of field conditions such as heterogeneity of wastes, chemistry of leachate, and density and pore volume of disposed wastes; and
- Any method for using leachate data could not be consistently or uniformly applied to all sites.

EPA also examined the feasibility of developing site-specific leachate data for estimating leachable hazardous substance quantity for the ground water migration pathway. EPA decided against this option because reliable estimation of leachable hazardous substance quantity requires comprehensive sampling of site-specific heterogeneous waste, which would be prohibitively expensive and not feasible. In some cases, such sampling would be technically unfeasible and unsafe.

EPA evaluated alternatives for developing a surrogate for estimating leachable hazardous substance quantity. The Agency found that adding the mobility factor to the ground water migration pathway, based both on solubilities and distribution coefficients ($K_d$s) of hazardous substances, and multiplying it by the hazardous waste quantity factor would be a feasible alternative for approximating the fraction of hazardous substance quantity expected to be released to ground water.

*Q. Consideration of Removal Actions (Current Versus Initial Conditions)*

The original HRS based the evaluation of factors on initial conditions. In the preamble to the proposed rule, EPA specifically requested comments on whether sites should be scored on the basis of initial or current conditions. The principal question is whether the effect of response actions, such as the removal of some quantity of the waste, should be considered when sites are scored. Initial conditions are defined by the timing of the response action; that is, initial conditions are the conditions that existed prior to any response action. For sites where no response action has occurred, initial and current conditions are the same for evaluating sites.

Of the 25 commenters responding to this issue, 15—including all industry commenters—supported scoring on current conditions. In the preamble of

the proposed rule, EPA presented two approaches for considering response actions in HRS scores: (1) Consider these actions only for those pathways and factors for which they are most appropriate; and (2) consider these actions in all pathways, but make exceptions at sites where initial conditions more accurately reflect risks.

Those who stated a preference favored the second, specifying that the exceptions should be clearly defined in the final rule. These commenters stated that scoring all pathways on current conditions would encourage responsible parties to clean up sites quickly. They reasoned that if cleanups are delayed, the threat of migration of the hazardous substances increases; therefore, scoring on current conditions is consistent with the intent of CERCLA because it encourages rapid remedial action. One commenter said that scoring on initial conditions made little sense when, as a result of the cleanup, the level of residual contamination was below the level required by CERCLA.

Several proponents of scoring on current conditions stated that EPA's concern that responsible parties would clean up sites just enough to avoid being listed on the NPL was unfounded. They argued that the proposed scoring system is too complicated to manipulate, and that predicting the effect of partial cleanups on the final score would be difficult. Others suggested that where contamination remains, sampling during an SI will discover it.

Ten commenters did not fully support scoring on current conditions. Only one opposed any consideration of current conditions. Several commenters supported scoring the soil exposure and air migration pathways on current conditions. Others stated that response actions should be considered only when the actions are conducted under Federal or State direction, or when the action constitutes a complete cleanup. Several added that State actions should not be considered because it would penalize States with active remedial programs. One commenter suggested scoring sites on both current and initial conditions; if the response action had addressed all hazards, then the current conditions score should be used.

Based on public comment, EPA has decided to change its policy on consideration of removal actions. The Agency agrees that consideration of such actions in HRS scores is likely to increase incentives for rapid actions by responsible parties, reducing risks to the public and allowing for more cost effective expenditure of the Fund. In making this decision, EPA tried to balance the benefits of considering removal actions in HRS scores (e.g., increased incentives for rapid actions) while also ensuring that the HRS score reflects any continuing risks at sites where contamination occurred prior to any response action.

Therefore, EPA will calculate waste quantities based on current conditions. However, EPA believes the accuracy of this approach depends on being able to determine with reasonable confidence the quantity of hazardous constituents remaining in sources at the site and the quantity released into the environment. As a consequence, where the Agency does not have sufficient information to estimate the quantity of hazardous constituents remaining in the sources at the site and in the associated releases, a minimum factor value may be assigned to the hazardous waste quantity factor value. Thus, removal actions may not reduce waste quantity factor values unless the quantity of hazardous constituents remaining in sources and in releases can be estimated with reasonable confidence.

In addition to providing incentives for early response, this approach also provides incentives for potentially responsible parties to ascertain the extent of the remaining contamination at sites. Potentially responsible parties undertaking removal actions will have the primary responsibility for collecting any data needed to support a determination of the quantity of hazardous constituents remaining. EPA expects responsible parties may need to conduct sampling and analyses to determine the extent of hazardous substance migration in soils and other media in order to estimate with reasonable confidence the quantity of hazardous constituents remaining.

EPA decided not to limit the consideration of response actions to certain pathways (e.g., the soil exposure pathway) because this would overstate the risk at sites where removal of wastes has eliminated threats in all pathways. Moreover, a more limited approach to consideration of response actions would provide less incentive for rapid response action.

EPA will evaluate a site based on current conditions provided that response actions actually have removed wastes from the site for proper disposal or destruction in a facility permitted under the Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA), or by the Nuclear Regulatory Commission. HRS scoring will not consider the effects of responses that do not reduce waste quantities such as providing alternate drinking water supplies to populations with drinking water supplies contaminated by the site. In such cases, EPA believes that the initial targets factor should be used to reflect the adverse impacts caused by contamination of drinking water supplies; otherwise, a contaminated aquifer could be artificially shielded from further remediation. This decision is consistent with SARA section 118(a), which requires that EPA give high priority to sites where contamination from the site results in closed drinking water wells. Similarly, if residents are relocated or if a school is closed because of contamination due to the site, EPA will consider the initial targets in scoring the site.

As noted in the proposed rule preamble, EPA would only consider removals conducted prior to an SI. EPA believes that the SI is the appropriate time to evaluate conditions, because it is the source of most of the data used to score a site. Because response action at sites may be an ongoing process, it would be burdensome to recalculate scores continually to reflect such actions.

In response to commenters, EPA also considered whether response actions should be considered in HRS scores only if they are performed under a State or EPA order. EPA decided not to choose this approach for two reasons. First, it would diminish the incentive for an expeditious response at the site if a signed order were required. Second, because a response action must be conducted before the SI to be considered in the HRS score, there would be little information on site conditions upon which this order could be based.

EPA has also decided not to differentiate between response actions initiated by States and those conducted by other parties. The Agency believes this approach will help ensure consistent application of the HRS by avoiding situations where two similar sites are scored using different sets of rules. Moreover, although the Agency is sympathetic to concerns about disincentives to States for initiating actions, it believes that such cases will be rare. Many State (and Federal) removal actions are interim measures designed to stabilize conditions at the site. Given the more limited definition of response action noted above (e.g., removal of waste from the site for disposal or destruction in a RCRA-permitted facility), many actions conducted by States would not be considered in HRS scoring. In addition, in many cases, State and Federal removal actions are undertaken after an SI has been conducted. As noted above,

EPA will only consider removals conducted before the SI in the HRS score.

*R. Cutoff Score*

In the NPRM preamble, EPA proposed that the cutoff score for the revised HRS be functionally equivalent to the current cutoff score of 28.5. The Agency also requested comment on three proposed options for determining functional equivalence:

- Option 1: Score sites using both the original and final rule, then use statistical analysis to determine what revised HRS score best corresponds to 28.5;
- Option 2: Choose a score that would result in an NPL of the same size as the NPL that would be created by using the original HRS; and
- Option 3: Identify the risk level that would correspond to 28.5 in the original HRS and then determine what revised HRS score corresponds to that risk level.

Some commenters stated that there cannot be a functional equivalence if the revisions have any meaning. They argued that if the revisions meet the statutory mandate to make the HRS more accurate, the scores should be different and, therefore, cannot be related. Several commenters supported the use of a functional equivalent, but were divided about which option should be used. One commenter stated that the 28.5 score should be evaluated to determine whether it reflected minimum risk levels. If it did, the commenter suggested that a functional equivalent would be appropriate and should be determined using equivalent risk levels (option 3), but also with an eye toward keeping the NPL to a manageable size (option 2).

Commenters not supporting the use of a functional equivalent suggested a variety of alternative approaches, including:

- Establish the cutoff score based on risk, without regard to the current cutoff level or a functional equivalent;
- Leave the score at 28.5;
- Propose a new cutoff score and a description of methodology in a public notice with a 60-day public comment period;
- Lower the cutoff score to provide an incentive to responsible parties to undertake remedial efforts and make it possible for sites where a removal action has taken place to make the NPL, thus reducing the controversy over whether to score sites based on current conditions;
- Raise the cutoff score by at least 20 points;
- Eliminate the present cutoff score by creating categories of sites instead of individual ranks as a means of prioritizing NPL sites;
- Amend the NPL annually to include only those sites that deserve priority attention (e.g., orphaned sites) and are likely to receive Superfund financing; or
- Rank all sites showing any degree of public health and/or environmental risk on a relative scale and perform remedial activities based on available funding.

In addition, four commenters felt that the cutoff score for the final rule should not be fixed until the technical merits and potential scores of representative sites are tested and compared using both the current and proposed HRS. Further, one commenter noted that the field test did not indicate the relationship between the revised HRS score for a given site and the current score; another added that until this equivalency issue is clarified, meaningful comment on any proposed revisions cannot be made.

Based on an analysis of 110 test sites, EPA has decided not to change the cutoff score at this time. This conclusion was reached after applying all three approaches to setting a cutoff score that would be functionally equivalent to 28.5. In its analysis, the Agency scored field test sites with both the original and revised HRS. The data from these test sites show that few sites score in the range of 25 to 30 with the revised HRS model. The Agency believes that this range may represent a breakpoint in the distribution of site scores and that the sites scoring above the range of 25–30 are clearly the types of sites that the Agency should capture with a screening model. Because the analysis did not point to a single number as the appropriate cutoff, the Agency has decided to continue to employ 28.5 as a management tool for identifying sites that are candidates for the National Priorities List.

EPA believes that the cutoff score has been, and should continue to be, a mechanism that allows it to make objective decisions on national priorities. Because the HRS is intended to be a screening system, the Agency has never attached significance to the cutoff score as an indicator of a specific level of risk from a site, nor has the Agency intended the cutoff to reflect a point below which no risk was present. The score of 28.5 is not meant to imply that risky and non-risky sites can be precisely distinguished. Nevertheless, the cutoff score has been a useful screening tool that has allowed the Agency to set priorities and to move forward with studying and, where appropriate, cleaning up hazardous waste sites. The vast majority of sites scoring above 28.5 in the past have been shown to present risks. EPA believes that a cutoff score of 28.5 will continue to serve this crucial function.

## IV. Section-by-Section Analysis of Rule Changes

Besides the changes discussed above, EPA has made substantial editorial revisions in the rule being adopted today. Source characterization is discussed in section 2 of the final rule, along with factors that are evaluated in each pathway. These factors include hazardous waste quantity, toxicity, and evaluation of targets based on benchmarks. The order of presentation of the pathways has been changed to ground water, surface water, soil exposure, and air. Following the four sections describing the pathways, a section has been added explaining how to evaluate sites that have radionuclides either as the only hazardous substances at the site or in combination with other hazardous substances.

In general, descriptive text that provided background information has been removed as have references and data sources; the sections have been rewritten to make the rule easier to read and to apply. The figures presenting overviews of the pathways and the scoring sheets have been revised throughout to reflect changes in the rule and assigned values.

This section describes, for each section of the rule and each table, the specific substantive changes; editorial changes that do not affect the content of the rule are not generally noted.

*Section 1 Introduction*

The text explaining the background of the HRS and describing the rule has been removed. Definitions of a number of additional terms used in the rule have been added for clarity. The definition of "hazardous substance" has been revised for clarification. The definition of "site" has been clarified and now indicates that the area between sources may also be considered part of the site. The definition of "source" has been revised to explain that those volumes of air, ground water, surface water, or surface water sediments that become contaminated by migration of hazardous substances are not considered a source, except contaminated ground water plumes or contaminated surface water sediments may be considered a source if they cannot be attributed to an identified source. In addition, the definition of source now includes soils contaminated by migration of hazardous substances.

Under the original HRS, the Agency took the approach that all feasible efforts should be made to identify sources before listing a site on the NPL. If, after an appropriate effort has failed to identify a source, the Agency believed that the contamination was likely to have originated at the type of source that would be addressed under Superfund, such sites were listed. Subsequent investigations after listing have generally identified a specific source. In some cases, EPA has not listed contaminated media without clearly identified sources because it appeared the source of pollution would not be addressed by Superfund programs; an example of such a source would be extensive, low-level contamination of surface water sediments caused by pesticide applications. EPA has found this approach to be generally workable and will continue to evaluate, on a case-by-case basis, whether sites with no identified sources should be listed.

Where contaminated media with no identified sources exist, the final rule generally assigns a hazardous waste quantity factor value to such contamination, with the value depending on whether there are any targets subject to Level I or Level II concentrations. For contaminated sediments in the surface water migration pathway, if there is a clearly defined direction of flow, target distances are measured from the point of observed sediment contamination that is farthest upstream. For ground water plumes and for contaminated sediments where there is no clear direction of flow, the center of the observed ground water or sediment contamination is used for the purpose of measuring target distance limits.

*Section 2 Evaluations Common to Multiple Pathways*

This section covers factors and evaluations common to multiple pathways. The major changes to these factors include: observed release criteria have been revised; the toxicity factor has been changed to a linear rather than a log scale; scales for hazardous waste quantity have been made linear and expanded, and the hazardous waste quantity minimum value has been changed; the waste characteristics factor category score is now obtained by multiplying the factor values and using a table to assign the final score; use of benchmarks has been extended to all pathways and to the nearest individual (well/intake) factor; and the methods for comparisons to benchmarks have been changed as have the benchmarks used. The purpose of this part is to make the rule less repetitious by presenting full explanations of the evaluation of certain factors only once rather than in each pathway in which they occur. Exceptions related to radionuclides are noted throughout the rule and referenced to Section 7.

*Section 2.1 Overview.* Introduces the pathways and threats included in HRS scoring.

*Section 2.1.1 Calculation of HRS site score.* Provides the equation used to calculate the final HRS score.

*Section 2.1.2 Calculation of pathway score.* Indicates, in general, how pathway scores are calculated and includes a sample pathway score sheet (Table 2–1).

*Section 2.1.3 Common evaluations.* Lists evaluations common to all pathways.

*Section 2.2 Characterize sources.* Introduces source characterization and references Table 2–2, the new sample source characterization worksheet.

*Section 2.2.1 Identify sources.* Explains that for the three migration pathways, sources are identified, and for the soil exposure pathway, areas of observed contamination are identified.

*Section 2.2.2 Identify hazardous substances associated with a source.* Covers information previously provided in the introduction to the waste characteristics factor category.

*Section 2.2.3 Identify hazardous substances available to a pathway.* Explains which hazardous substances may be considered available to each pathway. For the three migration pathways, the primary limitation on availability of a hazardous substance to a pathway is that the substance must be in a source with a containment factor value, for that pathway, greater than 0; that is, the hazardous substance must be available to migrate from its source to the medium evaluated. For the soil exposure pathway, the primary limitation is that the substance must meet the criteria for observed contamination and, for the nearby threat, it must also be accessible.

*Section 2.3 Likelihood of release.* Specifies the criteria for establishing an observed release (discussed in section III G of this preamble) and explains that potential to release factors are evaluated only when an observed release cannot be documented. Table 2–3, which replaces Table 2–2 in the proposed rule, provides the revised observed release criteria for chemical analyses for the migration pathways. Table 2–3 is also used in establishing observed contamination for the soil exposure pathway.

*Section 2.4 Waste characteristics.* Defines the waste characteristics factor category.

*Section 2.4.1 Selection of substance potentially posing greatest hazard.* Explains how to select the substance potentially posing the greatest hazard.

*Section 2.4.1.1 Toxicity factor.* Explains how to assign toxicity values. Changes in the approach to scoring toxicity are discussed in section III D of this preamble. Table 2–4 (proposed rule Table 2–11) has been revised to make the assigned factor values linear rather than logarithmic values; however, the relationship among the values has not changed. A provision to always assign lead (and its compounds) an HRS toxicity factor value of 10,000 was added as a result of changes since the time of the proposed rule in the way EPA develops chronic toxicity values for lead (i.e., reference doses, in units of intake (mg/kg-day), are no longer developed for lead).

*Section 2.4.1.2 Hazardous substance selection.* Lists which factors are combined, in each pathway or threat, to select the hazardous substance potentially posing the greatest hazard. For each migration pathway, each substance eligible for consideration is evaluated based on the combination of toxicity (human or ecosystem) and/or mobility, persistence, and bioaccumulation (or ecosystem bioaccumulation) potential. The substances selected for each pathway or threat are those with the highest combined values. For the soil exposure pathway, the substance with the highest toxicity value is selected from among substances that meet the criteria for observed contamination for the threat being evaluated. The use of bioaccumulation in the selection of substances in the human food chain threat has changed as a result of the structural changes discussed above. In the proposed rule, only substances with the highest bioaccumulation values were evaluated for toxicity/persistence; in the final rule, the substance with the highest combined toxicity/persistence/bioaccumulation value is selected in the human food chain threat of the overland flow/flood migration component. For the ground water to surface water migration component, mobility is also considered. This revised method better reflects the overall threat.

*Section 2.4.2 Hazardous waste quantity.* Describes how to calculate the hazardous waste quantity factor value, as explained in section III D of this preamble. The explanation has been simplified from that presented in the proposed rule, and a discussion of unallocated sources has been added. A discussion clarifying the method for evaluating hazardous waste quantity in the soil exposure pathway was also added, and clarifying language on this

point was inserted throughout the subsections of § 2.4.2. Table 2–13 from the proposed rule has been eliminated.

*Section 2.4.2.1 Source hazardous waste quantity.* Details the measures that may be considered in evaluating hazardous waste quantity for a source or area of observed contamination.

*Section 2.4.2.1.1 Hazardous constituent quantity.* Explains how to assign a value to the hazardous constituent quantity factor. An explanation of the treatment of RCRA hazardous wastes has been added to clarify the scoring of these wastes. Table 2–5, Hazardous Waste Quantity Evaluation Equations (proposed rule Table 2–14), has been revised in several ways. The constant divisor of 10 has been moved from these equations and is now incorporated into the factor values assigned using Table 2–6. Two types of surface impoundments are now listed to ensure that buried surface impoundments are treated appropriately. The term "tanks" has been added to containers other than drums to clarify how tanks should be evaluated. Also, equations for calculating hazardous waste quantity based on area have been revised based on a study of waste sites. The study indicated that new depth assumptions should be used for some sources; the land treatment equation was revised based on data from the same study about typical loading rates in land treatment operations.

*Section 2.4.2.1.2 Hazardous wastestream quantity.* Explains how to assign a value for hazardous wastestream quantity based on the mass of the wastestream. An explanation of the treatment of RCRA hazardous wastes has been added to clarify the scoring of these wastes.

*Section 2.4.2.1.3 Volume.* Explains how to assign a value for source volume.

*Section 2.4.2.1.4 Area.* Explains how to assign a value for source area.

*Section 2.4.2.1.5 Calculation of source hazardous waste quantity value.* Explains how to assign a value to source hazardous waste quantity.

*Section 2.4.2.2 Calculation of hazardous waste quantity factor value.* Explains how to assign a factor value to hazardous waste quantity using Table 2–6. The values in Table 2–6 include several changes. The cap applied to the factor value (i.e., the lowest hazardous waste quantity value required to assign the maximum factor value) has been increased to reflect more accurately the range of hazardous substance quantities found at waste sites. The cap is set based on the maximum quantity found at current NPL sites. Rather than being assigned a maximum of 100, as in the proposed rule, the assigned factor values range to 1,000,000. Each factor value less than the cap is assigned for quantities that range across two orders of magnitude. The two-order-of-magnitude ranges reflect the uncertainty in estimates of both quantity and concentration of the hazardous substances in sources and associated releases as well as uncertainty in identifying all sources and associated releases. Using the ranges also simplifies documentation requirements. Non-zero values below 1 are rounded to 1 to ensure that sites with small amounts of hazardous substances will receive a non-zero score for waste characteristics. When hazardous constituent quantity data are incomplete, the minimum hazardous waste quantity factor value is 10, except for: (1) Migration pathways that have any target subject to Level I or II concentrations; and (2) migration pathways where there has been a removal action and the hazardous waste quantity factor value would be 100 or greater without consideration of the removal action. In these cases, the minimum hazardous waste quantity factor value has been changed to 100 (see sections III C and III Q above for further discussion of the new minimum values).

*Section 2.4.3 Waste characteristics factor category value.* Explains how to assign a value to the waste characteristics factor category. As discussed above, the final waste characteristics factor value is capped at 100 (1,000 with bioaccumulation potential). Values are assigned by placing the product of the waste characteristics factors into ranges of one order of magnitude, to a cap of $10^8$ ($10^{12}$ if bioaccumulation potential is considered).

*Section 2.4.3.1 Factor category value.* Explains how to use Table 2–7 to assign a value to waste characteristics when bioaccumulation (or ecosystem bioaccumulation) potential is not considered.

*Section 2.4.3.2 Factor category value, considering bioaccumulation potential.* Explains how to use Table 2–7 to assign a value to waste characteristics when bioaccumulation (or ecosystem bioaccumulation) potential is considered.

*Section 2.5 Targets.* Explains how targets factors are evaluated. This approach generally involves three levels of evaluation (Level I, Level II, and Potential) and the use of media-specific concentration benchmarks, as discussed in section III H of this preamble. Level III has been dropped; use of benchmarks has been extended to all pathways and to factors that assign values to the nearest individual (well/intake). Also discusses assigning level based on direct observation and describes when tissue samples that do not establish actual contamination may be used in comparisons to benchmarks.

*Section 2.5.1 Determination of level of actual contamination at a sampling location.* Explains the approach used for evaluating the level of actual contamination at a sampling location; changes have been made to allow the level of actual contamination in the human food chain threat to be based on tissue samples from aquatic food chain organisms that cannot be used to establish an observed release.

*Section 2.5.2 Comparison to benchmarks.* Lists benchmarks and explains how to determine whether benchmarks have been equalled or exceeded (see section III H of this preamble); changes have been made to allow the level of actual contamination in the human food chain threat to be based on tissue samples from aquatic food chain organisms that cannot be used to establish an observed release.

*Section 3 Ground Water Migration Pathway*

The ground water migration pathway evaluates threats resulting from releases or potential releases of hazardous substances to aquifers. The major changes specific only to this pathway include replacement of the depth to aquifer/hydraulic conductivity and sorptive capacity factors with travel time and depth to aquifer factors; a revised approach for assigning mobility values; removal of the ground water use factors and their replacement by a resources factor; evaluation of the nearest well factor based on benchmarks; and revisions to scoring of sites having both karst and non-karst aquifers present.

*Section 3.0 Ground Water Migration Pathway.* Descriptive text has been removed. Figure 3–1 has been revised to reflect revisions to the factors evaluated, and Table 3–1 has been revised to reflect the new factor category values throughout.

*Section 3.0.1 General considerations.* The title has been changed.

*Section 3.0.1.1 Ground water target distance limit.* An explanation of the treatment of contaminated ground water plumes with no identified source has been added. For these plumes, measurement of the target distance limit begins at the center of the area of observed ground water contamination:

the center is determined based on available data.

*Section 3.0.1.2 Aquifer boundaries.* Descriptive text has been removed.

*Section 3.0.1.2.1 Aquifer interconnections.* Descriptive text has been removed as have examples of information useful for identifying aquifer interconnections.

*Section 3.0.1.2.2 Aquifer discontinuities.* Descriptive text has been removed.

*Section 3.0.1.3 Karst aquifer.* Descriptive text has been removed, and references to factors have been revised to reflect changes in factors. Text was added to clarify that karst aquifers underlying any portion of the sources at a site are given special consideration.

*Section 3.1 Likelihood of release.* Descriptive text has been removed.

*Section 3.1.1 Observed release.* Description of the criteria for establishing an observed release has been revised as discussed in Section III G of this preamble.

*Section 3.1.2 Potential to release.* Text has been revised to reflect changes in the factors evaluated and to clarify that karst aquifers underlying any portion of the sources at a site are given special consideration in evaluating depth to aquifer and travel time.

*Section 3.1.2.1 Containment.* Explanatory text has been removed and the ground water containment table is referenced. Only sources that meet the minimum size requirement (i.e., that have a source hazardous waste quantity value of 0.5 or higher) are used in assigning containment factor values. This requirement has been added to ensure that very small, uncontained sources do not unduly influence the score. For example, a site might have a large, but highly contained source and a very small, uncontained source; without a minimum size requirement, potential to release could be assigned the maximum value based on the very small source, which could overestimate the potential hazard posed by the site. If no source meets the minimum size requirement, the highest ground water containment factor value assigned to the sources at the site is used as the factor value. Table 3–2—Containment Factor Values for Ground Water Migration Pathway, has been simplified by combining repetitious items and has been moved from an attachment to the proposed rule into the body of the rule.

*Section 3.1.2.2 Net precipitation.* A new map has been added as Figure 3–2 to assign net precipitation factor values. The equation for calculating monthly potential evapotranspiration was clarified. Descriptive text has been removed.

*Section 3.1.2.3 Depth to aquifer.* As described in section III L of this preamble, the depth to aquifer factor has replaced the sorptive capacity factor and is no longer combined in a matrix with hydraulic conductivity for scoring. Table 3–5 is new and provides the factor values. The depth to aquifer factor reflects the geochemical retardation capacity of the subsurface materials, which generally increases as the depth increases. Depth to aquifer factor values are assigned to three depth ranges. Clarifying language was added related to karst aquifers.

*Section 3.1.2.4 Travel time.* As discussed in section III L of this preamble, this factor replaces the depth to aquifer/hydraulic conductivity factor and is based on the least conductive layer(s) rather than on the conductivities of all layers between the hazardous substances and the aquifer. Table 3–7 has been revised to reflect these changes. Table 3–5 from the proposed rule has been renumbered as Table 3–6. Text on how to obtain information to score this factor has been removed. Clarifying language was added related to karst aquifers.

*Section 3.1.2.5 Calculation of potential to release factor value.* Text has been revised to reflect new factor names.

*Section 3.1.3 Calculation of likelihood of release factor category value.* New maximum value of 550 based on observed release has been added.

*Section 3.2 Waste characteristics.* Descriptive text has been removed.

*Section 3.2.1 Toxicity/mobility.* Descriptive text has been removed.

*Section 3.2.1.1 Toxicity.* References § 2.4.1.1.

*Section 3.2.1.2 Mobility.* As discussed in sections III F and III P of this preamble, the method for assigning mobility values to hazardous substances has been revised. Table 3–8 has been revised. Mobility values are now linear rather than categorical place holders and are assigned in a matrix combining water solubility and distribution coefficients. Mobility values may now vary by aquifer for a specific hazardous substance. The maximum mobility value is no longer assigned based on observed release by direct observation. A factor value of 0 is no longer assigned for mobility, as had been the case under the proposed rule, where categorical place-holder values were used; because mobility is now multiplied by toxicity and hazardous waste quantity, assigning a 0 value would result in a pathway score of 0. This result could understate the risk posed by a site with a large volume of highly toxic hazardous substances with low mobility. Furthermore, given the uncertainties about estimates of mobility in ground water and their applicability in site-specific situations, EPA determined that a 0 value should not be assigned to the mobility factor under any conditions.

*Section 3.2.1.3 Calculation of toxicity/mobility factor value.* Text has been simplified. Table 3–9 (proposed rule Table 3–10), the matrix for assigning factor values, has been revised to reflect the linear nature of the assigned values. Values for a specific hazardous substance may now vary by aquifer.

*Section 3.2.2 Hazardous waste quantity.* References § 2.4.2.

*Section 3.2.3 Calculation of waste characteristics factor category value.* Text has been revised to indicate the multiplication of the factors, the new maximum value, and the table used to assign the factor category value.

*Section 3.3 Targets.* Text has been revised to reflect the new names for factors. Descriptive text has been removed. Table 3–10 (Table 3–12 in the proposed rule) has been modified to list the revised benchmarks in this pathway.

*Section 3.3.1 Nearest well.* Title has been changed from maximally exposed individual. Text has been added to explain how to evaluate nearest wells with documented contamination (at Level I and II) and those potentially contaminated. Text was added to assign Level II contamination to any drinking water well where an observed release was established by direct observation. This section also explains how to evaluate wells drawing from karst aquifers. Table 3–11 has been renamed and the factor values have been changed. See section III B of this preamble for a discussion of the changes to assigned values for this factor.

*Section 3.3.2 Population.* As discussed in section III H, population is evaluated using health-based benchmarks for drinking water. For populations potentially exposed, population ranges are used to evaluate the factor. This section explains whom to count for population. Populations served by wells whose water is blended with that from other drinking water sources are to be apportioned based on the well's relative contribution to the total blended system. The rule includes instructions on the type of data to use when determining relative contributions of wells and intakes. This change is intended to reflect more accurately the exposure to populations through blended systems. The rule also includes instructions on how to apportion population for systems with standby wells or standby surface water intakes.

*Section 3.3.2.1 Level of contamination.* Explains how to evaluate population based on concentrations of hazardous substances in samples. Text was added to assign Level II contamination to any drinking water wells where there is an observed release by direct observation.

*Section 3.3.2.2 Level I concentrations.* Explains how to evaluate populations exposed to Level I concentrations. The scoring cap was eliminated, and the multiplier (i.e., weight) is now 10.

*Section 3.3.2.3 Level II concentrations.* Explains how to evaluate populations exposed to Level II concentrations. The scoring cap was eliminated, and the multiplier (i.e., weight) is now 1.

*Section 3.3.2.4 Potential contamination.* Explains how to assign values to populations potentially exposed to contamination from the site. The formula for calculating population values has been modified to reflect both the revised method for evaluating karst aquifers (see below) and the use of distance-weighted population values from Table 3–12, which has been added to assign distance-weighted values for populations in each distance category. The values are determined for each istance category and are then added across distance categories, and the sum is divided by 10 to derive the factor value for potentially contaminated population. The assigned values in Table 3–12 were determined by statistical simulation to yield the same population value, on average, as the use of the formulas in the proposed rule. The use of range values has been adopted as part of the simplification discussed in section III A. The rounding rules have also changed. The method for evaluating karst aquifers has been simplified and is explained in this section. Table 3–14 in the proposed rule, which included dilution weighting factors for the general case and for two special cases, has been removed, and the two special karst cases are no longer evaluated. (The generally applicable dilution factors for karst have not changed and are all incorporated into the distance-weighted population values in Table 3–12.) The scoring cap was eliminated, and the multiplier (i.e., weight) is now 0.1.

*Section 3.3.2.5 Calculation of population factor value.* Has been revised to reflect the changes in the evaluation of actually contaminated wells. The rounding rule has also been changed, and the scoring cap was liminated.

*Section 3.3.3 Resources.* Describes how points are assigned to resource uses of ground water. Points may be assigned if there are no drinking water wells within the target distance limit, but the water is usable for drinking water. This scoring allows for consideration of potential future uses of the aquifers. (See section III I of this preamble for a discussion of the relative weighting of these factors.)

*Section 3.3.4 Wellhead protection area.* Explains how to assign values to this factor. The maximum value is assigned when a source or an observed release lies partially or fully within a wellhead protection area applicable to the aquifer being evaluated, and this value has been changed from 50 to 20 to adjust for scale changes. A new criterion for scoring this factor has been added. If a wellhead protection area applicable to the aquifer being evaluated is within the target distance limit and neither of the other conditions is met, a value of five is assigned. This change allows the HRS to place a value on the resource.

*Section 3.3.5 Calculation of targets factor category value.* Has been revised to reflect changes in the factor names. The rounding rule has been changed, and the scoring cap was eliminated.

*Section 3.4 Ground water migration score for an aquifer.* Text has been revised to reflect the new divisor for normalizing pathway scores.

*Section 3.5 Calculation of ground water migration pathway score.* Text has been simplified.

In addition to the above noted changes, the sorptive capacity factor has been eliminated and replaced by the depth to aquifer factor, as have the tables used to assign values to this factor (Tables 3–6 and 3–7 in the proposed rule). The ground water use factors have also been eliminated as have the tables used to assign their values (Tables 3–15 and 3–16 in the proposed rule). Figures 3–2, 3–3, and 3–4 and Tables 3–4, 3–8, 3–9, 3–13 of the proposed rule have been removed .

*Section 4 Surface Water Migration Pathway*

The surface water migration pathway evaluates threats resulting from releases or potential releases of hazardous substances to surface water bodies. One major change to this pathway is the addition of a new component for scoring ground water discharge to surface water: either this component or the overland flow/flood migration component or both may be scored. For each component, three threats are evaluated: drinking water threat, human food chain threat, and environmental threat. Other major changes specific to this pathway include elimination of the recreational use threat; simplification of overland flow potential to release factors; modifications to the human food chain threat including addition of a food chain individual; modifications to the treatment of bioaccumulation potential and addition of a similar factor, ecosystem bioaccumulation potential, to the evaluation of the environmental threat; modifications to the persistence factor; revisions to the dilution weights; additions of benchmarks, extension of benchmarks to evaluation of the nearest intake, and addition of levels of contamination to the human food chain targets; modifications to criteria for establishing actual food chain contamination; elimination of the surface water use factor; addition of a resources factor to the targets evaluation in the drinking water threat; and revisions to sensitive environments.

*Section 4.0 Surface Water Migration Pathway.* New structure of the pathway is explained. Descriptive text has been removed. Figure 4–1 has been revised to reflect revisions to the factors evaluated, and Table 4–1 has been revised to reflect the new factor category values throughout.

*Section 4.0.1 Migration components.* Explains how to score the two migration components.

*Section 4.0.2 Surface water categories.* A definition of coastal tidal waters has been added. Some surface water bodies that belong in this new category were listed in other categories in the proposed rule (e.g., bays and wetlands contiguous with oceans). Isolated perennial wetlands have been added to the definition of lakes; salt water harbors largely protected by seawalls have been removed from the definition of lakes. Ocean has been defined more precisely as areas seaward from the baseline of the Territorial Sea. Contiguous bays have been removed from, and wetlands contiguous to the Great Lakes have been added to ocean and ocean-like bodies. These definitional changes/clarifications more accurately reflect the different characteristics of the water bodies.

*Section 4.1 Overland flow/flood migration component.* As discussed in section III M of this preamble, the surface water migration pathway has been divided into two components. The overland flow/flood component is essentially the surface water migration pathway as proposed except that the recreational use threat has been eliminated.

*Section 4.1.1 General considerations.* Consists of several subsections.

*Section 4.1.1.1 Definition of the hazardous substance migration path for overland flow/flood migration component.* Text has been simplified.

*Section 4.1.1.2 Target distance limit.* Explains target distance limits for sites in general and adds an explanation of how to calculate the target distance limit for contaminated sediments with no identified source. For these latter sources only, when there is a clearly defined direction of flow, the target distance limit is measured beginning at the observed sediment contamination farthest upstream; when there is no clearly defined direction of flow, the target distance limit is measured from the center of the area of observed sediment contamination. Discusses the determination of whether surface water targets are subject to actual or potential contamination. Also, text was added to assign Level II to targets subject to actual contamination based on direct observation.

*Section 4.1.1.3 Evaluation of the overland flow/flood migration component.* Explains that for multiple watersheds, highest score assigned to a watershed is used instead of summing watershed scores as proposed.

*Section 4.1.2 Drinking water threat.* Descriptive text has been removed.

*Section 4.1.2.1 Drinking water threat—likelihood of release.* Text has been simplified to clarify when potential to release factors need to be evaluated.

*Section 4.1.2.1.1 Observed release.* Text has been revised to reflect the changed maximum value.

*Section 4.1.2.1.2 Potential to release.* Text has been revised to reflect the changed maximum value and has been simplified.

*Section 4.1.2.1.2.1 Potential to release by overland flow.* Explains when overland flow potential to release is not evaluated.

*Section 4.1.2.1.2.1.1 Containment.* Text has been revised to reflect changes in the numbering of the containment table. Only sources that meet the minimum size requirement (i.e., that have a source hazardous waste quantity value of 0.5 or higher) are used in assigning containment values. This requirement has been added to ensure that very small, uncontained sources do not unduly influence the score. For example, a site might have a large, but highly contained source and a very small, uncontained source; without a minimum size requirement, the potential to release could be assigned the maximum value based on the very small source, which could overestimate the potential hazard posed by the site. If no source meets the minimum size requirement, the source with the highest surface water containment factor value is used. Descriptive text has been removed. Table 4–2, Containment Factor Values for Surface Water Migration Pathway, has been simplified by combining repetitious items and has been moved from an attachment to the proposed rule into this section of the final rule.

*Section 4.1.2.1.2.1.2 Runoff.* Text on evaluating rainfall has been simplified by removing explanatory references. The runoff curve number has been simplified by substituting a soil group designation in its place. Table 4–4 (proposed rule Table 4–2) has been revised to list only the soil group designations. Based on analyses of runoff and actual drainage area sizes, Table 4–3 (proposed rule Table 4–3) has been revised by changing the divisions of drainage area size. Table 4–5 (proposed rule Table 4–4) has been revised to reflect the changes related to the use of soil group designations. Table 4–6 (proposed rule Table 4–5) has been revised so that the heading in the table reads Rainfall/Runoff Value; the values assigned have been adjusted on the basis of both the higher maximum value assigned to the factor category and the analyses described above. Explanatory text has been removed.

*Section 4.1.2.1.2.1.3 Distance to surface water.* Values assigned to distance to surface water factor values in Table 4–7 (proposed rule Table 4–6) have been revised to adjust for the higher maximum assigned to the factor category.

*Section 4.1.2.1.2.1.4 Calculation of the factor value for potential to release by overland flow.* Has not been changed except for assigned value.

*Section 4.1.2.1.2.2 Potential to release by flood.* Descriptive text has been removed.

*Section 4.1.2.1.2.2.1 Containment (flood).* Text in Table 4–8 (proposed rule Table 4–7) has been revised to incorporate new language on required documentation on containment. The requirement for certification by an engineer has been dropped. The new documentation requirements have been added to make the rule consistent with RCRA requirements.

*Section 4.1.2.1.2.2.2 Flood frequency.* Values assigned to this factor by Table 4–9 (proposed rule Table 4–8) have been revised to better reflect probabilities and to adjust for the higher maximum assigned to the factor category. Descriptive text has been removed.

*Section 4.1.2.1.2.2.3 Calculation of the factor value for potential to release by flood.* Has been revised to reflect a minimum size requirement for sources.

*Section 4.1.2.1.2.3 Calculation of potential to release factor value.* Text has been simplified, and the assigned value has been changed.

*Section 4.1.2.1.3 Calculation of drinking water threat—likelihood of release factor category value.* Text has been simplified. The maximum value has been changed, and the maximum for potential to release is no longer equal to the maximum for observed release.

*Section 4.1.2.2 Drinking water threat—waste characteristics.* Descriptive text has been removed.

*Section 4.1.2.2.1 Toxicity/persistence.* Editorial changes have been made.

*Section 4.1.2.2.1.1 Toxicity.* References § 2.4.1.1.

*Section 4.1.2.2.1.2 Persistence.* As discussed in section III F of this preamble, several changes have been made to this factor, including the deletion of free-radical oxidation as a decay process and the inclusion of consideration of $K_{ow}$ to account for sorption to sediments. Table 4–10 (proposed rule Table 4–9) has been revised to change the values assigned from categorical numbers to linear scales. The divisions among the half-lives for rivers, oceans, coastal tidal waters, and Great Lakes have changed based on a study of travel time, and the text has been modified to clarify the procedure for determining whether to base the persistence factor on lakes or on rivers, oceans, coastal tidal waters, and Great Lakes. A factor value of 0 is no longer assigned for persistence, as had been the case under the proposed rule, where categorical place-holder values were used; because persistence is now multiplied by toxicity and hazardous waste quantity, assigning a 0 value would result in a pathway score of 0. This result could understate the risk posed by a site with a large volume of highly toxic hazardous substances with low persistence. Furthermore, given the uncertainties about half-life estimates and their applicability in site-specific situations, EPA determined that a 0 value should not be assigned to the persistence factor under any conditions. The text has been modified to clarify selection of an appropriate default value. Table 4–11—Persistence Values—Log $K_{ow}$, has been added. Descriptive text has been removed.

*Section 4.1.2.2.1.3 Calculation of toxicity/persistence factor value.* Table reference has been changed to reflect the change in numbering. Table 4–12 (proposed rule Table 4–10) has been changed to reflect the multiplicative relationship.

*Section 4.1.2.2.2 Hazardous waste quantity.* References § 2.4.2.

*Section 4.1.2.2.3 Calculation of drinking water threat—waste characteristics factor category value.* Text has been revised to indicate the multiplication of the factors, the new maximum value, and the table used to assign the factor category value.

*Section 4.1.2.3 Drinking water threat—targets.* Descriptive text has been removed. Text was added to assign Level II to actual contamination based on direct observation.

*Section 4.1.2.3.1 Nearest intake.* Title and the factor name have been changed. As discussed in Section III B of this preamble, this factor is now assigned values based on health-based benchmarks. Instructions for how to assign dilution weights to closed lakes and lakes with no surface flow entering have been added. Table 4–13, Surface Water Dilution Weights (proposed rule Table 4–11), has been revised to add more types of surface water bodies and to change the dilution weights. These changes have been made to reflect more accurately the flow ranges of water bodies and are based on analysis of data on flow rates and dilution.

*Section 4.1.2.3.2 Population.* As explained above, population is evaluated based on two levels of actual contamination. Targets potentially contaminated are dilution weighted and are assigned values based on ranges. Populations served by intakes which are blended with water from other drinking water sources are to be apportioned based on the intake's relative contribution to the total blended system. The rule includes instructions on the type of data to use when determining relative contributions of intakes and wells. This change is intended to reflect more accurately the exposure of populations through blended systems. The rule also includes instructions on how to apportion population for systems with standby wells or standby surface water intakes.

*Section 4.1.2.3.2.1 Level of contamination.* Explains how to evaluate population based on the level of contamination to which they are exposed.

*Section 4.1.2.3.2.2 Level I concentrations.* Descriptive text has been removed. The scoring cap was eliminated, and the multiplier (i.e., weight) is now 10.

*Section 4.1.2.3.2.3 Level II concentrations.* Text has been simplified and revised to reflect the changes discussed above. The scoring cap was eliminated, and the multiplier (i.e., weight) is now 1.

*Section 4.1.2.3.2.4 Potential contamination.* Equation used to calculate this factor has been revised as discussed above. A new table, Table 4–14, Dilution-Weighted Population Values for Potential Contamination Factor for Surface Water Migration Pathway, has been added to assign values, which are then added across different surface water body types and divided by 10 to derive the value for potentially contaminated population. The assigned values in Table 4–14 for each population range category were determined by statistical simulation to yield the same population value, on average, as the use of the formulas in the proposed rule. The use of range values has been added as part of the simplification discussed in section III A. The rounding rule has also been changed, the scoring cap was eliminated, and the multiplier (i.e., weight) is now 0.1.

*Section 4.1.2.3.2.5 Calculation of population factor value.* Explains how to combine values assigned to the three population groups. The rounding rule has also been changed, and the scoring cap was eliminated.

*Section 4.1.2.3.3 Resources.* As discussed in section III J of this preamble, this factor has been added to account for the potential impact of surface water contamination on resource uses.

*Section 4.1.2.3.4 Calculation of drinking water threat—targets factor category value.* Has been revised to reflect the changes in this factor category. The rounding rule has also been changed, and the scoring cap was eliminated.

*Section 4.1.2.4 Calculation of drinking water threat score for a watershed.* Text has been simplified. The divisor has changed.

*Section 4.1.3 Human food chain threat.* Descriptive text has been removed.

*Section 4.1.3.1 Human food chain threat—likelihood of release.* Section references have been changed.

*Section 4.1.3.2 Human food chain threat—waste characteristics.* Text has been simplified.

*Section 4.1.3.2.1 Toxicity/persistence/bioaccumulation.* Text has been simplified and modified because of the change in the use of bioaccumulation potential in selecting the substance potentially posing the greatest hazard.

*Section 4.1.3.2.1.1 Toxicity.* Has been changed to reference § 2.4.1.1. Also changed so that evaluation of toxicity is not limited to substances with the highest bioaccumulation potential.

*Section 4.1.3.2.1.2 Persistence.* Clarifies how to evaluate persistence for contaminated sediment sources, and adds coastal tidal waters as a category of surface water. Also changed so that evaluation of persistence is not limited to substances with the highest bioaccumulation potential.

*Section 4.1.3.2.1.3 Bioaccumulation potential.* As described in section III M of this preamble, the method of accounting for bioaccumulation potential in the selection of the substance potentially posing the greatest hazard has been changed. In the final rule, bioaccumulation potential is considered together with toxicity and persistence rather than as a primary selection criterion. This change was made because all three factors are now scored on linear scales. In addition, where data exist, separate bioconcentration factor values are assigned for salt water and fresh water; the text now clarifies that the higher of these values is used for fisheries in brackish water and for sites with fisheries present in both salt water and fresh water. The adjustment for biomagnification has been dropped because it tended to double count bioaccumulation. Both Table 4–15 (Table 4–14 in the proposed rule) and the text have been modified to clarify the data hierarchy for assigning bioaccumulation potential factor values. Also, Table 4–15 now makes it clear that the assigned values for bioaccumulation potential are on a linear scale.

*Section 4.1.3.2.1.4 Calculation of toxicity/persistence/bioaccumulation factor value.* Explains how to calculate a toxicity/persistence/bioaccumulation value. Table 4–16, Toxicity/Persistence/Bioaccumulation, has been added to assign the factor value.

*Section 4.1.3.2.2 Hazardous waste quantity.* References § 4.1.2.2.2.

*Section 4.1.3.2.3 Calculation of human food chain threat—waste characteristics factor category value.* Text has been revised to indicate the multiplication of the toxicity/persistence and hazardous waste quantity factor values, subject to a maximum, and the further multiplication of that product by the bioaccumulation potential factor value, subject to a maximum for this second product, and to reference the table for assigning the factor category value.

*Section 4.1.3.3 Human food chain threat—targets.* Has been revised to reflect addition of the new food chain individual and the deletion of the fishery use factor. As discussed in section III M of this preamble, criteria for establishing a fishery subject to actual contamination have been revised. Text was added to describe the additional

tissue samples that can be used to establish Level I contamination.

*Section 4.1.3.3.1 Food chain individual.* As discussed in section III M of this preamble, this factor is new. This section explains how to assign a value to the factor.

*Section 4.1.3.3.2 Population.* Has been changed as discussed in section III M of this preamble.

*Section 4.1.3.3.2.1 Level I concentrations.* The approach to calculating this factor value has been revised as discussed in section III M of this preamble. The rounding rule has been changed, the scoring cap was eliminated, and the multiplier (i.e., weight) is now 10.

*Section 4.1.3.3.2.2 Level II concentrations.* Explains how to assign values as discussed in section III M of this preamble. The rounding rule has been changed, the scoring cap was eliminated, and the multiplier (i.e., weight) is now 1.

*Section 4.1.3.3.2.3 Potential human food chain contamination.* The approach to calculating this factor value has been revised as discussed in section III M of this preamble. The rounding rule has been changed, the scoring cap was eliminated, and the multiplier (i.e., weight) is now 0.1.

*Section 4.1.3.3.2.4 Calculation of the population factor value.* Text has been revised to omit the maximum. The rounding rule has been changed, and the scoring cap was eliminated.

*Section 4.1.3.3.3 Calculation of human food chain threat—targets factor category value.* Explains how to calculate the targets value. The rounding rule has been changed, and the scoring cap was eliminated.

*Section 4.1.3.4 Calculation of human food chain threat score for a watershed.* Text has been simplified. The divisor has changed.

*Section 4.1.4 Environmental threat.* Descriptive text has been removed.

*Section 4.1.4.1 Environmental threat—likelihood of release.* Section references have been changed.

*Section 4.1.4.2 Environmental threat—waste characteristics.* Descriptive text has been removed.

*Section 4.1.4.2.1 Ecosystem toxicity/persistence/bioaccumulation.* Text has been revised to include the addition of ecosystem bioaccumulation potential as a multiplicative factor.

*Section 4.1.4.2.1.1 Ecosystem toxicity.* The approach for evaluating ecosystem toxicity has been revised. Additions have been made to the data hierarchy (see section III J of this preamble), and a default value of 100 was added to cover the situation where appropriate aquatic toxicity data were unavailable for all of the substances being evaluated. Table 4–19 (proposed rule Table 4–23) has been revised to make the factor linear and to eliminate the rating category of 0 (except when data are unavailable for a given substance); these changes make the ecosystem toxicity factor more consistent with the toxicity factor in the other pathways and threats. Text was added to clarify the evaluation of ecosystem toxicity for brackish water.

*Section 4.1.4.2.1.2 Persistence.* Section references have been changed. Clarifies how to evaluate persistence for contaminated sediment sources, and adds coastal tidal waters as a category of surface water.

*Section 4.1.4.2.1.3 Ecosystem bioaccumulation potential.* As explained in section III J of this preamble, this factor is new for this threat and is evaluated similarly to (but with several key differences from) the bioaccumulation potential factor in the human food chain threat.

*Section 4.1.4.2.1.4 Calculation of ecosystem toxicity/persistence/bioaccumulation factor value.* Section references have been changed. Table 4–20 (proposed rule Table 4–24) has been changed to reflect the changes in the values for the factors. Table 4–21, Ecosystem Toxicity/Persistence/Bioaccumulation Values, is new and assigns values for the combined toxicity/persistence/bioaccumulation factor.

*Section 4.1.4.2.2 Hazardous waste quantity.* Section references have been changed.

*Section 4.1.4.2.3 Calculation of environmental threat—waste characteristics factor category value.* Text has been revised to indicate the multiplication of the ecosystem toxicity/persistence and hazardous waste quantity factor values, subject to a maximum, and the further multiplication of that product by the ecosystem bioaccumulation potential factor value, subject to a maximum for this second product, and to reference the table for assigning the factor category value.

*Section 4.1.4.3 Environmental threat—targets.* Descriptive text has been removed.

*Section 4.1.4.3.1 Sensitive environments.* Explains how to evaluate sensitive environments. Table 4–22, Ecological-Based Benchmarks for Hazardous Substances in Surface Water, has been revised as described in section III H of this preamble. The rounding rule has also been changed.

*Section 4.1.4.3.1.1 Level I concentrations.* Explains the new method of evaluating wetlands based on wetland frontage, or, in some situations, wetland perimeter. Table 4–23, Sensitive Environments Rating Values, has been revised as discussed in section III J of this preamble. Table 4–24, Wetlands Rating Values for Surface Water Migration Pathway, has been added to assign values to wetlands based on the total length of wetlands. The scoring cap was eliminated, and the multiplier (i.e., weight) is now 10.

*Section 4.1.4.3.1.2 Level II concentrations.* Has been revised to reflect the method of evaluating wetlands. The scoring cap was eliminated, and the multiplier (i.e., weight) is now 1.

*Section 4.1.4.3.1.3 Potential contamination.* Has been revised to reflect the method of evaluating wetlands. The rounding rule has also been changed, the scoring cap was eliminated, and the multiplier (i.e., weight) is now 0.1.

*Section 4.1.4.3.1.4 Calculation of environmental threat—targets factor category value.* Has been revised to remove the maximum from the targets factor category. The rounding rule has also been changed.

*Section 4.1.4.4 Calculation of environmental threat score for a watershed.* Divisor for the threat has changed. A cap of 60 was explicitly placed on the environmental threat score, which results in the same maximum possible threat score as in the proposed rule. (In the proposed rule, environmental threat targets were capped at 120, which resulted in an environmental threat score maximum of 60.) However, in the final rule the targets category is uncapped and can score higher than 120 to compensate for low scores in other factor categories.

*Section 4.1.5 Calculation of overland flow/flood migration component score for a watershed.* Explains how to calculate the score for the watershed.

*Section 4.1.6 Calculation of overland flow/flood migration component score.* Explains how to calculate the score for the component based on the highest watershed score (in the proposed rule watershed scores were summed).

*Section 4.2 Ground water to surface water migration component.* As discussed in section III M of this preamble, this component has been added to the rule to account for contamination of surface water bodies through ground water migration of hazardous substances. Thus, all sections referring to this component are new.

*Section 4.2.1 General considerations.*

*Section 4.2.1.1 Eligible surface waters.* Explains the conditions that must apply before this component is

scored. In general, this component is scored only when there is a surface water within one mile of a source, the top of the uppermost aquifer is at or above the bottom of the surface water, and no aquifer discontinuity is established between the source and the portion of surface water within one mile of the source. Exceptions are also explained.

*Section 4.2.1.2 Definition of the hazardous substance migration path for ground water to surface water migration component.* Explains that the migration path is defined as shortest straight-line distance, within the aquifer boundary, from a source to surface water.

*Section 4.2.1.3 Observed release of a specific hazardous substance to surface water in-water segment.* Explains that before an observed release of an individual hazardous substance can be established to the surface water in-water segment, the substance must meet the criteria for an observed release both to ground water and to surface water (this requirement does not affect the actual scoring of observed release). Also clarifies the use of samples from the surface water in-water segment.

*Section 4.2.1.4 Target distance limit.* Explains the criteria for determining the target distance limit and for establishing whether targets are subject to actual or potential contamination.

*Section 4.2.1.5 Evaluation of the ground water to surface water migration component.* Explains the general approach for evaluating this component. Figure 4–2, Overview of Ground Water to Surface Water Migration Component, is new. Table 4–25, which is new, provides the scoring sheets for this component.

*Section 4.2.2 Drinking water threat.* Explains the general approach for evaluating this threat.

*Section 4.2.2.1 Drinking water threat—likelihood of release.* Explains the general approach for evaluating this factor category.

*Section 4.2.2.1.1 Observed release.* Explains that scoring an observed release is based on releases to ground water.

*Section 4.2.2.1.2 Potential to release.* Explains that scoring is based on the scoring of potential release to uppermost aquifer.

*Section 4.2.2.1.3 Calculation of drinking water threat—likelihood of release factor category value.* Explains how to assign the factor category value.

*Section 4.2.2.2 Drinking water threat—waste characteristics.* Explains the general approach for evaluating this factor category.

*Section 4.2.2.2.1 Toxicity/mobility/persistence.* Explains the approach for evaluating these factors.

*Section 4.2.2.2.1.1 Toxicity.* Explains that toxicity values are assigned to all hazardous substances available to migrate to ground water.

*Section 4.2.2.2.1.2 Mobility.* Explains that the mobility value is assigned to all hazardous substances available to migrate to ground water.

*Section 4.2.2.2.1.3 Persistence.* Explains that this factor value is assigned as in the drinking water threat for the overland flow/flood migration component for all hazardous substances available to migrate to ground water.

*Section 4.2.2.2.1.4 Calculation of toxicity/mobility/persistence factor value.* Explains that the factor value is the highest value assigned to any hazardous substance evaluated using Table 4–26, which is new.

*Section 4.2.2.2.2 Hazardous waste quantity.* Explains that hazardous waste quantity is calculated for hazardous substances available to migrate to ground water.

*Section 4.2.2.2.3 Calculation of drinking water threat—waste characteristics factor category value.* Explains how to calculate the factor category value.

*Section 4.2.2.3 Drinking water threat—targets.* Explains the general approach for evaluating this factor category.

*Section 4.2.2.3.1 Nearest intake.* Explains how to determine the dilution weight adjustment using Table 4–27, which was added, and how to assign factor values. Figure 4–3 was added to illustrate determination of the ground water to surface water angle. (See section III O of this preamble for a discussion of this adjustment.)

*Section 4.2.2.3.2 Population.* This section parallels other population factor sections.

*Section 4.2.2.3.2.1 Level I concentrations.* Parallels the population factor sections in the overland flow/flood migration component.

*Section 4.2.2.3.2.2 Level II concentrations.* Parallels the population factor sections in the overland flow/flood migration component.

*Section 4.2.2.3.2.3 Potential contamination.* Parallels the population factor sections in the overland flow/flood migration component, except for addition of the dilution weight adjustment.

*Section 4.2.2.3.2.4 Calculation of population factor value.* Parallels other population factor sections.

*Section 4.2.2.3.3 Resources.* Parallels other resources factor sections.

*Section 4.2.2.3.4 Calculation of the drinking water threat—targets factor category value.* Explains how to calculate the factor category value.

*Section 4.2.2.4 Calculation of drinking water threat score for a watershed.* Explains how to calculate the score for a watershed.

*Section 4.2.3 Human food chain threat.* Lists the factors evaluated.

*Section 4.2.3.1 Human food chain threat—likelihood of release.* Explains how to assign the factor category value.

*Section 4.2.3.2 Human food chain threat—waste characteristics.* Lists the factors evaluated.

*Section 4.2.3.2.1 Toxicity/mobility/persistence/bioaccumulation.* Explains how to calculate these factor values using Table 4–28, which is new.

*Section 4.2.3.2.1.1 Toxicity.* Explains how to calculate this factor value.

*Section 4.2.3.2.1.2 Mobility.* Explains how to calculate this factor value.

*Section 4.2.3.2.1.3 Persistence.* Explains how to calculate this factor value.

*Section 4.2.3.2.1.4 Bioaccumulation potential.* Explains how to calculate this factor value.

*Section 4.2.3.2.1.5 Calculation of toxicity/mobility/persistence/bioaccumulation factor value.* Explains how to calculate this value using Tables 3–9, 4–26, and 4–28.

*Section 4.2.3.2.2 Hazardous waste quantity.* Explains how to assign the factor value.

*Section 4.2.3.2.3 Calculation of human food chain threat—waste characteristics factor category value.* Explains how to calculate this factor category value.

*Section 4.2.3.3 Human food chain threat—targets.* Explains the factors to be evaluated.

*Section 4.2.3.3.1 Food chain individual.* Explains how to assign the factor value.

*Section 4.2.3.3.2 Population.* Explains how to calculate this factor value.

*Section 4.2.3.3.2.1 Level I concentrations.* Parallels the population factor in the human food chain threat for the overland flow/flood migration component.

*Section 4.2.3.3.2.2 Level II concentrations.* Parallels the population factor in the human food chain threat for the overland flow/flood migration component.

*Section 4.2.3.3.2.3 Potential human food chain contamination.* Parallels the population factor in the human food chain threat for the overland flow/flood component, except for addition of the dilution weight adjustment.

*Section 4.2.3.3.2.4 Calculation of the population factor value.* Explains how to calculate this factor value.

*Section 4.2.3.3.3 Calculation of human food chain threat—targets factor category value.* Explains how to calculate this factor category value.

*Section 4.2.3.4 Calculation of human food chain threat score for a watershed.* Explains how to calculate the score for a watershed.

*Section 4.2.4 Environmental threat.* Lists the factors evaluated.

*Section 4.2.4.1 Environmental threat—likelihood of release.* Explains how to calculate this factor category value.

*Section 4.2.4.2 Environmental threat—waste characteristics.* Explains how to calculate this factor category value.

*Section 4.2.4.2.1 Ecosystem toxicity/mobility/persistence/bioaccumulation.* Explains how to calculate these factor values.

*Section 4.2.4.2.1.1 Ecosystem toxicity.* Explains how to calculate this factor value.

*Section 4.2.4.2.1.2 Mobility.* Explains how to calculate this factor value.

*Section 4.2.4.2.1.3 Persistence.* Explains how to calculate this factor value.

*Section 4.2.4.2.1.4 Ecosystem bioaccumulation potential.* Parallels the ecosystem bioaccumulation evaluation in the overland flow/flood component, except expands the species considered as discussed in section III J.

*Section 4.2.4.2.1.5 Calculation of ecosystem toxicity/mobility/persistence/bioaccumulation factor value.* Explains how to calculate this factor value using Tables 3–9, 4–29, and 4–30, which were added.

*Section 4.2.4.2.2 Hazardous waste quantity.* Explains how to calculate this factor value.

*Section 4.2.4.2.3 Calculation of environmental threat—waste characteristics factor category value.* Explains how to calculate this factor category value.

*Section 4.2.4.3 Environmental threat—targets.* Explains how to calculate this factor category value.

*Section 4.2.4.3.1 Sensitive environments.* Explains how to calculate this factor value.

*Section 4.2.4.3.1.1 Level I concentrations.* Parallels factor sections in the overland flow/flood migration component.

*Section 4.2.4.3.1.2 Level II concentrations.* Parallels factor sections in the overland flow/flood migration component.

*Section 4.2.4.3.1.3 Potential contamination.* Parallels factor sections in the overland flow/flood migration component, except for addition of the dilution weight adjustment.

*Section 4.2.4.3.1.4 Calculation of environmental threat—targets factor category value.* Explains how to calculate the value for the factor category.

*Section 4.2.4.4 Calculation of environmental threat score for a watershed.* Explains how to calculate this threat score for a watershed.

*Section 4.2.5 Calculation of ground water to surface water migration component score for a watershed.* Explains how to calculate a watershed score for this component.

*Section 4.2.6 Calculation of ground water to surface water migration component score.* Explains how to calculate this score based on the scores for watersheds evaluated for this component.

*Section 4.3 Calculation of surface water migration pathway score.* Explains how to assign the pathway score.

In addition to the above noted changes, the recreational use threat has been eliminated. The drinking water use and other use factors have also been eliminated as have the tables (4–12 and 4–13 in the proposed rule) that related to scoring these factors. Figures 4–1, 4–2, and 4–3 as well as Tables 4–15, and 4–17 through 4–22 from the proposed rule have been eliminated.

*Section 5 Soil Exposure Pathway*

The soil exposure pathway evaluates threats resulting from contamination of surface material. The major changes specific to this pathway include revision of the name of the pathway; elimination of children under seven as a population that must be counted and evaluated separately; addition of hazardous waste quantity to the waste characteristics factor category; inclusion of workers in the evaluation of resident population targets; weighting of resident population based on benchmarks; inclusion of the nearest individual factor in both the resident and nearby targets factor category; inclusion of a resources factor in the resident population evaluation; and revisions to the sensitive environments factor.

*Section 5.0 Soil Exposure Pathway.* The name of the pathway has been changed from onsite exposure to soil exposure. Descriptive text has been removed. Figure 5–1 has been revised to reflect revisions to the factors evaluated. Table 5–1 has been revised to reflect the new factor category values throughout, which were made more consistent with the other pathways.

*Section 5.0.1 General considerations.* Has been revised to reflect the redefinition of source, discussed in section III N of this preamble. The methods for establishing areas of observed contamination and for determining the hazardous substances associated with an area of observed contamination have been clarified. The instructions have been revised to make clear that any part of a site that is covered by a permanent or otherwise maintained impermeable material such as asphalt is not considered in evaluating the pathway.

*Section 5.1 Resident population threat.* Has been revised to specify when the resident population threat should be evaluated. The requirements state that this threat is scored when there is an area of observed contamination within the property boundary and within 200 feet of a residence, school, day care center, or workplace, or within the boundaries of terrestrial sensitive environments and specified resources.

*Section 5.1.1 Likelihood of exposure.* Text has been simplified.

*Section 5.1.2 Waste characteristics.* Evaluation of waste characteristics has been changed to include hazardous waste quantity as well as toxicity. Hazardous waste quantity was added to the factor category in response to comments that the pathway did not consider the dose relationship; the combination of hazardous waste quantity and toxicity is a surrogate for that relationship and makes the pathway more consistent with the rest of the rule. The text has been revised to reflect the change.

*Section 5.1.2.1 Toxicity.* References the section explaining how to assign toxicity factor values.

*Section 5.1.2.2 Hazardous waste quantity.* This section is new and explains how to assign a value to this factor. Table 5–2, Hazardous Waste Quantity Evaluation Equations for Soil Exposure Pathway, is a revision of Table 2–14 from the proposed rule. This table differs from Table 2–5 of the final rule because generally only the top two feet of an area of observed contamination are considered in evaluating the pathway. Landfills, contaminated soils, waste piles, land treatment areas, dry surface impoundments, and buried/backfilled surface impoundments, which can be evaluated based on their volume in Table 2–5, are evaluated for this pathway using the area measure because the area measure now has a two-foot depth built into the equation. Surface impoundments containing

hazardous substances present as liquids, tanks, and containers may be evaluated based on volume because it is possible that a person could wade, swim, reach, or fall to a depth greater than two feet.

*Section 5.1.2.3 Calculation of waste characteristics factor category value.* Explains how to combine the toxicity and hazardous waste quantity factor values, subject to the new maximum.

*Section 5.1.3 Targets.* This factor category has been revised substantially. As discussed in section III N above, the high-risk target population has been eliminated, and workers have been added as targets. Table 5–3, Health-Based Benchmarks for Hazardous Substances in Soils, has been added to list benchmarks appropriate for this pathway.

*Section 5.1.3.1 Resident individual.* The resident individual factor has been added for consistency with other pathways.

*Section 5.1.3.2 Resident population.* Explains how to evaluate the resident population using health-based benchmarks, described in section III H above, and how to estimate this population.

*Section 5.1.3.2.1 Level I concentrations.* Explains how to assign a value for this new factor.

*Section 5.1.3.2.2 Level II concentrations.* Explains how to assign a value for this new factor.

*Section 5.1.3.2.3 Calculation of resident population factor value.* Explains how to calculate this factor value.

*Section 5.1.3.3 Workers.* Explains how to evaluate workers.

*Section 5.1.3.4 Resources.* Explains how to assign values if the area of observed contamination includes land used for commercial agriculture, commercial silviculture, or commercial livestock grazing or production.

*Section 5.1.3.5 Terrestrial sensitive environments.* The value assigned for this factor has been revised so that the value is based on the sum of the values assigned to terrestrial sensitive environments in areas of observed contamination, rather than on the highest scoring terrestrial sensitive environment. The maximum value that can be assigned to this factor is limited, but is higher than under the proposed rule. The limit is determined by scoring the pathway with only sensitive environments in the targets factor category; the pathway score under these conditions may not exceed 60 points. The sensitive environments listed in Table 5–5 have been modified. The text has been simplified and references changed to correspond to changes in the rule. The rounding rule has been changed.

*Section 5.1.3.6 Calculation of resident population targets factor category value.* Explains how to calculate the factor category value from the revised factors. The rounding rule has been changed.

*Section 5.1.4 Calculation of resident population threat score.* Has only minor editorial changes.

*Section 5.2 Nearby population threat.* Introductory text has been clarified.

*Section 5.2.1 Likelihood of exposure.* Lists the factors evaluated.

*Section 5.2.1.1 Attractiveness/accessibility.* As explained in section III N of this preamble, the name of this factor has changed as have the criteria used to assign values. This factor now emphasizes the use of the area by the general public. Descriptive text has been removed. Table 5–6 (proposed rule Table 5–4) has been changed by redefining the criteria and the assigned values, and by adding a value of 0 for sites that are physically inaccessible to the public.

*Section 5.2.1.2 Area of contamination.* The title of this section has been changed. This factor is now based solely on area of contamination, which relates to the likelihood of exposure, unlike hazardous waste quantity, which serves as part of the surrogate for dose. Values are assigned using Table 5–7, which is new.

*Section 5.2.1.3 Likelihood of exposure factor category value.* Text has been revised to reflect the new names of the factors. Table 5–8 (proposed rule Table 5–5) has been revised in response to the changes noted above for the attractiveness/accessibility and area of contamination factors.

*Section 5.2.2 Waste characteristics.* Text has been revised to reflect changes in the factor category.

*Section 5.2.2.1 Toxicity.* Explains how to evaluate the toxicity factor for the nearby population threat.

*Section 5.2.2.2 Hazardous waste quantity.* This section is new, as is consideration of this factor in this threat. As discussed above, this factor has been added in response to comments and to make the pathway more consistent with the other pathways. The section explains how to assign the factor value.

*Section 5.2.2.3 Calculation of waste characteristics factor category value.* Explains how to combine the toxicity and hazardous waste quantity factor values, subject to the new maximum.

*Section 5.2.3 Targets.* Descriptive text has been removed.

*Section 5.2.3.1 Nearby individual.* This section is new and explains how to assign a value to the nearby individual (i.e., resident or student with shortest travel distance) if there is no resident individual. The factor has been added to make the nearby threat consistent with other pathways. Table 5–9, Nearby Individual Factor Values, is new.

*Section 5.2.3.2 Population within one mile.* This section is new and includes the text that previously appeared under the Targets section. The section explains how to assign a value using Table 5–10. The text has been revised for clarity. Table 5–10, Distance-Weighted Population Values for Nearby Population Threat, is new. The table assigns distance-weighted values for population in each travel distance category. The values in the table were determined by statistical simulation to yield the same population, on average, as the use of the formulas in the proposed rule. The distance weights have been modified as follows: for travel distance of $>0$ to ¼ mile, the assigned distance weight is 0.025; for $>$ ¼ to ½ mile, 0.0125, and for $>$ ½ to 1 mile, 0.00625. The use of population ranges has been adopted as part of the simplification discussed in section III A.

*Section 5.2.3.3 Calculation of nearby population targets factor category value.* Text has been revised to reflect the changes in the targets factor category and in the rounding rule.

*Section 5.2.4 Calculation of nearby population threat score.* Minor editorial changes only.

*Section 5.3 Calculation of the soil exposure pathway score.* Has been changed to reflect the change in the value used as a divisor.

In addition to the above noted changes, Figures 5–2 and 5–3 and Tables 5–4 and 5–6 from the proposed rule have been removed.

*Section 6 Air Migration Pathway*

The air migration pathway evaluates the relative threat resulting from releases or potential releases of hazardous substances, either as gases or particulates, to the air. The major changes specific to this pathway include separate evaluation of gas and particulates in the likelihood to release factor category; inclusion of benchmarks to evaluate population and the nearest individual; weighting of sensitive environments based on actual or potential contamination; revision of the distance weights; deletion of the land use factor and inclusion of a resources factor in the evaluation of population; and revisions to the mobility factor.

*Section 6.0 Air Migration Pathway.* Descriptive text has been removed. Figure 6–1 has been revised to reflect revisions to the factors evaluated, and Table 6–1 has been revised to reflect the new factor category values throughout.

*Section 6.1 Likelihood of release.* Has been revised to eliminate explanatory text and to add instructions about which factors to evaluate for this factor category.

*Section 6.1.1 Observed release.* As discussed in section III G of this preamble, the specific criteria have been revised.

*Section 6.1.2 Potential to release.* As explained in section III O of this preamble, the method for evaluating this factor has been revised. Gas potential to release and particulate potential to release are evaluated separately. The explanatory text has been removed.

*Section 6.1.2.1 Gas potential to release.* Explains how this factor is evaluated. Table 6–2 (proposed rule Table 2–3) has been revised to apply only to the gas potential to release factors.

*Section 6.1.2.1.1 Gas containment.* Descriptive text has been removed. Table 6–3 (proposed rule Table 2–5) has been simplified. The depth requirements and other containment requirements have been revised based on public comment, the field test, and a review of recent information on covering systems. Consideration of biogas releases has been added. Assigned values have been revised and also reflect the revised maximum value for the factor.

*Section 6.1.2.1.2 Gas source type.* New source types have been added to Table 6–4 (proposed rule Table 2–6), and the assigned values have been revised. As explained in section III O of this preamble, new source types and subgroups for specific types have been added, in response to comments and the field test, to make this factor easier to evaluate. Treatment of sources when no source meets the minimum size has been clarified.

*Section 6.1.2.1.3 Gas migration potential.* As explained in section III O of this preamble, this section has been renamed and the approach for assigning values changed slightly. This section explains how to assign values to each substance and subsequently to the source using Tables 6–5, 6–6, and 6–7. Dry soil relative volatility has been removed as a measure of gas migration potential. The footnotes have been removed from Table 6–5 (proposed rule Table 2–7) and the name has been changed to "Values for Vapor Pressure and Henry's Constant." The titles of Tables 6–6 and 6–7 have been changed. The values assigned have also been changed to reflect the revised maximum value for the factor category. Descriptive text has been removed.

*Section 6.1.2.1.4 Calculation of gas potential to release value.* Explains how to calculate this value.

*Section 6.1.2.2 Particulate potential to release.* Explains how this factor is evaluated. Table 6–8 (proposed rule Table 2–3) has been revised to apply only to the particulate potential to release factors.

*Section 6.1.2.2.1 Particulate containment.* References Table 6–9 (Table 2–5 from the proposed rule). The criteria and values assigned using this table have been changed, as discussed in section III O of this preamble. Considerations of depth have been added for particulates.

*Section 6.1.2.2.2 Particulate source type.* In response to comments, new kinds of source types and subgroups of source types have been added to make this factor easier to score. The values assigned have been revised to reflect the changed factor category maximum. Treatment of sources when no source meets the minimum size has been clarified.

*Section 6.1.2.2.3 Particulate migration potential.* Has been renamed. Descriptive text has been removed. Proposed rule Figure 2–3 has been simplified, expanded, and renumbered as Figure 6–2. Proposed rule Table 2–9 has been renumbered as Table 6–10.

*Section 6.1.2.2.4 Calculation of particulate potential to release value.* Describes how to calculate this value.

*Section 6.1.2.3 Calculation of potential to release factor value for the site.* Text has been simplified and modified to account for gas and particulate potential to release.

*Section 6.1.3 Calculation of likelihood of release factor category value.* Describes calculation procedure.

*Section 6.2 Waste characteristics.* Descriptive text has been removed.

*Section 6.2.1 Toxicity/mobility.* Text has been simplified.

*Section 6.2.1.1 Toxicity.* Descriptive text has been removed and § 2.4.1.1 is referenced.

*Section 6.2.1.2 Mobility.* As explained in section III F of this preamble, the scoring of this factor has changed. Gas mobility is now based only on vapor pressure. The maximum value assigned for particulate mobility is no longer the same as the maximum assigned for gas mobility. The particulate mobility values are assigned based on Figure 6–3 or the equation in the text along with Table 6–12. The values assigned have been put on linear scales to be consistent with the new structure of the waste characteristics factor category. The text has been simplified.

*Section 6.2.1.3 Calculation of toxicity/mobility factor value.* Table 6–13, proposed rule Table 2–12, the matrix for assigning toxicity/mobility factor values has been revised to reflect the changes in values assigned to both factors.

*Section 6.2.2 Hazardous waste quantity.* Descriptive text has been removed and § 2.4.2 is referenced.

*Section 6.2.3 Calculation of waste characteristics factor category value.* The text has been revised to indicate the multiplication of the component factors, the new maximum value, and the table used to assign the factor category value.

*Section 6.3 Targets.* The target distance limit has been modified to include targets beyond four miles when an observed release extends beyond that distance. Text has been added to explain how to evaluate populations and sensitive environments exposed to actual contamination. Text was added to clarify that actual contamination based on an observed release established by direct observation should be considered Level II. Table 6–14, Health-Based Benchmarks for Hazardous Substances in Air, has been added to list the benchmarks used for this pathway. Table 6–15, Air Migration Pathway Distance Weights (proposed rule Table 2–16), has been revised to reflect changes in the distance weights discussed in section III O of this preamble.

*Section 6.3.1 Nearest individual.* The title has been changed from maximally exposed individual. As discussed above, this factor is now evaluated based on actual contamination and potential contamination. The name of Table 6–16 (proposed rule Table 2–15) has been changed and the values have been revised based on changes to the distance weights. Descriptive text has been removed.

*Section 6.3.2 Population.* Evaluation of population based on health-based benchmarks has been added as discussed in section III H of this preamble.

*Section 6.3.2.1 Level of contamination.* Explains how to evaluate population based on concentrations of hazardous substances in samples.

*Section 6.3.2.2 Level I concentrations.* Explains how to evaluate populations exposed to Level I concentrations. The scoring cap was eliminated, and the multiplier (i.e., weight) is now 10.

*Section 6.3.2.3 Level II concentrations.* Explains how to

evaluate populations exposed to Level II concentrations.

*Section 6.3.2.4 Potential contamination.* Explains how to assign values to populations potentially exposed to contamination from the site. The formula for calculating population values has been revised. Table 6–17, which assigns distance-weighted values for populations in each distance category, has been added. The values in the table were determined by statistical simulation to yield the same population, on average, as the use of the formulas in the proposed rule. The use of population ranges has been adopted as part of the simplification discussed in section III A. The rounding rule has been changed, the scoring cap was eliminated, and the multiplier (i.e., weight) is now 0.1.

*Section 6.3.2.5 Calculation of the population factor value.* Explains how to calculate the factor value. The scoring cap was eliminated.

*Section 6.3.3 Resources.* Explains how to assign points to resources, which in this pathway is based on the presence of commercial agriculture, commercial silviculture, and major or designated recreation areas.

*Section 6.3.4 Sensitive environments.* Explains how sensitive environments are evaluated based on actual and potential contamination. The maximum value that can be assigned to this factor is limited, but is greater than in the proposed rule. The limit is determined by scoring the pathway with only sensitive environments in the targets factor category; the pathway score under these conditions may not exceed 60 points.

*Section 6.3.4.1 Actual contamination.* Explains how to assign factor values for sensitive environments subject to actual contamination and how to assign values to wetlands based on total acreage. A new Table 6–18, Wetlands Rating Values for the Air Migration Pathway, has been added to assign values to wetlands based on acreage.

*Section 6.3.4.2 Potential contamination.* Explains how to calculate the factor value for potentially contaminated sensitive environments and how to assign values to wetlands based on total acreage within each distance category. The rounding rule has been changed.

*Section 6.3.4.3 Calculation of sensitive environments factor value.* Explains how to calculate the factor value. The rounding rule has been changed.

*Section 6.3.5 Calculation of targets factor category value.* Text has been revised to reflect the new names for factors.

*Section 6.4 Calculation of air migration pathway score.* Text has been revised to reflect the new divisor.

In addition to the above noted changes, the land use factor, Figure 2–2, and Tables 2–2, 2–3, 2–13, 2–17, and 2–19 in the proposed rule have been removed.

*Section 7 Sites Containing Radioactive Substances*

This entire part of the rule is new. As discussed in section III E of the preamble, this section has been added to provide direction on evaluating sites containing radioactive substances. Table 7–1 lists factors evaluated differently for such sites.

*Section 7.1 Likelihood of release/ likelihood of exposure.* Explains the approach to evaluating the factor category.

*Section 7.1.1 Observed release/ observed contamination.* Explains how to evaluate observed release (observed contamination) for radionuclides. The evaluation differs for radionuclides that occur naturally or are ubiquitous in the environment, for man-made radionuclides without ubiquitous background concentrations in the environment, and for gamma-emitting radionuclides in the soil exposure pathway. This section also explains the appropriate procedures for sites with mixed radioactive and other hazardous substances.

*Section 7.1.2 Potential to release.* Explains that potential to release factors are evaluated on the physical and chemical properties of radionuclides, not their radioactivity.

*Section 7.2 Waste characteristics.* Lists the factors evaluated.

*Section 7.2.1 Human toxicity.* Explains how to assign toxicity values to radioactive substances and describes appropriate procedures for sites containing mixed radionuclides and other hazardous substances.

*Section 7.2.2 Ecosystem toxicity.* Explains that ecosystem toxicity for radionuclides is assigned a value in the same way as is human toxicity except that the default value is 100 rather than 1,000.

*Section 7.2.3 Persistence.* Explains that radioactive substances are assigned persistence values based solely on half-life—radioactive half-life and volatilization half-life. Explains how to evaluate persistence for mixed radioactive and other hazardous substances.

*Section 7.2.4 Selection of the substance potentially posing greatest hazard.* The section explains how to select the substance potentially posing the greatest hazard.

*Section 7.2.5 Hazardous waste quantity.* Explains how to evaluate the hazardous waste quantity factor for sites containing radioactive substances.

*Section 7.2.5.1 Source hazardous waste quantity for radionuclides.* Describes differences between the migration pathways and the soil exposure pathway.

*Section 7.2.5.1.1 Radionuclide constituent quantity (Tier A).* Explains how to evaluate radionuclide constituent quantity for radionuclides.

*Section 7.2.5.1.2 Radionuclide wastestream quantity (Tier B).* Explains how to evaluate radionuclide wastestream quantity for radionuclides.

*Section 7.2.5.1.3 Calculation of source hazardous waste quantity value for radionuclides.* Explains how to assign a source value.

*Section 7.2.5.2 Calculation of hazardous waste quantity factor value for radionuclides.* Explains how to calculate the hazardous waste quantity factor value for radionuclides and describes use of the minimum value, which is either 10 or 100 (as described in section 2.4.2.2 above).

*Section 7.2.5.3 Calculation of hazardous waste quantity factor value for sites containing mixed radioactive and other hazardous substances.* Explains how to calculate the factor value for these sites.

*Section 7.3 Targets.* Explains how to evaluate targets at sites containing radioactive substances and sites containing radioactive and other hazardous substances.

*Section 7.3.1 Level of contamination at a sampling location.* Explains how to determine the appropriate level of contamination.

*Section 7.3.2 Selection of benchmarks and comparisons with observed release/observed contamination.* This section lists the benchmarks and explains how they are used in determining the level of contamination.

## V. Required Analyses

### *A. Executive Order No. 12291*

Under Executive Order No. 12291, the Agency must judge whether a regulation is "major" and thus subject to the requirement of a Regulatory Impact Analysis. The rule published today is not major because the rule will not result in an effect on the economy of $100 million or more, will not result in increased costs or prices, will not have significant adverse effects on competition, employment, investment, productivity, and innovation, and will

not significantly disrupt domestic and export markets.

To estimate the costs associated with the final rule, a final economic analysis entitled "Economic Impact Analysis of the Revised Hazard Ranking System" was prepared as an addendum to the December 1987 economic impact analysis (EIA) to incorporate new data. As in the January 1988 EIA, the total annual cost of implementing the final rule is estimated as a function of the number of Screening SIs (SSI) and Listing SIs (LSI) that will be conducted annually and the unit cost of each. In the January 1988 EIA, estimates of total costs were developed assuming 1,130 SSIs and 100 LSIs would be conducted annually. The Agency now estimates that 1,100 SIs will be conducted annually (EPA is no longer using the terms SSI and LSI). The total annual cost is estimated to be $78.8 million, the sum of the cost of conducting 1,000 SIs at a unit cost of $55,000, 70 SIs for NPL sites (without monitoring wells) at a unit cost of $100,000, and 30 SIs for NPL sites (with monitoring wells) at a unit cost of $160,000.

To estimate the incremental cost of implementing the final revised version of the HRS, the unit cost of conducting all preremedial listing activities using the current HRS from the January 1988 EIA is updated. That cost was estimated to be $58,200 in the January 1988 EIA, and was developed assuming the PA had already been conducted. The 1988 estimate is a function of 480 hours of Field Investigation Team (FIT) technical time valued at $40 per hour and 30 samples being evaluated at a unit cost of $1,300 per sample. To compare the costs of the current HRS to those developed above for the final revised version of the HRS, the FIT technical time is valued at $50 per hour and each sample evaluation is estimated to cost $1,000. The revised total cost of conducting all listing activities beyond the PA for the current HRS, therefore, is estimated to be $54,000. In addition, the average level of effort for a PA under the current HRS is estimated to be 60 hours, and the unit cost of the PA, assuming a $50 FIT hourly rate, is estimated to be $3,000.

Based on these revisions, the annual cost of using the current HRS is estimated to be $65.4 million, the sum of the cost of conducting 2,000 PAs at a unit cost of $3,000 ($6 million) and the cost of conducting 1,100 SIs at a unit cost of $54,000 ($59.4 million). Compared to the current HRS, the annual incremental cost of using the final revised version of the HRS is estimated to be $13.4 million. On the basis of this evaluation, implementing the final revised version of the HRS would not constitute a major rule, because the annual incremental cost of the final rule is less than $100 million. No negative economic effects are anticipated from this rule.

*B. Regulatory Flexibility Determination*

Appendix A of the December 1987 EIA includes an assessment of the ability of responsible parties to pay the costs of HRS scoring under the current HRS and the three alternative scoring mechanisms considered at that time. That analysis evaluated the impact of HRS costs under each ranking methodology on the financial viability of 15 sample companies. Under that analysis, only the smallest sample firm (one with an average net income of $53,700) was expected to have difficulty in paying the costs of conducting a complete SI under each of the alternative ranking scenarios. The new unit cost of a complete SI developed during the Phase I field test and used in this economic analysis falls within the range of costs already evaluated in appendix A of the December 1987 EIA. Given the previous analysis, EPA concludes that most sample firms are healthy enough financially to be able to afford the expenditures associated with HRS site inspections. Responsible Parties (RPs) that are financially similar to the smallest firm (Firm 15 in appendix A of the December 1987 RIA), however, do not have the assets or the income to enable them to assume payments similar to the estimates derived for the SI done under the current HRS or the final revised version of the HRS.

The Regulatory Flexibility Act of 1980 requires that Federal agencies explicitly consider the effects of proposed and existing regulations on small entities and examine alternative regulations that would reduce significant adverse impacts on small entities. The small entities that could be affected by the revisions to the HRS are small businesses and small municipalities that are responsible for hazardous wastes at a site. Based on the updated analysis presented here, EPA concludes that using the final rule is unlikely to result in a significant impact on a substantial number of small entities. As discussed in the December 1987 EIA, this conclusion is drawn because small firms are no more or less likely to be responsible parties than are large firms. In addition, when they are RPs, small firms usually are one of several companies responsible for a site and probably would not bear the full burden of liability for HRS expenditures and other cleanup costs.

*C. Paperwork Reduction Act*

The information collection requirements contained in this rule have been approved by the Office of Management and Budget (OMB) under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.*, and has assigned OMB control number 2050-0095.

Public reporting burden for this collection of information is estimated to be 620 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief, Information Policy Branch, PM—U.S. Environmental Protection Agency, 401 M St., SW., Washington, DC 20460; and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA."

*D. Federalism Implications*

E.O. 12612 requires agencies to assess whether a regulation will have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPA has determined that this regulation does not have federalism implications and that, therefore, a Federalism Assessment is not required.

**List of Subjects in 40 CFR Part 300**

Air pollution controls, Chemicals, Hazardous materials, Intergovernmental relations, Natural resources, Oil pollution, Reporting and recordkeeping, Superfund, Waste treatment and disposal, Water pollution control, Water supply.

Dated: November 9, 1990.

**William K. Reilly,**

*Administrator.*

40 CFR part 300 is amended as follows:

**PART 300—[AMENDED]**

1. The authority citation for part 300 continues to read as follows:

Authority: 42 U.S.C. 9605; 33 U.S.C. 1321(c)(2); E.O. No. 117535, 38 FR 21243; E.O No. 12580, 52 FR 2923.

2. Part 300, appendix A is revised to read as follows:

## Appendix A to Part 300—The Hazard Ranking System

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## *1.0 Introduction*

The Hazard Ranking System (HRS) is the principal mechanism the U.S. Environmental Protection Agency (EPA) uses to place sites on the National Priorities List (NPL). The HRS serves as a screening device to evaluate the potential for releases of uncontrolled hazardous substances to cause human health or environmental damage. The HRS provides a measure of relative rather than absolute risk. It is designed so that it can be consistently applied to a wide variety of sites.

## *1.1 Definitions*

*Acute toxicity:* Measure of toxicological responses that result from a single exposure to a substance or from multiple exposures within a short period of time (typically several days or less). Specific measures of acute toxicity used within the HRS include lethal $dose_{50}$ ($LD_{50}$) and lethal $concentration_{50}$ ($LC_{50}$), typically measured within a 24-hour to 96-hour period.

*Ambient Aquatic Life Advisory Concentrations (AALACs):* EPA's advisory concentration limit for acute or chronic toxicity to aquatic organisms as established under section 304(a)(1) of the Clean Water Act, as amended.

*Ambient Water Quality Criteria (AWQC):* EPA's maximum acute or chronic toxicity concentrations for protection of aquatic life and its uses as established under section 304(a)(1) of the Clean Water Act, as amended.

*Bioconcentration factor (BCF):* Measure of the tendency for a substance to accumulate in the tissue of an aquatic organism. BCF is determined by the extent of partitioning of a substance, at equilibrium, between the tissue of an aquatic organism and water. As the ratio of concentration of a substance in the organism divided by the concentration in water, higher BCF values reflect a tendency for substances to accumulate in the tissue of aquatic organisms. [unitless].

*Biodegradation:* Chemical reaction of a substance induced by enzymatic activity of microorganisms.

*CERCLA:* Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (Pub. L. 96–510, as amended).

*Chronic toxicity:* Measure of toxicological responses that result from repeated exposure to a substance over an extended period of time (typically 3 months or longer). Such responses may persist beyond the exposure or may not appear until much later in time than the exposure. HRS measures of chronic toxicity include Reference Dose (RfD) values.

*Contract Laboratory Program (CLP):* Analytical program developed for CERCLA waste site samples to fill the need for legally defensible analytical results supported by a high level of quality assurance and documentation.

*Contract-Required Detection Limit (CRDL).* Term equivalent to contract-required quantitation limit, but used primarily for inorganic substances.

*Contract-Required Quantitation Limit (CRQL):* Substance-specific level that a CLP laboratory must be able to routinely and reliably detect in specific sample matrices. It is not the lowest detectable level achievable, but rather the level that a CLP laboratory should reasonably quantify. The CRQL may or may not be equal to the quantitation limit of a given substance in a given sample. For HRS purposes, the term CRQL refers to both the contract-required quantitation limit and the contract-required detection limit.

*Curie (Ci):* Measure used to quantify the amount of radioactivity. One curie equals 37 billion nuclear transformations per second, and one picocurie (pCi) equals $10^{-12}$ Ci.

*Decay product:* Isotope formed by the radioactive decay of some other isotope. This newly formed isotope possesses physical and chemical properties that are different from

those of its parent isotope, and may also be radioactive.

*Detection Limit (DL):* Lowest amount that can be distinguished from the normal random "noise" of an analytical instrument or method. For HRS purposes, the detection limit used is the method detection limit (MDL) or, for real-time field instruments, the detection limit of the instrument as used in the field.

*Dilution weight:* Parameter in the HRS surface water migration pathway that reduces the point value assigned to targets as the flow or depth of the relevant surface water body increases. [unitless].

*Distance weight:* Parameter in the HRS air migration, ground water migration, and soil exposure pathways that reduces the point value assigned to targets as their distance increases from the site. [unitless].

*Distribution coefficient ($K_d$):* Measure of the extent of partitioning of a substance between geologic materials (for example, soil, sediment, rock) and water (also called partition coefficient). The distribution coefficient is used in the HRS in evaluating the mobility of a substance for the ground water migration pathway. [ml/g].

*$ED_{10}$ (10 percent effective dose):* Estimated dose associated with a 10 percent increase in response over control groups. For HRS purposes, the response considered is cancer. [milligrams toxicant per kilogram body weight per day (mg/kg-day)].

*Food and Drug Administration Action Level (FDAAL):* Under section 408 of the Federal Food, Drug and Cosmetic Act, as amended, concentration of a poisonous or deleterious substance in human food or animal feed at or above which FDA will take legal action to remove adulterated products from the market. Only FDAALs established for fish and shellfish apply in the HRS.

*Half-life:* Length of time required for an initial concentration of a substance to be halved as a result of loss through decay. The HRS considers five decay processes: biodegradation, hydrolysis, photolysis, radioactive decay, and volatilization.

*Hazardous substance:* CERCLA hazardous substances, pollutants, and contaminants as defined in CERCLA sections 101(14) and 101(33), except where otherwise specifically noted in the HRS.

*Hazardous wastestream:* Material containing CERCLA hazardous substances (as defined in CERCLA section 101[14]) that was deposited, stored, disposed, or placed in, or that otherwise migrated to, a source.

HRS *"factor":* Primary rating elements internal to the HRS.

HRS *"factor category":* Set of HRS factors (that is, likelihood of release [or exposure], waste characteristics, targets).

HRS *"migration pathways":* HRS ground water, surface water, and air migration pathways.

HRS *"pathway":* Set of HRS factor categories combined to produce a score to measure relative risks posed by a site in one of four environmental pathways (that is, ground water, surface water, soil, and air).

HRS *"site score":* Composite of the four HRS pathway scores.

*Henry's law constant:* Measure of the volatility of a substance in a dilute solution of water at equilibrium. It is the ratio of the vapor pressure exerted by a substance in the gas phase over a dilute aqueous solution of that substance to its concentration in the solution at a given temperature. For HRS purposes, use the value reported at or near 25° C. [atmosphere-cubic meters per mole (atm-$m^3$/mol)].

*Hydrolysis:* Chemical reaction of a substance with water.

*Karst:* Terrain with characteristics of relief and drainage arising from a high degree of rock solubility in natural waters. The majority of karst occurs in limestones, but karst may also form in dolomite, gypsum, and salt deposits. Features associated with karst terrains typically include irregular topography, sinkholes, vertical shafts, abrupt ridges, caverns, abundant springs, and/or disappearing streams. Karst aquifers are associated with karst terrain.

*$LC_{50}$ (lethal concentration, 50 percent):* Concentration of a substance in air [typically micrograms per cubic meter ($\mu g/m^3$)] or water [typically micrograms per liter ($\mu g/l$)] that kills 50 percent of a group of exposed organisms. The $LC_{50}$ is used in the HRS in assessing acute toxicity.

*$LD_{50}$ (lethal dose, 50 percent):* Dose of a substance that kills 50 percent of a group of exposed organisms. The $LD_{50}$ is used in the HRS in assessing acute toxicity [milligrams toxicant per kilogram body weight (mg/kg)].

*Maximum Contaminant Level (MCL):* Under section 1412 of the Safe Drinking Water Act, as amended, the maximum permissible concentration of a substance in water that is delivered to any user of a public water supply.

*Maximum Contaminant Level Goal (MCLG):* Under section 1412 of the Safe Drinking Water Act, as amended, a nonenforceable concentration for a substance in drinking water that is protective of adverse human health effects and allows an adequate margin of safety.

*Method Detection Limit (MDL):* Lowest concentration of analyte that a method can detect reliably in either a sample or blank.

*Mixed radioactive and other hazardous substances:* Material containing both radioactive hazardous substances and nonradioactive hazardous substances, regardless of whether these types of substances are physically separated, combined chemically, or simply mixed together.

*National Ambient Air Quality Standards (NAAQS):* Primary standards for air quality established under sections 108 and 109 of the Clean Air Act, as amended.

*National Emission Standards for Hazardous Air Pollutants (NESHAPs):* Standards established for substances listed under section 112 of the Clean Air Act, as amended. Only those NESHAPs promulgated in ambient concentration units apply in the HRS.

*Octanol-water partition coefficient ($K_{ow}$ [for P]):* Measure of the extent of partitioning of a substance between water and octanol at equilibrium. The $K_{ow}$ is determined by the ratio between the concentration in octanol divided by the concentration in water at equilibrium. [unitless].

*Organic carbon partition coefficient ($K_{oc}$):* Measure of the extent of partitioning of a substance, at equilibrium, between organic carbon in geologic materials and water. The higher the $K_{oc}$, the more likely a substance is to bind to geologic materials than to remain in water. [ml/g].

*Photolysis:* Chemical reaction of a substance caused by direct absorption of solar energy (direct photolysis) or caused by other substances that absorb solar energy (indirect photolysis).

*Radiation:* Particles (alpha, beta, neutrons) or photons (x- and gamma-rays) emitted by radionuclides.

*Radioactive decay:* Process of spontaneous nuclear transformation, whereby an isotope of one element is transformed into an isotope of another element, releasing excess energy in the form of radiation.

*Radioactive half-life:* Time required for one-half the atoms in a given quantity of a specific radionuclide to undergo radioactive decay.

*Radioactive substance:* Solid, liquid, or gas containing atoms of a single radionuclide or multiple radionuclides.

*Radioactivity:* Property of those isotopes of elements that exhibit radioactive decay and emit radiation.

*Radionuclide/radioisotope:* Isotope of an element exhibiting radioactivity. For HRS purposes, "radionuclide" and "radioisotope" are used synonymously.

*Reference dose (RfD):* Estimate of a daily exposure level of a substance to a human population below which adverse noncancer health effects are not anticipated. [milligrams toxicant per kilogram body weight per day (mg/kg-day)].

*Removal action:* Action that removes hazardous substances from the site for proper disposal or destruction in a facility permitted under the Resource Conservation and Recovery Act or the Toxic Substances Control Act or by the Nuclear Regulatory Commission.

*Roentgen (R):* Measure of external exposures to ionizing radiation. One roentgen equals that amount of x-ray or gamma radiation required to produce ions carrying a charge of 1 electrostatic unit (esu) in 1 cubic centimeter of dry air under standard conditions. One microroentgen ($\mu R$) equals $10^{-6}$ R.

*Sample quantitation limit (SQL):* Quantity of a substance that can be reasonably quantified given the limits of detection for the methods of analysis and sample characteristics that may affect quantitation (for example, dilution, concentration).

*Screening concentration:* Media-specific benchmark concentration for a hazardous substance that is used in the HRS for comparison with the concentration of that hazardous substance in a sample from that media. The screening concentration for a specific hazardous substance corresponds to its reference dose for inhalation exposures or for oral exposures, as appropriate, and, if the substance is a human carcinogen with a weight-of-evidence classification of A, B, or C, to that concentration that corresponds to its $10^{-6}$ individual lifetime excess cancer risk for inhalation exposures or for oral exposures, as appropriate.

*Site:* Area(s) where a hazardous substance has been deposited, stored, disposed, or placed, or has otherwise come to be located. Such areas may include multiple sources and may include the area between sources.

*Slope factor (also referred to as cancer potency factor):* Estimate of the probability of response (for example, cancer) per unit intake of a substance over a lifetime. The slope factor is typically used to estimate upper-bound probability of an individual developing cancer as a result of exposure to a particular level of a human carcinogen with a weight-of-evidence classification of A, B, or C. [(mg/kg-day)$^{-1}$ for non-radioactive substances and (pC$_i$)$^{-1}$ for radioactive substances].

*Source:* Any area where a hazardous substance has been deposited, stored, disposed, or placed, plus those soils that have become contaminated from migration of a hazardous substance. Sources do not include those volumes of air, ground water, surface water, or surface water sediments that have become contaminated by migration, except: in the case of either a ground water plume with no identified source or contaminated surface water sediments with no identified source, the plume or contaminated sediments may be considered a source.

*Target distance limit:* Maximum distance over which targets for the site are evaluated. The target distance limit varies by HRS pathway.

*Uranium Mill Tailings Radiation Control Act (UMTRCA) Standards:* Standards for radionuclides established under sections 102, 104, and 108 of the Uranium Mill Tailings Radiation Control Act, as amended.

*Vapor pressure:* Pressure exerted by the vapor of a substance when it is in equilibrium with its solid or liquid form at a given temperature. For HRS purposes, use the value reported at or near 25° C. [atmosphere or torr].

*Volatilization:* Physical transfer process through which a substance undergoes a change of state from a solid or liquid to a gas.

*Water solubility:* Maximum concentration of a substance in pure water at a given temperature. For HRS purposes, use the value reported at or near 25° C. [milligrams per liter (mg/l)].

*Weight-of-evidence:* EPA classification system for characterizing the evidence supporting the designation of a substance as a human carcinogen. EPA weight-of-evidence groupings include:

Group A: Human carcinogen--sufficient evidence of carcinogenicity in humans.
Group B1: Probable human carcinogen--limited evidence of carcinogenicity in humans.
Group B2: Probable human carcinogen--sufficient evidence of carcinogenicity in animals.
Group C: Possible human carcinogen--limited evidence of carcinogenicity in animals.
Group D: Not classifiable as to human carcinogenicity--applicable when there is no animal evidence, or when human or animal evidence is inadequate.
Group E: Evidence of noncarcinogenicity for humans.

*2.0 Evaluations Common to Multiple Pathways*

2.1 *Overview.* The HRS site score (S) is the result of an evaluation of four pathways:

- Ground Water Migration ($S_{gw}$).
- Surface Water Migration ($S_{sw}$).
- Soil Exposure ($S_s$).
- Air Migration ($S_a$).

The ground water and air migration pathways use single threat evaluations, while the surface water migration and soil exposure pathways use multiple threat evaluations. Three threats are evaluated for the surface water migration pathway: drinking water, human food chain, and environmental. These threats are evaluated for two separate migration components--overland/flood migration and ground water to surface water migration. Two threats are evaluated for the soil exposure pathway: resident population and nearby population.

The HRS is structured to provide a parallel evaluation for each of these pathways and threats. This section focuses on these parallel evaluations, starting with the calculation of the HRS site score and the individual pathway scores.

2.1.1 *Calculation of HRS site score.* Scores are first calculated for the individual pathways as specified in sections 2 through 7 and then are combined for the site using the following root-mean-square equation to determine the overall HRS site score, which ranges from 0 to 100:

$$S = \sqrt{\frac{S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2}{4}}$$

2.1.2 *Calculation of pathway score.* Table 2-1, which is based on the air migration pathway, illustrates the basic parameters used to calculate a pathway score. As Table 2-1 shows, each pathway (or threat) score is the product of three "factor categories": likelihood of release, waste characteristics, and targets. (The soil exposure pathway uses likelihood of exposure rather than likelihood of release.) Each of the three factor categories contains a set of factors that are assigned numerical values and combined as specified in sections 2 through 7. The factor values are rounded to the nearest integer, except where otherwise noted.

2.1.3 *Common evaluations.* Evaluations common to all four HRS pathways include:

- Characterizing sources.
  - –Identifying sources (and, for the soil exposure pathway, areas of observed contamination [see section 5.0.1]).
  - –Identifying hazardous substances associated with each source (or area of observed contamination).
  - –Identifying hazardous substances available to a pathway.

TABLE 2-1.—SAMPLE PATHWAY SCORESHEET

| Factor category | Maximum value | Value assigned |
|---|---|---|
| **Likelihood of Release** | | |
| 1. Observed Release | 550 | |
| 2. Potential to Release | 500 | |
| 3. Likelihood of Release (higher of lines 1 and 2) | 550 | |
| **Waste Characteristics** | | |
| 4. Toxicity/Mobility | (a) | |
| 5. Hazardous Waste Quantity | (a) | |
| 6. Waste Characteristics | 100 | |
| **Targets** | | |
| 7. Nearest Individual | | |
| 7a. Level I | 50 | |
| 7b. Level II | 45 | |
| 7c. Potential Contamination | 20 | |
| 7d. Nearest Individual (higher of lines 7a, 7b, or 7c) | 50 | |
| 8. Population | | |
| 8a. Level I | (b) | |
| 8b. Level II | (b) | |
| 8c. Potential Contamination | (b) | |
| 8d. Total Population (lines 8a + 8b + 8c) | (b) | |
| 9. Resources | 5 | |
| 10. Sensitive Environments | (b) | |
| 10a. Actual Contamination | (b) | |
| 10b. Potential Contamination | (b) | |
| 10c. Sensitive Environments (lines 10a + 10b) | (b) | |
| 11. Targets (lines 7d + 8d + 9 + 10c) | (b) | |
| 12. **Pathway Score** is the product of Likelihood of Release, Waste Characteristics, and Targets, divided by 82,500. Pathway scores are limited to a maximum of 100 points. | | |

[a] Maximum value applies to waste characteristics category. The product of lines 4 and 5 is used in Table 2-7 to derive the value for the waste characteristics factor category.

[b] There is no limit to the human population or sensitive environments factor values. However, the pathway score based solely on sensitive environments is limited to a maximum of 60 points.

- Scoring likelihood of release (or likelihood of exposure) factor category.
  - –Scoring observed release (or observed contamination).
  - –Scoring potential to release when there is no observed release.
- Scoring waste characteristics factor category.
  - –Evaluating toxicity.
  - –Combining toxicity with mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential, as appropriate to the pathway (or threat).
  - –Evaluating hazardous waste quantity.
  - –Combining hazardous waste quantity with the other waste characteristics factors.
  - –Determining waste characteristics factor category value.
- Scoring targets factor category.
  - –Determining level of contamination for targets.

These evaluations are essentially identical for the three migration pathways (ground water, surface water, and air). However, the