NW., Washington, DC 20460. If EPA determines that the required data were submitted, EPA will add the product to the Schedule.

(2) EPA will inform the submitter in writing, within 60 days of the receipt of technical product data, of its decision on adding the product to the Schedule.

(c) The submitter may assert that certain information in the technical product data submissions, including technical product data submissions for sorbents pursuant to §300.915(g)(3), is confidential business information. EPA will handle such claims pursuant to the provisions in 40 CFR part 2, subpart B. Such information must be submitted separately from non-confidential information, clearly identified, and clearly marked ''Confidential Business Information.'' If the submitter fails to make such a claim at the time of submittal, EPA may make the information available to the public without further notice.

(d) The submitter must notify EPA of any changes in the composition, formulation, or application of the dispersant, surface washing agent, surface collecting agent, bioremediation agent, or miscellaneous oil spill control agent. On the basis of this data, EPA may require retesting of the product if the change is likely to affect the effectiveness or toxicity of the product.

(e) The listing of a product on the NCP Product Schedule does not constitute approval of the product. To avoid possible misinterpretation or misrepresentation, any label, advertisement, or technical literature that refers to the placement of the product on the NCP Product Schedule must either reproduce in its entirety EPA's written statement that it will add the product to the NCP Product Schedule under §300.920(a)(2) or (b)(2), or include the disclaimer shown below. If the disclaimer is used, it must be conspicuous and must be fully reproduced. Failure to comply with these restrictions or any other improper attempt to demonstrate the approval of the product by any NRT or other U.S. Government agency shall constitute grounds for removing the product from the NCP Product Schedule.

DISCLAIMER

[PRODUCT NAME] is on the U.S. Environmental Protection Agency's NCP Product Schedule. This listing does NOT mean that EPA approves, recommends, licenses, certifies, or authorizes the use of [PRODUCT NAME] on an oil discharge. This listing means only that data have been submitted to EPA as required by subpart J of the National Contingency Plan, §300.915.

Subpart K—Federal Facilities [Reserved]

Subpart L—National Oil and Hazardous Substances Pollution Contingency Plan; Involuntary Acquisition of Property by the Government

SOURCE: 62 FR 34602, June 26, 1997, unless otherwise noted.

§ 300.1105 Involuntary acquisition of property by the government.

(a) Governmental ownership or control of property by involuntary acquisitions or involuntary transfers within the meaning of CERCLA section 101(20)(D) or section 101(35)(A)(ii) includes, but is not limited to:

(1) Acquisitions by or transfers to the government in its capacity as a sovereign, including transfers or acquisitions pursuant to abandonment proceedings, or as the result of tax delinquency, or escheat, or other circumstances in which the government involuntarily obtains ownership or control of property by virtue of its function as sovereign;

(2) Acquisitions by or transfers to a government entity or its agent (including governmental lending and credit institutions, loan guarantors, loan insurers, and financial regulatory entities which acquire security interests or properties of failed private lending or depository institutions) acting as a conservator or receiver pursuant to a clear and direct statutory mandate or regulatory authority;

(3) Acquisitions or transfers of assets through foreclosure and its equivalents (as defined in 40 CFR 300.1100(d)(1)) or other means by a Federal, state, or local government entity in the course of administering a governmental loan

or loan guarantee or loan insurance program; and

(4) Acquisitions by or transfers to a government entity pursuant to seizure or forfeiture authority.

(b) Nothing in this section or in CERCLA section 101(20)(D) or section 101(35)(A)(ii) affects the applicability of 40 CFR 300.1100 to any security interest, property, or asset acquired pursuant to an involuntary acquisition or transfer, as described in this section.

NOTE TO PARAGRAPHS (A)(3) AND (B) OF THIS SECTION: Reference to 40 CFR 300.1100 is a reference to the provisions regarding secured creditors in CERCLA sections 101(20)(E)–(G), 42 U.S.C. 9601(20)(E)–(G). *See* Section 2504(a) of the Asset Conservation, Lender Liability, and Deposit Insurance Protection Act, Public Law, 104–208, 110 Stat. 3009–462, 3009–468 (1996).

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_l) 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 ($atm\text{-}m^3/mol$)].

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} [or 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 (μR) 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 evaluations differ in certain respects for the soil exposure pathway.

Section 7 specifies modifications that apply to each pathway when evaluating sites containing radioactive substances.

Section 2 focuses on evaluations common at the pathway and threat levels. Note that for the ground water and surface water migration pathways, separate scores are calculated for each aquifer (see section 3.0) and each watershed (see sections 4.1.1.3 and 4.2.1.5) when determining the pathway scores for a site. Although the evaluations in section 2 do not vary when different aquifers or watersheds are scored at a site, the specific factor values (for example, observed release, hazardous waste quantity, toxicity/mobility) that result from these evaluations can vary by aquifer and by watershed at the site. This can occur through differences both in the specific sources and targets eligible to be evaluated for each aquifer and watershed and in whether observed releases can be established for each aquifer and watershed. Such differences in scoring at the aquifer and watershed level are addressed in sections 3 and 4, not section 2.

2.2 *Characterize sources.* Source characterization includes identification of the following:

• Sources (and areas of observed contamination) at the site.

• Hazardous substances associated with these sources (or areas of observed contamination).

• Pathways potentially threatened by these hazardous substances.

Table 2–2 presents a sample worksheet for source characterization.

2.2.1 *Identify sources.* For the three migration pathways, identify the sources at the site that contain hazardous substances. Identify the migration pathway(s) to which each source applies. For the soil exposure pathway, identify areas of observed contamination at the site (see section 5.0.1).

TABLE 2–2—SAMPLE SOURCE CHARACTERIZATION WORKSHEET

Source: _____

A. Source dimensions and hazardous waste quantity.
Hazardous constituent quantity: _____
Hazardous wastestream quantity: _____
Volume: _____
Area: _____
Area of observed contamination: _____

B. Hazardous substances associated with the source.

Hazardous substance	Available to pathway						
	Air		Ground water (GW)	Surface water (SW)		Soil	
	Gas	Particulate		Overland/ flood	GW to SW	Resident	Nearby
.							
.							
.							
.							
.							
.							
.							

2.2.2 *Identify hazardous substances associated with a source.* For each of the three migration pathways, consider those hazardous substances documented in a source (for example, by sampling, labels, manifests, oral or written statements) to be associated with that source when evaluating each pathway. In some instances, a hazardous substance can be documented as being present at a site (for example, by labels, manifests, oral or written statements), but the specific source(s) containing that hazardous substance cannot be documented. For the three migration pathways, in those instances when the specific source(s) cannot be documented for a hazardous substance, consider the hazardous substance to be present in each source at the site, except sources for which definitive information indicates that the hazardous substance was not or could not be present.

For an area of observed contamination in the soil exposure pathway, consider only those hazardous substances that meet the criteria for observed contamination for that area (see section 5.0.1) to be associated with that area when evaluating the pathway.

2.2.3 *Identify hazardous substances available to a pathway.* In evaluating each migration pathway, consider the following hazardous substances available to migrate from the sources at the site to the pathway:

• Ground water migration.

–Hazardous substances that meet the criteria for an observed release (see section 2.3) to ground water.

–All hazardous substances associated with a source with a ground water containment factor value greater than 0 (see section 3.1.2.1).

• Surface water migration—overland/flood component.

–Hazardous substances that meet the criteria for an observed release to surface water in the watershed being evaluated.

–All hazardous substances associated with a source with a surface water containment factor value greater than 0 for the watershed (see sections 4.1.2.1.2.1.1 and 4.1.2.1.2.2.1).

• Surface water migration—ground water to surface water component.

–Hazardous substances that meet the criteria for an observed release to ground water.

–All hazardous substances associated with a source with a ground water containment factor value greater than 0 (see sections 4.2.2.1.2 and 3.1.2.1).

• Air migration.

–Hazardous substances that meet the criteria for an observed release to the atmosphere.

–All gaseous hazardous substances associated with a source with a gas containment factor value greater than 0 (see section 6.1.2.1.1).

–All particulate hazardous substances associated with a source with a particulate containment factor value greater than 0 (see section 6.1.2.2.1).

• For each migration pathway, in those instances when the specific source(s) containing the hazardous substance cannot be documented, consider that hazardous substance to be available to migrate to the pathway when it can be associated (see section 2.2.2) with at least one source having a containment factor value greater than 0 for that pathway.

In evaluating the soil exposure pathway, consider the following hazardous substances available to the pathway:

• Soil exposure—resident population threat.

–All hazardous substances that meet the criteria for observed contamination at the site (see section 5.0.1).

• Soil exposure—nearby population threat.

–All hazardous substances that meet the criteria for observed contamination at areas with an attractiveness/accessibility factor value greater than 0 (see section 5.2.1.1).

2.3 *Likelihood of release.* Likelihood of release is a measure of the likelihood that a waste has been or will be released to the environment. The likelihood of release factor category is assigned the maximum value of 550 for a migration pathway whenever the

criteria for an observed release are met for that pathway. If the criteria for an observed release are met, do not evaluate potential to release for that pathway. When the criteria for an observed release are not met, evaluate potential to release for that pathway, with a maximum value of 500. The evaluation of potential to release varies by migration pathway (see sections 3, 4 and 6).

Establish an observed release either by direct observation of the release of a hazardous substance into the media being evaluated (for example, surface water) or by chemical analysis of samples appropriate to the pathway being evaluated (see sections 3, 4, and 6). The minimum standard to establish an observed release by chemical analysis is analytical evidence of a hazardous substance in the media significantly above the background level. Further, some portion of the release must be attributable to the site. Use the criteria in table 2–3 as the standard for determining analytical significance. (The criteria in table 2–3 are also used in establishing observed contamination for the soil exposure pathway, see section 5.0.1.) Separate criteria apply to radionuclides (see section 7.1.1).

TABLE 2–3—OBSERVED RELEASE CRITERIA FOR CHEMICAL ANALYSIS

Sample Measurement < Sample Quantitation Limit [a] No observed release is established.
Sample Measurement ≥ Sample Quantitation Limit [a] An observed release is established as follows: • If the background concentration is not detected (or is less than the detection limit), an observed release is established when the sample measurement equals or exceeds the sample quantitation limit. [a] • If the background concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is 3 times or more above the background concentration.

[a] If the sample quantitation limit (SQL) cannot be established, determine if there is an observed release as follows:

—If the sample analysis was performed under the EPA Contract Laboratory Program, use the EPA contract-required quantitation limit (CRQL) in place of the SQL.

—If the sample analysis is not performed under the EPA Contract Laboratory Program, use the detection limit (DL) in place of the SQL.

2.4 *Waste characteristics.* The waste characteristics factor category includes the following factors: hazardous waste quantity, toxicity, and as appropriate to the pathway or threat being evaluated, mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential.

2.4.1 *Selection of substance potentially posing greatest hazard.* For all pathways (and threats), select the hazardous substance potentially posing the greatest hazard for the pathway (or threat) and use that substance in evaluating the waste characteristics category of the pathway (or threat). For the three migration pathways (and threats), base the selection of this hazardous substance on the toxicity factor value for the substance, combined with its mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factor values, as applicable to the migration pathway (or threat). For the soil exposure pathway, base the selection on the toxicity factor alone.

Evaluation of the toxicity factor is specified in section 2.4.1.1. Use and evaluation of the mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factors vary by pathway (or threat) and are specified under the appropriate pathway (or threat) section. Section 2.4.1.2 identifies the specific factors that are combined with toxicity in evaluating each pathway (or threat).

2.4.1.1 *Toxicity factor.* Evaluate toxicity for those hazardous substances at the site that are available to the pathway being scored. For all pathways and threats, except the surface water environmental threat, evaluate human toxicity as specified below. For the surface water environmental threat, evaluate ecosystem toxicity as specified in section 4.1.4.2.1.1.

Establish human toxicity factor values based on quantitative dose-response parameters for the following three types of toxicity:

• Cancer– –Use slope factors (also referred to as cancer potency factors) combined with weight-of-evidence ratings for carcinogenicity. If a slope factor is not available for a substance, use its ED_{10} value to estimate a slope factor as follows:

$$\text{Slope factor} = \frac{1}{6\left(ED_{10}\right)}$$

• Noncancer toxicological responses of chronic exposure– –use reference dose (RfD) values.

• Noncancer toxicological responses of acute exposure– –use acute toxicity parameters, such as the LD_{50}.

Assign human toxicity factor values to a hazardous substance using table 2–4, as follows:

• If RfD and slope factor values are both available for the hazardous substance, assign the substance a value from table 2–4 for each. Select the higher of the two values assigned and use it as the overall toxicity factor value for the hazardous substance.

• If either an RfD or slope factor value is available, but not both, assign the hazardous substance an overall toxicity factor value from table 2–4 based solely on the available value (RfD or slope factor).

• If neither an RfD nor slope factor value is available, assign the hazardous substance an overall toxicity factor value from table 2–4 based solely on acute toxicity. That is, consider acute toxicity in table 2–4 only when both RfD and slope factor values are not available.

• If neither an RfD, nor slope factor, nor acute toxicity value is available, assign the hazardous substance an overall toxicity factor value of 0 and use other hazardous substances for which information is available in evaluating the pathway.

TABLE 2–4—TOXICITY FACTOR EVALUATION

Chronic Toxicity (Human)

Reference dose (RfD) (mg/kg-day)	Assigned value
RfD < 0.0005	10,000
0.0005 ≤ RfD < 0.005	1,000
0.005 ≤ RfD < 0.05	100
0.05 ≤ RfD < 0.5	10
0.5 ≤ RfD	1
RfD not available	0

Carcinogenicity (Human)

Weight-of-evidence [a]/slope factor $(mg/kg\text{-}day)^{-1}$			Assigned value
A	B	C	
0.5 ≤ SF [b]	5 ≤ SF	50 ≤ SF	10,000
0.05 ≤ SF < 0.5	0.5 ≤ SF < 5	5 ≤ SF < 50	1,000
SF < 0.05	0.05 ≤ SF < 0.5	0.5 ≤ SF < 5	100
— — —	SF < 0.05	SF < 0.5	10
Slope factor not available.	Slope factor not available.	Slope factor not available.	0

[a] A, B, and C refer to weight-of-evidence categories. Assign substances with a weight-of-evidence category of D (inadequate evidence of carcinogenicity) or E (evidence of lack of carcinogenicity) a value of 0 for carcinogenicity.
[b] SF = Slope factor.

TABLE 2–4—TOXICITY FACTOR EVALUATION—CONCLUDED

Acute Toxicity (Human)

Oral LD_{50} (mg/kg)	Dermal LD_{50} (mg/kg)	Dust or mist LC_{50} (mg/l)	Gas or vapor LC_{50} (ppm)	Assigned value
— — —	— — —	— — —	— — —	— — —
LD_{50} < 5	LD_{50} < 2	LC_{50} < 0.2	LC_{50} < 20	1,000
5 ≤ LD_{50} < 50	2 ≤ LD_{50} < 20	0.2 ≤ LC_{50} < 2	20 ≤ LC_{50} < 200	100
50 ≤ LD_{50} < 500	20 ≤ LD_{50} < 200	2 ≤ LC_{50} < 20	200 ≤ LC_{50} < 2,000	10
500 ≤ LD_{50}	200 ≤ LD_{50}	20 ≤ LC_{50}	2,000 ≤ LC_{50}	1
LD_{50} not available	LD_{50} not available	LC_{50} not available	LC_{50} not available	0

If a toxicity factor value of 0 is assigned to all hazardous substances available to a particular pathway (that is, insufficient toxicity data are available for evaluating all the substances), use a default value of 100 as the overall human toxicity factor value for all hazardous substances available to the pathway. For hazardous substances having usable toxicity data for multiple exposure routes (for example, inhalation and ingestion), consider all exposure routes and use the highest assigned value, regardless of exposure route, as the toxicity factor value.

For HRS purposes, assign both asbestos and lead (and its compounds) a human toxicity factor value of 10,000.

Separate criteria apply for assigning factor values for human toxicity and ecosystem toxicity for radionuclides (see sections 7.2.1 and 7.2.2).

2.4.1.2 *Hazardous substance selection.* For each hazardous substance evaluated for a migration pathway (or threat), combine the human toxicity factor value (or ecosystem toxicity factor value) for the hazardous substance with a mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factor value as follows:

• Ground water migration.

–Determine a combined human toxicity/mobility factor value for the hazardous substance (see section 3.2.1).

• Surface water migration-overland/flood migration component.

–Determine a combined human toxicity/persistence factor value for the hazardous substance for the drinking water threat (see section 4.1.2.2.1).

–Determine a combined human toxicity/persistence/bioaccumulation factor value for the hazardous substance for the human food chain threat (see section 4.1.3.2.1).

–Determine a combined ecosystem toxicity/persistence/bioaccumulation factor value for the hazardous substance for the environmental threat (see section 4.1.4.2.1).

• Surface water migration-ground water to surface water migration component.

–Determine a combined human toxicity/mobility/persistence factor value for the hazardous substance for the drinking water threat (see section 4.2.2.2.1).

–Determine a combined human toxicity/mobility/persistence/bioaccumulation factor value for the hazardous substance for the human food chain threat (see section 4.2.3.2.1).

–Determine a combined ecosystem toxicity/mobility/persistence/bioaccumulation factor value for the hazardous substance

for the environmental threat (see section 4.2.4.2.1).

• Air migration.

–Determine a combined human toxicity/mobility factor value for the hazardous substance (see section 6.2.1).

Determine each combined factor value for a hazardous substance by multiplying the individual factor values appropriate to the pathway (or threat). For each migration pathway (or threat) being evaluated, select the hazardous substance with the highest combined factor value and use that substance in evaluating the waste characteristics factor category of the pathway (or threat).

For the soil exposure pathway, select the hazardous substance with the highest human toxicity factor value from among the substances that meet the criteria for observed contamination for the threat evaluated and use that substance in evaluating the waste characteristics factor category.

2.4.2 *Hazardous waste quantity*. Evaluate the hazardous waste quantity factor by first assigning each source (or area of observed contamination) a source hazardous waste quantity value as specified below. Sum these values to obtain the hazardous waste quantity factor value for the pathway being evaluated.

In evaluating the hazardous waste quantity factor for the three migration pathways, allocate hazardous substances and hazardous wastestreams to specific sources in the manner specified in section 2.2.2, except: consider hazardous substances and hazardous wastestreams that cannot be allocated to any specific source to constitute a separate ''unallocated source'' for purposes of evaluating only this factor for the three migration pathways. Do not, however, include a hazardous substance or hazardous wastestream in the unallocated source for a migration pathway if there is definitive information indicating that the substance or wastestream could only have been placed in sources with a containment factor value of 0 for that migration pathway.

In evaluating the hazardous waste quantity factor for the soil exposure pathway, allocate to each area of observed contamination only those hazardous substances that meet the criteria for observed contamination for that area of observed contamination and only those hazardous wastestreams that contain hazardous substances that meet the criteria for observed contamination for that area of observed contamination. Do not consider other hazardous substances or hazardous wastestreams at the site in evaluating this factor for the soil exposure pathway.

2.4.2.1 *Source hazardous waste quantity*. For each of the three migration pathways, assign a source hazardous waste quantity value to each source (including the unallocated source) having a containment factor value greater than 0 for the pathway being evaluated. Consider the unallocated source to have a containment factor value greater than 0 for each migration pathway.

For the soil exposure pathway, assign a source hazardous waste quantity value to each area of observed contamination, as applicable to the threat being evaluated.

For all pathways, evaluate source hazardous waste quantity using the following four measures in the following hierarchy:

- Hazardous constituent quantity.
- Hazardous wastestream quantity.
- Volume.
- Area.

For the unallocated source, use only the first two measures.

Separate criteria apply for assigning a source hazardous waste quantity value for radionuclides (see section 7.2.5).

2.4.2.1.1 *Hazardous constituent quantity*. Evaluate hazardous constituent quantity for the source (or area of observed contamination) based solely on the mass of CERCLA hazardous substances (as defined in CERCLA section 101(14), as amended) allocated to the source (or area of observed contamination), except:

• For a hazardous waste listed pursuant to section 3001 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 (RCRA), 42 U.S.C. 6901 et seq., determine its mass for the evaluation of this measure as follows:

–If the hazardous waste is listed solely for Hazard Code T (toxic waste), include only the mass of constituents in the hazardous waste that are CERCLA hazardous substances and not the mass of the entire hazardous waste.

–If the hazardous waste is listed for any other Hazard Code (including T plus any other Hazard Code), include the mass of the entire hazardous waste.

• For a RCRA hazardous waste that exhibits the characteristics identified under section 3001 of RCRA, as amended, determine its mass for the evaluation of this measure as follows:

–If the hazardous waste exhibits only the characteristic of toxicity (or only the characteristic of EP toxicity), include only the mass of constituents in the hazardous waste that are CERCLA hazardous substances and not the mass of the entire hazardous waste.

–If the hazardous waste exhibits any other characteristic identified under section 3001 (including any other characteristic plus the characteristic of toxicity [or the characteristic of EP toxicity]), include the mass of the entire hazardous waste.

Based on this mass, designated as C, assign a value for hazardous constituent quantity as follows:

• For the migration pathways, assign the source a value for hazardous constituent quantity using the Tier A equation of table 2–5.

• For the soil exposure pathway, assign the area of observed contamination a value using the Tier A equation of table 5–2 (section 5.1.2.2).

If the hazardous constituent quantity for the source (or area of observed contamination) is adequately determined (that is, the total mass of all CERCLA hazardous substances in the source and releases from the source [or in the area of observed contamination] is known or is estimated with reasonable confidence), do not evaluate the other three measures discussed below. Instead assign these other three measures a value of 0 for the source (or area of observed contamination) and proceed to section 2.4.2.1.5.

If the hazardous constituent quantity is not adequately determined, assign the source (or area of observed contamination) a value for hazardous constituent quantity based on the available data and proceed to section 2.4.2.1.2.

TABLE 2–5—HAZARDOUS WASTE QUANTITY EVALUATION EQUATIONS

Tier	Measure	Units	Equation for assigning value[a]
A	Hazardous constituent quantity (C)	lb	C
B[b]	Hazardous wastestream quantity (W)	lb	W/5,000
C[b]	Volume (V)		
	Landfill	yd^3	V/2,500
	Surface impoundment	yd^3	V/2.5
	Surface impoundment (buried/backfilled)	yd^3	V/2.5
	Drums[c]	gallon	V/500
	Tanks and containers other than drums	yd^3	V/2.5
	Contaminated soil	yd^3	V/2,500
	Pile	yd^3	V/2.5
	Other	yd^3	V/2.5
D[b]	Area (A).		
	Landfill	ft^2	A/3,400
	Surface impoundment	ft^2	A/13
	Surface impoundment (buried/backfilled)	ft^2	A/13
	Land treatment	ft^2	A/270
	Pile[d]	ft^2	A/13
	Contaminated soil	ft^2	A/34,000

[a] Do not round to nearest integer.
[b] Convert volume to mass when necessary: 1 ton=2,000 pounds=1 cubic yard=4 drums=200 gallons.
[c] If actual volume of drums is unavailable, assume 1 drum=50 gallons.
[d] Use land surface area under pile, not surface area of pile.

2.4.2.1.2 *Hazardous wastestream quantity.* Evaluate hazardous wastestream quantity for the source (or area of observed contamination) based on the mass of hazardous wastestreams plus the mass of any additional CERCLA pollutants and contaminants (as defined in CERCLA section 101[33], as amended) that are allocated to the source (or area of observed contamination). For a wastestream that consists solely of a hazardous waste listed pursuant to section 3001 of RCRA, as amended or that consists solely of a RCRA hazardous waste that exhibits the characteristics identified under section 3001 of RCRA, as amended, include the mass of that entire hazardous waste in the evaluation of this measure.

Based on this mass, designated as W, assign a value for hazardous wastestream quantity as follows:

• For the migration pathways, assign the source a value for hazardous wastestream quantity using the Tier B equation of table 2–5.

• For the soil exposure pathway, assign the area of observed contamination a value using the Tier B equation of table 5–2 (section 5.1.2.2).

Do not evaluate the volume and area measures described below if the source is the unallocated source or if the following condition applies:

• The hazardous wastestream quantity for the source (or area of observed contamination) is adequately determined—that is, total mass of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source (or for the area of observed contamination) is known or is estimated with reasonable confidence.

If the source is the unallocated source or if this condition applies, assign the volume and area measures a value of 0 for the source (or area of observed contamination) and proceed to section 2.4.2.1.5. Otherwise, assign the source (or area of observed contamination) a value for hazardous wastestream quantity based on the available data and proceed to section 2.4.2.1.3.

2.4.2.1.3 *Volume.* Evaluate the volume measure using the volume of the source (or the volume of the area of observed contamination). For the soil exposure pathway, restrict the use of the volume measure to those areas of observed contamination specified in section 5.1.2.2.

Based on the volume, designated as V, assign a value to the volume measure as follows:

• For the migration pathways, assign the source a value for volume using the appropriate Tier C equation of table 2–5.

• For the soil exposure pathway, assign the area of observed contamination a value for volume using the appropriate Tier C equation of table 5–2 (section 5.1.2.2).

If the volume of the source (or volume of the area of observed contamination, if applicable) can be determined, do not evaluate the area measure. Instead, assign the area measure a value of 0 and proceed to section 2.4.2.1.5. If the volume cannot be determined (or is not applicable for the soil exposure pathway), assign the source (or area of observed contamination) a value of 0 for the volume measure and proceed to section 2.4.2.1.4.

2.4.2.1.4 *Area.* Evaluate the area measure using the area of the source (or the area of the area of observed contamination). Based on this area, designated as A, assign a value to the area measure as follows:

• For the migration pathways, assign the source a value for area using the appropriate Tier D equation of table 2–5.

• For the soil exposure pathway, assign the area of observed contamination a value for area using the appropriate Tier D equation of table 5–2 (section 5.1.2.2).

2.4.2.1.5 *Calculation of source hazardous waste quantity value.* Select the highest of the values assigned to the source (or area of observed contamination) for the hazardous constituent quantity, hazardous wastestream quantity, volume, and area measures. Assign this value as the source hazardous waste quantity value. Do not round to the nearest integer.

2.4.2.2 *Calculation of hazardous waste quantity factor value.* Sum the source hazardous waste quantity values assigned to all sources (including the unallocated source) or areas of observed contamination for the pathway being evaluated and round this sum to the nearest integer, except: if the sum is greater than 0, but less than 1, round it to 1. Based on this value, select a hazardous waste quantity factor value for the pathway from table 2–6.

TABLE 2–6—HAZARDOUS WASTE QUANTITY FACTOR VALUES

Hazardous waste quantity value	Assigned value
0	0
1 [a] to 100	1 [b]
Greater than 100 to 10,000	100
Greater than 10,000 to 1,000,000	10,000
Greater than 1,000,000	1,000,000

[a] If the hazardous waste quantity value is greater than 0, but less than 1, round it to 1 as specified in text.

[b] For the pathway, if hazardous constituent quantity is not adequately determined, assign a value as specified in the text; do not assign the value of 1.

For a migration pathway, if the hazardous constituent quantity is adequately determined (see section 2.4.2.1.1) for all sources (or all portions of sources and releases remaining after a removal action), assign the value from table 2–6 as the hazardous waste quantity factor value for the pathway. If the hazardous constituent quantity is not adequately determined for one or more sources (or one or more portions of sources or releases remaining after a removal action) assign a factor value as follows:

• If any target for that migration pathway is subject to Level I or Level II concentrations (see section 2.5), assign either the value from table 2–6 or a value of 100, whichever is greater, as the hazardous waste quantity factor value for that pathway.

• If none of the targets for that pathway is subject to Level I or Level II concentrations, assign a factor value as follows:

–If there has been no removal action, assign either the value from table 2–6 or a value of 10, whichever is greater, as the hazardous waste quantity factor value for that pathway.

–If there has been a removal action:

–Determine values from table 2–6 with and without consideration of the removal action.

–If the value that would be assigned from table 2–6 without consideration of the removal action would be 100 or greater, assign either the value from table 2–6 with consideration of the removal action or a value of 100, whichever is greater, as the hazardous waste quantity factor value for the pathway.

–If the value that would be assigned from table 2–6 without consideration of the removal action would be less than 100, assign a value of 10 as the hazardous waste quantity factor value for the pathway.

For the soil exposure pathway, if the hazardous constituent quantity is adequately determined for all areas of observed contamination, assign the value from table 2–6 as the hazardous waste quantity factor value. If the hazardous constituent quantity is not adequately determined for one or more areas of observed contamination, assign either the value from table 2–6 or a value of 10, whichever is greater, as the hazardous waste quantity factor value.

2.4.3 *Waste characteristics factor category value.* Determine the waste characteristics factor category value as specified in section 2.4.3.1 for all pathways and threats, except the surface water-human food chain threat and the surface water-environmental threat. Determine the waste characteristics factor category value for these latter two threats as specified in section 2.4.3.2.

2.4.3.1 *Factor category value.* For the pathway (or threat) being evaluated, multiply the toxicity or combined factor value, as appropriate, from section 2.4.1.2 and the hazardous waste quantity factor value from section 2.4.2.2, subject to a maximum product of 1×10^8. Based on this waste characteristics product, assign a waste characteristics factor category value to the pathway (or threat) from table 2–7.

TABLE 2–7—WASTE CHARACTERISTICS FACTOR CATEGORY VALUES

Waste characteristics product	Assigned value
0	0
Greater than 0 to less than 10	1
10 to less than 1×10^2	2
1×10^2 to less than 1×10^3	3
1×10^3 to less than 1×10^4	6
1×10^4 to less than 1×10^5	10
1×10^5 to less than 1×10^6	18
1×10^6 to less than 1×10^7	32
1×10^7 to less than 1×10^8	56
1×10^8 to less than 1×10^9	100
1×10^9 to less than 1×10^{10}	180
1×10^{10} to less than 1×10^{11}	320
1×10^{11} to less than 1×10^{12}	560
1×10^{12}	1,000

2.4.3.2 *Factor category value, considering bioaccumulation potential.* For the surface water-human food chain threat and the surface water-environmental threat, multiply the toxicity or combined factor value, as appropriate, from section 2.4.1.2 and the hazardous waste quantity factor value from section 2.4.2.2, subject to:

• A maximum product of 1×10^{12}, *and*

• A maximum product exclusive of the bioaccumulation (or ecosystem bioaccumulation) potential factor of 1×10^8.

Based on the total waste characteristics product, assign a waste characteristics factor category value to these threats from table 2–7.

2.5 *Targets.*

The types of targets evaluated include the following:

• Individual (factor name varies by pathway and threat).

• Human population.

• Resources (these vary by pathway and threat).

• Sensitive environments (included for all pathways except ground water migration).

The factor values that may be assigned to each type of target have the same range for each pathway for which that type of target is evaluated. The factor value for most types of targets depends on whether the target is subject to actual or potential contamination for the pathway and whether the actual contamination is Level I or Level II:

• Actual contamination: Target is associated either with a sampling location that meets the criteria for an observed release (or observed contamination) for the pathway or with an observed release based on direct observation for the pathway (additional criteria apply for establishing actual contamination for the human food chain threat in the surface water migration pathway, see sections 4.1.3.3 and 4.2.3.3). sections 3 through 6 specify how to determine the targets associated with a sampling location or with an observed release based on direct observation. Determine whether the actual contamination is Level I or Level II as follows:

–Level I:

–Media-specific concentrations for the target meet the criteria for an observed release (or observed contamination) for the pathway and are at or above media-specific benchmark values. These benchmark values (see section 2.5.2) include both screening concentrations and concentrations specified in regulatory limits (such as Maximum Contaminant Level (MCL) values), or

–For the human food chain threat in the surface water migration pathway, concentrations in tissue samples from aquatic human food chain organisms are at or above benchmark values. Such tissue samples may be used in addition to media-specific concentrations only as specified in sections 4.1.3.3 and 4.2.3.3.

–Level II:

–Media-specific concentrations for the target meet the criteria for an observed release (or observed contamination) for the pathway, but are less than media-specific benchmarks. If none of the hazardous substances eligible to be evaluated for the sampling location has an applicable benchmark, assign Level II to the actual contamination at the sampling location, or

–For observed releases based on direct observation, assign Level II to targets as specified in sections 3, 4, and 6, or

–For the human food chain threat in the surface water migration pathway, concentrations in tissue samples from aquatic human food chain organisms, when applicable, are below benchmark values.

–If a target is subject to both Level I and Level II concentrations for a pathway (or threat), evaluate the target using Level I concentrations for that pathway (or threat).

• Potential contamination: Target is subject to a potential release (that is, target is not associated with actual contamination for that pathway or threat).

Assign a factor value for individual risk as follows (select the highest value that applies to the pathway or threat):

• 50 points if any individual is exposed to Level I concentrations.

• 45 points if any individual is exposed to Level II concentrations.

• Maximum of 20 points if any individual is subject to potential contamination. The value assigned is 20 multiplied by the distance or dilution weight appropriate to the pathway.

Assign factor values for population and sensitive environments as follows:

• Sum Level I targets and multiply by 10. (Level I is not used for sensitive environments in the soil exposure and air migration pathways.)

• Sum Level II targets.

• Multiply potential targets by distance or dilution weights appropriate to the pathway, sum, and divide by 10. Distance or dilution weighting accounts for diminishing exposure with increasing distance or dilution within the different pathways.

• Sum the values for the three levels.

In addition, resource value points are assigned within all pathways for welfare-related impacts (for example, impacts to agricultural land), but do not depend on whether there is actual or potential contamination.

2.5.1 *Determination of level of actual contamination at a sampling location.* Determine whether Level I concentrations or Level II concentrations apply at a sampling location (and thus to the associated targets) as follows:

• Select the benchmarks applicable to the pathway (or threat) being evaluated.

• Compare the concentrations of hazardous substances in the sample (or comparable samples) to their benchmark concentrations for the pathway (or threat), as specified in section 2.5.2.

• Determine which level applies based on this comparison.

• If none of the hazardous substances eligible to be evaluated for the sampling location has an applicable benchmark, assign Level II to the actual contamination at that sampling location for the pathway (or threat).

In making the comparison, consider only those samples, and only those hazardous substances in the sample, that meet the criteria for an observed release (or observed contamination) for the pathway, except: tissue samples from aquatic human food chain organisms may also be used as specified in sections 4.1.3.3 and 4.2.3.3 of the surface water-human food chain threat. If any hazardous substance is present in more than one comparable sample for the sampling location, use the highest concentration of that hazardous substance from any of the comparable samples in making the comparisons.

Treat sets of samples that are not comparable separately and make a separate comparison for each such set.

2.5.2 *Comparison to benchmarks.* Use the following media-specific benchmarks for making the comparisons for the indicated pathway (or threat):

• Maximum Contaminant Level Goals (MCLGs)—ground water migration pathway and drinking water threat in surface water migration pathway. Use only MCLG values greater than 0.

• Maximum Contaminant Levels (MCLs)—ground water migration pathway and drinking water threat in surface water migration pathway.

• Food and Drug Administration Action Level (FDAAL) for fish or shellfish—human food chain threat in surface water migration pathway.

• EPA Ambient Water Quality Criteria (AWQC) for protection of aquatic life—environmental threat in surface water migration pathway.

• EPA Ambient Aquatic Life Advisory Concentrations (AALAC)—environmental threat in surface water migration pathway.

• National Ambient Air Quality Standards (NAAQS)—air migration pathway.

• National Emission Standards for Hazardous Air Pollutants (NESHAPs)—air migration pathway. Use only those NESHAPs promulgated in ambient concentration units.

• Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for inhalation exposures (air migration pathway) or for oral exposures (ground water migration pathway; drinking water and human food chain threats in surface water migration pathway; and soil exposure pathway).

• Screening concentration for noncancer toxicological responses corresponding to the RfD for inhalation exposures (air migration pathway) or for oral exposures (ground water migration pathway; drinking water and human food chain threats in surface water migration pathway; and soil exposure pathway).

Select the benchmark(s) applicable to the pathway (or threat) being evaluated as specified in sections 3 through 6. Compare the concentration of each hazardous substance from the sampling location to its benchmark concentration(s) for that pathway (or threat). Use only those samples and only those hazardous substances in the sample that meet the criteria for an observed release (or observed contamination) for the pathway, except: tissue samples from aquatic human food chain organisms may be used as specified in sections 4.1.3.3 and 4.2.3.3. If the concentration of any applicable hazardous substance from any sample equals or exceeds its benchmark concentration, consider the sampling location to be subject to Level I concentrations for that pathway (or threat). If more than one benchmark applies to the hazardous substance, assign Level I if the concentration of the hazardous substance equals or exceeds the lowest applicable benchmark concentration.

If no hazardous substance individually equals or exceeds its benchmark concentration, but more than one hazardous substance either meets the criteria for an observed release (or observed contamination) for the sample (or comparable samples) or is eligible to be evaluated for a tissue sample (see sections 4.1.3.3 and 4.2.3.3), calculate the indices I and J specified below based on these hazardous substances.

For those hazardous substances that are carcinogens (that is, those having a carcinogen weight-of-evidence classification of A, B, or C), calculate an index I for the sample location as follows:

$$I = \sum_{i=1}^{n} \frac{C_i}{SC_i}$$

where:

C_i=Concentration of hazardous substance i in sample (or highest concentration of hazardous substance i from among comparable samples).

SC_i=Screening concentration for cancer corresponding to that concentration that corresponds to its 10^{-6} individual cancer risk for applicable exposure (inhalation or oral) for hazardous substance i.

n=Number of applicable hazardous substances in sample (or comparable samples) that are carcinogens and for which an SC_i is available.

For those hazardous substances for which an RfD is available, calculate an index J for the sample location as follows:

$$I = \sum_{j=1}^{m} \frac{C_j}{CR_j}$$

where:

C_j=Concentration of hazardous substance j in sample (or highest concentration of hazardous substance j from among comparable samples).

CR_j=Screening concentration for noncancer toxicological responses corresponding to RfD for applicable exposure (inhalation or oral) for hazardous substance j.

m=Number of applicable hazardous substances in sample (or comparable samples) for which a CR_j is available.

If either I or J equals or exceeds 1, consider the sampling location to be subject to Level I concentrations for that pathway (or threat). If both I and J are less than 1, consider the sampling location to be subject to Level II concentrations for that pathway (or threat). If, for the sampling location, there are sets of samples that are not comparable, calculate I and J separately for each such set, and use the highest calculated values of I and J to assign Level I and Level II.

See sections 7.3.1 and 7.3.2 for criteria for determining the level of contamination for radioactive substances.

3.0 Ground Water Migration Pathway

Evaluate the ground water migration pathway based on three factor categories: likelihood of release, waste characteristics, and targets. Figure 3–1 indicates the factors included within each factor category.

Determine the ground water migration pathway score (S_{gw}) in terms of the factor category values as follows:

$$S_{gw} = \frac{(LR)(WC)(T)}{SF}$$

where:

LR=Likelihood of release factor category value.

WC=Waste characteristics factor category value.

T=Targets factor category value.

SF=Scaling factor.

Table 3–1 outlines the specific calculation procedure.

Calculate a separate ground water migration pathway score for each aquifer, using the factor category values for that aquifer for likelihood of release, waste characteristics, and targets. In doing so, include both the targets using water from that aquifer and the targets using water from all overlying aquifers through which the hazardous substances would migrate to reach the aquifer being evaluated. Assign the highest ground water migration pathway score that results for any aquifer as the ground water migration pathway score for the site.

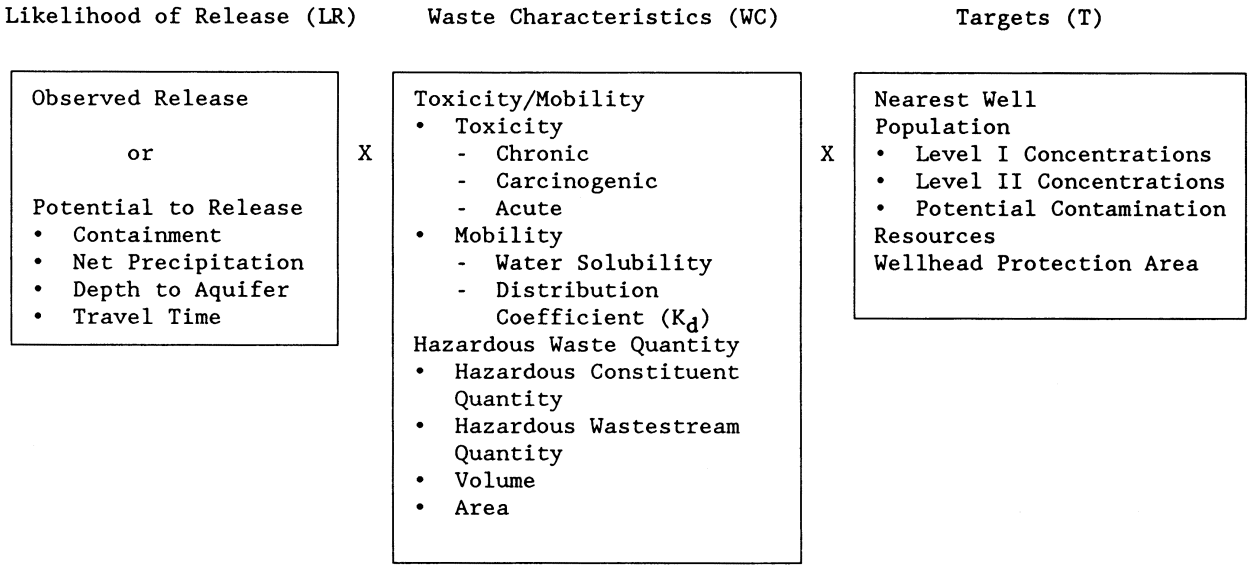


FIGURE 3-1
OVERVIEW OF GROUND WATER MIGRATION PATHWAY

TABLE 3–1—GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor categories and factors	Maximum value	Value assigned
Likelihood of Release to an Aquifer:		
1. Observed Release	550	
2. Potential to Release:		
2a. Containment	10	
2b. Net Precipitation	10	
2c. Depth to Aquifer	5	
2d. Travel Time	35	
2e. Potential to Release [lines 2a(2b+2c+2d)]	500	
3. Likelihood of Release (higher of lines 1 and 2e)	550	
Waste Characteristics:		
4. Toxicity/Mobility	(a)	
5. Hazardous Waste Quantity	(a)	
6. Waste Characteristics	100	
Targets:		
7. Nearest Well	50	
8. Population:		
8a. Level I Concentrations	(b)	
8b. Level II Concentrations	(b)	
8c. Potential Contamination	(b)	
8d. Population (lines 8a+8b+8c)	(b)	
9. Resources	5	
10. Wellhead Protection Area	20	
11. Targets (lines 7+8d+9+10)	(b)	
Ground Water Migration Score for an Aquifer:		
12. Aquifer Score [(lines 3 x 6 x 11)/82,500][c]	100	
Ground Water Migration Pathway Score:		
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated)[c]	100	

[a] Maximum value applies to waste characteristics category.
[b] Maximum value not applicable.
[c] Do not round to nearest integer.

3.0.1 *General considerations*

3.0.1.1 *Ground water target distance limit.* The target distance limit defines the maximum distance from the sources at the site over which targets are evaluated. Use a target distance limit of 4 miles for the ground water migration pathway, except when aquifer discontinuities apply (see section 3.0.1.2.2). Furthermore, consider any well with an observed release from a source at the site (see section 3.1.1) to lie within the target distance limit of the site, regardless of the well's distance from the sources at the site.

For sites that consist solely of a contaminated ground water plume with no identified source, begin measuring the 4-mile target distance limit at the center of the area of observed ground water contamination. Determine the area of observed ground water contamination based on available samples that meet the criteria for an observed release.

3.0.1.2 *Aquifer boundaries.* Combine multiple aquifers into a single hydrologic unit for scoring purposes if aquifer interconnections can be established for these aquifers. In contrast, restrict aquifer boundaries if aquifer discontinuities can be established.

3.0.1.2.1 *Aquifer interconnections.* Evaluate whether aquifer interconnections occur within 2 miles of the sources at the site. If they occur within this 2-mile distance, combine the aquifers having interconnections in scoring the site. In addition, if observed ground water contamination attributable to the sources at the site extends beyond 2 miles from the sources, use any locations within the limits of this observed ground water contamination in evaluating aquifer interconnections. If data are not adequate to establish aquifer interconnections, evaluate the aquifers as separate aquifers.

3.0.1.2.2 *Aquifer discontinuities.* Evaluate whether aquifer discontinuities occur within the 4-mile target distance limit. An aquifer discontinuity occurs for scoring purposes only when a geologic, topographic, or other structure or feature entirely transects an aquifer within the 4-mile target distance limit, thereby creating a continuous boundary to ground water flow within this limit. If two or more aquifers can be combined into a single hydrologic unit for scoring purposes, an aquifer discontinuity occurs only when the structure or feature entirely transects the boundaries of this single hydrologic unit.

When an aquifer discontinuity is established within the 4-mile target distance limit, exclude that portion of the aquifer beyond the discontinuity in evaluating the ground water migration pathway. However, if hazardous substances have migrated across an apparent discontinuity within the 4-mile target distance limit, do not consider this to be a discontinuity in scoring the site.

3.0.1.3 *Karst aquifer.* Give a karst aquifer that underlies any portion of the sources at

the site special consideration in the evaluation of two potential to release factors (depth to aquifer in section 3.1.2.3 and travel time in section 3.1.2.4), one waste characteristics factor (mobility in section 3.2.1.2), and two targets factors (nearest well in section 3.3.1 and potential contamination in section 3.3.2.4).

3.1 *Likelihood of release.* For an aquifer, evaluate the likelihood of release factor category in terms of an observed release factor or a potential to release factor.

3.1.1 *Observed release.* Establish an observed release to an aquifer by demonstrating that the site has released a hazardous substance to the aquifer. Base this demonstration on either:

• Direct observation—a material that contains one or more hazardous substances has been deposited into or has been observed entering the aquifer.

• Chemical analysis—an analysis of ground water samples from the aquifer indicates that the concentration of hazardous substance(s) has increased significantly above the background concentration for the site (see section 2.3). Some portion of the significant increase must be attributable to the site to establish the observed release, except: when the source itself consists of a ground water plume with no identified source, no separate attribution is required.

If an observed release can be established for the aquifer, assign the aquifer an observed release factor value of 550, enter this value in table 3–1, and proceed to section 3.1.3. If an observed release cannot be established for the aquifer, assign an observed release factor value of 0, enter this value in table 3–1, and proceed to section 3.1.2.

3.1.2 *Potential to release.* Evaluate potential to release only if an observed release cannot be established for the aquifer. Evaluate potential to release based on four factors: containment, net precipitation, depth to aquifer, and travel time. For sources overlying karst terrain, give any karst aquifer that underlies any portion of the sources at the site special consideration in evaluating depth to aquifer and travel time, as specified in sections 3.1.2.3 and 3.1.2.4.

3.1.2.1 *Containment.* Assign a containment factor value from table 3–2 to each source at the site. Select the highest containment factor value assigned to those sources with a source hazardous waste quantity value of 0.5 or more (see section 2.4.2.1.5). (Do not include this minimum size requirement in evaluating any other factor of this pathway.) Assign this highest value as the containment factor value for the aquifer being evaluated. Enter this value in Table 3–1.

If no source at the site meets the minimum size requirement, then select the highest value assigned to the sources at the site and assign it as the containment factor value for the aquifer being evaluated. Enter this value in table 3–1.

3.1.2.2 *Net precipitation.* Assign a net precipitation factor value to the site. Figure 3–2 provides computed net precipitation factor values, based on site location. Where necessary, determine the net precipitation factor value as follows:

• Determine monthly precipitation and monthly evapotranspiration:

–Use local measured monthly averages.

–When local data are not available, use monthly averages from the nearest National Oceanographic and Atmospheric Administration weather station that is in a similar geographic setting.

TABLE 3–2—CONTAINMENT FACTOR VALUES FOR GROUND WATER MIGRATION PATHWAY

Source	Assigned value
All Sources (Except Surface Impoundments, Land Treatment, Containers, and Tanks)	
Evidence of hazardous substance migration from source area (i.e., source area includes source and any associated containment structures).	10
No liner	10
No evidence of hazardous substance migration from source area, a liner, *and:*	
(a) None of the following present: (1) maintained engineered cover, or (2) functioning and maintained run-on control system and runoff management system, or (3) functioning leachate collection and removal system immediately above liner.	10
(b) Any one of the three items in (a) present	9
(c) Any two of the items in (a) present	7
(d) All three items in (a) present plus a functioning ground water monitoring system	5
(e) All items in (d) present, plus no bulk or non-containerized liquids nor materials containing free liquids deposited in source area.	3
No evidence of hazardous substance migration from source area, double liner with functioning leachate collection and removal system above and between liners, functioning ground water monitoring system, *and:*	
(f) Only one of the following deficiencies present in containment: (1) bulk or noncontainerized liquids or materials containing free liquids deposited in source area, or (2) no or nonfunctioning or nonmaintained run-on control system and runoff management system, or (3) no or nonmaintained engineered cover.	3
(g) None of the deficiencies in (f) present	0
Source area inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate is generated, liquids or materials containing free liquids not deposited in source area, and functioning and maintained run-on control present.	0

TABLE 3–2—CONTAINMENT FACTOR VALUES FOR GROUND WATER MIGRATION PATHWAY—Continued

Source	Assigned value
Surface Impoundment	
Evidence of hazardous substance migration from surface impoundment	10
No liner	10
Free liquids present with either no diking, unsound diking, or diking that is not regularly inspected and maintained.	10
No evidence of hazardous substance migration from surface impoundment, free liquids present, sound diking that is regularly inspected and maintained, adequate freeboard, *and:*	
(a) Liner	9
(b) Liner with functioning leachate collection and removal system below liner, and functioning ground water monitoring system.	5
(c) Double liner with functioning leachate collection and removal system between liners, and functioning ground water monitoring system.	3
No evidence of hazardous substance migration from surface impoundment and all free liquids eliminated at closure (either by removal of liquids or solidification of remaining wastes and waste residues).	Evaluate using **All sources** criteria (with no bulk or free liquid deposited).
Land Treatment	
Evidence of hazardous substance migration from land treatment zone	10
No functioning, maintained, run-on control and runoff management system	10
No evidence of hazardous substance migration from land treatment zone *and:*	
(a) Functioning and maintained run-on control and runoff management system	7
(b) Functioning and maintained run-on control and runoff management system, and vegetative cover established over entire land treatment area.	5
(c) Land treatment area maintained in compliance with 40 CFR 264.280	0
Containers	
All containers buried	Evaluate using **All sources** criteria.
Evidence of hazardous substance migration from container area (i.e., container area includes containers and any associated containment structures).	10
No liner (or no essentially impervious base) under container area.	10
No diking (or no similar structure) surrounding container area	10
Diking surrounding container area unsound or not regularly inspected and maintained	10
No evidence of hazardous substance migration from container area, container area surrounded by sound diking that is regularly inspected and maintained, *and:*	
(a) Liner (or essentially impervious base) under container area	9
(b) Essentially impervious base under container area with liquids collection and removal system	7
(c) Containment system includes essentially impervious base, liquids collection system, sufficient capacity to contain 10 percent of volume of all containers, and functioning and maintained run-on control; plus functioning ground water monitoring system, and spilled or leaked hazardous substances and accumulated precipitation removed in timely manner to prevent overflow of collection system, at least weekly inspection of containers, hazardous substances in leaking or deteriorating containers transferred to containers in good condition, and containers sealed except when waste is added or removed.	5
(d) Free liquids present, containment system has sufficient capacity to hold total volume of all containers and to provide adequate freeboard, single liner under container area with functioning leachate collection and removal system below liner, and functioning ground water monitoring system.	5
(e) Same as (d) except: double liner under container area with functioning leachate collection and removal system between liners.	3
Containers inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate would be generated from any unsealed or ruptured containers, liquids or materials containing free liquids not deposited in any container, and functioning and maintained run-off control present.	0
No evidence of hazardous substance migration from container area, containers leaking, and all free liquids eliminated at closure (either by removal of liquid or solidification of remaining wastes and waste residues).	Evaluate using **All sources** criteria (with no bulk or free liquid deposited).
Tank	
Below-ground tank	Evaluate using **All sources** criteria.
Evidence of hazardous substance migration from tank area (i.e., tank area includes tank, ancillary equipment such as piping, and any associated containment structures).	10
Tank and ancillary equipment not provided with secondary containment (e.g., liner under tank area, vault system, double wall).	10
No diking (or no similar structure) surrounding tank and ancillary equipment	10
Diking surrounding tank and ancillary equipment unsound or not regularly inspected and maintained	10

TABLE 3–2—CONTAINMENT FACTOR VALUES FOR GROUND WATER MIGRATION PATHWAY—Continued

Source	Assigned value
No evidence of hazardous substance migration from tank area, tank and ancillary equipment surrounded by sound diking that is regularly inspected and maintained, *and:*	
(a) Tank and ancillary equipment provided with secondary containment	9
(b) Tank and ancillary equipment provided with secondary containment with leak detection and collection system.	7
(c) Tank and ancillary equipment provided with secondary containment system that detects and collects spilled or leaked hazardous substances and accumulated precipitation and has sufficient capacity to contain 110 percent of volume of largest tank within containment area, spilled or leaked hazardous substances and accumulated precipitation removed in timely manner, at least weekly inspection of tank and secondary containment system, all leaking or unfit-for-use tank systems promptly responded to, and functioning ground water monitoring system.	5
(d) Containment system has sufficient capacity to hold volume of all tanks within tank containment area and to provide adequate freeboard, single liner under that containment area with functioning leachate collection and removal system below liner, and functioning ground water monitoring system.	5
(e) Same as (d) except: double liner under tank containment area with functioning leachate collection and removal system between liners.	3
Tank is above ground, and inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate would be generated from any material released from tank, liquids or materials containing free liquids not deposited in any tank, and functioning and maintained run-on control present.	0

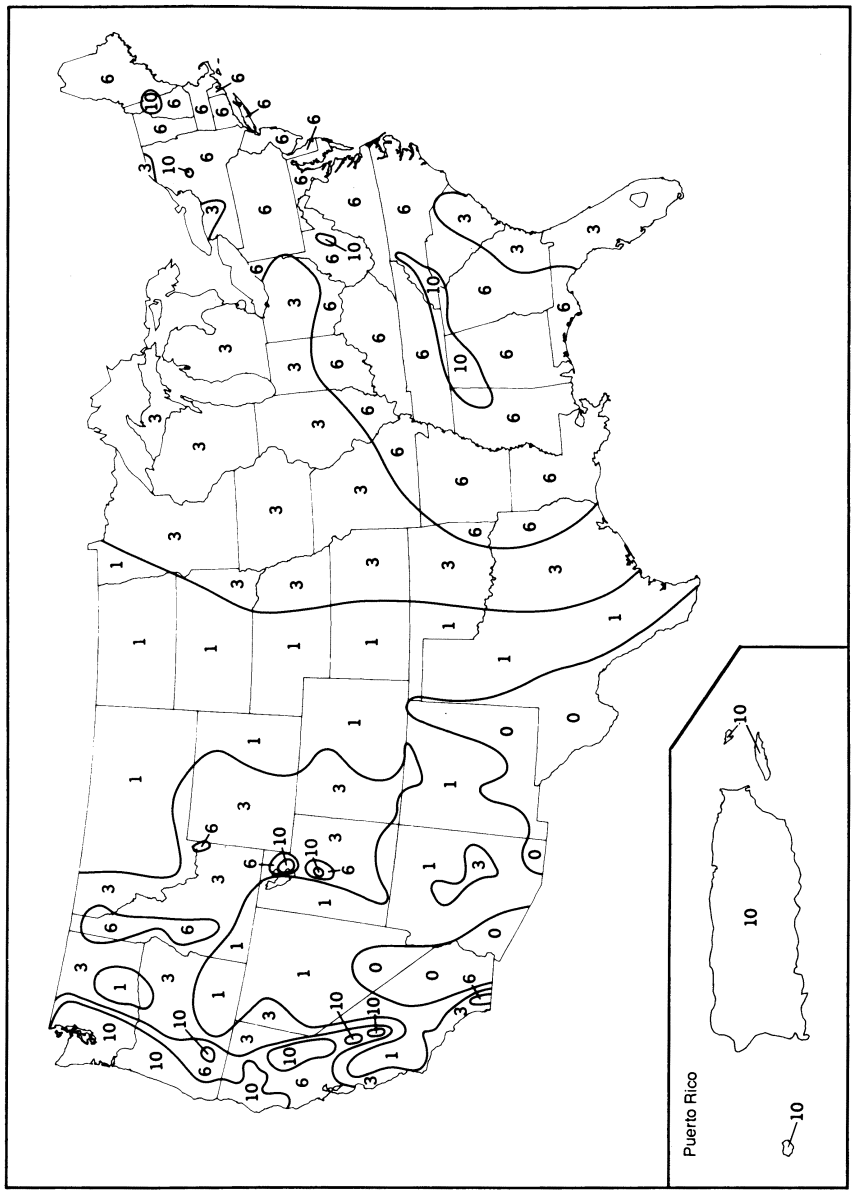


FIGURE 3-2
NET PRECIPITATION FACTOR VALUES

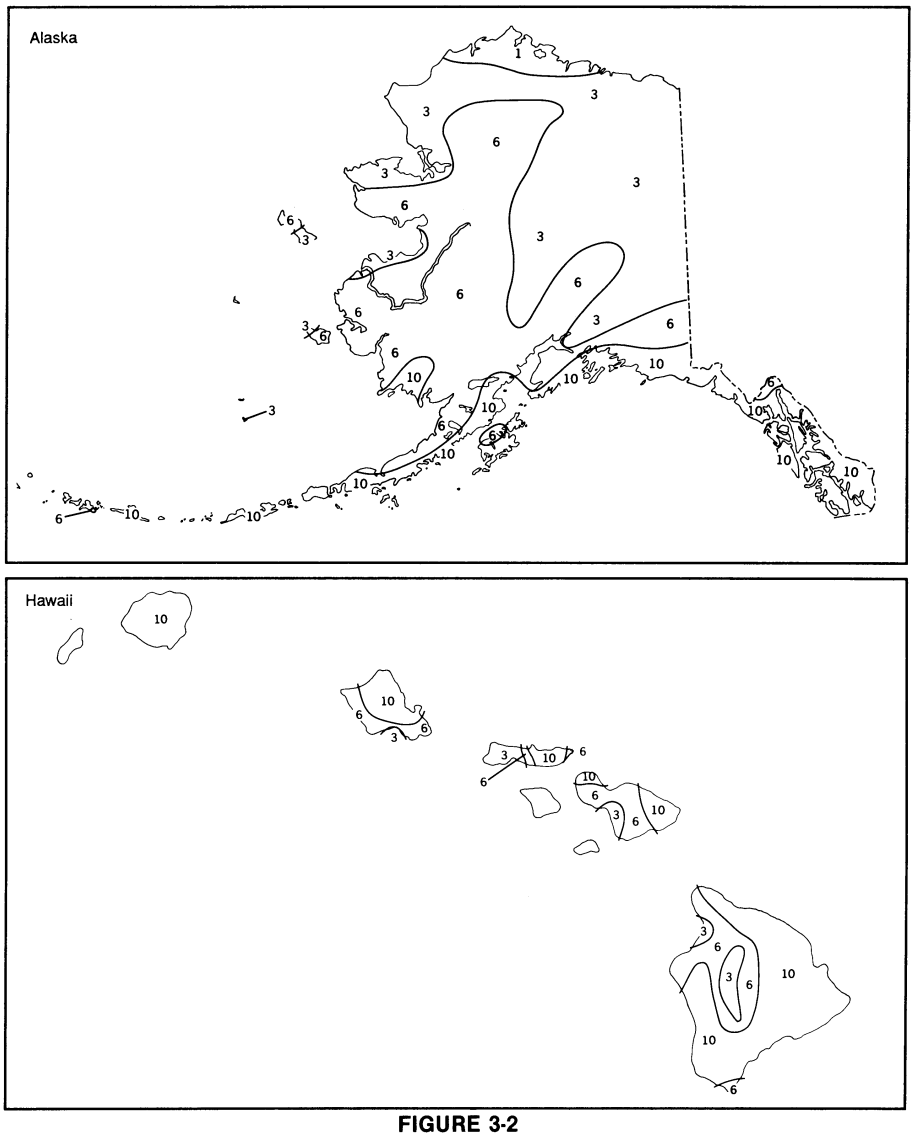


FIGURE 3-2
NET PRECIPITATION FACTOR VALUES
(CONCLUDED)

–When measured monthly evapotranspiration is not available, calculate monthly potential evapotranspiration (E_i) as follows:

$E_i = 0.6\ F_i\ (10\ T_i/I)^a$

where:

E_i=Monthly potential evapotranspiration (inches) for month i.

F_i=Monthly latitude adjusting value for month i.

T_i=Mean monthly temperature (°C) for month i.

$$I = \sum_{i=1}^{12} (T_i/5)^{1.514}$$

$a = 6.75\times10^{-7}\, I^3 - 7.71\times10^{-5}\, I^2 + 1.79\times10^{-2}\, I + 0.49239$

Select the latitude adjusting value for each month from table 3–3. For latitudes lower than 50° North or 20° South, determine the monthly latitude adjusting value by interpolation.

• Calculate monthly net precipitation by subtracting monthly evapotranspiration (or monthly potential evapotranspiration) from monthly precipitation. If evapotranspiration (or potential evapotranspiration) exceeds precipitation for a month, assign that month a net precipitation value of 0.

• Calculate the annual net precipitation by summing the monthly net precipitation values.

• Based on the annual net precipitation, assign a net precipitation factor value from table 3–4.

Enter the value assigned from Figure 3–2 or from table 3–4, as appropriate, in table 3–1.

TABLE 3–3—MONTHLY LATITUDE ADJUSTING VALUES [A]

Latitude [b] (degrees)	Month											
	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
≥50 N	0.74	0.78	1.02	1.15	1.33	1.36	1.37	1.25	1.06	0.92	0.76	0.70
45 N	0.80	0.81	1.02	1.13	1.28	1.29	1.31	1.21	1.04	0.94	0.79	0.75
40 N	0.84	0.83	1.03	1.11	1.24	1.25	1.27	1.18	1.04	0.96	0.83	0.81
35 N	0.87	0.85	1.03	1.09	1.21	1.21	1.23	1.16	1.03	0.97	0.89	0.85
30 N	0.90	0.87	1.03	1.08	1.18	1.17	1.20	1.14	1.03	0.98	0.89	0.88
20 N	0.95	0.90	1.03	1.05	1.13	1.11	1.14	1.11	1.02	1.00	0.93	0.94
10 N	1.00	0.91	1.03	1.03	1.08	1.06	1.08	1.07	1.02	1.02	0.98	0.99
0	1.04	0.94	1.04	1.01	1.04	1.01	1.04	1.04	1.01	1.04	1.01	1.04
10 S	1.08	0.97	1.05	0.99	1.00	0.96	1.00	1.02	1.00	1.06	1.05	1.09
20 S	1.14	0.99	1.05	0.97	0.96	0.91	0.95	0.99	1.00	1.08	1.09	1.15

[a] Do not round to nearest integer.
[b] For unlisted latitudes lower than 50° North or 20° South, determine the latitude adjusting value by interpolation.

TABLE 3–4—NET PRECIPITATION FACTOR VALUES

Net precipitation (inches)	Assigned value
0	0
Greater than 0 to 5	1
Greater than 5 to 15	3
Greater than 15 to 30	6
Greater than 30	10

3.1.2.3 *Depth to aquifer*. Evaluate depth to aquifer by determining the depth from the lowest known point of hazardous substances at a site to the top of the aquifer being evaluated, considering all layers in that interval. Measure the depth to an aquifer as the distance from the surface to the top of the aquifer minus the distance from the surface to the lowest known point of hazardous substances eligible to be evaluated for that aquifer. In evaluating depth to aquifer in karst terrain, assign a thickness of 0 feet to a karst aquifer that underlies any portion of the sources at the site. Based on the calculated depth, assign a value from table 3–5 to the depth to aquifer factor.

Determine the depth to aquifer only at locations within 2 miles of the sources at the site, except: if observed ground water contamination attributable to sources at the site extends more than 2 miles beyond these sources, use any location within the limits of this observed ground water contamination when evaluating the depth to aquifer factor for any aquifer that does not have an observed release. If the necessary geologic information is available at multiple locations, calculate the depth to aquifer at each location. Use the location having the smallest depth to assign the factor value. Enter this value in table 3–1.

TABLE 3–5—DEPTH TO AQUIFER FACTOR VALUES

Depth to aquifer [a] (feet)	Assigned value
Less than or equal to 25	5
Greater than 25 to 250	3
Greater than 250	1

[a] Use depth of all layers between the hazardous substances and aquifer. Assign a thickness of 0 feet to any karst aquifer that underlies any portion of the sources at the site.

3.1.2.4 *Travel time*. Evaluate the travel time factor based on the geologic materials in the interval between the lowest known point of hazardous substances at the site and the top of the aquifer being evaluated. Assign a value to the travel time factor as follows:

• If the depth to aquifer (see section 3.1.2.3) is 10 feet or less, assign a value of 35.

• If, for the interval being evaluated, all layers that underlie a portion of the sources at the site are karst, assign a value of 35.

• Otherwise:

–Select the lowest hydraulic conductivity layer(s) from within the above interval.

Consider only layers at least 3 feet thick. However, do not consider layers or portions of layers within the first 10 feet of the depth to the aquifer.

–Determine hydraulic conductivities for individual layers from table 3–6 or from in-situ or laboratory tests. Use representative, measured, hydraulic conductivity values whenever available.

–If more than one layer has the same lowest hydraulic conductivity, include all such layers and sum their thicknesses. Assign a thickness of 0 feet to a karst layer that underlies any portion of the sources at the site.

–Assign a value from table 3–7 to the travel time factor, based on the thickness and hydraulic conductivity of the lowest hydraulic conductivity layer(s).

TABLE 3–6—HYDRAULIC CONDUCTIVITY OF GEOLOGIC MATERIALS

Type of material	Assigned hydraulic conductivity [a] (cm/sec)
Clay; low permeability till (compact unfractured till); shale; unfractured metamorphic and igneous rocks	10^{-8}
Silt; loesses; silty clays; sediments that are predominantly silts; moderately permeable till (fine-grained, unconsolidated till, or compact till with some fractures); low permeability limestones and dolomites (no karst); low permeability sandstone; low permeability fractured igneous and metamorphic rocks	10^{-6}
Sands; sandy silts; sediments that are predominantly sand; highly permeable till (coarse-grained, unconsolidated or compact and highly fractured); peat; moderately permeable limestones and dolomites (no karst); moderately permeable sandstone; moderately permeable fractured igneous and metamorphic rocks	10^{-4}
Gravel; clean sand; highly permeable fractured igneous and metamorphic rocks; permeable basalt; karst limestones and dolomites	10^{-2}

[a] Do not round to nearest integer.

TABLE 3–7—TRAVEL TIME FACTOR VALUES [A]

Hydraulic conductivity (cm/sec)	Thickness of lowest hydraulic conductivity layer(s) [b] (feet)			
	Greater than 3 to 5	Greater than 5 to 100	Greater than 100 to 500	Greater than 500
Greater than or equal to 10^{-3}	35	35	35	25
Less than 10^{-3} to 10^{-5}	35	25	15	15
Less than 10^{-5} to 10^{-7}	15	15	5	5
Less than 10^{-7}	5	5	1	1

[a] If depth to aquifer is 10 feet or less or if, for the interval being evaluated, all layers that underlie a portion of the sources at the site are karst, assign a value of 35.

[b] Consider only layers at least 3 feet thick. Do not consider layers or portions of layers within the first 10 feet of the depth to the aquifer.

Determine travel time only at locations within 2 miles of the sources at the site, except: if observed ground water contamination attributable to sources at the site extends more than 2 miles beyond these sources, use any location within the limits of this observed ground water contamination when evaluating the travel time factor for any aquifer that does not have an observed release. If the necessary subsurface geologic information is available at multiple locations, evaluate the travel time factor at each location. Use the location having the highest travel time factor value to assign the factor value for the aquifer. Enter this value in table 3–1.

3.1.2.5 *Calculation of potential to release factor value.* Sum the factor values for net precipitation, depth to aquifer, and travel time, and multiply this sum by the factor value for containment. Assign this product as the potential to release factor value for the aquifer. Enter this value in table 3–1.

3.1.3 *Calculation of likelihood of release factor category value.* If an observed release is established for an aquifer, assign the observed release factor value of 550 as the likelihood of release factor category value for that aquifer. Otherwise, assign the potential to release factor value for that aquifer as the likelihood of release value. Enter the value assigned in table 3–1.

3.2 *Waste characteristics.* Evaluate the waste characteristics factor category for an aquifer based on two factors: toxicity/mobility and hazardous waste quantity. Evaluate only those hazardous substances available to migrate from the sources at the site to ground water. Such hazardous substances include:

• Hazardous substances that meet the criteria for an observed release to ground water.

• All hazardous substances associated with a source that has a ground water containment factor value greater than 0 (see sections 2.2.2, 2.2.3, and 3.1.2.1).

3.2.1 *Toxicity/mobility*. For each hazardous substance, assign a toxicity factor value, a mobility factor value, and a combined toxicity/mobility factor value as specified in the following sections. Select the toxicity/mobility factor value for the aquifer being evaluated as specified in section 3.2.1.3.

3.2.1.1 *Toxicity*. Assign a toxicity factor value to each hazardous substance as specified in Section 2.4.1.1.

3.2.1.2 *Mobility*. Assign a mobility factor value to each hazardous substance for the aquifer being evaluated as follows:

• For any hazardous substance that meets the criteria for an observed release by chemical analysis to one or more aquifers underlying the sources at the site, regardless of the aquifer being evaluated, assign a mobility factor value of 1.

• For any hazardous substance that does not meet the criteria for an observed release by chemical analysis to at least one of the aquifers, assign that hazardous substance a mobility factor value from table 3–8 for the aquifer being evaluated, based on its water solubility and distribution coefficient (K_d).

• If the hazardous substance cannot be assigned a mobility factor value because data on its water solubility or distribution coefficient are not available, use other hazardous substances for which information is available in evaluating the pathway.

TABLE 3–8—GROUND WATER MOBILITY FACTOR VALUES [A]

Water solubility (mg/l)	Distribution coefficient (K_d) (ml/g)			
	Karst [c]	≤10	>10 to 1,000	>1,000
Present as liquid [b]	1	1	0.01	0.0001
Greater than 100	1	1	0.01	0.0001
Greater than 1 to 100	0.2	0.2	0.002	2×10^{-5}
Greater than 0.01 to 1	0.002	0.002	2×10^{-5}	2×10^{-7}
Less than or equal to 0.01	2×10^{-5}	2×10^{-5}	2×10^{-7}	2×10^{-9}

[a] Do not round to nearest integer.
[b] Use if the hazardous substance is present or deposited as a liquid.
[c] Use if the entire interval from the source to the aquifer being evaluated is karst.

• If none of the hazardous substances eligible to be evaluated can be assigned a mobility factor value, use a default value of 0.002 as the mobility factor value for all these hazardous substances.

Determine the water solubility to be used in table 3–8 for the hazardous substance as follows (use this same water solubility for all aquifers):

• For any hazardous substance that does not meet the criteria for an observed release by chemical analysis, if the hazardous substance is present or deposited as a liquid, use the water solubility category ''Present as Liquid'' in table 3–8 to assign the mobility factor value to that hazardous substance.

• Otherwise:

–For any hazardous substance that is a metal (or metalloid) and that does not meet the criteria for an observed release by chemical analysis, establish a water solubility for the hazardous substance as follows:

–Determine the overall range of water solubilities for compounds of this hazardous substance (consider all compounds for which adequate water solubility information is available, not just compounds identified as present at the site).

–Calculate the geometric mean of the highest and the lowest water solubility in this range.

–Use this geometric mean as the water solubility in assigning the hazardous substance a mobility factor value from table 3–8.

–For any other hazardous substance (either organic or inorganic) that does not meet the criteria for an observed release by chemical analysis, use the water solubility of that hazardous substance to assign a mobility factor value from table 3–8 to the hazardous substance.

For the aquifer being evaluated, determine the distribution coefficient to be used in table 3–8 for the hazardous substance as follows:

• For any hazardous substance that does not meet the criteria for an observed release by chemical analysis, if the entire interval from a source at the site to the aquifer being evaluated is karst, use the distribution coefficient category ''Karst'' in table 3–8 in assigning the mobility factor value for that hazardous substance for that aquifer.

• Otherwise:

–For any hazardous substance that is a metal (or metalloid) and that does not meet the criteria for an observed release by chemical analysis, use the distribution coefficient for the metal or (metalloid) to assign a mobility factor value from table 3–8 for that hazardous substance.

–For any other inorganic hazardous substance that does not meet the criteria for an observed release by chemical analysis,

use the distribution coefficient for that inorganic hazardous substance, if available, to assign a mobility factor value from table 3–8. If the distribution coefficient is not available, use a default value of ''less than 10'' as the distribution coefficient, except: for asbestos use a default value of ''greater than 1,000'' as the distribution coefficient.

–For any hazardous substance that is organic and that does not meet the criteria for an observed release by chemical analysis, establish a distribution coefficient for that hazardous substance as follows:

–Estimate the K_d range for the hazardous substance using the following equation:

$K_d=(K_{oc})(f_s)$

where:

K_{oc}=Soil-water partition coefficient for organic carbon for the hazardous substance.

f_s=Sorbent content (fraction of clays plus organic carbon) in the subsurface.

–Use f_s values of 0.03 and 0.77 in the above equation to establish the upper and lower values of the K_d range for the hazardous substance.

–Calculate the geometric mean of the upper and lower K_d range values. Use this geometric mean as the distribution coefficient in assigning the hazardous substance a mobility factor value from table 3–8.

3.2.1.3 *Calculation of toxicity/mobility factor value.* Assign each hazardous substance a toxicity/mobility factor value from table 3–9, based on the values assigned to the hazardous substance for the toxicity and mobility factors. Use the hazardous substance with the highest toxicity/mobility factor value for the aquifer being evaluated to assign the value to the toxicity/mobility factor for that aquifer. Enter this value in table 3–1.

TABLE 3–9—TOXICITY/MOBILITY FACTOR VALUES [A]

Mobility factor value	Toxicity factor value					
	10,000	1,000	100	10	1	0
1.0	10,000	1,000	100	10	1	0
0.2	2,000	200	20	2	0.2	0
0.01	100	10	1	0.1	0.01	0
0.002	20	2	0.2	0.02	0.002	0
0.0001	1	0.1	0.01	0.001	1×10^{-4}	0
2×10^{-5}	0.2	0.02	0.002	2×10^{-4}	2×10^{-5}	0
2×10^{-7}	0.002	2×10^{-4}	2×10^{-5}	2×10^{-6}	2×10^{-7}	0
2×10^{-9}	2×10^{-5}	2×10^{-6}	2×10^{-7}	2×10^{-8}	2×10^{-9}	0

[a] Do not round to nearest integer.

3.2.2 *Hazardous waste quantity.* Assign a hazardous waste quantity factor value for the ground water pathway (or aquifer) as specified in section 2.4.2. Enter this value in table 3–1.

3.2.3 *Calculation of waste characteristics factor category value.* Multiply the toxicity/mobility and hazardous waste quantity factor values, subject to a maximum product of 1×10^{8}. Based on this product, assign a value from table 2–7 (section 2.4.3.1) to the waste characteristics factor category. Enter this value in table 3–1.

3.3 *Targets.* Evaluate the targets factor category for an aquifer based on four factors: nearest well, population, resources, and Wellhead Protection Area. Evaluate these four factors based on targets within the target distance limit specified in section 3.0.1.1 and the aquifer boundaries specified in section 3.0.1.2. Determine the targets to be included in evaluating these factors for an aquifer as specified in section 3.0.

3.3.1 *Nearest well.* In evaluating the nearest well factor, include both the drinking water wells drawing from the aquifer being evaluated and those drawing from overlying aquifers as specified in section 3.0. Include standby wells in evaluating this factor only if they are used for drinking water supply at least once every year.

If there is an observed release by direct observation for a drinking water well within the target distance limit, assign Level II concentrations to that well. However, if one or more samples meet the criteria for an observed release for that well, determine if that well is subject to Level I or Level II concentrations as specified in sections 2.5.1 and 2.5.2. Use the health-based benchmarks from table 3–10 in determining the level of contamination.

Assign a value for the nearest well factor as follows:

• If one or more drinking water wells is subject to Level I concentrations, assign a value of 50.

• If not, but if one or more drinking water wells is subject to Level II concentrations, assign a value of 45.

• If none of the drinking water wells is subject to Level I or Level II concentrations, assign a value as follows:

–If one of the target aquifers is a karst aquifer that underlies any portion of the sources at the site and any well draws

drinking water from this karst aquifer within the target distance limit, assign a value of 20.

–If not, determine the shortest distance to any drinking water well, as measured from any source at the site with a ground water containment factor value greater than 0. Select a value from table 3–11 based on this distance. Assign it as the value for the nearest well factor.

Enter the value assigned to the nearest well factor in table 3–1.

TABLE 3–10—HEALTH-BASED BENCHMARKS FOR HAZARDOUS SUBSTANCES IN DRINKING WATER

- Concentration corresponding to Maximum Contaminant Level (MCL).
- Concentration corresponding to a nonzero Maximum Contaminant Level Goal (MCLG).
- Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for oral exposures.
- Screening concentration for noncancer toxicological responses corresponding to the Reference Dose (RfD) for oral exposures.

TABLE 3–11—NEAREST WELL FACTOR VALUES

Distance from source (miles)	Assigned value
Level I concentrations [a]	50
Level II concentrations [a]	45
0 to ¼	20
Greater than ¼ to ½	18
Greater than ½ to 1	9
Greater than 1 to 2	5
Greater than 2 to 3	3
Greater than 3 to 4	2
Greater than 4	0

[a] Distance does not apply.

3.3.2 *Population.* In evaluating the population factor, include those persons served by drinking water wells within the target distance limit specified in section 3.0.1.1. For the aquifer being evaluated, count those persons served by wells in that aquifer and those persons served by wells in overlying aquifers as specified in section 3.0. Include residents, students, and workers who regularly use the water. Exclude transient populations such as customers and travelers passing through the area. Evaluate the population based on the location of the water supply wells, not on the location of residences, work places, etc. When a standby well is maintained on a regular basis so that water can be withdrawn, include it in evaluating the population factor.

In estimating residential population, when the estimate is based on the number of residences, multiply each residence by the average number of persons per residence for the county in which the residence is located.

In determining the population served by a well, if the water from the well is blended with other water (for example, water from other ground water wells or surface water intakes), apportion the total population regularly served by the blended system to the well based on the well's relative contribution to the total blended system. In estimating the well's relative contribution, assume each well and intake contributes equally and apportion the population accordingly, except: if the relative contribution of any one well or intake exceeds 40 percent based on average annual pumpage or capacity, estimate the relative contribution of the wells and intakes considering the following data, if available:

- Average annual pumpage from the ground water wells and surface water intakes in the blended system.
- Capacities of the wells and intakes in the blended system.

For systems with standby ground water wells or standby surface water intakes, apportion the total population regularly served by the blended system as described above, except:

- Exclude standby surface water intakes in apportioning the population.
- When using pumpage data for a standby ground water well, use average pumpage for the period during which the standby well is used rather than average annual pumpage.
- For that portion of the total population that could be apportioned to a standby ground water well, assign that portion of the population either to that standby well or to the other ground water well(s) and surface water intake(s) that serve that population; do not assign that portion of the population both to the standby well and to the other well(s) and intake(s) in the blended system. Use the apportioning that results in the highest population factor value. (Either include all standby well(s) or exclude some or all of the standby well(s) as appropriate to obtain this highest value.) Note that the specific standby well(s) included or excluded and, thus, the specific apportioning may vary in evaluating different aquifers and in evaluating the surface water pathway.

3.3.2.1 *Level of contamination.* Evaluate the population served by water from a point of withdrawal based on the level of contamination for that point of withdrawal. Use the applicable factor: Level I concentrations, Level II concentrations, or potential contamination.

If no samples meet the criteria for an observed release for a point of withdrawal and there is no observed release by direct observation for that point of withdrawal, evaluate that point of withdrawal using the potential contamination factor in section 3.3.2.4. If there is an observed release by direct observation, use Level II concentrations for that point of withdrawal. However, if one or more samples meet the criteria for an observed release for the point of withdrawal, determine

which factor (Level I or Level II concentrations) applies to that point of withdrawal as specified in sections 2.5.1 and 2.5.2. Use the health-based benchmarks from table 3–10 in determining the level of contamination. Evaluate the point of withdrawal using the Level I concentrations factor in section 3.3.2.2 or the Level II concentrations factor in section 3.3.2.3, as appropriate.

For the potential contamination factor, use population ranges in evaluating the factor as specified in section 3.3.2.4. For the Level I and Level II concentrations factors, use the population estimate, not population ranges, in evaluating both factors.

3.3.2.2 *Level I concentrations.* Sum the number of people served by drinking water from points of withdrawal subject to Level I concentrations. Multiply this sum by 10. Assign this product as the value for this factor. Enter this value in table 3–1.

3.3.2.3 *Level II concentrations.* Sum the number of people served by drinking water from points of withdrawal subject to Level II concentrations. Do not include those people already counted under the Level I concentrations factor. Assign this sum as the value for this factor. Enter this value in table 3–1.

3.3.2.4 *Potential contamination.* Determine the number of people served by drinking water from points of withdrawal subject to potential contamination. Do not include those people already counted under the Level I and Level II concentrations factors.

Assign distance-weighted population values from table 3–12 to this population as follows:

• Use the ''Karst'' portion of table 3–12 to assign values only for that portion of the population served by points of withdrawal that draw drinking water from a karst aquifer that underlies any portion of the sources at the site.

–For this portion of the population, determine the number of people included within each ''Karst'' distance category in table 3–12.

TABLE 3–12—DISTANCE-WEIGHTED POPULATION VALUES FOR POTENTIAL CONTAMINATION FACTOR FOR GROUND WATER MIGRATION PATHWAY [A]

Distance category (miles)	Number of people within the distance category												
	0	1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000	1,000,001 to 3,000,000
Other Than Karst [b]:													
0 to ¼	0	4	17	53	164	522	1,633	5,214	16,325	52,137	163,246	521,360	1,632,455
Greater than ¼ to ½	0	2	11	33	102	324	1,013	3,233	10,122	32,325	101,213	323,243	1,012,122
Greater than ½ to 1	0	1	5	17	52	167	523	1,669	5,224	16,684	52,239	166,835	522,385
Greater than 1 to 2	0	0.7	3	10	30	94	294	939	2,939	9,385	29,384	93,845	293,842
Greater than 2 to 3	0	0.5	2	7	21	68	212	678	2,122	6,778	21,222	67,777	212,219
Greater than 3 to 4	0	0.3	1	4	13	42	131	417	1,306	4,171	13,060	41,709	130,596
Karst [c]:													
0 to ¼	0	4	17	53	164	522	1,633	5,214	16,325	52,137	163,246	521,360	1,632,455
Greater than ¼ to ½	0	2	11	33	102	324	1,013	3,233	10,122	32,325	101,213	323,243	1,012,122
Greater than ½ to 1	0	2	9	26	82	261	817	2,607	8,163	26,068	81,623	260,680	816,227
Greater than 1 to 2	0	2	9	26	82	261	817	2,607	8,163	26,068	81,623	260,680	816,227
Greater than 2 to 3	0	2	9	26	82	261	817	2,607	8,163	26,068	81,623	260,680	816,227
Greater than 3 to 4	0	2	9	26	82	261	817	2,607	8,163	26,068	81,623	260,680	816,227

[a] Round the number of people present within a distance category to nearest integer. Do not round the assigned distance-weighted population value to nearest integer.
[b] Use for all aquifers, except karst aquifers underlying any portion of the sources at the site.
[c] Use only for karst aquifers underlying any portion of the sources at the site.

–Assign a distance-weighted population value for each distance category based on the number of people included within the distance category.

• Use the ''Other Than Karst'' portion of table 3–12 for the remainder of the population served by points of withdrawal subject to potential contamination.

–For this portion of the population, determine the number of people included within each ''Other Than Karst'' distance category in table 3–12.

–Assign a distance-weighted population value for each distance category based on the number of people included within the distance category.

Calculate the value for the potential contamination factor (PC) as follows:

$$PC = \frac{1}{10}\sum_{i=1}^{n}\left(W_i + K_i\right)$$

where:

W_i=Distance-weighted population from ''Other Than Karst'' portion of table 3–12 for distance category i.

K_i=Distance-weighted population from ''Karst'' portion of table 3–12 for distance category i.

n=Number of distance categories.

If PC is less than 1, do not round it to the nearest integer; if PC is 1 or more, round to the nearest integer. Enter this value in table 3–1.

3.3.2.5 *Calculation of population factor value.* Sum the factor values for Level I concentrations, Level II concentrations, and potential contamination. Do not round this sum to the nearest integer. Assign this sum as the population factor value for the aquifer. Enter this value in table 3–1.

3.3.3 *Resources.* To evaluate the resources factor, select the highest value specified below that applies for the aquifer being evaluated. Assign this value as the resources factor value for the aquifer. Enter this value in table 3–1.

Assign a resources value of 5 if water drawn from any target well for the aquifer being evaluated or overlying aquifers (as specified in section 3.0) is used for one or more of the following purposes:

• Irrigation (5-acre minimum) of commercial food crops or commercial forage crops.

• Watering of commercial livestock.

• Ingredient in commercial food preparation.

• Supply for commercial aquaculture.

• Supply for a major or designated water recreation area, excluding drinking water use.

Assign a resources value of 5 if no drinking water wells are within the target distance limit, but the water in the aquifer being evaluated or any overlying aquifers (as specified in section 3.0) is usable for drinking water purposes.

Assign a resources value of 0 if none of the above applies.

3.3.4 *Wellhead Protection Area.* Evaluate the Wellhead Protection Area factor based on Wellhead Protection Areas designated according to section 1428 of the Safe Drinking Water Act, as amended. Consider only those Wellhead Protection Areas applicable to the aquifer being evaluated or overlying aquifers (as specified in section 3.0). Select the highest value below that applies. Assign it as the value for the Wellhead Protection Area factor for the aquifer being evaluated. Enter this value in table 3–1.

Assign a value of 20 if either of the following criteria applies for the aquifer being evaluated or overlying aquifers:

• A source with a ground water containment factor value greater than 0 lies, either partially or fully, within or above the designated Wellhead Protection Area.

• Observed ground water contamination attributable to the sources at the site lies, either partially or fully, within the designated Wellhead Protection Area.

If neither criterion applies, assign a value of 5, if, within the target distance limit, there is a designated Wellhead Protection Area applicable to the aquifer being evaluated or overlying aquifers.

Assign a value of 0 if none of the above applies.

3.3.5 *Calculation of targets factor category value.* Sum the factor values for nearest well, population, resources, and Wellhead Protection Area. Do not round this sum to the nearest integer. Use this sum as the targets factor category value for the aquifer. Enter this value in table 3–1.

3.4 *Ground water migration score for an aquifer.* For the aquifer being evaluated, multiply the factor category values for likelihood of release, waste characteristics, and targets, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum value of 100, as the ground water migration pathway score for the aquifer. Enter this score in table 3–1.

3.5 *Calculation of ground water migration pathway score.* Calculate a ground water migration score for each aquifer underlying the sources at the site, as appropriate. Assign the highest ground water migration score for an aquifer as the ground water migration pathway score (S_{gw}) for the site. Enter this score in table 3–1.

4.0 Surface Water Migration Pathway

4.0.1 *Migration components.* Evaluate the surface water migration pathway based on two migration components:

• Overland/flood migration to surface water (see section 4.1).

• Ground water to surface water migration (see section 4.2).

Evaluate each component based on the same three threats: drinking water threat, human food chain threat, and environmental threat.

Score one or both components, considering their relative importance. If only one component is scored, assign its score as the surface

water migration pathway score. If both components are scored, select the higher of the two scores and assign it as the surface water migration pathway score.

4.0.2 *Surface water categories.* For HRS purposes, classify surface water into four categories: rivers, lakes, oceans, and coastal tidal waters.

Rivers include:

• Perennially flowing waters from point of origin to the ocean or to coastal tidal waters, whichever comes first, and wetlands contiguous to these flowing waters.

• Aboveground portions of disappearing rivers.

• Man-made ditches only insofar as they perennially flow into other surface water.

• Intermittently flowing waters and contiguous intermittently flowing ditches only in arid or semiarid areas with less than 20 inches of mean annual precipitation.

Lakes include:

• Natural and man-made lakes (including impoundments) that lie along rivers, but excluding the Great Lakes.

• Isolated, but perennial, lakes, ponds, and wetlands.

• Static water channels or oxbow lakes contiguous to rivers.

• Small rivers, without diking, that merge into surrounding perennially inundated wetlands.

• Wetlands contiguous to water bodies defined here as lakes.

Ocean and ocean-like water bodies include:

• Ocean areas seaward from the baseline of the Territorial Sea. (This baseline represents the generalized coastline of the United States. It is parallel to the seaward limit of the Territorial Sea and other maritime limits such as the inner boundary of Federal fisheries jurisdiction and the limit of States jurisdiction under the Submerged Lands Act, as amended.)

• The Great Lakes.

• Wetlands contiguous to the Great Lakes.

Coastal tidal waters include:

• Embayments, harbors, sounds, estuaries, back bays, lagoons, wetlands, etc. seaward from mouths of rivers and landward from the baseline of the Territorial Sea.

4.1 *Overland/flood migration component.* Use the overland/flood migration component to evaluate surface water threats that result from overland migration of hazardous substances from a source at the site to surface water. Evaluate three types of threats for this component: drinking water threat, human food chain threat, and environmental threat.

4.1.1 *General considerations.*

4.1.1.1 *Definition of hazardous substance migration path for overland/flood migration component.* The hazardous substance migration path includes both the overland segment and the in-water segment that hazardous substances would take as they migrate away from sources at the site:

• Begin the overland segment at a source and proceed downgradient to the probable point of entry to surface water.

• Begin the in-water segment at this probable point of entry.

–For rivers, continue the in-water segment in the direction of flow (including any tidal flows) for the distance established by the target distance limit (see section 4.1.1.2).

–For lakes, oceans, coastal tidal waters, or Great Lakes, do not consider flow direction. Instead apply the target distance limit as an arc.

–If the in-water segment includes both rivers and lakes (or oceans, coastal tidal waters, or Great Lakes), apply the target distance limit to their combined in-water segments.

For sites that consist of contaminated sediments with no identified source, the hazardous substance migration path consists solely of the in-water segment specified in section 4.1.1.2.

Consider a site to be in two or more watersheds for this component if two or more hazardous substance migration paths from the sources at the site do not reach a common point within the target distance limit. If the site is in more than one watershed, define a separate hazardous substance migration path for each watershed. Evaluate the overland/flood migration component for each watershed separately as specified in section 4.1.1.3.

4.1.1.2 *Target distance limit.* The target distance limit defines the maximum distance over which targets are considered in evaluating the site. Determine a separate target distance limit for each watershed as follows:

• If there is no observed release to surface water in the watershed or if there is an observed release only by direct observation (see section 4.1.2.1.1), begin measuring the target distance limit for the watershed at the probable point of entry to surface water and extend it for 15 miles along the surface water from that point.

• If there is an observed release from the site to the surface water in the watershed that is based on sampling, begin measuring the target distance limit for the watershed at the probable point of entry; extend the target distance limit either for 15 miles along the surface water or to the most distant sample point that meets the criteria for an observed release to that watershed, whichever is greater.

In evaluating the site, include only surface water targets (for example, intakes, fisheries, sensitive environments) that are within or contiguous to the hazardous substance migration path and located, partially or wholly, at or between the probable point of entry and the target distance limit applicable to the watershed:

• If flow within the hazardous substance migration path is reversed by tides, evaluate upstream targets only if there is documentation that the tidal run could carry substances from the site as far as those upstream targets.

• Determine whether targets within or contiguous to the hazardous substance migration path are subject to actual or potential contamination as follows:

–If a target is located, partially or wholly, either at or between the probable point of entry and any sampling point that meets the criteria for an observed release to the watershed or at a point that meets the criteria for an observed release by direct observation, evaluate that target as subject to actual contamination, except as otherwise specified for fisheries in section 4.1.3.3 and for wetlands in section 4.1.4.3.1.1. If the actual contamination is based on direct observation, assign Level II to the actual contamination. However, if the actual contamination is based on samples, determine whether the actual contamination is at Level I or Level II concentrations as specified in sections 4.1.2.3, 4.1.3.3, and 4.1.4.3.1.

–If a target is located, partially or wholly, within the target distance limit for the watershed, but not at or between the probable point of entry and any sampling point that meets the criteria for an observed release to the watershed, nor at a point that meets the criteria for an observed release by direct observation, evaluate it as subject to potential contamination.

For sites consisting solely of contaminated sediments with no identified source, determine the target distance limit as follows:

• If there is a clearly defined direction of flow for the surface water body (or bodies) containing the contaminated sediments, begin measuring the target distance limit at the point of observed sediment contamination that is farthest upstream (that is, at the location of the farthest available upstream sediment sample that meets the criteria for an observed release); extend the target distance limit either for 15 miles along the surface water or to the most distant downstream sample point that meets the criteria for an observed release to that watershed, whichever is greater.

• If there is no clearly defined direction of flow, begin measuring the target distance limit at the center of the area of observed sediment contamination. Extend the target distance limit as an arc either for 15 miles along the surface water or to the most distant sample point that meets the criteria for an observed release to that watershed, whichever is greater. Determine the area of observed sediment contamination based on available samples that meet the criteria for an observed release.

Note that the hazardous substance migration path for these contaminated sediment sites consists solely of the in-water segment defined by the target distance limit; there is no overland segment.

For these contaminated sediment sites, include only those targets (for example, intakes, fisheries, sensitive environments) that are within or contiguous to the hazardous substance migration path and located, wholly or partially, within the target distance limit for the site. Determine whether these targets are subject to actual or potential contamination as follows:

• If a target is located, partially or wholly, within the area of observed sediment contamination, evaluate it as subject to actual contamination, except as otherwise specified for fisheries in section 4.1.3.3 and wetlands in section 4.1.4.3.1.1.

–If a drinking water target is subject to actual contamination, evaluate it using Level II concentrations.

–If a human food chain target or environmental target is subject to actual contamination, evaluate it using Level I or Level II concentrations, as appropriate (see sections 4.1.3.3 and 4.1.4.3.1).

• If a target is located, partially or wholly, within the target distance limit for the watershed, but not within the area of observed sediment contamination, evaluate it as subject to potential contamination.

4.1.1.3 *Evaluation of overland/flood migration component.* Evaluate the drinking water threat, human food chain threat, and environmental threat for each watershed for this component based on three factor categories: likelihood of release, waste characteristics, and targets. Figure 4–1 indicates the factors included within each factor category for each type of threat.

Determine the overland/flood migration component score (S_{of}) for a watershed in terms of the factor category values as follows:

$$S_{of} = \sum_{i=1}^{3} \frac{(LR_i)(WC_i)(T_i)}{SF}$$

where:

LR_i=Likelihood of release factor category value for threat i (that is, drinking water, human food chain, or environmental threat).

WC_i=Waste characteristics factor category value for threat i.

T_i=Targets factor category value for threat i.

SF=Scaling factor.

Table 4–1 outlines the specific calculation procedure.

If the site is in only one watershed, assign the overland/flood migration score for that watershed as the overland/flood migration component score for the site.

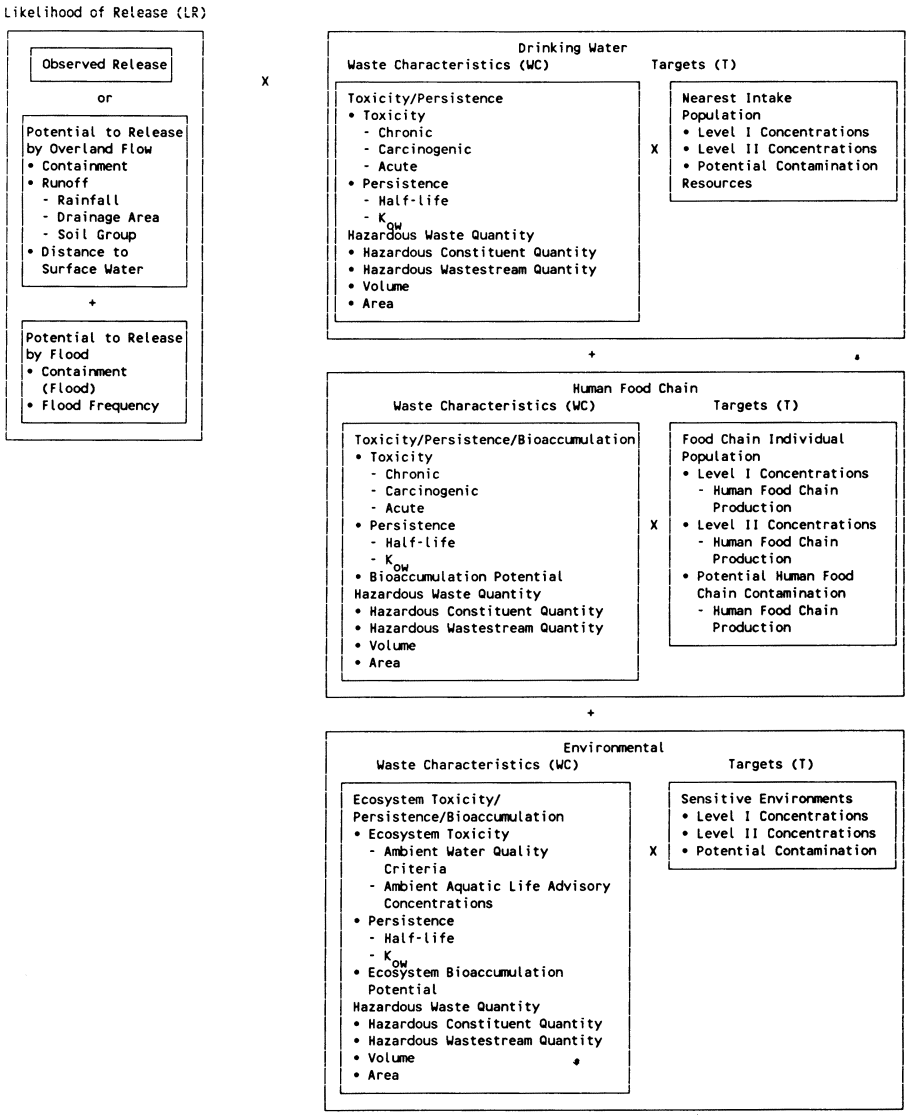


FIGURE 4-1
OVERVIEW OF SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT

TABLE 4–1—SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET

Factor categories and factors	Maximum value	Value assigned
Drinking Water Threat		
Likelihood of Release:		
1. Observed Release	550	
2. Potential to Release by Overland Flow:		
2a. Containment	10	
2b. Runoff	25	
2c. Distance to Surface Water	25	
2d. Potential to Release by Overland Flow (lines 2a[2b+2c])	500	
3. Potential to Release by Flood:		
3a. Containment (Flood)	10	
3b. Flood Frequency	50	
3c. Potential to Release by Flood (lines 3a×3b)	500	
4. Potential to Release (lines 2d+3c, subject to a maximum of 500)	500	
5. Likelihood of Release (higher of lines 1 and 4)	550	
Waste Characteristics:		
6. Toxicity/Persistence	(a)	
7. Hazardous Waste Quantity	(a)	
8. Waste Characteristics	100	
Targets:		
9. Nearest Intake	50	
10. Population		
10a. Level I Concentrations	(b)	
10b. Level II Concentrations	(b)	
10c. Potential Contamination	(b)	
10d. Population (lines 10a+10b+10c)	(b)	
11. Resources	5	
12. Targets (lines 9+10d+11)	(b)	
Drinking Water Threat Score:		
13. Drinking Water Threat Score ([lines 5×8×12]/82,500, subject to a maximum of 100)	100	
Human Food Chain Threat		
Likelihood of Release:		
14. Likelihood of Release (same value as line 5)	550	
Waste Characteristics:		
15. Toxicity/Persistence/Bioaccumulation	(a)	
16. Hazardous Waste Quantity	(a)	
17. Waste Characteristics	1,000	
Targets:		
18. Food Chain Individual	50	
19. Population		
19a. Level I Concentrations	(b)	
19b. Level II Concentrations	(b)	
19c. Potential Human Food Chain Contamination	(b)	
19d. Population (lines 19a+19b+19c)	(b)	
20. Targets (lines 18+19d)	(b)	
Human Food Chain Threat Score:		
21. Human Food Chain Threat Score ([lines 14×17×20]/82,500, subject to a maximum of 100)	100	
Environmental Threat		
Likelihood of Release:		
22. Likelihood of Release (same value as line 5)	550	
Waste Characteristics:		
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	
24. Hazardous Waste Quantity	(a)	
25. Waste Characteristics	1,000	
Targets:		
26. Sensitive Environments.		
26a. Level I Concentrations	(b)	
26b. Level II Concentrations	(b)	
26c. Potential Contamination	(b)	
26d. Sensitive Environments (lines 26a+26b+26c)	(b)	
27. Targets (value from line 26d)	(b)	
Environmental Threat Score:		
28. Environmental Threat Score ([lines 22×25×27]/82,500, subject to a maximum of 60)	60	
Surface Water Overland/Flood Migration Component Score for a Watershed		
29. Watershed Score[c] (lines 13+21+28, subject to a maximum of 100)	100	

TABLE 4–1—SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET—Continued

Factor categories and factors	Maximum value	Value assigned
Surface Water Overland/Flood Migration Component Score		
30. Component Score (S_{of}) [c] (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100)	100	

[a] Maximum value applies to waste characteristics category.
[b] Maximum value not applicable.
[c] Do not round to nearest integer.

If the site is in more than one watershed:

• Calculate a separate overland/flood migration component score for each watershed, using likelihood of release, waste characteristics, and targets applicable to each watershed.

• Select the highest overland/flood migration component score from the watersheds evaluated and assign it as the overland/flood migration component score for the site.

4.1.2 *Drinking water threat.* Evaluate the drinking water threat for each watershed based on three factor categories: likelihood of release, waste characteristics, and targets.

4.1.2.1 *Drinking water threat—likelihood of release.* Evaluate the likelihood of release factor category for each watershed in terms of an observed release factor or a potential to release factor.

4.1.2.1.1 *Observed release.* Establish an observed release to surface water for a watershed by demonstrating that the site has released a hazardous substance to the surface water in the watershed. Base this demonstration on either:

• Direct observation:

–A material that contains one or more hazardous substances has been seen entering surface water through migration or is known to have entered surface water through direct deposition, or

–A source area has been flooded at a time that hazardous substances were present, and one or more hazardous substances were in contact with the flood waters, or

–When evidence supports the inference of a release of a material that contains one or more hazardous substances by the site to surface water, demonstrated adverse effects associated with that release may also be used to establish an observed release.

• Chemical analysis:

–Analysis of surface water, benthic, or sediment samples indicates that the concentration of hazardous substance(s) has increased significantly above the background concentration for the site for that type of sample (see section 2.3).

–Limit comparisons to similar types of samples and background concentrations—for example, compare surface water samples to surface water background concentrations.

–For benthic samples, limit comparisons to essentially sessile organisms.

–Some portion of the significant increase must be attributable to the site to establish the observed release, except: when the site itself consists of contaminated sediments with no identified source, no separate attribution is required.

If an observed release can be established for a watershed, assign an observed release factor value of 550 to that watershed, enter this value in table 4–1, and proceed to section 4.1.2.1.3. If no observed release can be established for the watershed, assign an observed release factor value of 0 to that watershed, enter this value in table 4–1, and proceed to section 4.1.2.1.2.

4.1.2.1.2 *Potential to release.* Evaluate potential to release only if an observed release cannot be established for the watershed. Evaluate potential to release based on two components: potential to release by overland flow (see section 4.1.2.1.2.1) and potential to release by flood (see section 4.1.2.1.2.2). Sum the values for these two components to obtain the potential to release factor value for the watershed, subject to a maximum value of 500.

4.1.2.1.2.1 *Potential to release by overland flow.* Evaluate potential to release by overland flow for the watershed based on three factors: containment, runoff, and distance to surface water.

Assign potential to release by overland flow a value of 0 for the watershed if:

• No overland segment of the hazardous substance migration path can be defined for the watershed, or

• The overland segment of the hazardous substance migration path for the watershed exceeds 2 miles before surface water is encountered.

If either condition applies, enter a value of 0 in table 4–1 and proceed to section 4.1.2.1.2.2 to evaluate potential to release by flood. If neither applies, proceed to section 4.1.2.1.2.1.1 to evaluate potential to release by overland flow.

4.1.2.1.2.1.1 *Containment.* Determine the containment factor value for the watershed as follows:

• If one or more sources is located in surface water in the watershed (for example, intact sealed drums in surface water), assign

the containment factor a value of 10 for the watershed. Enter this value in table 4–1.

• If none of the sources is located in surface water in the watershed, assign a containment factor value from table 4–2 to each source at the site that can potentially release hazardous substances to the hazardous substance migration path for this watershed. Assign the containment factor value for the watershed as follows:

–Select the highest containment factor value assigned to those sources that meet the minimum size requirement described below. Assign this highest value as the containment factor value for the watershed. Enter this value in table 4–1.

–If, for this watershed, no source at the site meets the minimum size requirement, then select the highest containment factor value assigned to the sources at the site eligible to be evaluated for this watershed and assign it as the containment factor value for the watershed. Enter this value in table 4–1.

A source meets the minimum size requirement if its source hazardous waste quantity value (see section 2.4.2.1.5) is 0.5 or more. Do not include the minimum size requirement in evaluating any other factor of this surface water migration component, except potential to release by flood as specified in section 4.1.2.1.2.2.3.

4.1.2.1.2.1.2 *Runoff.* Evaluate runoff based on three components: rainfall, drainage area, and soil group.

TABLE 4–2—CONTAINMENT FACTOR VALUES FOR SURFACE WATER MIGRATION PATHWAY

Source	Assigned value
All Sources (Except Surface Impoundments, Land Treatment, Containers, and Tanks)	
Evidence of hazardous substance migration from source area (i.e., source area includes source and any associated containment structures)..	10
No evidence of hazardous substance migration from source area *and:*	
(a) Neither of the following present: (1) maintained engineered cover, or (2) functioning and maintained run-on control system and runoff management system.	10
(b) Any one of the two items in (a) present	9
(c) Any two of the following present: (1) maintained engineered cover, or (2) functioning and maintained run-on control system and runoff management system, or (3) liner with functioning leachate collection and removal system immediately above liner.	7
(d) All items in (c) present	5
(e) All items in (c) present, plus no bulk or non-containerized liquids nor materials containing free liquids deposited in source area..	3
No evidence of hazardous substance migration from source area, double liner with functioning leachate collection and removal system above and between liners, *and:*	
(f) Only one of the following deficiencies present in containment: (1) bulk or noncontainerized liquids or materials containing free liquids deposited in source area, or (2) no or nonfunctioning or nonmaintained run-on control system and runoff management system, or (3) no or nonmaintained engineered cover.	3
(g) None of the deficiencies in (f) present.	0
Source area inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate is generated, liquids or materials containing free liquids not deposited in source area, and functioning and maintained run-on control present.	
Surface Impoundment	
Evidence of hazardous substance migration from surface impoundment	10
Free liquids present with either no diking, unsound diking, or diking that is not regularly inspected and maintained.	10
No evidence of hazardous substance migration from surface impoundment, free liquids present, sound diking that is regularly inspected and maintained, adequate freeboard, *and:*	
(a) No liner	9
(b) Liner	7
(c) Liner with functioning leachate collection and removal system below liner	5
(d) Double liner with functioning leachate collection and removal system between liners	3
No evidence of hazardous substance migration from surface impoundment and all free liquids eliminated at closure (either by removal of liquids or solidification of remaining wastes and waste residues).	Evaluate using **All Sources** criteria (with no bulk or free liquids deposited).
Land Treatment	
Evidence of hazardous substance migration from land treatment zone	10
No functioning and maintained run-on control and runoff management system	10
No evidence of hazardous substance migration from land treatment zone *and:*	
(a) Functioning and maintained run-on control and runoff management system	7
(b) Functioning and maintained run-on control and runoff management system, and vegetative cover established over entire land treatment area.	5

TABLE 4–2—CONTAINMENT FACTOR VALUES FOR SURFACE WATER MIGRATION PATHWAY—Continued

Source	Assigned value
(c) Land treatment area maintained in compliance with 40 CFR 264.280	0
Containers	
All containers buried	Evaluate using **All Sources** criteria.
Evidence of hazardous substance migration from container area (i.e., container area includes containers and any associated containment structures).	10
No diking (or no similar structure) surrounding container area	10
Diking surrounding container area unsound or not regularly inspected and maintained	10
No evidence of hazardous substance migration from container area and container area surrounded by sound diking that is regularly inspected and maintained.	9
No evidence of hazardous substance migration from container area, container area surrounded by sound diking that is regularly inspected and maintained, *and:*	9
(a) Essentially impervious base under container area with liquids collection and removal system	7
(b) Containment system includes essentially impervious base, liquids collection system, sufficient capacity to contain 10 percent of volume of all containers, and functioning and maintained run-on control; and spilled or leaked hazardous substances and accumulated precipitation removed in timely manner to prevent overflow of collection system, at least weekly inspection of containers, hazardous substances in leaking or deteriorating containers transferred to containers in good condition, and containers sealed except when waste is added or removed.	5
(c) Free liquids present, containment system has sufficient capacity to hold total volume of all containers and to provide adequate freeboard, and single liner under container area with functioning leachate collection and removal system below liner.	5
(d) Same as (c) except: double liner under container area with functioning leachate collection and removal system between liners.	3
Containers inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate would be generated from any unsealed or ruptured containers, liquids or materials containing free liquids not deposited in any container, and functioning and maintained run-on control present.	0
No evidence of hazardous substance migration from container area, containers leaking, and all free liquids eliminated at closure (either by removal of liquids or solidification of remaining wastes and waste residues).	Evaluate using All Sources criteria (with no bulk or free liquids deposited).
Tank	
Below-ground tank	Evaluate using All Sources criteria
Evidence of hazardous substance migration from tank area (i.e., tank area includes tank, ancillary equipment such as piping, and any associated containment structures).	10
No diking (or no similar structure) surrounding tank and ancillary equipment	10
Diking surrounding tank and ancillary equipment unsound or not regularly inspected and maintained	10
No evidence of hazardous substance migration from tank area and tank and ancillary equipment surrounded by sound diking that is regularly inspected and maintained.	9
No evidence of hazardous substance migration from tank area, tank and ancillary equipment surrounded by sound diking that is regularly inspected and maintained, *and:*	
(a) Tank and ancillary equipment provided with secondary containment (e.g., liner under tank area, vault system, double-wall) with leak detection and collection system.	7
(b) Tank and ancillary equipment provided with secondary containment system that detects and collects spilled or leaked hazardous substances and accumulated precipitation and has sufficient capacity to contain 110 percent of volume of largest tank within containment area, spilled or leaked hazardous substances and accumulated precipitation removed in a timely manner, at least weekly inspection of tank and secondary containment system, and all leaking or unfit-for-use tank systems promptly responded to.	5
(c) Containment system has sufficient capacity to hold total volume of all tanks within the tank containment area and to provide adequate freeboard, and single liner under tank containment area with functioning leachate collection and removal system below liner.	5
(d) Same as (c) except: double liner under tank containment area with functioning leachate collection and removal system between liners.	3
Tank is above ground, and inside or under maintained intact structure that provides protection from precipitation so that neither runoff nor leachate would be generated from any material released from tank, liquids or materials containing free liquids not deposited in any tank, and functioning and maintained run-on control present.	0

Rainfall. Determine the 2-year, 24-hour rainfall for the site. Use site-specific, 2-year, 24-hour rainfall data if records are available for at least 20 years. If such site-specific data are not available, estimate the 2-year, 24-

hour rainfall for the site from a rainfall-frequency map. Do not round the rainfall value to the nearest integer.

Drainage area. Determine the drainage area for the sources at the site. Include in this drainage area both the source areas and the area upgradient of the sources, but exclude any portion of this drainage area for which runoff is diverted from entering the sources by storm sewers or run-on control and/or runoff management systems. Assign a drainage area value for the watershed from table 4–3.

Soil group. Based on the predominant soil group within the drainage area described above, assign a soil group designation for the watershed from table 4–4 as follows:

• Select the predominant soil group as that type which comprises the largest total area within the applicable drainage area.

• If a predominant soil group cannot be delineated, select that soil group in the drainage area that yields the highest value for the runoff factor.

Calculation of runoff factor value. Assign a combined rainfall/runoff value for the watershed from table 4–5, based on the 2-year, 24-hour rainfall and the soil group designation. Determine the runoff factor value for the watershed from table 4–6, based on the rainfall/runoff and drainage area values. Enter the runoff factor value in table 4–1.

TABLE 4–3—DRAINAGE AREA VALUES

Drainage area (acres)	Assigned value
Less than 50	1
50 to 250	2
Greater than 250 to 1,000	3
Greater than 1,000	4

TABLE 4–4—SOIL GROUP DESIGNATIONS

Surface soil description	Soil group designation
Coarse-textured soils with high infiltration rates (for example, sands, loamy sands).	A
Medium-textured soils with moderate infiltration rates (for example, sandy loams, loams).	B
Moderately fine-textured soils with low infiltration rates (for example, silty loams, silts, sandy clay loams).	C
Fine-textured soils with very low infiltration rates (for example, clays, sandy clays, silty clay loams, clay loams, silty clays); or impermeable surfaces (for example, pavement).	D

TABLE 4–5—RAINFALL/RUNOFF VALUES

2-Year, 24-hour rainfall (inches)	Soil group designation			
	A	B	C	D
Less than 1.0	0	0	2	3
1.0 to less than 1.5	0	1	2	3
1.5 to less than 2.0	0	2	3	4
2.0 to less than 2.5	1	2	3	4
2.5 to less than 3.0	2	3	4	4
3.0 to less than 3.5	2	3	4	5
3.5 or greater	3	4	5	6

TABLE 4–6—RUNOFF FACTOR VALUES

Drainage area value	Rainfall/runoff value						
	0	1	2	3	4	5	6
1	0	0	0	1	1	1	1
2	0	0	1	1	2	3	4
3	0	0	1	3	7	11	15
4	0	1	2	7	17	25	25

4.1.2.1.2.1.3 *Distance to surface water.* Evaluate the distance to surface water as the shortest distance, along the overland segment, from any source with a surface water containment factor value greater than 0 to either the mean high water level for tidal waters or the mean water level for other surface waters. Based on this distance, assign a value from table 4–7 to the distance to surface water factor for the watershed. Enter this value in table 4–1.

4.1.2.1.2.1.4 *Calculation of factor value for potential to release by overland flow.* Sum the factor values for runoff and distance to surface water for the watershed and multiply this sum by the factor value for containment. Assign the resulting product as the factor value for potential to release by overland flow for the watershed. Enter this value in table 4–1.

4.1.2.1.2.2 *Potential to release by flood.* Evaluate potential to release by flood for each watershed as the product of two factors: containment (flood) and flood frequency. Evaluate potential to release by flood separately for each source that is within the watershed. Furthermore, for each source, evaluate potential to release by flood separately for each category of floodplain in which the source lies. (See section 4.1.2.1.2.2.2 for the applicable floodplain categories.) Calculate the value for the potential to release by flood factor as specified in 4.1.2.1.2.2.3.

4.1.2.1.2.2.1 *Containment (flood).* For each source within the watershed, separately evaluate the containment (flood) factor for each category of floodplain in which the source is partially or wholly located. Assign a containment (flood) factor value from table 4–8 to each floodplain category applicable to that source. Assign a containment (flood) factor value of 0 to each floodplain category in which the source does not lie.

4.1.2.1.2.2.2 *Flood frequency.* For each source within the watershed, separately

evaluate the flood frequency factor for each category of floodplain in which the source is partially or wholly located. Assign a flood frequency factor value from table 4–9 to each floodplain category in which the source is located.

4.1.2.1.2.2.3 *Calculation of factor value for potential to release by flood.* For each source within the watershed and for each category of floodplain in which the source is partially or wholly located, calculate a separate potential to release by flood factor value. Calculate this value as the product of the containment (flood) value and the flood frequency value applicable to the source for the floodplain category. Select the highest value calculated for those sources that meet the minimum size requirement specified in section 4.1.2.1.2.1.1 and assign it as the value for the potential to release by flood factor for the watershed. However, if, for this watershed, no source at the site meets the minimum size requirement, select the highest value calculated for the sources at the site eligible to be evaluated for this watershed and assign it as the value for this factor.

TABLE 4–7—DISTANCE TO SURFACE WATER FACTOR VALUES

Distance	Assigned value
Less than 100 feet	25
100 feet to 500 feet	20
Greater than 500 feet to 1,000 feet	16
Greater than 1,000 feet to 2,500 feet	9
Greater than 2,500 feet to 1.5 miles	6
Greater than 1.5 miles to 2 miles	3

TABLE 4–8—CONTAINMENT (FLOOD) FACTOR VALUES

Containment criteria	Assigned value
Documentation that containment at the source is designed, constructed, operated, and maintained to prevent a washout of hazardous substances by the flood being evaluated.	0
Other	10

TABLE 4–9—FLOOD FREQUENCY FACTOR VALUES

Floodplain category	Assigned value
Source floods annually	50
Source in 10-year floodplain	50
Source in 100-year floodplain	25
Source in 500-year floodplain	7
None of above	0

Enter this highest potential to release by flood factor value for the watershed in table 4–1, as well as the values for containment (flood) and flood frequency that yield this highest value.

4.1.2.1.2.3 *Calculation of potential to release factor value.* Sum the factor values assigned to the watershed for potential to release by overland flow and potential to release by flood. Assign this sum as the potential to release factor value for the watershed, subject to a maximum value of 500. Enter this value in table 4–1.

4.1.2.1.3 *Calculation of drinking water threat-likelihood of release factor category value.* If an observed release is established for the watershed, assign the observed release factor value of 550 as the likelihood of release factor category value for that watershed. Otherwise, assign the potential to release factor value for that watershed as the likelihood of release factor category value for that watershed. Enter the value assigned in table 4–1.

4.1.2.2 *Drinking water threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: toxicity/persistence and hazardous waste quantity. Evaluate only those hazardous substances that are available to migrate from the sources at the site to surface water in the watershed via the overland/flood hazardous substance migration path for the watershed (see section 4.1.1.1). Such hazardous substances include:

- Hazardous substances that meet the criteria for an observed release to surface water in the watershed.
- All hazardous substances associated with a source that has a surface water containment factor value greater than 0 for the watershed (see sections 2.2.2, 2.2.3, 4.1.2.1.2.1.1, and 4.1.2.1.2.2.1).

4.1.2.2.1 *Toxicity/persistence.* For each hazardous substance, assign a toxicity factor value, a persistence factor value, and a combined toxicity/persistence factor value as specified in sections 4.1.2.2.1.1 through 4.1.2.2.1.3. Select the toxicity/persistence factor value for the watershed as specified in section 4.1.2.2.1.3.

4.1.2.2.1.1 *Toxicity.* Assign a toxicity factor value to each hazardous substance as specified in section 2.4.1.1.

4.1.2.2.1.2 *Persistence.* Assign a persistence factor value to each hazardous substance. In assigning this value, evaluate persistence based primarily on the half-life of the hazardous substance in surface water and secondarily on the sorption of the hazardous substance to sediments. The half-life in surface water is defined for HRS purposes as the time required to reduce the initial concentration in surface water by one-half as a result of the combined decay processes of biodegradation, hydrolysis, photolysis, and volatilization. Sorption to sediments is evaluated for the HRS based on the logarithm of the n-octanol-water partition coefficient (log K_{ow}) of the hazardous substance.

Estimate the half-life ($t_{1/2}$) of a hazardous substance as follows:

$$t_{1/2} = \frac{1}{1/h + 1/b + 1/p + 1/v}$$

where:

h=Hydrolysis half-life.
b=Biodegradation half-life.
p=Photolysis half-life.
v=Volatilization half-life.

If one or more of these four component half-lives cannot be estimated for the hazardous substance from available data, delete that component half-life from the above equation. If none of these four component half-lives can be estimated for the hazardous substance from available data, use the default procedure indicated below. Estimate a half-life for the hazardous substance for lakes or for rivers, oceans, coastal tidal waters, and Great Lakes, as appropriate.

If a half-life can be estimated for a hazardous substance:

• Assign that hazardous substance a persistence factor value from the appropriate portion of table 4–10 (that is lakes; or rivers, oceans, coastal tidal waters, and Great Lakes).

• Select the appropriate portion of table 4–10 as follows:

–If there is one or more drinking water intakes along the hazardous substance migration path for the watershed, select the nearest drinking water intake as measured from the probable point of entry. If the in-water segment between the probable point of entry and this selected intake includes both lakes and other water bodies, use the lakes portion of table 4–10 only if more than half the distance to this selected intake lies in lake(s). Otherwise, use the rivers, oceans, coastal tidal waters, and Great Lakes portion of table 4–10. For contaminated sediments with no identified source, use the point where measurement begins (see section 4.1.1.2) rather than the probable point of entry.

–If there are no drinking water intakes but there are intakes or points of use for any of the resource types listed in section 4.1.2.3.3, select the nearest such intake or point of use. Select the portion of table 4–10 based on this intake or point of use in the manner specified for drinking water intakes.

–If there are no drinking water intakes and no specified resource intakes and points of use, but there is another type of resource listed in section 4.1.2.3.3 (for example, the water is usable for drinking water purposes even though not used), select the portion of table 4–10 based on the nearest point of this resource in the manner specified for drinking water intakes.

TABLE 4–10—PERSISTENCE FACTOR VALUES—HALF-LIFE

Surface water category	Substance half-life (days)	Assigned value [a]
Rivers, oceans, coastal tidal waters, and Great Lakes	Less than or equal to 0.2	0.0007
	Greater than 0.2 to 0.5	0.07
	Greater than 0.5 to 1.5	0.4
	Greater than 1.5	1
Lakes	Less than or equal to 0.02	0.0007
	Greater than 0.02 to 2	0.07
	Greater than 2 to 20	0.4
	Greater than 20	1

[a] Do not round to nearest integer.

If a half-life cannot be estimated for a hazardous substance from available data, use the following default procedure to assign a persistence factor value to that hazardous substance:

• For those hazardous substances that are metals (or metalloids), assign a persistence factor value of 1 as a default for all surface water bodies.

• For other hazardous substances (both organic and inorganic), assign a persistence factor value of 0.4 as a default for rivers, oceans, coastal tidal waters, and Great Lakes, and a persistence factor value of 0.07 as a default for lakes. Select the appropriate value in the same manner specified for using table 4–10.

Use the persistence factor value assigned based on half-life or the default procedure unless the hazardous substance can be assigned a higher factor value from Table 4–11, based on its Log K_{ow}. If a higher value can be assigned from table 4–11, assign this higher value as the persistence factor value for the hazardous substance.

TABLE 4–11—PERSISTENCE FACTOR VALUES—LOG K_{ow}

Log K_{ow}	Assigned value [a]
Less than 3.5	0.0007
3.5 to less than 4.0	0.07
4.0 to 4.5	0.4
Greater than 4.5	1

[a] Use for lakes, rivers, oceans, coastal tidal waters, and Great Lakes. Do not round to nearest integer.

4.1.2.2.1.3 *Calculation of toxicity/persistence factor value.* Assign each hazardous substance a toxicity/persistence factor value from table 4–12, based on the values assigned to the hazardous substance for the toxicity and persistence factors. Use the hazardous substance with the highest toxicity/persistence factor value for the watershed to assign the toxicity/persistence factor value for the drinking water threat for the watershed. Enter this value in table 4–1.

4.1.2.2.2 *Hazardous waste quantity.* Assign a hazardous waste quantity factor value for the watershed as specified in section 2.4.2. Enter this value in table 4–1.

4.1.2.2.3 *Calculation of drinking water threat-waste characteristics factor category value.* Multiply the toxicity/persistence and hazardous waste quantity factor values for the watershed, subject to a maximum product of 1×10^8. Based on this product, assign a value from table 2–7 (section 2.4.3.1) to the drinking water threat-waste characteristics factor category for the watershed. Enter this value in table 4–1.

TABLE 4–12—TOXICITY/PERSISTENCE FACTOR VALUES [A]

Persistence factor value	Toxicity factor value					
	10,000	1,000	100	10	1	0
1.0	10,000	1,000	100	10	1	0
0.4	4,000	400	40	4	0.4	0
0.07	700	70	7	0.7	0.07	0
0.0007	7	0.7	0.07	0.007	0.0007	0

[a] Do not round to nearest integer.

4.1.2.3 *Drinking water threat-targets.* Evaluate the targets factor category for each watershed based on three factors: nearest intake, population, and resources.

To evaluate the nearest intake and population factors, determine whether the target surface water intakes are subject to actual or potential contamination as specified in section 4.1.1.2. Use either an observed release based on direct observation at the intake or the exposure concentrations from samples (or comparable samples) taken at or beyond the intake to make this determination (see section 4.1.2.1.1). The exposure concentrations for a sample (that is, surface water, benthic, or sediment sample) consist of the concentrations of those hazardous substances present that are significantly above background levels and attributable at least in part to the site (that is, those hazardous substance concentrations that meet the criteria for an observed release).

When an intake is subject to actual contamination, evaluate it using Level I concentrations or Level II concentrations. If the actual contamination is based on an observed release by direct observation, use Level II concentrations for that intake. However, if the actual contamination is based on an observed release from samples, determine which level applies for the intake by comparing the exposure concentrations from samples (or comparable samples) to health-based benchmarks as specified in sections 2.5.1 and 2.5.2. Use the health-based benchmarks from table 3–10 (section 3.3.1) in determining the level of contamination from samples. For contaminated sediments with no identified source, evaluate the actual contamination using Level II concentrations (see section 4.1.1.2).

4.1.2.3.1 *Nearest intake.* Evaluate the nearest intake factor based on the drinking water intakes along the overland/flood hazardous substance migration path for the watershed. Include standby intakes in evaluating this factor only if they are used for supply at least once a year.

Assign the nearest intake factor a value as follows and enter the value in table 4–1:

• If one or more of these drinking water intakes is subject to Level I concentrations as specified in section 4.1.2.3, assign a factor value of 50.

• If not, but if one or more of these drinking water intakes is subject to Level II concentrations, assign a factor value of 45.

• If none of these drinking water intakes is subject to Level I or Level II concentrations, determine the nearest of these drinking water intakes, as measured from the probable point of entry (or from the point where measurement begins for contaminated sediments with no identified source). Assign a dilution weight from table 4–13 to this intake, based on the type of surface water body in which it is located. Multiply this dilution weight by 20, round the product to the nearest integer, and assign it as the factor value.

Assign the dilution weight from table 4–13 as follows:

TABLE 4–13—SURFACE WATER DILUTION WEIGHTS

Type of surface water body[a]		Assigned dilution weight[b]
Descriptor	Flow characteristics	
Minimal stream	Less than 10 cfs[c]	1
Small to moderate stream	10 to 100 cfs	0.1
Moderate to large stream	Greater than 100 to 1,000 cfs	0.01
Large stream to river	Greater than 1,000 to 10,000 cfs	0.001
Large river	Greater than 10,000 to 100,000 cfs	0.0001
Very large river	Greater than 100,000 cfs	0.00001
Coastal tidal waters[d]	Flow not applicable, depth not applicable	0.0001
Shallow ocean zone[e] or Great Lake	Flow not applicable, depth less than 20 feet	0.0001
Moderate depth ocean zone[e] or Great Lake	Flow not applicable, depth 20 to 200 feet	0.00001
Deep ocean zone[e] or Great Lake	Flow not applicable, depth greater than 200 feet	0.000005
3-mile mixing zone in quiet flowing river	10 cfs or greater	0.5

[a] Treat each lake as a separate type of water body and assign a dilution weight as specified in text.
[b] Do not round to nearest integer.
[c] cfs = cubic feet per second.
[d] Embayments, harbors, sounds, estuaries, back bays, lagoons, wetlands, etc., seaward from mouths of rivers and landward from baseline of Territorial Sea.
[e] Seaward from baseline of Territorial Sea. This baseline represents the generalized U.S. coastline. It is parallel to the seaward limit of the Territorial Sea and other maritime limits such as the inner boundary of the Federal fisheries jurisdiction and the limit of States jurisdiction under the Submerged Lands Act, as amended.

• For a river (that is, surface water body types specified in table 4–13 as minimal stream through very large river), assign a dilution weight based on the average annual flow in the river at the intake. If available, use the average annual discharge as defined in the U.S. Geological Survey Water Resources Data Annual Report. Otherwise, estimate the average annual flow.

• For a lake, assign a dilution weight as follows:

–For a lake that has surface water flow entering the lake, assign a dilution weight based on the sum of the average annual flows for the surface water bodies entering the lake up to the point of the intake.

–For a lake that has no surface water flow entering, but that does have surface water flow leaving, assign a dilution weight based on the sum of the average annual flows for the surface water bodies leaving the lake.

–For a closed lake (that is, a lake without surface water flow entering or leaving), assign a dilution weight based on the average annual ground water flow into the lake, if available, using the dilution weight for the corresponding river flow rate in table 4–13. If not available, assign a default dilution weight of 1.

• For the ocean and the Great Lakes, assign a dilution weight based on depth.

• For coastal tidal waters, assign a dilution weight of 0.0001; do not consider depth or flow.

• For a quiet-flowing river that has average annual flow of 10 cubic feet per second (cfs) or greater and that contains the probable point of entry to surface water, apply a zone of mixing in assigning the dilution weight:

–Start the zone of mixing at the probable point of entry and extend it for 3 miles from the probable point of entry, except: if the surface water characteristics change to turbulent within this 3-mile distance, extend the zone of mixing only to the point at which the change occurs.

–Assign a dilution weight of 0.5 to any intake that lies within this zone of mixing.

–Beyond this zone of mixing, assign a dilution weight the same as for any other river (that is, assign the dilution weight based on average annual flow).

–Treat a quiet-flowing river with an average annual flow of less than 10 cfs the same as any other river (that is, assign it a dilution weight of 1).

In those cases where water flows from a surface water body with a lower assigned dilution weight (from table 4–13) to a surface water body with a higher assigned dilution weight (that is, water flows from a surface water body with more dilution to one with less dilution), use the lower assigned dilution weight as the dilution weight for the latter surface water body.

4.1.2.3.2 *Population.* In evaluating the population factor, include only persons served by drinking water drawn from intakes that are along the overland/flood hazardous substance migration path for the watershed and that are within the target distance limit specified in section 4.1.1.2. Include residents, students, and workers who regularly use the water. Exclude transient populations such as customers and travelers passing through the area. When a standby intake is maintained

on a regular basis so that water can be withdrawn, include it in evaluating the population factor.

In estimating residential population, when the estimate is based on the number of residences, multiply each residence by the average number of persons per residence for the county in which the residence is located.

In estimating the population served by an intake, if the water from the intake is blended with other water (for example, water from other surface water intakes or ground water wells), apportion the total population regularly served by the blended system to the intake based on the intake's relative contribution to the total blended system. In estimating the intake's relative contribution, assume each well or intake contributes equally and apportion the population accordingly, except: if the relative contribution of any one intake or well exceeds 40 percent based on average annual pumpage or capacity, estimate the relative contribution of the wells and intakes considering the following data, if available:

• Average annual pumpage from the ground water wells and surface water intakes in the blended system.

• Capacities of the wells and intakes in the blended system.

For systems with standby surface water intakes or standby ground water wells, apportion the total population regularly served by the blended system as described above, except:

• Exclude standby ground water wells in apportioning the population.

• When using pumpage data for a standby surface water intake, use average pumpage for the period during which the standby intake is used rather than average annual pumpage.

• For that portion of the total population that could be apportioned to a standby surface water intake, assign that portion of the population either to that standby intake or to the other surface water intake(s) and ground water well(s) that serve that population; do not assign that portion of the population both to the standby intake and to the other intake(s) and well(s) in the blended system. Use the apportioning that results in the highest population factor value. (Either include all standby intake(s) or exclude some or all of the standby intake(s) as appropriate to obtain this highest value.) Note that the specific standby intake(s) included or excluded and, thus, the specific apportioning may vary in evaluating different watersheds and in evaluating the ground water pathway.

4.1.2.3.2.1 *Level of contamination.* Evaluate the population factor based on three factors: Level I concentrations, Level II concentrations, and potential contamination. Determine which factor applies for an intake as specified in section 4.1.2.3. Evaluate intakes subject to Level I concentration as specified in section 4.1.2.3.2.2, intakes subject to Level II concentration as specified in section 4.1.2.3.2.3, and intakes subject to potential contamination as specified in section 4.1.2.3.2.4.

For the potential contamination factor, use population ranges in evaluating the factor as specified in section 4.1.2.3.2.4. For the Level I and Level II concentrations factors, use the population estimate, not population ranges, in evaluating both factors.

4.1.2.3.2.2 *Level I concentrations.* Sum the number of people served by drinking water from intakes subject to Level I concentrations. Multiply this sum by 10. Assign this product as the value for this factor. Enter this value in table 4–1.

4.1.2.3.2.3 *Level II concentrations.* Sum the number of people served by drinking water from intakes subject to Level II concentrations. Do not include people already counted under the Level I concentrations factor. Assign this sum as the value for this factor. Enter this value in table 4–1.

4.1.2.3.2.4 *Potential contamination.* For each applicable type of surface water body in table 4–14, first determine the number of people served by drinking water from intakes subject to potential contamination in that type of surface water body. Do not include those people already counted under the Level I and Level II concentrations factors.

TABLE 4–14—DILUTION-WEIGHTED POPULATION VALUES FOR POTENTIAL CONTAMINATION FACTOR FOR SURFACE WATER MIGRATION PATHWAY [A]

Type of surface water body [b]	Number of people													
	0	1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000	1,000,001 to 3,000,000	3,000,001 to 10,000,000
Minimal stream (<10 cfs) ...	0	4	17	53	164	522	1,633	5,214	16,325	52,137	163,246	521,360	1,632,455	5,213,590
Small to moderate stream (10 to 100 cfs)	0	0.4	2	5	16	52	163	521	1,633	5,214	16,325	52,136	163,245	521,359
Moderate to large stream (>100 to 1,000 cfs)	0	0.04	0.2	0.5	2	5	16	52	163	521	1,633	5,214	16,325	52,136
Large stream to river (>1,000 to 10,000 cfs)	0	0.004	0.02	0.05	0.2	0.5	2	5	16	52	163	521	1,632	5,214
Large river (>10,000 to 100,000 cfs)	0	0	0.002	0.005	0.02	0.05	0.2	0.5	2	5	16	52	163	521
Very large river (>100,000 cfs)	0	0	0	0.001	0.002	0.005	0.02	0.05	0.2	0.5	2	5	16	52
Shallow ocean zone or Great Lake (depth <20 feet)	0	0	0.002	0.005	0.02	0.05	0.2	0.5	2	5	16	52	163	521
Moderate ocean zone or Great Lake (depth 20 to 200 feet)	0	0	0	0.001	0.002	0.005	0.02	0.05	0.2	0.5	2	5	16	52
Deep ocean zone or Great Lakes (depth >200 feet)	0	0	0	0	0.001	0.003	0.008	0.03	0.08	0.3	1	3	8	26
3-mile mixing zone in quiet flowing river (≥10 cfs)	0	2	9	26	82	261	817	2,607	8,163	26,068	81,623	260,680	816,227	2,606,795

[a] Round the number of people to nearest integer. Do not round the assigned dilution-weighted population value to nearest integer.

[b] Treat each lake as a separate type of water body and assign it a dilution-weighted population value using the surface water body type with the same dilution-weighted from table 4–13 as the lake. If drinking water is withdrawn from coastal tidal water or the ocean, assign a dilution-weighted population value to it using the surface water body type with the same dilution weight from table 4–13 as the coastal tidal water or the ocean zone.

For each type of surface water body, assign a dilution-weighted population value from table 4–14, based on the number of people included for that type of surface water body. (Note that the dilution-weighted population values in table 4–14 incorporate the dilution weights from table 4–13. Do not multiply the values from table 4–14 by these dilution weights.)

Calculate the value for the potential contamination factor (PC) for the watershed as follows:

$$PC = \frac{1}{10}\sum_{i=1}^{n}(W_i)$$

where:

W_i=Dilution-weighted population from table 4–14 for surface water body type i.

n=Number of different surface water body types in the watershed.

If PC is less than 1, do not round it to the nearest integer; if PC is 1 or more, round to the nearest integer. Enter this value for the potential contamination factor in table 4–1.

4.1.2.3.2.5 *Calculation of population factor value.* Sum the factor values for Level I concentrations, Level II concentrations, and potential contamination. Do not round this sum to the nearest integer. Assign this sum as the population factor value for the watershed. Enter this value in table 4–1.

4.1.2.3.3 *Resources.* To evaluate the resources factor for the watershed, select the highest value below that applies to the watershed. Assign this value as the resources factor value for the watershed. Enter this value in table 4–1.

Assign a value of 5 if, within the in-water segment of the hazardous substance migration path for the watershed, the surface water is used for one or more of the following purposes:

• Irrigation (5 acre minimum) of commercial food crops or commercial forage crops.

• Watering of commercial livestock.

• Ingredient in commercial food preparation.

• Major or designated water recreation area, excluding drinking water use.

Assign a value of 5 if, within the in-water segment of the hazardous substance migration path for the watershed, the surface water is not used for drinking water, but either of the following applies:

• Any portion of the surface water is designated by a State for drinking water use under section 305(a) of the Clean Water Act, as amended.

• Any portion of the surface water is usable for drinking water purposes.

Assign a value of 0 if none of the above applies.

4.1.2.3.4 *Calculation of drinking water threat-targets factor category value.* Sum the nearest intake, population, and resources factor values for the watershed. Do not round this sum to the nearest integer. Assign this sum as the drinking water threat-targets factor category value for the watershed. Enter this value in table 4–1.

4.1.2.4 *Calculation of the drinking water threat score for a watershed.* Multiply the drinking water threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 100, as the drinking water threat score for the watershed. Enter this value in table 4–1.

4.1.3 *Human food chain threat.* Evaluate the human food chain threat for each watershed based on three factor categories: likelihood of release, waste characteristics, and targets.

4.1.3.1 *Human food chain threat-likelihood of release.* Assign the same likelihood of release factor category value for the human food chain threat for the watershed as would be assigned in section 4.1.2.1.3 for the drinking water threat. Enter this value in table 4–1.

4.1.3.2 *Human food chain threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: toxicity/persistence/bioaccumulation and hazardous waste quantity.

4.1.3.2.1 *Toxicity/persistence/bioaccumulation.* Evaluate all those hazardous substances eligible to be evaluated for toxicity/persistence in the drinking water threat for the watershed (see section 4.1.2.2).

4.1.3.2.1.1 *Toxicity.* Assign a toxicity factor value to each hazardous substance as specified in section 2.4.1.1.

4.1.3.2.1.2 *Persistence.* Assign a persistence factor value to each hazardous substance as specified for the drinking water threat (see section 4.1.2.2.1.2), except: use the predominant water category (that is, lakes; or rivers, oceans, coastal tidal waters, or Great Lakes) between the probable point of entry and the nearest fishery (not the nearest drinking water or resources intake) along the hazardous substance migration path for the watershed to determine which portion of table 4–10 to use. Determine the predominant water category based on distance as specified in section 4.1.2.2.1.2. For contaminated sediments with no identified source, use the point where measurement begins rather than the probable point of entry.

4.1.3.2.1.3 *Bioaccumulation potential.* Use the following data hierarchy to assign a bioaccumulation potential factor value to each hazardous substance:

• Bioconcentration factor (BCF) data.

• Logarithm of the n-octanol-water partition coefficient (log K_{ow}) data.

• Water solubility data.

Assign a bioaccumulation potential factor value to each hazardous substance from table 4–15.

If BCF data are available for any aquatic human food chain organism for the substance being evaluated, assign the bioaccumulation potential factor value to the hazardous substance as follows:

• If BCF data are available for both fresh water and salt water for the hazardous substance, use the BCF data that correspond to the type of water body (that is, fresh water or salt water) in which the fisheries are located to assign the bioaccumulation potential factor value to the hazardous substance.

• If, however, some of the fisheries being evaluated are in fresh water and some are in salt water, or if any are in brackish water, use the BCF data that yield the higher factor value to assign the bioaccumulation potential factor value to the hazardous substance.

• If BCF data are available for either fresh water or salt water, but not for both, use the available BCF data to assign the bioaccumulation potential factor value to the hazardous substance.

If BCF data are not available for the hazardous substance, use log K_{ow} data to assign a bioaccumulation potential factor value to organic substances, but not to inorganic substances. If BCF data are not available, and if either log K_{ow} data are not available, the log K_{ow} is available but exceeds 6.0, or the substance is an inorganic substance, use water solubility data to assign a bioaccumulation potential factor value.

TABLE 4–15—BIOACCUMULATION POTENTIAL FACTOR VALUES [A]

If bioconcentration factor (BCF) data are available for any aquatic human food chain organism, assign a value as follows: [b]

BCF	Assigned value
Greater than or equal to 10,000	50,000
1,000 to less than 10,000	5,000
100 to less than 1,000	500
10 to less than 100	50
1 to less than 10	5
Less than 1	0.5

If BCF data are not available, and log K_{ow} data are available and do not exceed 6.0, assign a value to an organic hazardous substance as follows (for inorganic hazardous substances, skip this step and proceed to the next):

Log K_{ow}	Assigned value
5.5 to 6.0	50,000
4.5 to less than 5.5	5,000
3.2 to less than 4.5	500
2.0 to less than 3.2	50
0.8 to less than 2.0	5
Less than 0.8	0.5

If BCF data are not available, and if either Log K_{ow} data are not available, a log K_{ow} is available but exceeds 6.0, or the substance is an inorganic substance, assign a value as follows:

TABLE 4–15—BIOACCUMULATION POTENTIAL FACTOR VALUES [A]—CONCLUDED

Water solubility (mg/l)	Assigned value
Less than 25	50,000
25 to 500	5,000
Greater than 500 to 1,500	500
Greater than 1,500	0.5

If none of these data are available, assign a value of 0.5.

[a] Do not round to nearest integer.
[b] See text for use of freshwater and saltwater BCF data.

Do not distinguish between fresh water and salt water in assigning the bioaccumulation potential factor value based on log K_{ow} or water solubility data.

If none of these data are available, assign the hazardous substance a bioaccumulation potential factor value of 0.5.

4.1.3.2.1.4 *Calculation of toxicity/persistence/bioaccumulation factor value.* Assign each hazardous substance a toxicity/persistence factor value from table 4–12, based on the values assigned to the hazardous substance for the toxicity and persistence factors. Then assign each hazardous substance a toxicity/persistence/bioaccumulation factor value from table 4–16, based on the values assigned for the toxicity/persistence and bioaccumulation potential factors. Use the hazardous substance with the highest toxicity/persistence/bioaccumulation factor value for the watershed to assign the value to this factor. Enter this value in table 4–1.

TABLE 4–16—TOXICITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES [A]

Toxicity persistence factor value	Bioaccumulation potential factor value					
	50,000	5,000	500	50	5	0.5
10,000	5×10^8	5×10^7	5×10^6	5×10^5	5×10^4	5,000
4,000	2×10^8	2×10^7	2×10^6	2×10^5	2×10^4	2,000
1,000	5×10^7	5×10^6	5×10^5	5×10^4	5,000	500
700	3.5×10^7	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350
400	2×10^7	2×10^6	2×10^5	2×10^4	2,000	200
100	5×10^6	5×10^5	5×10^4	5,000	500	50
70	3.5×10^6	3.5×10^5	3.5×10^4	3,500	350	35
40	2×10^6	2×10^5	2×10^4	2,000	200	20

TABLE 4–16—TOXICITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES [A]—Continued

Toxicity persistence factor value	Bioaccumulation potential factor value					
	50,000	5,000	500	50	5	0.5
10	5×10^5	5×10^4	5,000	500	50	5
7	3.5×10^5	3.5×10^4	3,500	350	35	3.5
4	2×10^5	2×10^4	2,000	200	20	2
1	5×10^4	5,000	500	50	5	0.5
0.7	3.5×10^4	3,500	350	35	3.5	0.35
0.4	2×10^4	2,000	200	20	2	0.2
0.07	3,500	350	35	3.5	0.35	0.035
0.007	350	35	3.5	0.35	0.035	0.0035
0.0007	35	3.5	0.35	0.035	0.0035	0.00035
0	0	0	0	0	0	0

[a] Do not round to nearest integer.

4.1.3.2.2 *Hazardous waste quantity*. Assign the same factor value for hazardous waste quantity for the watershed as would be assigned in section 4.1.2.2.2 for the drinking water threat. Enter this value in table 4–1.

4.1.3.2.3 *Calculation of human food chain threat-waste characteristics factor category value*. For the hazardous substance selected for the watershed in section 4.1.3.2.1.4, use its toxicity/persistence factor value and bioaccumulation potential factor value as follows to assign a value to the waste characteristics factor category. First, multiply the toxicity/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^8. Then multiply this product by the bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12}. Based on this second product, assign a value from Table 2–7 (section 2.4.3.1) to the human food chain threat-waste characteristics factor category for the watershed. Enter this value in table 4–1.

4.1.3.3 *Human food chain threat-targets*. Evaluate two target factors for each watershed: food chain individual and population. For both factors, determine whether the target fisheries are subject to actual or potential human food chain contamination.

Consider a fishery (or portion of a fishery) within the target distance limit of the watershed to be subject to actual human food chain contamination if any of the following apply:

• A hazardous substance having a bioaccumulation potential factor value of 500 or greater is present either in an observed release by direct observation to the watershed or in a surface water or sediment sample from the watershed at a level that meets the criteria for an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release (that is, it is located either at the point of direct observation or at or between the probable point of entry and the most distant sampling point establishing the observed release).

• The fishery is closed, and a hazardous substance for which the fishery has been closed has been documented in an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release.

• A hazardous substance is present in a tissue sample from an essentially sessile, benthic, human food chain organism from the watershed at a level that meets the criteria for an observed release to the watershed from the site, and at least a portion of the fishery is within the boundaries of the observed release.

For a fishery that meets any of these three criteria, but that is not wholly within the boundaries of the observed release, consider only the portion of the fishery that is within the boundaries of the observed release to be subject to actual human food chain contamination. Consider the remainder of the fishery within the target distance limit to be subject to potential food chain contamination.

In addition, consider all other fisheries that are partially or wholly within the target distance limit for the watershed, including fisheries partially or wholly within the boundaries of an observed release for the watershed that do not meet any of the three criteria listed above, to be subject to potential human food chain contamination. If only a portion of the fishery is within the target distance limit for the watershed, include only that portion in evaluating the targets factor category.

When a fishery (or portion of a fishery) is subject to actual food chain contamination, determine the part of the fishery subject to Level I concentrations and the part subject to Level II concentrations. If the actual food chain contamination is based on direct observation, evaluate it using Level II concentrations. However, if the actual food chain contamination is based on samples from the watershed, use these samples and, if available, additional tissue samples from aquatic human food chain organisms as specified below, to determine the part subject to

Level I concentrations and the part subject to Level II concentrations:

• Determine the level of actual contamination from samples (including tissue samples from essentially sessile, benthic organisms) that meet the criteria for actual food chain contamination by comparing the exposure concentrations (see section 4.1.2.3) from these samples (or comparable samples) to the health-based benchmarks from table 4–17, as described in section 2.5.1 and 2.5.2. Use only the exposure concentrations for those hazardous substances in the sample (or comparable samples) that meet the criteria for actual contamination of the fishery.

• In addition, determine the level of actual contamination from other tissue samples by comparing the concentrations of hazardous substances in the tissue samples (or comparable tissue samples) to the health-based benchmarks from table 4–17, as described in sections 2.5.1 and 2.5.2. Use only those additional tissue samples and only those hazardous substances in the tissue samples that meet all the following criteria:

–The tissue sample is from a location that is within the boundaries of the actual food chain contamination for the site (that is, either at the point of direct observation or at or between the probable point of entry and the most distant sample point meeting the criteria for actual food chain contamination).

–The tissue sample is from a species of aquatic human food chain organism that spends extended periods of time within the boundaries of the actual food chain contamination for the site and that is not an essentially sessile, benthic organism.

–The hazardous substance is a substance that is also present in a surface water, benthic, or sediment sample from within the target distance limit for the watershed and, for such a sample, meets the criteria for actual food chain contamination.

TABLE 4–17—HEALTH-BASED BENCHMARKS FOR HAZARDOUS SUBSTANCES IN HUMAN FOOD CHAIN

• Concentration corresponding to Food and Drug Administration Action Level (FDAAL) for fish or shellfish.

• Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for oral exposures.

• Screening concentration for noncancer toxicological responses corresponding to the Reference Dose (RfD) for oral exposures.

4.1.3.3.1 *Food chain individual.* Evaluate the food chain individual factor based on the fisheries (or portions of fisheries) within the target distance limit for the watershed. Assign this factor a value as follows:

• If any fishery (or portion of a fishery) is subject to Level I concentrations, assign a value of 50.

• If not, but if any fishery (or portion of a fishery) is subject to Level II concentrations, assign a value of 45.

• If not, but if there is an observed release of a hazardous substance having a bioaccumulation potential factor value of 500 or greater to surface water in the watershed and there is a fishery (or portion of a fishery) present anywhere within the target distance limit, assign a value of 20.

• If there is no observed release to surface water in the watershed or there is no observed release of a hazardous substance having a bioaccumulation potential factor value of 500 or greater, but there is a fishery (or portion of a fishery) present anywhere within the target distance limit, assign a value as follows:

–Using table 4–13, determine the highest dilution weight (that is, lowest amount of dilution) applicable to the fisheries (or portions of fisheries) within the target distance limit. Multiply this dilution weight by 20 and round to the nearest integer.

–Assign this calculated value as the factor value.

• If there are no fisheries (or portions of fisheries) within the target distance limit of the watershed, assign a value of 0.

Enter the value assigned in table 4–1.

4.1.3.3.2 *Population.* Evaluate the population factor for the watershed based on three factors: Level I concentrations, Level II concentrations, and potential human food chain contamination. Determine which factor applies for a fishery (or portion of a fishery) as specified in section 4.1.3.3.

4.1.3.3.2.1 *Level I concentrations.* Determine those fisheries (or portions of fisheries) within the watershed that are subject to Level I concentrations.

Estimate the human food chain population value for each fishery (or portion of a fishery) as follows:

• Estimate human food chain production for the fishery based on the estimated annual production (in pounds) of human food chain organisms (for example, fish, shellfish) for that fishery, except: if the fishery is closed and a hazardous substance for which the fishery has been closed has been documented in an observed release to the fishery from a source at the site, use the estimated annual production for the period prior to closure of the fishery or use the estimated annual production from comparable fisheries that are not closed.

• Assign the fishery a value for human food chain population from table 4–18, based on the estimated human food production for the fishery.

• Set boundaries between fisheries at those points where human food chain production

changes or where the surface water dilution weight changes.

Sum the human food chain population value for each fishery (and portion of a fishery). Multiply this sum by 10. If the product is less than 1, do not round it to the nearest integer; if 1 or more, round to the nearest integer. Assign the resulting value as the Level I concentrations factor value. Enter this value in table 4–1.

4.1.3.3.2.2 *Level II concentrations.* Determine those fisheries (or portions of fisheries) within the watershed that are subject to Level II concentrations. Do not include any fisheries (or portions of fisheries) already counted under the Level I concentrations factor.

Assign each fishery (or portion of a fishery) a value for human food chain population from table 4–18, based on the estimated human food production for the fishery. Estimate the human food chain production for the fishery as specified in section 4.1.3.3.2.1.

Sum the human food chain population value for each fishery (and portion of a fishery). If this sum is less than 1, do not round it to the nearest integer; if 1 or more, round to the nearest integer. Assign the resulting value as the Level II concentrations factor value. Enter this value in table 4–1.

TABLE 4–18—HUMAN FOOD CHAIN POPULATION VALUES [A]

Human food chain production (pounds per year)	Assigned human food chain population value
0	0
Greater than 0 to 100	0.03
Greater than 100 to 1,000	0.3
Greater than 1,000 to 10,000	3
Greater than 10,000 to 100,000	31
Greater than 100,000 to 1,000,000	310
Greater than 10^6 to 10^7	3,100
Greater than 10^7 to 10^8	31,000
Greater than 10^8 to 10^9	310,000
Greater than 10^9	3,100,000

[a] Do not round to nearest integer.

4.1.3.3.2.3 *Potential human food chain contamination.* Determine those fisheries (or portions of fisheries) within the watershed that are subject to potential human food chain contamination. Do not include those fisheries (or portion of fisheries) already counted under the Level I or Level II concentrations factors.

Calculate the value for the potential human food chain contamination factor (PF) for the watershed as follows:

$$PF = \frac{1}{10}\sum_{i=1}^{n} P_i D_i$$

where:

P_i=Human food chain population value for fishery i.

D_i=Dilution weight from table 4–13 for fishery i.

n=Number of fisheries subject to potential human food chain contamination.

In calculating PF:

• Estimate the human food chain population value (P_i) for a fishery (or portion of a fishery) as specified in section 4.1.3.3.2.1.

• Assign the fishery (or portion of a fishery) a dilution weight as indicated in table 4–13 (section 4.1.2.3.1), except: do not assign a dilution weight of 0.5 for a ''3-mile mixing zone in quiet flowing river''; instead assign a dilution weight based on the average annual flow.

If PF is less than 1, do not round it to the nearest integer; if PF is 1 or more, round to the nearest integer. Enter the value assigned in table 4–1.

4.1.3.3.2.4 *Calculation of population factor value.* Sum the values for the Level I concentrations, Level II concentrations, and potential human food chain contamination factors for the watershed. Do not round this sum to the nearest integer. Assign it as the population factor value for the watershed. Enter this value in table 4–1.

4.1.3.3.3 *Calculation of human food chain threat-targets factor category value.* Sum the food chain individual and population factor values for the watershed. Do not round this sum to the nearest integer. Assign it as the human food chain threat-targets factor category value for the watershed. Enter this value in table 4–1.

4.1.3.4 *Calculation of human food chain threat score for a watershed.* Multiply the human food chain threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 100, as the human food chain threat score for the watershed. Enter this score in table 4–1.

4.1.4 *Environmental threat.* Evaluate the environmental threat for the watershed based on three factor categories: likelihood of release, waste characteristics, and targets.

4.1.4.1 *Environmental threat-likelihood of release.* Assign the same likelihood of release factor category value for the environmental threat for the watershed as would be assigned in section 4.1.2.1.3 for the drinking water threat. Enter this value in table 4–1.

4.1.4.2 *Environmental threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: ecosystem toxicity/persistence/bioaccumulation and hazardous waste quantity.

4.1.4.2.1 *Ecosystem toxicity/persistence/bioaccumulation.* Evaluate all those hazardous

substances eligible to be evaluated for toxicity/persistence in the drinking water threat for the watershed (see section 4.1.2.2).

4.1.4.2.1.1 *Ecosystem toxicity*. Assign an ecosystem toxicity factor value from Table 4–19 to each hazardous substance on the basis of the following data hierarchy:

- EPA chronic Ambient Water Quality Criterion (AWQC) for the substance.
- EPA chronic Ambient Aquatic Life Advisory Concentrations (AALAC) for the substance.
- EPA acute AWQC for the substance.
- EPA acute AALAC for the substance.
- Lowest LC_{50} value for the substance.

In assigning the ecosystem toxicity factor value to the hazardous substance:

- If either an EPA chronic AWQC or AALAC is available for the hazardous substance, use it to assign the ecosystem toxicity factor value. Use the chronic AWQC in preference to the chronic AALAC when both are available.
- If neither is available, use the EPA acute AWQC or AALAC to assign the ecosystem toxicity factor value. Use the acute AWQC in preference to the acute AALAC.
- If none of the chronic and acute AWQCs and AALACs is available, use the lowest LC_{50} value to assign the ecosystem toxicity factor value.
- If an LC_{50} value is also not available, assign an ecosystem toxicity factor value of 0 to the hazardous substance and use other hazardous substances for which data are available in evaluating the pathway.

If an ecosystem toxicity factor value of 0 is assigned to all hazardous substances eligible to be evaluated for the watershed (that is, insufficient data are available for evaluating all the substances), use a default value of 100 as the ecosystem toxicity factor value for all these hazardous substances.

With regard to the AWQC, AALAC, or LC_{50} selected for assigning the ecosystem toxicity factor value to the hazardous substance:

- If values for the selected AWQC, AALAC, or LC_{50} are available for both fresh water and marine water for the hazardous substance, use the value that corresponds to the type of water body (that is, fresh water or salt water) in which the sensitive environments are located to assign the ecosystem toxicity factor value to the hazardous substance.
- If, however, some of the sensitive environments being evaluated are in fresh water and some are in salt water, or if any are in brackish water, use the value (fresh water or marine) that yields the higher factor value to assign the ecosystem toxicity factor value to the hazardous substance.
- If a value for the selected AWQC, AALAC, or LC_{50} is available for either fresh water or marine water, but not for both, use the available one to assign an ecosystem toxicity factor value to the hazardous substance.

TABLE 4–19—ECOSYSTEM TOXICITY FACTOR VALUES

If an EPA chronic AWQC [a] or AALAC [b] is available, assign a value as follows: [c]

EPA chronic AWQC or AALAC	Assigned value
Less than 1 μg/l	10,000
1 to 10 μg/l	1,000
Greater than 10 to 100 μg/l	100
Greater than 100 to 1,000 μg/l	10
Greater than 1,000 μg/l	1

If neither an EPA chronic AWQC nor EPA chronic AALAC is available, assign a value based on the EPA acute AWQC or AALAC as follows: [c]

EPA acute AWQC or AALAC	Assigned value
Less than 100 μg/l	10,000
100 to 1,000 μg/l	1,000
Greater than 1,000 to 10,000 μg/l	100
Greater than 10,000 to 100,000 μg/l	10
Greater than 100,000 μg/l	1

If neither an EPA chronic or acute AWQC nor EPA chronic or acute AALAC is available, assign a value from the LC_{50} as follows:

LC_{50}	Assigned value
Less than 100 μg/l	10,000
100 to 1,000 μg/l	1,000
Greater than 1,000 to 10,000 μg/l	100
Greater than 10,000 to 100,000 μg/l	10
Greater than 100,000 μg/l	1

If none of the AWQCs and AALACs nor the LC_{50} is available, assign a value of 0.

[a] AWQC—Ambient Water Quality Criteria.
[b] AALAC—Ambient Aquatic Life Advisory Concentrations.
[c] Use the AWQC value in preference to the AALAC when both are available. See text for use of fresh water and marine values.

4.1.4.2.1.2 *Persistence*. Assign a persistence factor value to each hazardous substance as specified in section 4.1.2.2.1.2, except: use the predominant water category (that is lakes; or rivers, oceans, coastal tidal waters, or Great Lakes) between the probable point of entry and the nearest sensitive environment (not the nearest drinking water or resources intake) along the hazardous substance migration path for the watershed to determine which portion of table 4–10 to use. Determine the predominant water category based on distance as specified in section 4.1.2.2.1.2. For contaminated sediments with no identified source, use the point where measurement begins rather than the probable point of entry.

4.1.4.2.1.3 *Ecosystem bioaccumulation potential*. Assign an ecosystem bioaccumulation potential factor value to each hazardous substance in the same manner specified for the bioaccumulation potential factor in section 4.1.3.2.1.3, except:

- Use BCF data for all aquatic organisms, not just for aquatic human food chain organisms.

• Use the BCF data that corresponds to the type of water body (that is, fresh water or salt water) in which the sensitive environments (not fisheries) are located.

4.1.4.2.1.4 *Calculation of ecosystem toxicity/persistence/bioaccumulation factor value.* Assign each hazardous substance an ecosystem toxicity/persistence factor value from table 4–20, based on the values assigned to the hazardous substance for the ecosystem toxicity and persistence factors. Then assign each hazardous substance an ecosystem toxicity/persistence/bioaccumulation factor value from table 4–21, based on the values assigned for the ecosystem toxicity/persistence and ecosystem bioaccumulation potential factors. Select the hazardous substance with the highest ecosystem toxicity/persistence/bioaccumulation factor value for the watershed and use it to assign the value to this factor. Enter this value in table 4–1.

TABLE 4–20—ECOSYSTEM TOXICITY/PERSISTENCE FACTOR VALUES [A]

Persistence factor value	Ecosystem toxicity factor value					
	10,000	1,000	100	10	1	0
1.0	10,000	1,000	100	10	1	0
0.4	4,000	400	40	4	0.4	0
0.07	700	70	7	0.7	0.07	0
0.0007	7	0.7	0.07	0.007	0.0007	0

[a] Do not round to nearest integer.

TABLE 4–21—ECOSYSTEM TOXICITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES [A]

Ecosystem toxicity persistence factor value	Ecosystem bioaccumulation potential factor value					
	50,000	5,000	500	50	5	0.5
10,000	5×10^{8}	5×10^{7}	5×10^{6}	5×10^{5}	5×10^{4}	5,000
4,000	2×10^{8}	2×10^{7}	2×10^{6}	2×10^{5}	2×10^{4}	2,000
1,000	5×10^{7}	5×10^{6}	5×10^{5}	5×10^{4}	5,000	500
700	3.5×10^{7}	3.5×10^{6}	3.5×10^{5}	3.5×10^{4}	3,500	350
400	2×10^{7}	2×10^{6}	2×10^{5}	2×10^{4}	2,000	200
100	5×10^{6}	5×10^{5}	5×10^{4}	5,000	500	50
70	3.5×10^{6}	3.5×10^{5}	3.5×10^{4}	3,500	350	35
40	2×10^{6}	2×10^{5}	2×10^{4}	2,000	200	20
10	5×10^{5}	5×10^{4}	5,000	500	50	5
7	3.5×10^{5}	3.5×10^{4}	3,500	350	35	3.5
4	2×10^{5}	2×10^{4}	2,000	200	20	2
1	5×10^{4}	5,000	500	50	5	0.5
0.7	3.5×10^{4}	3,500	350	35	3.5	0.35
0.4	2×10^{4}	2,000	200	20	2	0.2
0.07	3,500	350	35	3.5	0.35	0.035
0.007	350	35	3.5	0.35	0.035	0.0035
0.0007	35	3.5	0.35	0.035	0.0035	0.00035
0	0	0	0	0	0	0

[a] Do not round to nearest integer.

4.1.4.2.2 *Hazardous waste quantity.* Assign the same factor value for hazardous waste quantity for the watershed as would be assigned in section 4.1.2.2.2 for the drinking water threat. Enter this value in table 4–1.

4.1.4.2.3 *Calculation of environmental threat-waste characteristics factor category value.* For the hazardous substance selected for the watershed in section 4.1.4.2.1.4, use its ecosystem toxicity/persistence factor value and ecosystem bioaccumulation potential factor value as follows to assign a value to the waste characteristics factor category. First, multiply the ecosystem toxicity/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^{8}. Then multiply this product by the ecosystem bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12}. Based on this second product, assign a value from Table 2–7 (section 2.4.3.1) to the environmental threat-waste characteristics factor category for the watershed. Enter this value in table 4–1.

TABLE 4–22—ECOLOGICAL-BASED BENCHMARKS FOR HAZARDOUS SUBSTANCES IN SURFACE WATER

• Concentration corresponding to EPA Ambient Water Quality Criteria (AWQC) for protection of aquatic life (fresh water or marine).

• Concentration corresponding to EPA Ambient Aquatic Life Advisory Concentrations (AALAC).

• Select the appropriate AWQC and AALAC as follows:

–Use chronic value, if available; otherwise use acute value.
–If the sensitive environment being evaluated is in fresh water, use fresh water value, except: if no fresh water value is available, use marine value if available.
–If the sensitive environment being evaluated is in salt water, use marine value, except: if no marine value is available, use fresh water value if available.
–If the sensitive environment being evaluated is in both fresh water and salt water, or is in brackish water, use lower of fresh water or marine values.

TABLE 4–23—SENSITIVE ENVIRONMENTS RATING VALUES

Sensitive environment	Assigned value
Critical habitat[a] for Federal designated endangered or threatened species Marine Sanctuary National Park Designated Federal Wilderness Area Areas identified under Coastal Zone Management Act[b] Sensitive areas identified under National Estuary Program[c] or Near Coastal Waters Program[d] Critical areas identified under the Clean Lakes Program[e] National Monument[f] National Seashore Recreational Area National Lakeshore Recreational Area	100
Habitat known to be used by Federal designated or proposed endangered or threatened species National Preserve National or State Wildlife Refuge Unit of Coastal Barrier Resources System Coastal Barrier (undeveloped) Federal land designated for protection of natural ecosystems Administratively Proposed Federal Wilderness Area Spawning areas critical[g] for the maintenance of fish/shellfish species within river, lake, or coastal tidal waters Migratory pathways and feeding areas critical for maintenance of anadromous fish species within river reaches or areas in lakes or coastal tidal waters in which the fish spend extended periods of time Terrestrial areas utilized for breeding by large or dense aggregations of animals[h] National river reach designated as Recreational	75
Habitat known to be used by State designated endangered or threatened species Habitat known to be used by species under review as to its Federal endangered or threatened status Coastal Barrier (partially developed) Federal designated Scenic or Wild River	50
State land designated for wildlife or game management State designated Scenic or Wild River State designated Natural Areas Particular areas, relatively small in size, important to maintenance of unique biotic communities	25
State designated areas for protection or maintenance of aquatic life[i]	5

[a] Critical habitat as defined in 50 CFR 424.02.
[b] Areas identified in State Coastal Zone Management plans as requiring protection because of ecological value.
[c] National Estuary Program study areas (subareas within estuaries) identified in Comprehensive Conservation and Management Plans as requiring protection because they support critical life stages of key estuarine species (Section 320 of Clean Water Act, as amended).
[d] Near Coastal Waters as defined in Sections 104(b)(3), 304(1), 319, and 320 of Clean Water Act, as amended.
[e] Clean Lakes Program critical areas (subareas within lakes, or in some cases entire small lakes) identified by State Clean Lake Plans as critical habitat (Section 314 of Clean Water Act, as amended).
[f] Use only for air migration pathway.
[g] Limit to areas described as being used for intense or concentrated spawning by a given species.
[h] For the air migration pathway, limit to terrestrial vertebrate species. For the surface water migration pathway, limit to terrestrial vertebrate species with aquatic or semiaquatic foraging habits.
[i] Areas designated under Section 305(a) of Clean Water Act, as amended.

TABLE 4–24—WETLANDS RATING VALUES FOR SURFACE WATER MIGRATION PATHWAY

Total length of wetlands[a] (miles)	Assigned value
Less than 0.1	0
0.1 to 1	25
Greater than 1 to 2	50
Greater than 2 to 3	75
Greater than 3 to 4	100
Greater than 4 to 8	150
Greater than 8 to 12	250
Greater than 12 to 16	350
Greater than 16 to 20	450
Greater than 20	500

[a] Wetlands as defined in 40 CFR section 230.3.

4.1.4.3 *Environmental threat-targets.* Evaluate the environmental threat-targets factor category for a watershed using one factor: sensitive environments.

4.1.4.3.1 *Sensitive environments.* Evaluate sensitive environments along the hazardous substance migration path for the watershed based on three factors: Level I concentrations, Level II concentrations, and potential contamination.

Determine which factor applies to each sensitive environment as specified in section 4.1.2.3, except: use ecological-based benchmarks (Table 4–22) rather than health-based benchmarks (Table 3–10) in determining the level of contamination from samples. In determining the level of actual contamination, use a point of direct observation anywhere within the sensitive environment or samples (that is, surface water, benthic, or sediment samples) taken anywhere within or beyond the sensitive environment (or anywhere adjacent to or beyond the sensitive environment if it is contiguous to the migration path).

4.1.4.3.1.1 *Level I concentrations.* Assign value(s) from table 4–23 to each sensitive environment subject to Level I concentrations.

For those sensitive environments that are wetlands, assign an additional value from table 4–24. In assigning a value from table 4–24, include only those portions of wetlands located along the hazardous substance migration path in the area of Level I concentrations. If a wetland is located partially along the area of Level I concentrations and partially along the area of Level II concentrations and/or potential contamination, then solely for purposes of table 4–24, count the portion(s) along the areas of Level II concentrations or potential contamination under the Level II concentrations factor (section 4.1.4.3.1.2) or potential contamination factor (section 4.1.4.3.1.3), as appropriate.

Estimate the total length of wetlands along the hazardous substance migration path (that is, wetland frontage) in the area of Level I concentrations and assign a value from table 4–24 based on this total length. Estimate this length as follows:

- For an isolated wetland or for a wetland where the probable point of entry to surface water is in the wetland, use the perimeter of that portion of the wetland subject to Level I concentrations as the length.
- For rivers, use the length of the wetlands contiguous to the in-water segment of the hazardous substance migration path (that is, wetland frontage).
- For lakes, oceans, coastal tidal waters, and Great Lakes, use the length of the wetlands along the shoreline within the target distance limit (that is, wetland frontage along the shoreline).

Calculate the Level I concentrations factor value (SH) for the watershed as follows:

$$SH = 10\left(WH + \sum_{i=1}^{n} S_i\right)$$

where:

WH=Value assigned from table 4–24 to wetlands along the area of Level I concentrations.

S_i=Value(s) assigned from table 4–23 to sensitive environment i.

n=Number of sensitive environments from table 4–23 subject to Level I concentrations.

Enter the value assigned in table 4–1.

4.1.4.3.1.2 *Level II concentrations.* Assign value(s) from table 4–23 to each sensitive environment subject to Level II concentrations. Do not include sensitive environments already counted for table 4–23 under the Level I concentrations factor for this watershed.

For those sensitive environments that are wetlands, assign an additional value from table 4–24. In assigning a value from table 4–24, include only those portions of wetlands located along the hazardous substance migration path in the area of Level II concentrations, as specified in section 4.1.4.3.1.1.

Estimate the total length of wetlands along the hazardous substance migration path (that is, wetland frontage) in the area of Level II concentrations and assign a value from table 4–24 based on this total length. Estimate this length as specified in section 4.1.4.3.1.1, except: for an isolated wetland or for a wetland where the probable point of entry to surface water is in the wetland, use the perimeter of that portion of the wetland subject to Level II (not Level I) concentrations as the length.

Calculate the Level II concentrations value (SL) for the watershed as follows:

$$SL = WL + \sum_{i=1}^{n} S_i$$

where:

WL=Value assigned from table 4–24 to wetlands along the area of Level II concentrations.

S_i=Value(s) assigned from table 4–23 to sensitive environment i.

n=Number of sensitive environments from table 4–23 subject to Level II concentrations.

Enter the value assigned in table 4–1.

4.1.4.3.1.3 *Potential contamination.* Assign value(s) from table 4–23 to each sensitive environment subject to potential contamination. Do not include sensitive environments already counted for table 4–23 under the Level I or Level II concentrations factors.

For each type of surface water body in table 4–13 (section 4.1.2.3.1), sum the value(s)

assigned from table 4–23 to the sensitive environments along that type of surface water body, except: do not use the surface water body type ''3-mile mixing zone in quiet flowing river.'' If a sensitive environment is along two or more types of surface water bodies (for example, Wildlife Refuge contiguous to both a moderate stream and a large river), assign the sensitive environment only to that surface water body type having the highest dilution weight value from table 4–13.

For those sensitive environments that are wetlands, assign an additional value from table 4–24. In assigning a value from table 4–24, include only those portions of wetlands located along the hazardous substance migration path in the area of potential contamination, as specified in section 4.1.4.3.1.1. Aggregate these wetlands by type of surface water body, except: do not use the surface water body type ''3-mile mixing zone in quiet flowing river.'' Treat the wetlands aggregated within each type of surface water body as separate sensitive environments solely for purposes of applying table 4–24. Estimate the total length of the wetlands within each surface water body type as specified in section 4.1.4.3.1.1, except: for an isolated wetland or for a wetland where the probable point of entry to surface water is in the wetland, use the perimeter of that portion of the wetland subject to potential contamination (or the portion of that perimeter that is within the target distance limit) as the length. Assign a separate value from table 4–24 for each type of surface water body in the watershed.

Calculate the potential contamination factor value (SP) for the watershed as follows:

$$SP = \frac{1}{10}\sum_{j=1}^{m}\left(\left[W_j + S_j\right]D_j\right)$$

where:

$$S_j = \sum_{i=1}^{n} S_{ij}$$

S_{ij}=Value(s) assigned from table 4–23 to sensitive environment i in surface water body type j.

n=Number of sensitive environments from table 4–23 subject to potential contamination.

W_j=Value assigned from table 4–24 for wetlands along the area of potential contamination in surface water body type j.

D_j=Dilution weight from table 4–13 for surface water body type j.

m=Number of different surface water body types from table 4–13 in the watershed.

If SP is less than 1, do not round it to the nearest integer; if SP is 1 or more, round to the nearest integer. Enter this value for the potential contamination factor in table 4–1.

4.1.4.3.1.4 *Calculation of environmental threat-targets factor category value.* Sum the values for the Level I concentrations, Level II concentrations, and potential contamination factors for the watershed. Do not round this sum to the nearest integer. Assign this sum as the environmental threat-targets factor category value for the watershed. Enter this value in table 4–1.

4.1.4.4 *Calculation of environmental threat score for a watershed.* Multiply the environmental threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 60, as the environmental threat score for the watershed. Enter this score in table 4–1.

4.1.5 *Calculation of overland/flood migration component score for a watershed.* Sum the scores for the three threats for the watershed (that is, drinking water, human food chain, and environmental threats). Assign the resulting score, subject to a maximum value of 100, as the surface water overland/flood migration component score for the watershed. Enter this score in table 4–1.

4.1.6 *Calculation of overland/flood migration component score.* Select the highest surface water overland/flood migration component score from the watersheds evaluated. Assign this score as the surface water overland/flood migration component score for the site, subject to a maximum score of 100. Enter this score in table 4–1.

4.2 *Ground water to surface water migration component.* Use the ground water to surface water migration component to evaluate surface water threats that result from migration of hazardous substances from a source at the site to surface water via ground water. Evaluate three types of threats for this component: drinking water threat, human food chain threat, and environmental threat.

4.2.1 *General considerations.*

4.2.1.1 *Eligible surface waters.* Calculate ground water to surface water migration component scores only for surface waters (see section 4.0.2) for which all the following conditions are met:

• A portion of the surface water is within 1 mile of one or more sources at the site having a containment factor value greater than 0 (see section 4.2.2.1.2).

• No aquifer discontinuity is established between the source and the portion of the surface water within 1 mile of the source (see section 3.0.1.2.2). However, if hazardous substances have migrated across an apparent discontinuity within this 1 mile distance, do not consider a discontinuity present in scoring the site.

• The top of the uppermost aquifer is at or above the bottom of the surface water.

Do not evaluate this component for sites consisting solely of contaminated sediments with no identified source.

4.2.1.2 *Definition of hazardous substance migration path for ground water to surface water migration component.* The hazardous substance migration path includes both the ground water segment and the surface water in-water segment that hazardous substances would take as they migrate away from sources at the site:

• Restrict the ground water segment to migration via the uppermost aquifer between a source and the surface water.

• Begin the surface water in-water segment at the probable point of entry from the uppermost aquifer to the surface water. Identify the probable point of entry as that point of the surface water that yields the shortest straight-line distance, within the aquifer boundary (see section 3.0.1.2), from the sources at the site with a containment factor value greater than 0 to the surface water.

–For rivers, continue the in-water segment in the direction of flow (including any tidal flows) for the distance established by the target distance limit (see section 4.2.1.4).

–For lakes, oceans, coastal tidal waters, or Great Lakes, do not consider flow direction. Instead apply the target distance limit as an arc.

–If the in-water segment includes both rivers and lakes (or oceans, coastal tidal waters, or Great Lakes), apply the target distance limit to their combined in-water segments.

Consider a site to be in two or more watersheds for this component if two or more hazardous substance migration paths from the sources at the site do not reach a common point within the target distance limit. If the site is in more than one watershed, define a separate hazardous substance migration path for each watershed. Evaluate the ground water to surface water migration component for each watershed separately as specified in section 4.2.1.5.

4.2.1.3 *Observed release of a specific hazardous substance to surface water in-water segment.* Section 4.2.2.1.1 specifies the criteria for assigning values to the observed release factor for the ground water to surface water migration component. With regard to an individual hazardous substance, consider an observed release of that hazardous substance to be established for the surface water in-water segment of the ground water to surface water migration component only when the hazardous substance meets the criteria both for an observed release both to ground water (see section 4.2.2.1.1) and for an observed release by chemical analysis to surface water (see section 4.1.2.1.1).

If the hazardous substance meets the section 4.1.2.1.1 criteria for an observed release by chemical analysis to surface water but does not also meet the criteria for an observed release to ground water, do not use any samples of that hazardous substance from the surface water in-water segment in evaluating the factors of this component (for example, do not use the hazardous substance in establishing targets subject to actual contamination or in determining the level of actual contamination for a target).

4.2.1.4 *Target distance limit.* Determine the target distance limit for each watershed as specified in section 4.1.1.2, except: do not extend the target distance limit to a sample location beyond 15 miles unless at least one hazardous substance in a sample from that location meets the criteria in section 4.2.1.3 for an observed release to the surface water in-water segment.

Determine the targets eligible to be evaluated for each watershed and establish whether these targets are subject to actual or potential contamination as specified in section 4.1.1.2, except: do not establish actual contamination based on a sample location unless at least one hazardous substance in a sample from that location meets the criteria in section 4.2.1.3 for an observed release to the surface water in-water segment.

4.2.1.5 *Evaluation of ground water to surface water migration component.* Evaluate the drinking water threat, human food chain threat, and environmental threat for each watershed for this component based on three factor categories: likelihood of release, waste characteristics, and targets. Figure 4–2 indicates the factors included within each factor category for each type of threat.

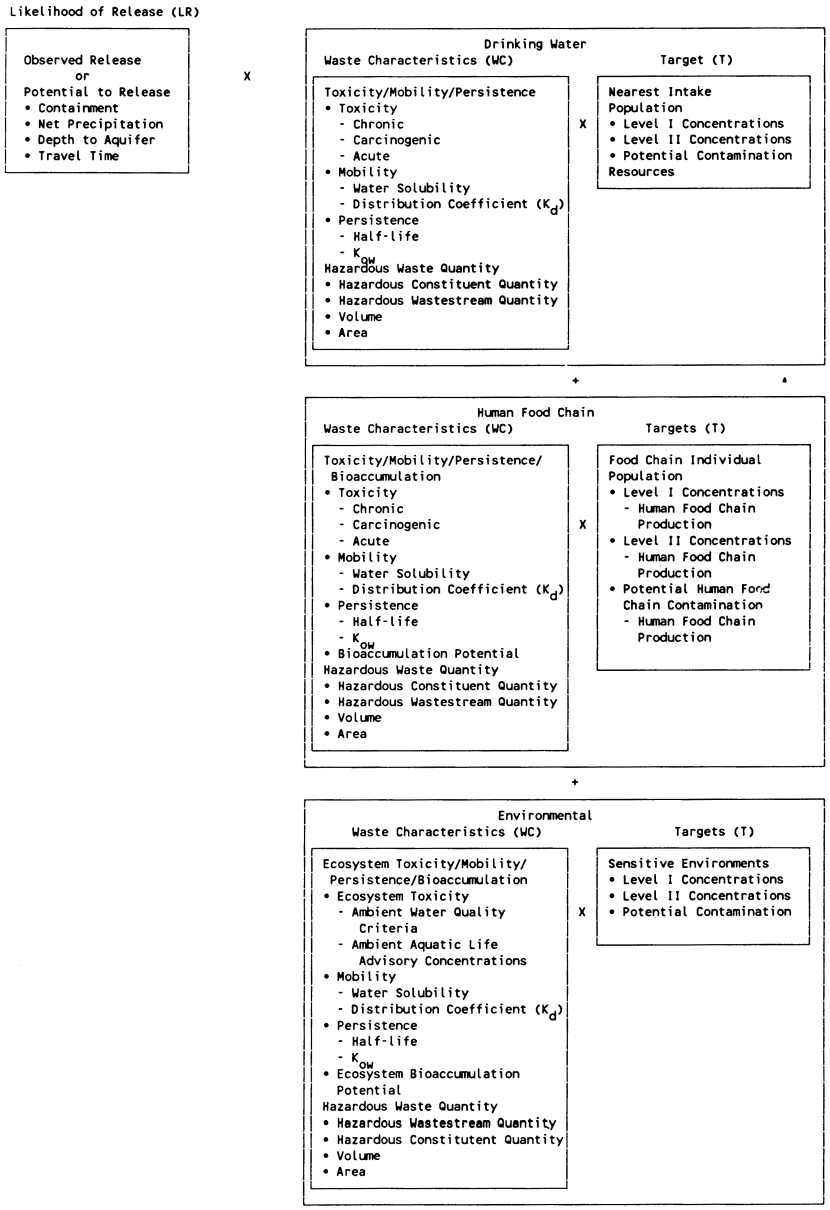


Figure 4-2
OVERVIEW OF GROUND WATER TO SURFACE WATER MIGRATION COMPONENT

Determine the ground water to surface water migration component score (S_{gs}) for a watershed in terms of the factor category values as follows:

$$S_{gs} = \frac{\sum_{i=1}^{3}(LR_i)(WC_i)(T_i)}{SF}$$

where:

LR_i=Likelihood of release factor category value for threat i (that is, drinking water, human food chain, or environmental threat).

WC_i=Waste characteristics factor category value for threat i.

T_i=Targets factor category value for threat i.

SF=Scaling factor.

Table 4–25 outlines the specific calculation procedure.

If the site is in only one watershed, assign the ground water to surface water migration component score for that watershed as the ground water to surface water migration component score for the site.

If the site is in more than one watershed:

• Calculate a separate ground water to surface water migration component score for each watershed, using likelihood of release, waste characteristics, and targets applicable to each watershed.

• Select the highest ground water to surface water migration component score from the watersheds evaluated and assign it as the ground water to surface water migration component score for the site.

TABLE 4–25—GROUND WATER TO SURFACE WATER MIGRATION COMPONENT SCORESHEET

Factor categories and factors	Maximum value	Value assigned
Drinking Water Threat		
Likelihood of Release to Aquifer:		
1. Observed Release	550	
2. Potential to Release:		
2a. Containment	10	
2b. Net Precipitation	10	
2c. Depth to Aquifer	5	
2d. Travel Time	35	
2e. Potential to Release (lines 2a[2b+2c+2d])	500	
3. Likelihood of Release (higher of lines 1 and 2e)	550	
Waste Characteristics:		
4. Toxicity/Mobility/Persistence	(a)	
5. Hazardous Waste Quantity	(a)	
6. Waste Characteristics	100	
Targets:		
7. Nearest Intake	50	
8. Population		
8a. Level I Concentrations	(b)	
8b. Level II Concentrations	(b)	
8c. Potential Contamination	(b)	
8d. Population (lines 8a + 8b + 8c)		
9. Resources	5	
10. Targets (lines 7 + 8d + 9)	(b)	
Drinking Water Threat Score:		
11. Drinking Water Threat Score ([lines 3×6×10]/82,500, subject to a maximum of 100)	100	
Human Food Chain Threat		
Likelihood of Release:		
12. Likelihood of Release (same value as line 3)	550	
Waste Characteristics:		
13. Toxicity/Mobility/Persistence/Bioaccumulation	(a)	
14. Hazardous Waste Quantity	(a)	
15. Waste Characteristics	1,000	
Targets:		
16. Food Chain Individual	50	
17. Population:		
17a. Level I Concentrations	(b)	
17b. Level II Concentrations	(b)	
17c. Potential Human Food Chain Contamination	(b)	
17d. Population (lines 17a + 17b + 17c)	(b)	
18. Targets (Lines 16 + 17d)	(b)	
Human Food Chain Threat Score:		
19. Human Food Chain Threat Score ([lines 12×15×18]/82,500, subject to a maximum of 100)	100	
Environmental Threat		
Likelihood of Release:		
20. Likelihood of Release (same value as line 3)	550	
Waste Characteristics:		
21. Ecosystem Toxicity/Mobility/Persistence/Bioaccumulation	(a)	

TABLE 4–25—GROUND WATER TO SURFACE WATER MIGRATION COMPONENT SCORESHEET—Continued

Factor categories and factors	Maximum value	Value assigned
22. Hazardous Waste Quantity	(a)	
23. Waste Characteristics	1,000	
Targets:		
24. Sensitive Environments:		
24a. Level I Concentrations	(b)	
24b. Level II Concentrations	(b)	
24c. Potential Contamination	(b)	
24d. Sensitive Environments (lines 24a + 24b + 24c)	(b)	
25. Targets (value from line 24d)	(b)	
Environmental Threat Score:		
26. Environmental Threat Score ([lines 20×23×25]/82,500, subject to a maximum of 60)	60	
Ground Water to Surface Water Migration Component Score for a Watershed		
27. Watershed Score[c] (lines 11 + 19 + 26, subject to a maximum of 100)	100	
28. Component Score (S_{gs})[c] (highest score from Line 27 for all watersheds evaluated, subject to a maximum of 100)	100	

[a] Maximum value applies to waste characteristics category.
[b] Maximum value not applicable.
[c] Do not round to nearest integer.

4.2.2 *Drinking water threat.* Evaluate the drinking water threat for each watershed based on three factor categories: likelihood of release, waste characteristics, and targets.

4.2.2.1 *Drinking water threat-likelihood of release.* Evaluate the likelihood of release factor category for each watershed in terms of an observed release factor or a potential to release factor.

4.2.2.1.1 *Observed release.* Establish an observed release to the uppermost aquifer as specified in section 3.1.1. If an observed release can be established for the uppermost aquifer, assign an observed release factor value of 550 to that watershed, enter this value in table 4–25, and proceed to section 4.2.2.1.3. If no observed release can be established, assign an observed release factor value of 0, enter this value in table 4–25, and proceed to section 4.2.2.1.2.

4.2.2.1.2 *Potential to release.* Evaluate potential to release only if an observed release cannot be established for the uppermost aquifer. Calculate a potential to release value for the uppermost aquifer as specified in section 3.1.2 and sections 3.1.2.1 through 3.1.2.5. Assign the potential to release value for the uppermost aquifer as the potential to release factor value for the watershed. Enter this value in table 4–25.

4.2.2.1.3 *Calculation of drinking water threat-likelihood of release factor category value.* If an observed release is established for the uppermost aquifer, assign the observed release factor value of 550 as the likelihood of release factor category value for the watershed. Otherwise, assign the potential to release factor value as the likelihood of release factor category value for the watershed. Enter the value assigned in table 4–25.

4.2.2.2 *Drinking water threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: toxicity/mobility/persistence and hazardous waste quantity. Evaluate only those hazardous substances available to migrate from the sources at the site to the uppermost aquifer (see section 3.2). Such hazardous substances include:

• Hazardous substances that meet the criteria for an observed release to ground water.

• All hazardous substances associated with a source that has a ground water containment factor value greater than 0 (see sections 2.2.2, 2.2.3, and 3.1.2.1).

4.2.2.2.1 *Toxicity/mobility/persistence.* For each hazardous substance, assign a toxicity factor value, a mobility factor value, a persistence factor value, and a combined toxicity/mobility/persistence factor value as specified in sections 4.2.2.2.1.1 through 4.2.2.2.1.4.

4.2.2.2.1.1 *Toxicity.* Assign a toxicity factor value to each hazardous substance as specified in section 2.4.1.1.

4.2.2.2.1.2 *Mobility.* Assign a ground water mobility factor value to each hazardous substance as specified in section 3.2.1.2.

4.2.2.2.1.3 *Persistence.* Assign a surface water persistence factor value to each hazardous substance as specified in section 4.1.2.2.1.2.

4.2.2.2.1.4 *Calculation of toxicity/mobility/persistence factor value.* First, assign each hazardous substance a toxicity/mobility factor value from table 3–9 (section 3.2.1.3), based on the values assigned to the hazardous substance for the toxicity and mobility factors. Then assign each hazardous substance a toxicity/mobility/persistence factor

value from table 4–26, based on the values assigned for the toxicity/mobility and persistence factors. Use the substance with the highest toxicity/mobility/ persistence factor value for the watershed to assign the value to this factor. Enter this value in table 4–25.

4.2.2.2.2 *Hazardous waste quantity.* Assign the same factor value for hazardous waste quantity for the watershed as would be assigned for the uppermost aquifer in section 3.2.2. Enter this value in table 4–25.

4.2.2.2.3 *Calculation of drinking water threat-waste characteristics factor category value.* Multiply the toxicity/mobility/persistence and hazardous waste quantity factor values for the watershed, subject to a maximum product of 1×10^{8}. Based on this product, assign a value from table 2–7 (section 2.4.3.1) to the drinking water threat-waste characteristics factor category for the watershed. Enter this value in table 4–25.

4.2.2.3 *Drinking water threat-targets.* Evaluate the targets factor category for each watershed based on three factors: nearest intake, population, and resources.

TABLE 4–26—TOXICITY/MOBILITY/PERSISTENCE FACTOR VALUES [A]

Toxicity/mobility factor value	Persistence factor value			
	1.0	0.4	0.07	0.0007
10,000	10,000	4,000	700	7
2,000	2,000	800	140	1.4
1,000	1,000	400	70	0.7
200	200	80	14	0.14
100	100	40	7	0.07
20	20	8	1.4	0.014
10	10	4	0.7	0.007
2	2	0.8	0.14	0.0014
1	1	0.4	0.07	7×10^{-4}
0.2	0.2	0.08	0.014	1.4×10^{-4}
0.1	0.1	0.04	0.007	7×10^{-5}
0.02	0.02	0.008	0.0014	1.4×10^{-5}
0.01	0.01	0.004	7×10^{-4}	7×10^{-6}
0.002	0.002	8×10^{-4}	1.4×10^{-4}	1.4×10^{-6}
0.001	0.001	4×10^{-4}	7×10^{-5}	7×10^{-7}
2×10^{-4}	2×10^{-4}	8×10^{-5}	1.4×10^{-5}	1.4×10^{-7}
1×10^{-4}	1×10^{-4}	4×10^{-5}	7×10^{-6}	7×10^{-8}
2×10^{-5}	2×10^{-5}	8×10^{-6}	1.4×10^{-6}	1.4×10^{-8}
2×10^{-6}	2×10^{-6}	8×10^{-7}	1.4×10^{-7}	1.4×10^{-9}
2×10^{-7}	2×10^{-7}	8×10^{-8}	1.4×10^{-8}	1.4×10^{-10}
2×10^{-8}	2×10^{-8}	8×10^{-9}	1.4×10^{-9}	1.4×10^{-11}
2×10^{-9}	2×10^{-9}	8×10^{-10}	1.4×10^{-10}	1.4×10^{-12}
0	0	0	0	0

[a] Do not round to nearest integer.

For the nearest intake and population factors, determine whether the target surface water intakes are subject to actual or potential contamination as specified in section 4.1.1.2, subject to the restrictions specified in sections 4.2.1.3 and 4.2.1.4.

When the intake is subject to actual contamination, evaluate it using Level I concentrations or Level II concentrations. Determine which level applies for the intake by comparing the exposure concentrations from a sample (or comparable samples) to health-based benchmarks as specified in section 4.1.2.3, except use only those samples from the surface water in-water segment and only those hazardous substances in such samples that meet the conditions in sections 4.2.1.3 and 4.2.1.4.

4.2.2.3.1 *Nearest intake.* Assign a value to the nearest intake factor as specified in section 4.1.2.3.1 with the following modification. For the intake being evaluated, multiply its dilution weight from table 4–13 (section 4.1.2.3.1) by a value selected from table 4–27. Use the resulting product, not the value from table 4–13, as the dilution weight for the intake for the ground water to surface water component. Do not round this product to the nearest integer.

Select the value from table 4–27 based on the angle Θ, the angle defined by the sources at the site and either the two points at the intersection of the surface water body and the 1-mile distance ring of any two other points of the surface water body within the 1-mile distance ring, whichever results in the largest angle. (See Figure 4–3 for an example of how to determine Θ.) If the surface water body does not extend to the 1-mile ring at one or both ends, define Θ using the surface water endpoint(s) within the 1-mile ring or any two other points of the surface water body within the 1-mile distance ring, whichever results in the largest angle.

TABLE 4–27—DILUTION WEIGHT ADJUSTMENTS

Angle Θ (degrees)	Assigned value [a]
0	0
Greater than 0 to 18	0.05
Greater than 18 to 54	0.1
Greater than 54 to 90	0.2
Greater than 90 to 126	0.3
Greater than 126 to 162	0.4
Greater than 162 to 198	0.5
Greater than 198 to 234	0.6
Greater than 234 to 270	0.7
Greater than 270 to 306	0.8
Greater than 306 to 342	0.9
Greater than 342 to 360	1.0

[a] Do not round to nearest integer.

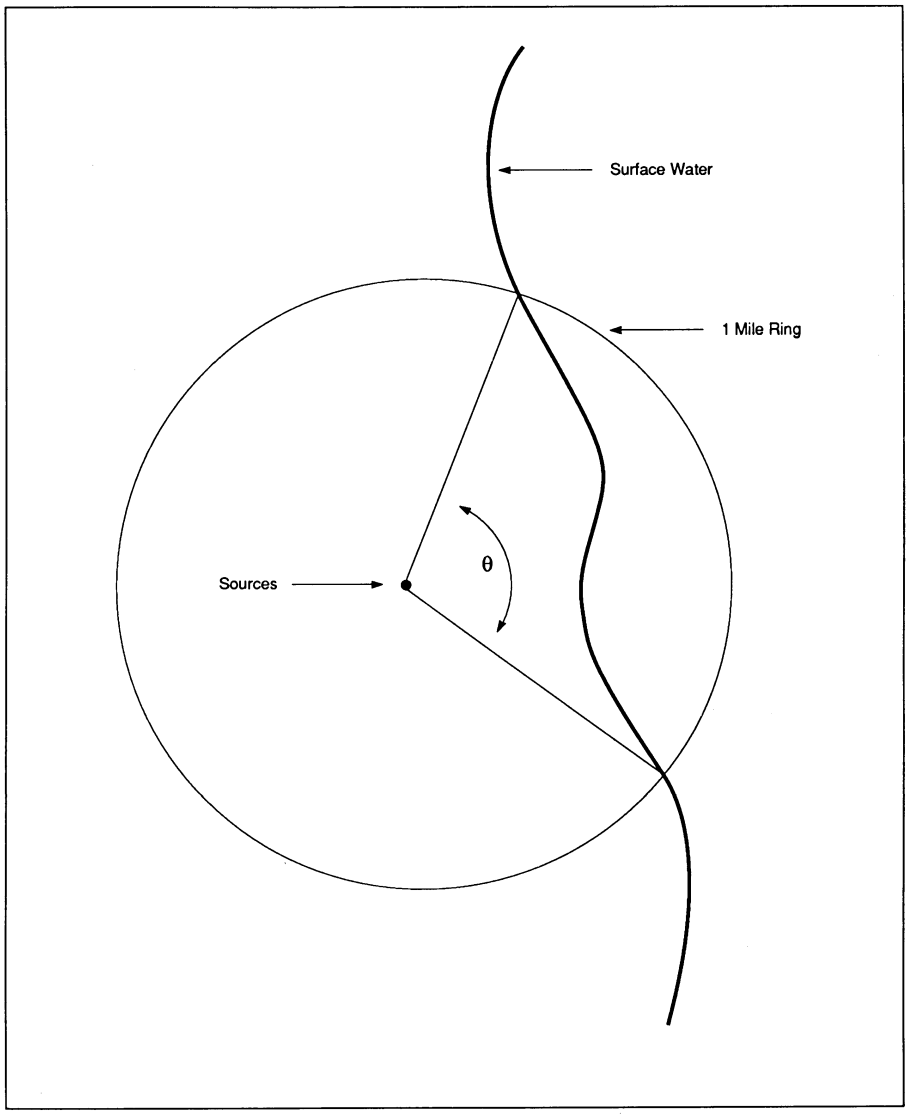


FIGURE 4-3
SAMPLE DETERMINATION OF GROUND WATER TO SURFACE WATER ANGLE

TABLE 4–28—TOXICITY/MOBILITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES [A]

Toxicity/mobility/persistence factor value	Bioaccumlation potential factor value					
	50,000	5,000	500	50	5	0.5
10,000	5×10^{8}	5×10^{7}	5×10^{6}	5×10^{5}	5×10^{4}	5,000
4,000	2×10^{8}	2×10^{7}	2×10^{6}	2×10^{5}	2×10^{4}	2,000
2,000	1×10^{8}	1×10^{7}	1×10^{6}	1×10^{5}	1×10^{4}	1,000

TABLE 4–28—TOXICITY/MOBILITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES [A]—Continued

Toxicity/mobility/persistence factor value	Bioaccumlation potential factor value					
	50,000	5,000	500	50	5	0.5
1,000	5×10^{7}	5×10^{6}	5×10^{5}	5×10^{4}	5,000	500
800	4×10^{7}	4×10^{6}	4×10^{5}	4×10^{4}	4,000	400
700	3.5×10^{7}	3.5×10^{6}	3.5×10^{5}	3.5×10^{4}	3,500	350
400	2×10^{7}	2×10^{6}	2×10^{5}	2×10^{4}	2,000	200
200	1×10^{7}	1×10^{6}	1×10^{5}	1×10^{4}	1,000	100
140	7×10^{6}	7×10^{5}	7×10^{4}	7,000	700	70
100	5×10^{6}	5×10^{5}	5×10^{4}	5,000	500	50
80	4×10^{6}	4×10^{5}	4×10^{4}	4,000	400	40
70	3.5×10^{6}	3.5×10^{5}	3.5×10^{4}	3,500	350	35
40	2×10^{6}	2×10^{5}	2×10^{4}	2,000	200	20
20	1×10^{6}	1×10^{5}	1×10^{4}	1,000	100	10
14	7×10^{5}	7×10^{4}	7,000	700	70	7
10	5×10^{5}	5×10^{4}	5,000	500	50	5
8	4×10^{5}	4×10^{4}	4,000	400	40	4
7	3.5×10^{5}	3.5×10^{4}	3,500	350	35	3.5
4	2×10^{5}	2×10^{4}	2,000	200	20	2
2	1×10^{5}	1×10^{4}	1,000	100	10	1
1.4	7×10^{4}	7,000	700	70	7	0.7
1.0	5×10^{4}	5,000	500	50	5	0.5
0.8	4×10^{4}	4,000	400	40	4	0.4
0.7	3.5×10^{4}	3,500	350	35	3.5	0.35
0.4	2×10^{4}	2,000	200	20	2	0.2
0.2	1×10^{4}	1,000	100	10	1	0.1
0.14	7,000	700	70	7	0.7	0.07
0.1	5,000	500	50	5	0.5	0.05
0.08	4,000	400	40	4	0.4	0.04
0.07	3,500	350	35	3.5	0.35	0.035
0.04	2,000	200	20	2	0.2	0.02
0.02	1,000	100	10	1	0.1	0.01
0.014	700	70	7	0.7	0.07	0.007
0.01	500	50	5	0.5	0.05	0.005
0.008	400	40	4	0.4	0.04	0.004
0.007	350	35	3.5	0.35	0.035	0.0035
0.004	200	20	2	0.2	0.02	0.002
0.002	100	10	1	0.1	0.01	0.001
0.0014	70	7	0.7	0.07	0.007	7×10^{-4}
0.001	50	5	0.5	0.05	0.005	5×10^{-4}
8×10^{-4}	40	4	0.4	0.04	0.004	4×10^{-4}
7×10^{-4}	35	3.5	0.035	0.035	0.0035	3.5×10^{-4}
4×10^{-4}	20	2	0.2	0.02	0.002	2×10^{-4}
2×10^{-4}	10	1	0.1	0.01	0.001	1×10^{-4}
1.4×10^{-4}	7	0.7	0.07	0.007	7×10^{-4}	7×10^{-5}
1×10^{-4}	5	0.5	0.05	0.005	5×10^{-4}	5×10^{-5}
8×10^{-5}	4	0.4	0.04	0.004	4×10^{-4}	4×10^{-5}
7×10^{-5}	3.5	0.35	0.035	0.0035	3.5×10^{-4}	3.5×10^{-5}
4×10^{-5}	2	0.2	0.02	0.002	2×10^{-4}	2×10^{-5}
2×10^{-5}	1	0.1	0.01	0.001	1×10^{-4}	1×10^{-5}
1.4×10^{-5}	0.7	0.07	0.007	7×10^{-4}	7×10^{-5}	7×10^{-6}
8×10^{-6}	0.4	0.04	0.004	4×10^{-4}	4×10^{-5}	4×10^{-6}
7×10^{-6}	0.35	0.035	0.0035	3.5×10^{-4}	3.5×10^{-5}	3.5×10^{-6}
2×10^{-6}	0.1	0.01	0.001	1×10^{-4}	1×10^{-5}	1×10^{-6}
1.4×10^{-6}	0.07	0.007	7×10^{-4}	7×10^{-5}	7×10^{-6}	7×10^{-7}
8×10^{-7}	0.04	0.004	4×10^{-4}	4×10^{-5}	4×10^{-6}	4×10^{-7}
7×10^{-7}	0.035	0.0035	3.5×10^{-4}	3.5×10^{-5}	3.5×10^{-6}	3.5×10^{-7}
2×10^{-7}	0.01	0.001	1×10^{-4}	1×10^{-5}	1×10^{-6}	1×10^{-7}
1.4×10^{-7}	0.007	7×10^{-4}	7×10^{-5}	7×10^{-6}	7×10^{-7}	7×10^{-8}
8×10^{-8}	0.004	4×10^{-4}	4×10^{-5}	4×10^{-6}	4×10^{-7}	4×10^{-8}
7×10^{-8}	0.0035	3.5×10^{-4}	3.5×10^{-5}	3.5×10^{-6}	3.5×10^{-7}	3.5×10^{-8}
2×10^{-8}	0.001	1×10^{-4}	1×10^{-5}	1×10^{-6}	1×10^{-7}	1×10^{-8}
1.4×10^{-8}	7×10^{-4}	7×10^{-5}	7×10^{-6}	7×10^{-7}	7×10^{-8}	7×10^{-9}
8×10^{-9}	4×10^{-4}	4×10^{-5}	4×10^{-6}	4×10^{-7}	4×10^{-8}	4×10^{-9}
2×10^{-9}	1×10^{-4}	1×10^{-5}	1×10^{-6}	1×10^{-7}	1×10^{-8}	1×10^{-9}
1.4×10^{-9}	7×10^{-5}	7×10^{-6}	7×10^{-7}	7×10^{-8}	7×10^{-9}	7×10^{-10}
8×10^{-10}	4×10^{-5}	4×10^{-6}	4×10^{-7}	4×10^{-8}	4×10^{-9}	4×10^{-10}
1.4×10^{-10}	7×10^{-6}	7×10^{-7}	7×10^{-8}	7×10^{-9}	7×10^{-10}	4×10^{-11}
1.4×10^{-11}	7×10^{-7}	7×10^{-8}	7×10^{-9}	7×10^{-10}	7×10^{-11}	7×10^{-12}
1.4×10^{-12}	7×10^{-8}	7×10^{-9}	7×10^{-10}	7×10^{-11}	7×10^{-12}	7×10^{-13}
0	0	0	0	0	0	0

[a] Do not round to nearest integer.

4.2.2.3.2 *Population.* Evaluate the population factor for the watershed based on three factors: Level I concentrations, Level II concentrations, and potential contamination. Determine which factor applies to an intake as specified in section 4.2.2.3. Determine the population to be counted for that intake as specified in section 4.1.2.3.2, using the target distance limits in section 4.2.1.4 and the hazardous substance migration path in section 4.2.1.2.

4.2.2.3.2.1 *Level I concentrations.* Assign a value to this factor as specified in section 4.1.2.3.2.2.

4.2.2.3.2.2 *Level II concentrations.* Assign a value to this factor as specified in section 4.1.2.3.2.3.

4.2.2.3.2.3 *Potential contamination.* For each applicable type of surface water body in table 4–14, determine the dilution-weighted population value as specified in section 4.1.2.3.2.4. Select the appropriate dilution weight adjustment value from table 4–27 as specified in section 4.2.2.3.1.

Calculate the value for the potential contamination factor (PC) for the watershed as follows:

$$PC = \frac{A}{10}\sum_{i=1}^{n} W_i$$

where:

A=Dilution weight adjustment value from table 4–27.

W_i=Dilution-weighted population from table 4–14 for surface water body type i.

n=Number of different surface water body types in the watershed.

If PC is less than 1, do not round it to the nearest integer; if PC is 1 or more, round to the nearest integer. Enter the value in table 4–25.

4.2.2.3.2.4 *Calculation of population factor value.* Sum the factor values for Level I concentrations, Level II concentrations, and potential contamination. Do not round this sum to the nearest integer. Assign this sum as the population factor value for the watershed. Enter this value in table 4–25.

4.2.2.3.3 *Resources.* Assign a value to the resources factor as specified in section 4.1.2.3.3.

4.2.2.3.4 *Calculation of drinking water threat-targets factor category value.* Sum the nearest intake, population, and resources factor values for the watershed. Do not round this sum to the nearest integer. Assign this sum as the drinking water threat-targets factor category value for the watershed. Enter this value in table 4–25.

4.2.2.4 *Calculation of drinking water threat score for a watershed.* Multiply the drinking water threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 100, as the drinking water threat score for the watershed. Enter this score in table 4–25.

4.2.3 *Human food chain threat.* Evaluate the human food chain threat for a watershed based on three factor categories: likelihood of release, waste characteristics, and targets.

4.2.3.1 *Human food chain threat-likelihood of release.* Assign the same likelihood of release factor category value for the human food chain threat for the watershed as would be assigned in section 4.2.2.1.3 for the drinking water threat. Enter this value in table 4–25.

4.2.3.2 *Human food chain threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: toxicity/mobility/persistence/bioaccumulation and hazardous waste quantity.

4.2.3.2.1 *Toxicity/mobility/persistence/bioaccumulation.* Evaluate all those hazardous substances eligible to be evaluated for toxicity/mobility/persistence in the drinking water threat for the watershed (see section 4.2.2.2.1).

4.2.3.2.1.1 *Toxicity.* Assign a toxicity factor value to each hazardous substance as specified in section 2.4.1.1.

4.2.3.2.1.2 *Mobility.* Assign a ground water mobility factor value to each hazardous substance as specified for the drinking water threat (see section 4.2.2.2.1.2).

4.2.3.2.1.3 *Persistence.* Assign a surface water persistence factor value to each hazardous substance as specified for the drinking water threat (see section 4.2.2.2.1.3), except: use the predominant water category (that is, lakes; or rivers, oceans, coastal tidal waters, or Great Lakes) between the probable point of entry and the nearest fishery (not the nearest drinking water or resources intake) along the hazardous substance migration path for the watershed to determine which portion of table 4–10 to use. Determine the predominant water category based on distance as specified in section 4.1.2.2.1.2.

4.2.3.2.1.4 *Bioaccumulation potential.* Assign a bioaccumulation potential factor value to each hazardous substance as specified in section 4.1.3.2.1.3.

4.2.3.2.1.5 *Calculation of toxicity/mobility/persistence/ bioaccumulation factor value.* Assign each hazardous substance a toxicity/mobility factor value from table 3–9 (section 3.2.1.3), based on the values assigned to the hazardous substance for the toxicity and mobility factors. Then assign each hazardous substance a toxicity/mobility/persistence factor value from table 4–26, based on the values assigned for the toxicity/mobility and persistence factors. Then assign each hazardous substance a toxicity/mobility/persistence/bioaccumulation factor value from

table 4–28. Use the substance with the highest toxicity/mobility/persistence/bioaccumulation factor value for the watershed to assign the value to this factor for the watershed. Enter this value in table 4–25.

4.2.3.2.2 *Hazardous waste quantity.* Assign the same factor value for hazardous waste quantity for the watershed as would be assigned in section 4.2.2.2.2 for the drinking water threat. Enter this value in table 4–25.

4.2.3.2.3 *Calculation of human food chain threat-waste characteristics factor category value.* For the hazardous substance selected for the watershed in section 4.2.3.2.1.5, use its toxicity/mobility/ persistence factor value and bioaccumulation potential factor value as follows to assign a value to the waste characteristics factor category. First, multiply the toxicity/mobility/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^{8}. Then multiply this product by the bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12}. Based on this second product, assign a value from table 2–7 (section 2.4.3.1) to the human food chain threat-waste characteristics factor category for the watershed. Enter this value in table 4–25.

4.2.3.3 *Human food chain threat-targets.* Evaluate two target factors for the watershed: food chain individual and population.

For both factors, determine whether the target fisheries are subject to Level I concentrations, Level II concentrations, or potential human food chain contamination. Determine which applies to each fishery (or portion of a fishery) as specified in section 4.1.3.3, subject to the restrictions specified in sections 4.2.1.3 and 4.2.1.4.

4.2.3.3.1 *Food chain individual.* Assign a value to the food chain individual factor as specified in section 4.1.3.3.1 with the following modification. When a dilution weight is used, multiply the appropriate dilution weight from table 4–13 by the adjustment value selected from table 4–27, as specified in section 4.2.2.3.1. Use the resulting product, not the value from table 4–13, as the dilution weight in assigning the factor value. Do not round this product to the nearest integer. Enter the value assigned in table 4–25.

4.2.3.3.2 *Population.* Evaluate the population factor for the watershed based on three factors: Level I concentrations, Level II concentrations, and potential human food chain contamination. Determine which of these factors is to be applied to each fishery as specified in section 4.2.3.3.

4.2.3.3.2.1 *Level I concentrations.* Assign a value to this factor as specified in section 4.1.3.3.2.1. Enter this value in table 4–25.

4.2.3.3.2.2 *Level II concentrations.* Assign a value to this factor as specified in section 4.1.3.3.2.2. Enter this value in table 4–25.

4.2.3.3.2.3 *Potential human food chain contamination.* Assign a value to this factor as specified in section 4.1.3.3.2.3 with the following modification. For each fishery being evaluated, multiply the appropriate dilution weight for that fishery from table 4–13 by the adjustment value selected from table 4–27, as specified in section 4.2.2.3.1. Use the resulting product, not the value from table 4–13, as the dilution weight for the fishery. Do not round this product to the nearest integer. Enter the value assigned in table 4–25.

4.2.3.3.2.4 *Calculation of population factor value.* Sum the factor values for Level I concentrations, Level II concentrations, and potential human food chain contamination for the watershed. Do not round this sum to the nearest integer. Assign this sum as the population factor value for the watershed. Enter this value in table 4–25.

4.2.3.3.3 *Calculation of human food chain threat-targets factor category value.* Sum the food chain individual and population factor values for the watershed. Do not round this sum to the nearest integer. Assign this sum as the human food chain threat-targets factor category value for the watershed. Enter this value in table 4–25.

4.2.3.4 *Calculation of human food chain threat score for a watershed.* Multiply the human food chain threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 100, as the human food chain threat score for the watershed. Enter this score in table 4–25.

4.2.4 *Environmental threat.* Evaluate the environmental threat for the watershed based on three factor categories: likelihood of release, waste characteristics, and targets.

4.2.4.1 *Environmental threat-likelihood of release.* Assign the same likelihood of release factor category value for the environmental threat for the watershed as would be assigned in section 4.2.2.1.3 for the drinking water threat. Enter this value in table 4–25.

4.2.4.2 *Environmental threat-waste characteristics.* Evaluate the waste characteristics factor category for each watershed based on two factors: ecosystem toxicity/mobility/persistence/bioaccumulation and hazardous waste quantity.

4.2.4.2.1 *Ecosystem toxicity/mobility/persistence/bioaccumulation.* Evaluate all those hazardous substances eligible to be evaluated for toxicity/mobility/persistence in the drinking water threat for the watershed (see section 4.2.2.2.1).

4.2.4.2.1.1 *Ecosystem toxicity.* Assign an ecosystem toxicity factor value to each hazardous substance as specified in section 4.1.4.2.1.1.

4.2.4.2.1.2 *Mobility*. Assign a ground water mobility factor value to each hazardous substance as specified in section 4.2.2.2.1.2 for the drinking water threat.

4.2.4.2.1.3 *Persistence*. Assign a surface water persistence factor value to each hazardous substance as specified in section 4.2.2.2.1.3 for the drinking water threat, except: use the predominant water category (that is, lakes; or rivers, oceans, coastal tidal waters, or Great Lakes) between the probable point of entry and the nearest sensitive environment (not the nearest drinking water or resources intake) along the hazardous substance migration path for the watershed to determine which portion of table 4–10 to use. Determine the predominant water category based on distance as specified in section 4.1.2.2.1.2.

4.2.4.2.1.4 *Ecosystem bioaccumulation potential*. Assign an ecosystem bioaccumulation potential factor value to each hazardous substance as specified in section 4.1.4.2.1.3.

4.2.4.2.1.5 *Calculation of ecosystem toxicity/mobility/persistence/ bioaccumulation factor value*. Assign each hazardous substance an ecosystem toxicity/mobility factor value from table 3–9 (section 3.2.1.3), based on the values assigned to the hazardous substance for the ecosystem toxicity and mobility factors. Then assign each hazardous substance an ecosystem toxicity/mobility/persistence factor value from table 4–29, based on the values assigned for the ecosystem toxicity/mobility and persistence factors. Then assign each hazardous substance an ecosystem toxicity/mobility/persistence/bioaccumulation factor value from table 4–30, based on the values assigned for the ecosystem toxicity/mobility/persistence and ecosystem bioaccumulation potential factors. Select the substance with the highest ecosystem toxicity/mobility/persistence/bioaccumulation factor value for the watershed and use it to assign the value to this factor for the watershed. Enter this value in table 4–25.

TABLE 4–29—ECOSYSTEM TOXICITY/MOBILITY/PERSISTENCE FACTOR VALUES [A]

Ecosystem toxicity/mobility factor value	Persistence factor value			
	1.0	0.4	0.07	0.0007
10,000	10,000	4,000	700	7
2,000	2,000	800	140	1.41,000
1,000	1,000	400	70	0.7
200	200	80	14	0.14
100	100	40	7	0.07
20	20	8	1.4	0.014
10	10	4	0.7	0.007
2	2	0.8	0.14	0.0014
1	1	0.4	0.07	7×10^{-4}
0.2	0.2	0.08	0.014	1.4×10^{-4}
0.1	0.1	0.04	0.007	7×10^{-5}
0.2	0.2	0.008	0.0014	1.4×10^{-5}
0.01	0.01	0.004	7×10^{-4}	7×10^{-6}
0.002	0.002	8×10^{-4}	1.4×10^{-4}	1.4×10^{-6}
0.001	0.001	4×10^{-4}	7×10^{-5}	7×10^{-7}
2×10^{-4}	2×10^{-4}	8×10^{-5}	1.4×10^{-5}	1.4×10^{-7}
1×10^{-4}	1×10^{-4}	4×10^{-5}	7×10^{-6}	7×10^{-8}
2×10^{-5}	2×10^{-5}	8×10^{-6}	1.4×10^{-6}	1.4×10^{-8}
2×10^{-6}	2×10^{-6}	8×10^{-7}	1.4×10^{-7}	1.4×10^{-9}
2×10^{-7}	2×10^{-7}	8×10^{-8}	1.4×10^{-8}	1.4×10^{-10}
2×10^{-8}	2×10^{-8}	8×10^{-9}	1.4×10^{-9}	1.4×10^{-11}
2×10^{-9}	2×10^{-9}	8×10^{-10}	1.4×10^{-10}	1.4×10^{-12}
0	0	0	0	0

[a] Do not round to nearest integer.

TABLE 4–30—ECOSYSTEM TOXICITY/MOBILITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES [A]

Ecosystem toxicity/mobility/persistence factor value	Ecosystem bioaccumulation potential factor value					
	50,000	5,000	500	50	5	0.5
10,000	5×10^{8}	5×10^{7}	5×10^{6}	5×10^{5}	5×10^{4}	5,000
4,000	2×10^{8}	2×10^{7}	2×10^{6}	2×10^{5}	2×10^{4}	2,000
2,000	$1,\times10^{8}$	1×10^{7}	1×10^{6}	1×10^{5}	1×10^{4}	1,000
1,000	5×10^{7}	5×10^{6}	5×10^{5}	5×10^{4}	5,000	500
800	4×10^{7}	4×10^{6}	4×10^{5}	4×10^{4}	4,000	400
700	3.5×10^{7}	3.5×10^{6}	3.5×10^{5}	3.5×10^{4}	3,500	350
400	2×10^{7}	2×10^{6}	2×10^{5}	2×10^{4}	2,000	200
200	1×10^{7}	1×10^{6}	1×10^{5}	1×10^{4}	1,000	100
140	7×10^{6}	7×10^{5}	7×10^{4}	7,000	700	70
100	5×10^{6}	5×10^{5}	5×10^{4}	5,000	500	50
80	4×10^{6}	4×10^{5}	4×10^{4}	4,000	400	40
70	3.5×10^{6}	3.5×10^{5}	3.5×10^{4}	3,500	350	35

TABLE 4–30—ECOSYSTEM TOXICITY/MOBILITY/PERSISTENCE/BIOACCUMULATION FACTOR VALUES [A]—Continued

Ecosystem toxicity/mobility/persistence factor value	Ecosystem bioaccumulation potential factor value					
	50,000	5,000	500	50	5	0.5
40	2×10^{6}	2×10^{5}	2×10^{4}	2,000	200	20
20	1×10^{6}	1×10^{5}	1×10^{4}	1,000	100	10
14	7×10^{5}	7×10^{4}	7,000	700	70	7
10	5×10^{5}	5×10^{4}	5,000	500	50	5
8	4×10^{5}	4×10^{4}	4,000	400	40	4
7	3.5×10^{5}	3.5×10^{4}	3,500	350	35	3.5
4	2×10^{5}	2×10^{4}	2,000	200	20	2
2	1×10^{5}	1×10^{4}	1,000	100	10	1
1.4	7×10^{4}	7,000	700	70	7	0.7
1.0	5×10^{4}	5,000	500	50	5	0.5
0.8	4×10^{4}	4,000	400	40	4	0.4
0.7	3.5×10^{4}	3,500	350	35	3.5	0.35
0.4	2×10^{4}	2,000	200	20	2	0.2
0.2	1×10^{4}	1,000	100	10	1	0.1
0.14	7,000	700	70	7	0.7	0.07
0.1	5,000	500	50	5	0.5	0.05
0.08	4,000	400	40	4	0.4	0.04
0.07	3,500	350	35	3.5	0.35	0.035
0.04	2,000	200	20	2	0.2	0.02
0.02	1,000	100	10	1	0.1	0.01
0.014	700	70	7	0.7	0.07	0.007
0.01	500	50	5	0.5	0.05	0.005
0.008	400	40	4	0.4	0.04	0.004
0.007	350	35	3.5	0.35	0.035	0.0035
0.004	200	20	2	0.2	0.02	0.002
0.002	100	10	1	0.1	0.01	0.001
0.0014	70	7	0.7	0.07	0.007	7×10^{-4}
0.001	50	5	0.5	0.05	0.005	5×10^{-4}
8×10^{-4}	40	4	0.4	0.04	0.004	4×10^{-4}
7×10^{-4}	35	3.5	0.35	0.035	0.0035	3.5×10^{-4}
4×10^{-4}	20	2	0.2	0.02	0.002	2×10^{-4}
2×10^{-4}	10	1	0.1	0.01	0.001	1×10^{-4}
1.4×10^{-4}	7	0.7	0.07	0.007	7×10^{-4}	7×10^{-5}
1×10^{-4}	5	0.5	0.05	0.005	5×10^{-4}	5×10^{-5}
8×10^{-5}	4	0.4	0.04	0.004	4×10^{-4}	4×10^{-5}
7×10^{-5}	3.5	0.35	0.035	0.0035	3.5×10^{-4}	3.5×10^{-5}
4×10^{-5}	2	0.2	0.02	0.002	2×10^{-4}	2×10^{-5}
2×10^{-5}	1	0.1	0.01	0.001	1×10^{-4}	1×10^{-5}
1.4×10^{-5}	0.7	0.07	0.007	7×10^{-4}	7×10^{-5}	7×10^{-6}
8×10^{-6}	0.4	0.04	0.004	4×10^{-4}	4×10^{-5}	4×10^{-6}
7×10^{-6}	0.35	0.035	0.0035	3.5×10^{-4}	3.5×10^{-5}	3.5×10^{-6}
2×10^{-6}	0.1	0.01	0.001	1×10^{-4}	1×10^{-5}	1×10^{-6}
1.4×10^{-6}	0.07	0.007	7×10^{-4}	7×10^{-5}	7×10^{-6}	7×10^{-7}
8×10^{-7}	0.04	0.004	4×10^{-4}	4×10^{-5}	4×10^{-6}	4×10^{-7}
7×10^{-7}	0.035	0.0035	3.5×10^{-4}	3.5×10^{-5}	3.5×10^{-6}	3.5×10^{-7}
2×10^{-7}	0.01	0.001	1×10^{-4}	1×10^{-5}	1×10^{-6}	1×10^{-7}
1.4×10^{-7}	0.007	7×10^{-4}	7×10^{-5}	7×10^{-6}	7×10^{-7}	7×10^{-8}
8×10^{-8}	0.004	4×10^{-4}	4×10^{-5}	4×10^{-6}	4×10^{-7}	4×10^{-8}
7×10^{-8}	0.0035	3.5×10^{-4}	3.5×10^{-5}	3.5×10^{-6}	3.5×10^{-7}	3.5×10^{-8}
2×10^{-8}	0.001	1×10^{-4}	1×10^{-5}	1×10^{-6}	1×10^{-7}	1×10^{-8}
1.4×10^{-8}	7×10^{-4}	7×10^{-5}	7×10^{-6}	7×10^{-7}	7×10^{-8}	7×10^{-9}
8×10^{-9}	4×10^{-4}	4×10^{-5}	4×10^{-6}	4×10^{-7}	4×10^{-8}	4×10^{-9}
2×10^{-9}	1×10^{-4}	1×10^{-5}	1×10^{-6}	1×10^{-7}	1×10^{-8}	1×10^{-9}
1.4×10^{-9}	7×10^{-5}	7×10^{-6}	7×10^{-7}	7×10^{-8}	7×10^{-9}	7×10^{-10}
8×10^{-10}	4×10^{-5}	4×10^{-6}	4×10^{-7}	4×10^{-8}	4×10^{-9}	4×10^{-10}
1.4×10^{-10}	7×10^{-6}	7×10^{-7}	7×10^{-8}	7×10^{-9}	7×10^{-10}	7×10^{-11}
1.4×10^{-11}	7×10^{-7}	7×10^{-8}	7×10^{-9}	7×10^{-10}	7×10^{-11}	7×10^{-12}
1.4×10^{-12}	7×10^{-8}	7×10^{-9}	7×10^{-10}	7×10^{-11}	7×10^{-12}	7×10^{-13}
0	0	0	0	0	0	0

[a] Do not round to nearest integer.

4.2.4.2.2 *Hazardous waste quantity*. Assign the same factor value for hazardous waste quantity for the watershed as would be assigned in section 4.2.2.2.2 for the drinking water threat. Enter this value in table 4–25.

4.2.4.2.3 *Calculation of environmental threat-waste characteristics factor category*

value. For the hazardous substance selected for the watershed in section 4.2.4.2.1.5, use its ecosystem toxicity/mobility/persistence factor value and ecosystem bioaccumulation potential factor value as follows to assign a value to the waste characteristics factor category. First, multiply the ecosystem toxicity/mobility/persistence factor value and the hazardous waste quantity factor value for the watershed, subject to a maximum product of 1×10^8. Then multiply this product by the ecosystem bioaccumulation potential factor value for this hazardous substance, subject to a maximum product of 1×10^{12}. Based on this product, assign a value from table 2–7 (section 2.4.3.1) to the environmental threat-waste characteristics category for the watershed. Enter the value in table 4–25.

4.2.4.3 *Environmental threat-targets*. Evaluate the environmental threat-targets factor category for a watershed using one factor: sensitive environments.

4.2.4.3.1 *Sensitive environments*. Evaluate sensitive environments for the watershed based on three factors: Level I concentrations, Level II concentrations, and potential contamination. Determine which applies to each sensitive environment as specified in section 4.1.4.3.1, except: use only those samples from the surface water in-water segment and only those hazardous substances in such samples that meet the conditions in sections 4.2.1.3 and 4.2.1.4.

4.2.4.3.1.1 *Level I concentrations*. Assign a value to this factor as specified in section 4.1.4.3.1.1. Enter this value in table 4–25.

4.2.4.3.1.2 *Level II concentrations*. Assign a value to this factor as specified in section 4.1.4.3.1.2. Enter this value in table 4–25.

4.2.4.3.1.3 *Potential contamination*. Assign a value to this factor as specified in section 4.1.4.3.1.3 with the following modification. Multiply the appropriate dilution weight from table 4–13 for the sensitive environments in each type of surface water body by the adjustment value selected from table 4–27, as specified in section 4.2.2.3.1. Use the resulting product, not the value from table 4–13, as the dilution weight for the sensitive environments in that type of surface water body. Do not round this product to the nearest integer. Enter the value assigned in table 4–25.

4.2.4.3.1.4 *Calculation of environmental threat-targets factor category value*. Sum the values for Level I concentrations, Level II concentrations, and potential contamination for the watershed. Do not round this sum to the nearest integer. Assign this sum as the environmental threat targets factor category value for the watershed. Enter this value in table 4–25.

4.2.4.4 *Calculation of environmental threat score for a watershed*. Multiply the environmental threat factor category values for likelihood of release, waste characteristics, and targets for the watershed, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum of 60, as the environmental threat score for the watershed. Enter this score in table 4–25.

4.2.5 *Calculation of ground water to surface water migration component score for a watershed*. Sum the scores for the three threats for the watershed (that is, drinking water, human food chain, and environmental threats). Assign the resulting score, subject to a maximum value of 100, as the ground water to surface water migration component score for the watershed. Enter this score in table 4–25.

4.2.6 *Calculation of ground water to surface water migration component score*. Select the highest ground water to surface water migration component score from the watersheds evaluated. Assign this score as the ground water to surface water migration component score for the site, subject to a maximum score of 100. Enter this score in table 4–25.

4.3 *Calculation of surface water migration pathway score*. Determine the surface water migration pathway score as follows:

- If only one of the two surface water migration components (overland/flood or ground water to surface water) is scored, assign the score of that component as the surface water migration pathway score.
- If both components are scored, select the higher of the two component scores from sections 4.1.6 and 4.2.6. Assign that score as the surface water migration pathway score.

5.0 Soil Exposure Pathway

Evaluate the soil exposure pathway based on two threats: Resident population threat and nearby population threat. Evaluate both threats based on three factor categories: Likelihood of exposure, waste characteristics, and targets. Figure 5–1 indicates the factors included within each factor category for each type of threat.

Determine the soil exposure pathway score (S_s)in terms of the factor category values as follows:

$$S_s = \frac{\sum_{i=1}^{2}(LE_i)(WC_i)(T_i)}{SF}$$

where:

LE_i=Likelihood of exposure factor category value for threat i (that is, resident population threat or nearby population threat).
WC_i=Waste characteristics factor category value for threat i.
T_i=Targets factor category value for threat i.
SF=Scaling factor.

Table 5–1 outlines the specific calculation procedure.

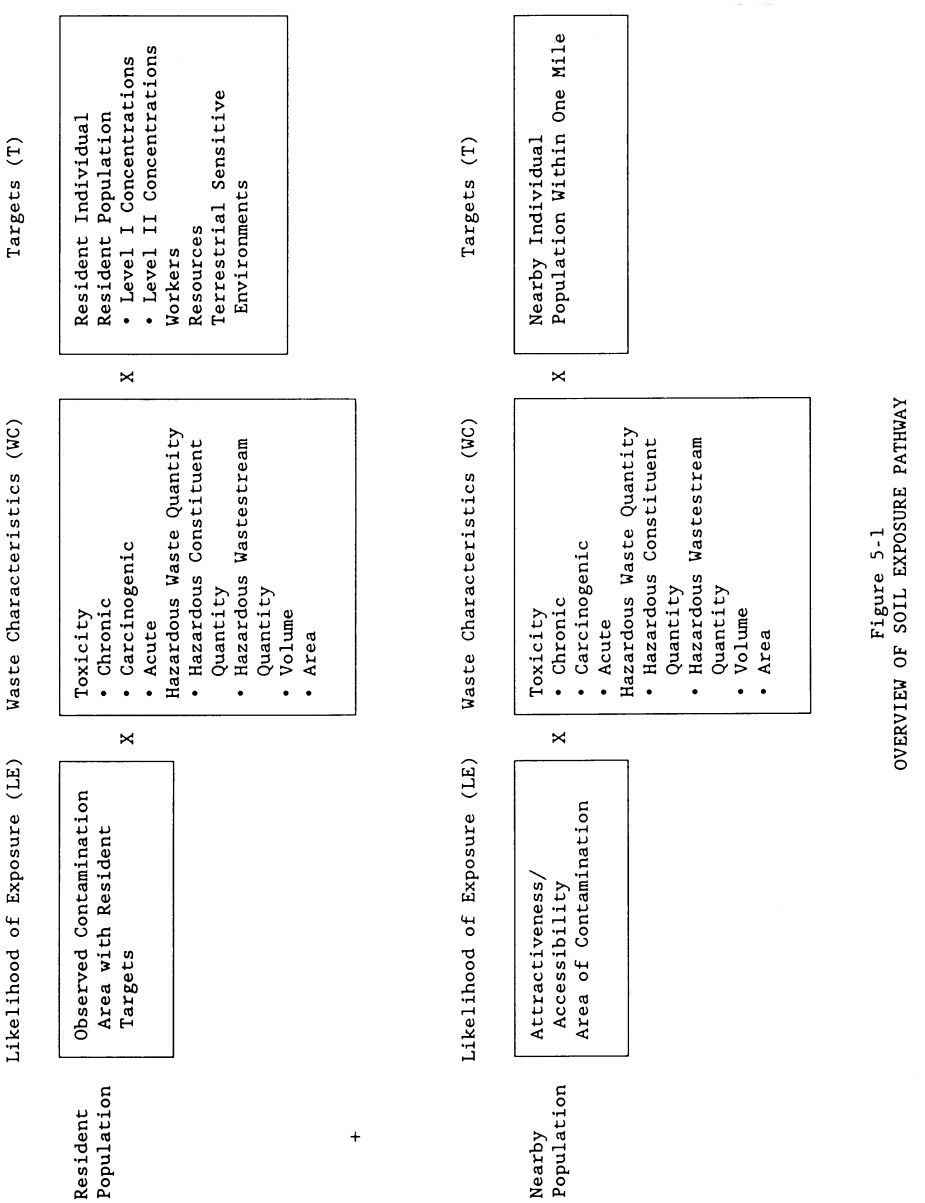


Figure 5-1
OVERVIEW OF SOIL EXPOSURE PATHWAY

TABLE 5–1—SOIL EXPOSURE PATHWAY SCORESHEET

Factor categories and factors	Maximum value	Value assigned
Resident Population Threat		
Likelihood of Exposure		
1. Likelihood of Exposure	550	___

TABLE 5–1—SOIL EXPOSURE PATHWAY SCORESHEET—Continued

Factor categories and factors	Maximum value	Value assigned
Waste Characteristics		
2. Toxicity	(a)	
3. Hazardous Waste Quantity	(a)	
4. Waste Characteristics	100	
Targets		
5. Resident Individual	50	
6. Resident Population:		
6a. Level I Concentrations	(b)	
6b. Level II Concentrations	(b)	
6c. Resident Population (lines 6a + 6b)	(b)	
7. Workers	15	
8. Resources	5	
9. Terrestrial Sensitive Environments	(c)	
10. Targets (lines 5 + 6c + 7 + 8 + 9)	(b)	
Resident Population Threat Score		
11. Resident Population Threat (lines 1×4× 10)	(b)	
Nearby Population Threat		
Likelihood of Exposure		
12. Attractiveness/Accessibility	100	
13. Area of Contamination	100	
14. Likelihood of Exposure	500	
Waste Characteristics		
15. Toxicity	(a)	
16. Hazardous Waste Quantity	(a)	
17. Waste Characteristics	100	
Targets		
18. Nearby Individual	1	
19. Population Within 1 Mile	(b)	
20. Targets (lines 18 + 19)	(b)	
Nearby Population Threat Score		
21. Nearby Population Threat (lines 14×17× 20)	(b)	
Soil Exposure Pathway Score		
22. Soil Exposure Pathway Score[d] (S_s), (lines [11+21] / 82,500, subject to a maximum of 100)	100	

[a] Maximum value applies to waste characteristics category.
[b] Maximum value not applicable.
[c] No specific maximum value applies to factor. However, pathway score based solely on terrestrial sensitive environments is limited to maximum of 60.
[d] Do not round to nearest integer.

5.0.1 *General considerations.* Evaluate the soil exposure pathway based on areas of observed contamination:

• Consider observed contamination to be present at sampling locations where analytic evidence indicates that:

–A hazardous substance attributable to the site is present at a concentration significantly above background levels for the site (see table 2–3 in section 2.3 for the criteria for determining analytical significance), *and*

–This hazardous substance, if not present at the surface, is covered by 2 feet or less of cover material (for example, soil).

• Establish areas of observed contamination based on sampling locations at which there is observed contamination as follows:

–For all sources except contaminated soil, if observed contamination from the site is present at any sampling location within the source, consider that entire source to be an area of observed contamination.

–For contaminated soil, consider both the sampling location(s) with observed contamination from the site and the area lying between such locations to be an area of observed contamination, unless available information indicates otherwise.

• If an area of observed contamination (or portion of such an area) is covered by a permanent, or otherwise maintained, essentially impenetrable material (for example, asphalt) that is not more than 2 feet thick, exclude that area (or portion of the area) in evaluating the soil exposure pathway.

• For an area of observed contamination, consider only those hazardous substances that meet the criteria for observed contamination for that area to be associated with that area in evaluating the soil exposure pathway (see section 2.2.2).

If there is observed contamination, assign scores for the resident population threat and the nearby population threat, as specified in sections 5.1 and 5.2. If there is no observed contamination, assign the soil exposure pathway a score of 0.

5.1 *Resident Population Threat.* Evaluate the resident population threat only if there

is an area of observed contamination in one or more of the following locations:

• Within the property boundary of a residence, school, or day care center *and* within 200 feet of the respective residence, school, or day care center, or

• Within a workplace property boundary *and* within 200 feet of a workplace area, or

• Within the boundaries of a resource specified in section 5.1.3.4, or

• Within the boundaries of a terrestrial sensitive environment specified in section 5.1.3.5.

If not, assign the resident population threat a value of 0, enter this value in table 5–1, and proceed to the nearby population threat (section 5.2).

5.1.1 *Likelihood of exposure.* Assign a value of 550 to the likelihood of exposure factor category for the resident population threat if there is an area of observed contamination in one or more locations listed in section 5.1. Enter this value in table 5–1.

5.1.2 *Waste characteristics.* Evaluate waste characteristics based on two factors: toxicity and hazardous waste quantity. Evaluate only those hazardous substances that meet the criteria for observed contamination at the site (see section 5.0.1).

5.1.2.1 *Toxicity.* Assign a toxicity factor value to each hazardous substance as specified in section 2.4.1.1. Use the hazardous substance with the highest toxicity factor value to assign the value to the toxicity factor for the resident population threat. Enter this value in table 5–1.

5.1.2.2 *Hazardous waste quantity.* Assign a hazardous waste quantity factor value as specified in section 2.4.2. In estimating the hazardous waste quantity, use table 5–2 and:

• Consider only the first 2 feet of depth of an area of observed contamination, except as specified for the volume measure.

• Use the volume measure (see section 2.4.2.1.3) only for those types of areas of observed contamination listed in Tier C of table 5–2. In evaluating the volume measure for these listed areas of observed contamination, use the full volume, not just the volume within the top 2 feet.

• Use the area measure (see section 2.4.2.1.4), not the volume measure, for all other types of areas of observed contamination, even if their volume is known.

Enter the value assigned in table 5–1.

TABLE 5–2—HAZARDOUS WASTE QUANTITY EVALUATION EQUATIONS FOR SOIL EXPOSURE PATHWAY

Tier	Measure	Units	Equation for assigning value [a]
A	**Hazardous Constituent Quantity (C)**	lb	C
B [b]	**Hazardous Wastestream Quantity (W)**	lb	W/5,000
C [b]	**Volume (V)**		
	Surface Impoundment [c]	yd^3	V/2.5
	Drums [d]	gallon	V/500
	Tanks and Containers Other Than Drums	yd^3	V/2.5
D [b]	Area (A)		
	Landfill	ft^2	A/34,000
	Surface Impoundment	ft^2	A/13
	Surface Impoundment (Buried/backfilled)	ft^2	A/13
	Land treatment	ft^2	A/270
	Pile [e]	ft^2	A/34
	Contaminated Soil	ft^2	A/34,000

[a] Do not round nearest integer.

[b] Convert volume to mass when necessary: 1 ton=2,000 pounds=1 cubic yard=4 drums=200 gallons.

[c] Use volume measure only for surface impoundments containing hazardous substances present as liquids. Use area measures in Tier D for dry surface impoundments and for buried/backfilled surface impoundments.

[d] If actual volume of drums is unavailable, assume 1 drum=50 gallons.

[e] Use land surface area under pile, not surface area of pile.

5.1.2.3 *Calculation of waste characteristics factor category value.* Multiply the toxicity and hazardous waste quantity factor values, subject to a maximum product of 1×10^8. Based on this product, assign a value from table 2–7 (section 2.4.3.1) to the waste characteristics factor category. Enter this value in table 5–1.

5.1.3 *Targets.* Evaluate the targets factor category for the resident population threat based on five factors: resident individual, resident population, workers, resources, and terrestrial sensitive environments.

In evaluating the targets factor category for the resident population threat, count only the following as targets:

• Resident individual—a person living or attending school or day care on a property with an area of observed contamination *and* whose residence, school, or day care center, respectively, is on or within 200 feet of the area of observed contamination.

• Worker—a person working on a property with an area of observed contamination *and* whose workplace area is on or within 200 feet of the area of observed contamination.

• Resources located on an area of observed contamination, as specified in section 5.1.

• Terrestrial sensitive environments located on an area of observed contamination, as specified in section 5.1.

5.1.3.1 *Resident individual.* Evaluate this factor based on whether there is a resident individual, as specified in section 5.1.3, who is subject to Level I or Level II concentrations.

First, determine those areas of observed contamination subject to Level I concentrations and those subject to Level II concentrations as specified in sections 2.5.1 and 2.5.2. Use the health-based benchmarks from table 5–3 in determining the level of contamination. Then assign a value to the resident individual factor as follows:

• Assign a value of 50 if there is at least one resident individual for one or more areas subject to Level I concentrations.

• Assign a value of 45 if there is no such resident individuals, but there is at least one resident individual for one or more areas subject to Level II concentrations.

• Assign a value of 0 if there is no resident individual.

Enter the value assigned in table 5–1.

5.1.3.2 *Resident population.* Evaluate resident population based on two factors: Level I concentrations and Level II concentrations. Determine which factor applies as specified in sections 2.5.1 and 2.5.2, using the health-based benchmarks from table 5–3. Evaluate populations subject to Level I concentrations as specified in section 5.1.3.2.1 and populations subject to Level II concentrations as specified in section 5.1.3.2.2.

TABLE 5–3—HEALTH-BASED BENCHMARKS FOR HAZARDOUS SUBSTANCES IN SOILS

• Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for oral exposures.

• Screening concentration for noncancer toxicological responses corresponding to the Reference Dose (RfD) for oral exposures.

Count only those persons meeting the criteria for resident individual as specified in section 5.1.3. In estimating the number of people living on property with an area of observed contamination, when the estimate in based on the number of residences, multiply each residence by the average number of persons per residence for the county in which the residence is located.

5.1.3.2.1 *Level I concentrations.* Sum the number of resident individuals subject to Level I concentrations and multiply this sum by 10. Assign the resulting product as the value for this factor. Enter this value in table 5–1.

5.1.3.2.2 *Level II concentrations.* Sum the number of resident individuals subject to Level II concentrations. Do not include those people already counted under the Level I concentrations factor. Assign this sum as the value for this factor. Enter this value in table 5–1.

5.1.3.2.3 *Calculation of resident population factor value.* Sum the factor values for Level I concentrations and Level II concentrations. Assign this sum as the resident population factor value. Enter this value in table 5–1.

5.1.3.3 *Workers.* Evaluate this factor based on the number of workers that meet the section 5.1.3 criteria. Assign a value for these workers using table 5–4. Enter this value in table 5–1.

TABLE 5–4—FACTOR VALUES FOR WORKERS

Number of workers	Assigned value
0	0
1 to 100	5
101 to 1,000	10
Greater than 1,000	15

5.1.3.4 *Resources.* Evaluate the resources factor as follows:

• Assign a value of 5 to the resources factor if one or more of the following is present on an area of observed contamination at the site:

–Commercial agriculture.
–Commercial silviculture.
–Commercial livestock production or commercial livestock grazing.

• Assign a value of 0 if none of the above are present.

Enter the value assigned in table 5–1.

5.1.3.5 *Terrestrial sensitive environments.* Assign value(s) from table 5–5 to each terrestrial sensitive environment that meets the eligibility criteria of section 5.1.3.

Calculate a value (ES) for terrestrial sensitive environments as follows:

$$ES = \sum_{i=1}^{n} S_i$$

where:

S_i=Value(s) assigned from table 5–5 to terrestrial sensitive environment i.

n=Number of terrestrial sensitive environments meeting section 5.1.3 criteria.

Because the pathway score based solely on terrestrial sensitive environments is limited to a maximum of 60, determine the value for the terrestrial sensitive environments factor as follows:

TABLE 5–5—TERRESTRIAL SENSITIVE ENVIRONMENTS RATING VALUES

Terrestrial sensitive environments	Assigned value
Terrestrial critical habitat[a] for Federal designated endangered or threatened species	100
National Park	
Designated Federal Wilderness Area	
National Monument	
Terrestrial habitat known to be used by Federal designated or proposed threatened or endangered species	75
National Preserve (terrestrial)	
National or State Terrestrial Wildlife Refuge	
Federal land designated for protection of natural ecosystems	

TABLE 5–5—TERRESTRIAL SENSITIVE ENVIRONMENTS RATING VALUES—Continued

Terrestrial sensitive environments	Assigned value
Administratively proposed Federal Wilderness Area	
Terrestrial areas utilized for breeding by large or dense aggregations of animals [b]	
Terrestrial habitat known to be used by State designated endangered or threatened species	50
Terrestrial habitat known to be used by species under review as to its Federal designated endangered or threatened status	
State lands designated for wildlife or game management	25
State designated Natural Areas	
Particular areas, relatively small in size, important to maintenance of unique biotic communities	

[a] Critical habitat as defined in 50 CFR 424.02.
[b] Limit to vertebrate species.

• Multiply the values assigned to the resident population threat for likelihood of exposure (LE), waste characteristics (WC), and ES. Divide the product by 82,500.

–If the result is 60 or less, assign the value ES as the terrestrial sensitive environments factor value.

–If the result exceeds 60, calculate a value EC as follows:

$$EC = \frac{(60)(82{,}500)}{(LE)(WC)}$$

Assign the value EC as the terrestrial sensitive environments factor value. Do not round this value to the nearest interger.

Enter the value assigned for the terrestrial sensitive environments factor in table 5–1.

5.1.3.6 *Calculation of resident population targets factor category value*. Sum the values for the resident individual, resident population, workers, resources, and terrestrial sensitive environments factors. Do not round to the nearest integer. Assign this sum as the targets factor category value for the resident population threat. Enter this value in table 5–1.

5.1.4 *Calculation of resident population threat score*. Multiply the values for likelihood of exposure, waste characteristics, and targets for the resident population threat, and round the product to the nearest integer. Assign this product as the resident population threat score. Enter this score in table 5–1.

5.2 *Nearby population threat*. Include in the nearby population only those individuals who live or attend school within a 1-mile travel distance of an area of observed contamination at the site and who do not meet the criteria for resident individual as specified in section 5.1.3.

Do not consider areas of observed contamination that have an attractiveness/accessibility factor value of 0 (see section 5.2.1.1) in evaluating the nearby population threat.

5.2.1 *Likelihood of exposure*. Evaluate two factors for the likelihood of exposure factor category for the nearby population threat: attractiveness/accessibility and area of contamination.

5.2.1.1. *Attractiveness/accessibility*. Assign a value for attractiveness/accessibility from table 5–6 to each area of observed contamination, excluding any land used for residences. Select the highest value assigned to the areas evaluated and use it as the value for the attractiveness/accessibility factor. Enter this value in table 5–1.

5.2.1.2 *Area of contamination*. Evaluate area of contamination based on the total area of the areas of observed contamination at the site. Count only the area(s) that meet the criteria in section 5.0.1 and that receive an attractiveness/accessibility value greater than 0. Assign a value to this factor from table 5–7. Enter this value in table 5–1.

TABLE 5–6—ATTRACTIVENESS/ACCESSIBILITY VALUES

Area of observed contamination	Assigned value
Designated recreational area	100
Regularly used for public recreation (for example, fishing, hiking, softball)	75
Accessible and unique recreational area (for example, vacant lots in urban area)	75
Moderately accessible (may have some access improvements—for example, gravel road), with some public recreation use	50
Slightly accessible (for example, extremely rural area with no road improvement), with some public recreation use	25
Accessible, with no public recreation use	10
Surrounded by maintained fence or combination of maintained fence and natural barriers	5
Physically inaccessible to public, with no evidence of public recreation use	0

TABLE 5–7—AREA OF CONTAMINATION FACTOR VALUES

Total area of the areas of observed contamination (square feet)	Assigned value
Less than or equal to 5,000	5
Greater than 5,000 to 125,000	20
Greater than 125,000 to 250,000	40
Greater than 250,000 to 375,000	60
Greater than 375,000 to 500,000	80
Greater than 500,000	100

5.2.1.3 *Likelihood of exposure factor category value*. Assign a value from Table 5–8 to the likelihood of exposure factor category, based on the values assigned to the attractiveness/accessibility and area of contamination factors. Enter this value in table 5–1.

TABLE 5–8—NEARBY POPULATION LIKELIHOOD OF EXPOSURE FACTOR VALUES

Area of contamination factor value	Attractiveness/accessibility factor value						
	100	75	50	25	10	5	0
100	500	500	375	250	125	50	0
80	500	375	250	125	50	25	0
60	375	250	125	50	25	5	0
40	250	125	50	25	5	5	0
20	125	50	25	5	5	5	0
5	50	25	5	5	5	5	0

5.2.2 *Waste characteristics.* Evaluate waste characteristics based on two factors: toxicity and hazardous waste quantity. Evaluate only those hazardous substances that meet the criteria for observed contamination (see section 5.0.1) at areas that can be assigned an attractiveness/accessibility factor value greater than 0.

5.2.2.1 *Toxicity.* Assign a toxicity factor value as specified in section 2.4.1.1 to each hazardous substance meeting the criteria in section 5.2.2. Use the hazardous substance with the highest toxicity factor value to assign the value to the toxicity factor for the nearby population threat. Enter this value in table 5–1.

5.2.2.2 *Hazardous waste quantity.* Assign a value to the hazardous waste quantity factor as specified in section 5.1.2.2, except: consider only those areas of observed contamination that can be assigned an attractiveness/accessibility factor value greater than 0. Enter the value assigned in table 5–1.

5.2.2.3 *Calculation of waste characteristics factor category value.* Multiply the toxicity and hazardous waste quantity factor values, subject to a maximum product of 1×10^8. Based on this product, assign a value from table 2–7 (section 2.4.3.1) to the waste characteristics factor category. Enter this value in table 5–1.

5.2.3 *Targets.* Evaluate the targets factory category for the nearby population threat based on two factors: nearby individual and population within a 1-mile travel distance from the site.

5.2.3.1 *Nearby individual.* If one or more persons meet the section 5.1.3 criteria for a resident individual, assign this factor a value of 0. Enter this value in table 5–1.

If no person meets the criteria for a resident individual, determine the shortest travel distance from the site to any residence or school. In determining the travel distance, measure the shortest overland distance an individual would travel from a residence or school to the nearest area of observed contamination for the site with an attractiveness/accessibility factor value greater than 0. If there are no natural barriers to travel, measure the travel distance as the shortest straight-line distance from the residence or school to the area of observed contamination. If natural barriers exist (for example, a river), measure the travel distance as the shortest straight-line distance from the residence or school to the nearest crossing point and from there as the shortest straight-line distance to the area of observed contamination. Based on the shortest travel distance, assign a value from table 5–9 to the nearest individual factor. Enter this value in table 5–1.

TABLE 5–9—NEARBY INDIVIDUAL FACTOR VALUES

Travel distance for nearby individual (miles)	Assigned value
Greater than 0 to ¼	1 [a]
Greater than ¼ to 1	0

[a] Assign a value of 0 if one or more persons meet the section 5.1.3 criteria for resident individual.

5.2.3.2 *Population within 1 mile.* Determine the population within each travel distance category of table 5–10. Count residents and students who attend school within this travel distance. Do not include those people already counted in the resident population threat. Determine travel distances as specified in section 5.2.3.1.

In estimating residential population, when the estimate is based on the number of residences, multiply each residence by the average number of persons per residence for the county in which the residence is located.

Based on the number of people included within a travel distance category, assign a distance-weighted population value for that travel distance from table 5–10.

Calculate the value for the population within 1 mile factor (PN) as follows:

$$PN = \frac{1}{10}\sum_{i=1}^{3} W_i$$

where:

W_i=Distance-weighted population value from table 5–10 for travel distance category i.

If PN is less than 1, do not round it to the nearest integer; if PN is 1 or more, round to the nearest integer. Enter this value in table 5–1.

5.2.3.3 *Calculation of nearby population targets factor category value.* Sum the values for the nearby individual factor and the population within 1 mile factor. Do not round this sum to the nearest integer. Assign this sum as the targets factor category value for the nearby population threat. Enter this value in table 5–1.

TABLE 5–10—DISTANCE-WEIGHTED POPULATION VALUES FOR NEARBY POPULATION THREAT [A]

Travel distance category (miles)	Number of people within the travel distance category											
	0	1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000
Greater than 0 to ¼	0	0.1	0.4	1.0	4	13	41	130	408	1,303	4,081	13,034
Greater than ¼ to ½	0	0.05	0.2	0.7	2	7	20	65	204	652	2,041	6,517
Greater than ½ to 1	0	0.02	0.1	0.3	1	3	10	33	102	326	1,020	3,258

[a] Round the number of people present within a travel distance category to nearest integer. Do not round the assigned distance-weighted population value to nearest integer.

5.2.4 *Calculation of nearby population threat score.* Multiply the values for likelihood of exposure, waste characteristics, and targets for the nearby population threat, and round the product to the nearest integer. Assign this product as the nearby population threat score. Enter this score in table 5–1.

5.3 *Calculation of soil exposure pathway score.* Sum the resident population threat score and the nearby population threat score, and divide the sum by 82,500. Assign the resulting value, subject to a maximum of 100, as the soil exposure pathway score (S_s). Enter this score in table 5–1.

6.0 Air Migration Pathway

Evaluate the air migration pathway based on three factor categories: likelihood of release, waste characteristics, and targets. Figure 6–1 indicates the factors included within each factor category.

Determine the air migration pathway score (S_a) in terms of the factor category values as follows:

$$S_a = \frac{(LR)(WC)(T)}{SF}$$

where:

LR=Likelihood of release factor category value.

WC=Waste characteristics factor category value.

T=Targets factor category value.

SF=Scaling factor.

Table 6–1 outlines the specific calculation procedure.

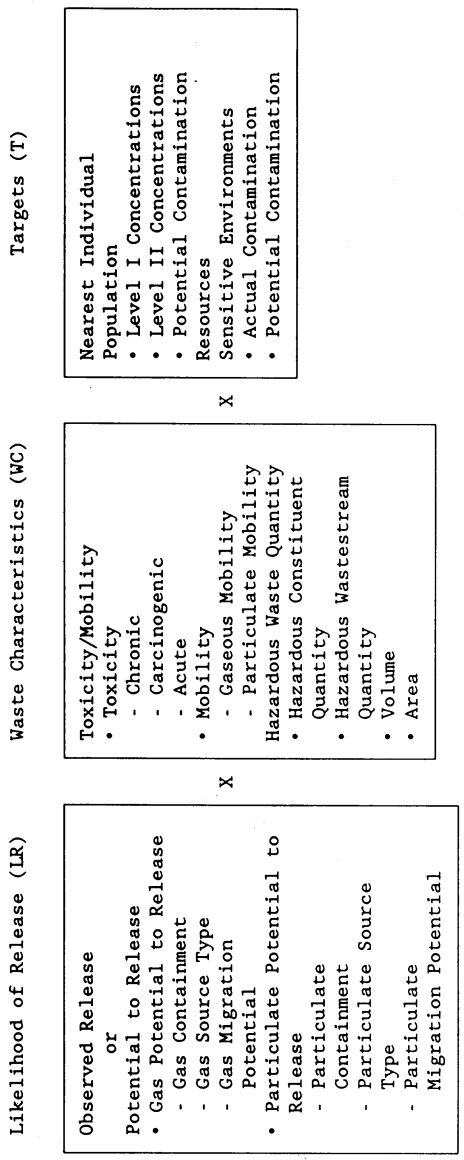


FIGURE 6-1
OVERVIEW OF AIR MIGRATION PATHWAY

TABLE 6–1—AIR MIGRATION PATHWAY SCORESHEET

Factor categories and factors	Maximum value	Value assigned
Likelihood of Release		
1. Observed Release	550	
2. Potential to Release:		
2a. Gas Potential to Release	500	
2b. Particulate Potential to Release	500	
2c. Potential to Release (higher of lines 2a and 2b)	500	

TABLE 6–1—AIR MIGRATION PATHWAY SCORESHEET—Continued

Factor categories and factors	Maximum value	Value assigned
3. Likelihood of Release (higher of lines 1 and 2c)	550	
Waste Characteristics		
4. Toxicity/Mobility	(a)	
5. Hazardous Waste Quantity	(a)	
6. Waste Characteristics	100	
Targets		
7. Nearest Individual	50	
8. Population:		
8a. Level I Concentrations	(b)	
8b. Level II Concentrations	(b)	
8c. Potential Contamination	(b)	
8d. Population (lines 8a+8b+8c)	(b)	
9. Resources	5	
10. Sensitive Environments		
10a. Actual Contamination	(c)	
10b. Potential Contamination	(c)	
10c. Sensitive Environments (lines 10a+10b)	(c)	
11. Targets (lines 7+8d+9+10c)	(b)	
Air Migration Pathway Score		
12. Pathway Score (S_a) [(lines 3×6×11)/82,500][d]	100	

[a] Maximum value applies to waste characteristics category.
[b] Maximum value not applicable.
[c] No specific maximum value applies to factor. However, pathway score based solely on sensitive environments is limited to maximum of 60.
[d] Do not round to nearest integer.

6.1 *Likelihood of Release.* Evaluate the likelihood of release factor category in terms of an observed release factor or a potential to release factor.

6.1.1 *Observed release.* Establish an observed release to the atmosphere by demonstrating that the site has released a hazardous substance to the atmosphere. Base this demonstration on either:

• Direct observation—a material (for example, particulate matter) that contains one or more hazardous substances has been seen entering the atmosphere directly. When evidence supports the inference of a release of a material that contains one or more hazardous substances by the site to the atmosphere, demonstrated adverse effects accumulated with that release may be used to establish an observed release.

• Chemical analysis—an analysis of air samples indicates that the concentration of ambient hazardous substance(s) has increased significantly above the background concentration for the site (see section 2.3). Some portion of the significant increase must be attributable to the site to establish the observed release.

If an observed release can be established, assign an observed release factor value of 550, enter this value in table 6–1, and proceed to section 6.1.3. If an observed release cannot be established, assign an observed release factor value of 0, enter this value in table 6–1, and proceed to section 6.1.2.

6.1.2 *Potential to release.* Evaluate potential to release only if an observed release cannot be established. Determine the potential to release factor value for the site by separately evaluating the gas potential to release and the particulate potential to release for each source at the site. Select the highest potential to release value (either gas or particulate) calculated for the sources evaluated and assign that value as the site potential to release factor value as specified below.

6.1.2.1 *Gas potential to release.* Evaluate gas potential to release for those sources that contain gaseous hazardous substances—that is, those hazardous substances with a vapor pressure greater than or equal to 10^{-9} torr.

Evaluate gas potential to release for each source based on three factors: gas containment, gas source type, and gas migration potential. Calculate the gas potential to release value as illustrated in table 6–2. Combine sources with similar characteristics into a single source in evaluating the gas potential to release factors.

TABLE 6–2—GAS POTENTIAL TO RELEASE EVALUATION

Source	Source type [a]	Gas containment factor value [b]	Gas source type factor value [c]	Gas migration potential factor value [d]	Sum	Gas source value
		A	B	C	(B+C)	A(B+C)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
Gas Potential to Release Factor (Select the Highest Gas Source Value)						

[a] Enter a Source Type listed in table 6–4.
[b] Enter Gas Containment Factor Value from section 6.1.2.1.1.
[c] Enter Gas Source Type Factor Value from section 6.1.2.1.2.
[d] Enter Gas Migration Potential Factor Value from section 6.1.2.1.3.

6.1.2.1.1 *Gas containment.* Assign each source a value from table 6–3 for gas containment. Use the lowest value from table 6–3 that applies to the source, except: assign a value of 10 if there is evidence of biogas release or if there is an active fire within the source.

TABLE 6–3—GAS CONTAINMENT FACTOR VALUES

Gas containment description	Assigned value
All situations except those specifically listed below	10
Evidence of biogas release	10 [a]
Active fire within source	10 [a]
Gas collection/treatment system functioning, regularly inspected, maintained, and completely covering source	0
Source substantially surrounded by engineering windbreak and no other containment specifically described in this table applies	7
Source covered with essentially impermeable, regularly inspected, maintained cover	0
Uncontaminated soil cover >3 feet:	
• Source substantially vegetated with little exposed soil	0
• Source lightly vegetated with much exposed soil	3
• Source substantially devoid of vegetation	7
Uncontaminated soil cover ≥1 foot and ≥3 feet:	
• Source heavily vegetated with essentially no exposed soil.	
—Cover soil type resistant to gas migration [b]	3
—Cover soil type not resistant to gas migration [b] or unknown	7
• Source substantially vegetated with little exposed soil and cover soil type resistant to gas migration [b]	7
• Other	10
Uncontaminated soil cover <1 foot:	
• Source heavily vegetated with essentially no exposed soil and cover soil type resistant to gas migration [b]	7
• Other	10
Totally or partially enclosed within structurally intact building and no other containment specifically described in this table applies	7
Source consists solely of intact, sealed containers:	
• Totally protected from weather by regularly inspected, maintained cover	0
• Other	3

[a] This value must be used if applicable.
[b] Consider moist fine-grained and saturated coarse-grained soils resistant to gas migration. Consider all other soils nonresistant.

6.1.2.1.2 *Gas source type.* Assign a value for gas source type to each source as follows:

• Determine if the source meets the minimum size requirement based on the source hazardous waste quantity value (see section 2.4.2.1.5). If the source receives a source hazardous waste quantity value of 0.5 or more, consider the source to meet the minimum size requirement.

• If the source meets the minimum size requirement, assign it a value from table 6–4 for gas source type.

• If the source does not meet the minimum size requirement, assign it a value of 0 for gas source type.

If no source at the site meets the minimum size requirement, assign each source at the

site a value from table 6–4 for gas source type.

TABLE 6–4—SOURCE TYPE FACTOR VALUES

Source type	Assigned value	
	Gas	Particulate
Active fire area	14	30
Burn pit	19	22
Containers or tanks (buried/below-ground):		
• Evidence of biogas release	33	22
• No evidence of biogas release	11	22
Containers or tanks, not elsewhere specified	28	14
Contaminated soil (excluding land treatment)	19	22
Landfarm/land treatment	28	22
Landfill:		
• Evidence of biogas release	33	22
• No evidence of biogas release	11	22
Pile:		
• Tailings pile	6	28
• Scrap metal or junk pile	6	17
• Trash pile	6	6
• Chemical waste pile	11	28
• Other waste piles	17	28
Surface impoundments (buried/backfilled):		
• Evidence of biogas release	33	22
• No evidence of biogas release	11	22
Surface impoundment (not buried/backfilled):		
• Dry	19	22
• Other	28	0
Other types of sources, not elsewhere specified	0	0

6.1.2.1.3 *Gas migration potential.* Evaluate this factor for each source as follows:

• Assign a value for gas migration potential to each of the gaseous hazardous substances associated with the source (see section 2.2.2) as follows:

–Assign values from table 6–5 for vapor pressure and Henry's constant to each hazardous substance. If Henry's constant cannot be determined for a hazardous substance, assign that hazardous substance a value of 2 for the Henry's constant component.

–Sum the two values assigned to the hazardous substance.

–Based on this sum, assign the hazardous substance a value from table 6–6 for gas migration potential.

• Assign a value for gas migration potential to each source as follows:

–Select three hazardous substances associated with the source:

–If more than three gaseous hazardous substances can be associated with the source, select three that have the highest gas migration potential values.

–If fewer than three gaseous hazardous substances can be associated with a source, select all of them.

–Average the gas migration potential values assigned to the selected hazardous substances.

–Based on this average value, assign the source a gas migration potential value from table 6–7.

TABLE 6–5—VALUES FOR VAPOR PRESSURE AND HENRY'S CONSTANT

Vapor pressure (Torr)	Assigned value
Greater than 10	3
Greater than 10^{-3} to 10	2
10^{-5} to 10^{-3}	1
Less than 10^{-5}	0
Henry's constant (atm-m³/mol)	**Assigned value**
Greater than 10^{-3}	3
Greater than 10^{-5} to 10^{-3}	2
10^{-7} to 10^{-5}	1
Less than 10^{-7}	0

TABLE 6–6—GAS MIGRATION POTENTIAL VALUES FOR A HAZARDOUS SUBSTANCE

Sum of values for vapor pressure and Henry's constant	Assigned value
0	0
1 or 2	6
3 or 4	11
5 or 6	17

TABLE 6–7—GAS MIGRATION POTENTIAL VALUES FOR THE SOURCE

Average of gas migration potential values for three hazardous substances [a]	Assigned value
0 to < 3	0
3 to < 8	6
8 to < 14	11
14 to 17	17

[a] If fewer than three hazardous substances can be associated with the source, compute the average based only on those hazardous substances that can be associated.

6.1.2.1.4 *Calculation of gas potential to release value.* Determine the gas potential to release value for each source as illustrated in table 6–2. For each source, sum the gas source type factor value and gas migration potential factor value and multiply this sum by the gas containment factor value. Select the highest product calculated for the sources evaluated and assign it as the gas potential to release value for the site. Enter this value in table 6–1.

6.1.2.2 *Particulate potential to release.* Evaluate particulate potential to release for those sources that contain particulate hazardous substances—that is, those hazardous substances with a vapor pressure less than or equal to 10^{-1} torr.

Evaluate particulate potential to release for each source based on three factors: particulate containment, particulate source type, and particulate migration potential.

Calculate the particulate potential to release value as illustrated in table 6–8. Combine sources with similar characteristics into a single source in evaluating the particulate potential to release factors.

6.1.2.2.1 *Particulate containment.* Assign each source a value from table 6–9 for particulate containment. Use the lowest value from table 6–9 that applies to the source.

6.1.2.2.2 *Particulate source type.* Assign a value for particulate source type to each source in the same manner as specified for gas sources in section 6.1.2.1.2.

6.1.2.2.3 *Particulate migration potential.* Based on the site location, assign a value from Figure 6–2 for particulate migration potential. Assign this same value to each source at the site.

TABLE 6–8—PARTICULATE POTENTIAL TO RELEASE EVALUATION

Source	Source type [a]	Particulate containment factor value [b]	Particulate type factor value [c]	Particulate migration potential factor value [d]	Sum	Particulate source value
		A	B	C	(B+C)	A (B+C)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
Particulate Potential to Release Factor Value (Select Highest Particulate Source Value)						

[a] Enter a Source Type listed in table 6–4.
[b] Enter Particulate Containment Factor Value from section 6.1.2.2.1.
[c] Enter Particulate Source Type Factor Value from section 6.1.2.2.2.
[d] Enter Particulate Migration Potential Factor Value from section 6.1.2.2.3.

TABLE 6–9—PARTICULATE CONTAINMENT FACTOR VALUES

Particulate containment description	Assigned value
All situations except those specifically listed below	10
Source contains only particulate hazardous substances totally covered by liquids	0
Source substantially surrounded by engineered windbreak and no other containment specifically described in this table applies	7
Source covered with essentially impermeable, regularly inspected, maintained cover	0
Uncontaminated soil cover > 3 feet:	
• Source substantially vegetated with little or no exposed soil	0
• Source lightly vegetated with much exposed soil	3
• Source substantially devoid of vegetation	7
Uncontaminated soil cover ≥ 1 foot and ≤ 3 feet:	
• Source heavily vegetated with essentially no exposed soil:	
—Cover soil type resistant to gas migration [a]	3
—Cover soil type not resistant to gas migration [a] or unknown	7
• Source substantially vegetated with little exposed soil and cover soil type resistant to gas migration [a]	7
• Other	10
Uncontaminated soil cover < 1 foot:	
• Source heavily vegetated with essentially no exposed soil and cover soil type resistant to gas migration [a]	7
• Other	10
Totally or partially enclosed within structurally intact building and no other containment specifically described in this table applies	7
Source consists solely of containers:	
• All containers contain only liquids	0
• All containers intact, sealed, and totally protected from weather by regularly inspected, maintained cover	0
• All containers intact and sealed	3
• Other	10

[a] Consider moist fine-grained and saturated coarse-grained soils resistant to gas migration. Consider all other soils nonresistant.

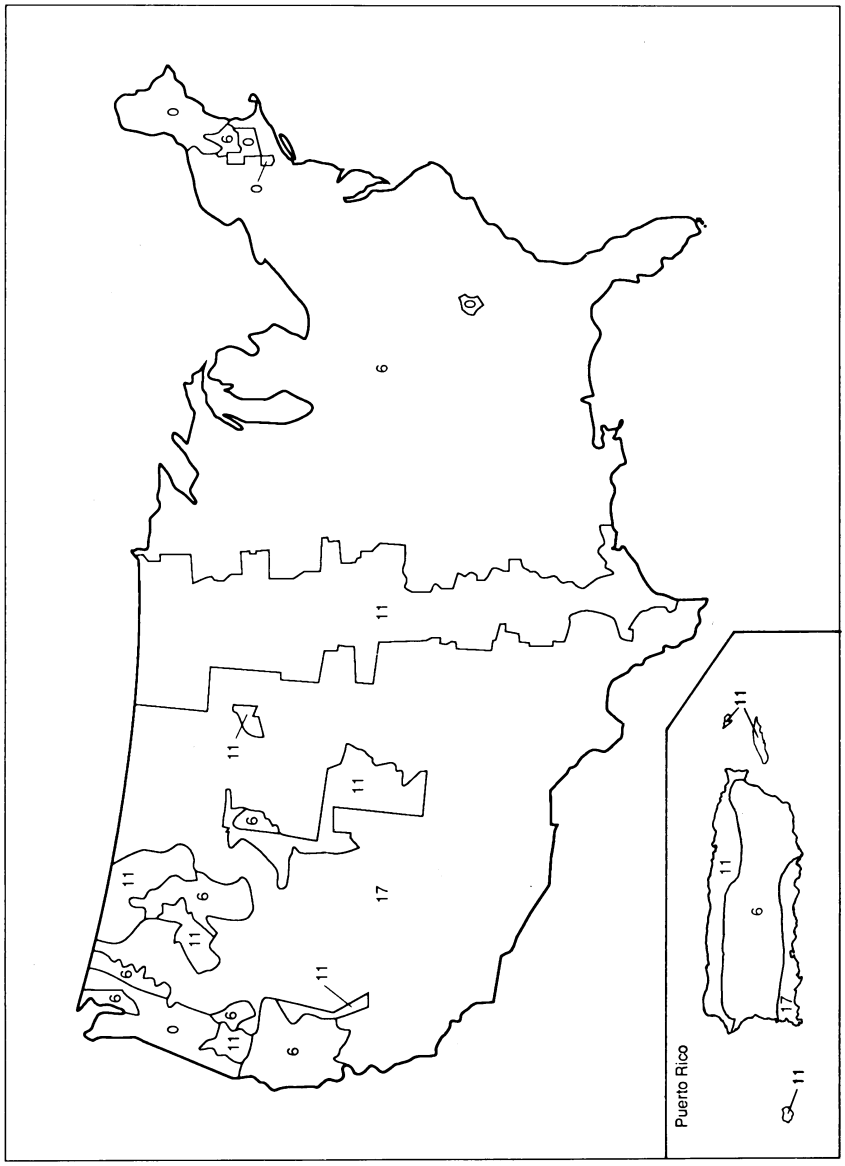


FIGURE 6-2
PARTICULATE MIGRATION POTENTIAL FACTOR VALUES

FIGURE 6–2—PARTICULATE MIGRATION POTENTIAL FACTOR VALUES—CONCLUDED

Location	Particulate migration potential assigned value
Hawaiian Islands	
Hilo, Hawaii	0
Honolulu, Oahu	17
Kahului, Maui	17
Lanai	17
Lihue, Kauai	11
Molokai	17
Pacific Islands	
Guam	6
Johnston Island	17
Koror Island	0
Kwajalein Island	6
Mujuro, Marshall Islands	0
Pago Pago, American Samoa	0
Ponape Island	0
Truk, Caroline Islands	0
Wake Island	17
Yap Island	0
Alaska	
Anchorage	17
Annette	0
Barrow	17
Barter Island	17
Bethel	17
Bettles	17
Big Delta	17
Cold Bay	6
Fairbanks	17
Gulkana	17
Homer	11
Juneau	0
King Salmon	11
Kodiak	0
Kutzebue	17
McGrath	17
Nome	11
St. Paul Island	11
Talkeetna	6
Unalakleet	17
Valdez	0
Yakutat	0
American Virgin Islands	
St. Croix	17
St. John	11
St. Thomas	11
Puerto Rico	
Arecibo	6
Coloso	6
Fajardo	11
Humacao	6
Isabela Station	11
Ponce	17
San Juan	11

For site locations not on Figure 6–2, and for site locations near the boundary points on Figure 6–2, assign a value as follows. First, calculate a Thornthwaite P-E index using the following equation:

$$PE = \sum_{i=1}^{12} 115\left[P_i/(T_i - 10)\right]^{10/9}$$

where:

PE=Thornthwaite P-E index.

P_i=Mean monthly precipitation for month i, in inches.

T_i=Mean monthly temperature for month i, in degrees Fahrenheit; for any month having a mean monthly temperature less than 28.4 °F, use 28.4 °F.

Based on the calculated Thornthwaite P-E index, assign a source particulate migration potential value to the site from table 6–10. Assign this same value to each source at the site.

TABLE 6–10—PARTICULATE MIGRATION POTENTIAL VALUES

Thornthwaite P-E Index	Assigned value
Greater than 150	0
85 to 150	6
50 to less than 85	11
Less than 50	17

6.1.2.2.4 *Calculation of particulate potential to release value.* Determine the particulate potential to release value for each source as illustrated in table 6–8. For each source, sum its particulate source type factor value and particulate migration potential factor value and multiply this sum by its particulate containment factor value. Select the highest product calculated for the sources evaluated and assign it as the particulate potential to release value for the site. Enter the value in table 6–1.

6.1.2.3 *Calculation of potential to release factor value for the site.* Select the higher of the gas potential to release value assigned in section 6.1.2.1.4 and the particulate potential to release value assigned in section 6.1.2.2.4. Assign the value selected as the site potential to release factor value. Enter this value in table 6–1.

6.1.3 *Calculation of likelihood of release factor category value.* If an observed release is established, assign the observed release factor value of 550 as the likelihood of release factor category value. Otherwise, assign the site potential to release factor value as the likelihood of release factor category value. Enter the value in table 6–1.

6.2 *Waste characteristics.* Evaluate the waste characteristics factor category based on two factors: toxicity/mobility and hazardous waste quantity. Evaluate only those hazardous substances available to migrate from the sources at the site to the atmosphere. Such hazardous substances include:

• Hazardous substances that meet the criteria for an observed release to the atmosphere.

• All gaseous hazardous substances associated with a source that has a gas containment factor value greater than 0 (see section 2.2.2, 2.2.3, and 6.1.2.1.1).

• All particulate hazardous substances associated with a source that has a particulate

containment factor value greater than 0 (see section 2.2.2, 2.2.3, and 6.1.2.2.1).

6.2.1 *Toxicity/mobility*. For each hazardous substance, assign a toxicity factor value, a mobility factor value, and a combined toxicity/mobility factor value as specified below. Select the toxicity/mobility factor value for the air migration pathway as specified in section 6.2.1.3.

6.2.1.1 *Toxicity*. Assign a toxicity factor value to each hazardous substance as specified in section 2.4.1.1.

6.2.1.2 *Mobility*. Assign a mobility factor value to each hazardous substance as follows:

• Gaseous hazardous substance.

–Assign a mobility factor value of 1 to each gaseous hazardous substance that meets the criteria for an observed release to the atmosphere.

–Assign a mobility factor value from table 6–11, based on vapor pressure, to each gaseous hazardous substance that does not meet the criteria for an observed release.

• Particulate hazardous substance.

–Assign a mobility factor value of 0.02 to each particulate hazardous substance that meets the criteria for an observed release to the atmosphere.

–Assign a mobility factor value from Figure 6–3, based on the site's location, to each particulate hazardous substance that does not meet the criteria for an observed release. (Assign all such particulate hazardous substances this same value.)

–For site locations not on Figure 6–3 and for site locations near the boundary points on Figure 6–3, assign a mobility factor value to each particulate hazardous substance that does not meet the criteria for an observed release as follows:

–Calculate a value M:

$M=0.0182\ (U^3/[PE]^2)$

where:

U=Mean average annual wind speed (meters per second).

PE=Thornthwaite P-E index from section 6.1.2.2.3.

–Based on the value M, assign a mobility factor value from table 6–12 to each particulate hazardous substance.

• Gaseous and particulate hazardous substances.

–For a hazardous substance potentially present in both gaseous and particulate forms, select the higher of the factor values for gas mobility and particulate mobility for that substance and assign that value as the mobility factor value for the hazardous substance.

6.2.1.3 *Calculation of toxicity/mobility factor value*. Assign each hazardous substance a toxicity/mobility factor value from table 6–13, based on the values assigned to the hazardous substance for the toxicity and mobility factors. Use the hazardous substance with the highest toxicity/mobility factor value to assign the value to the toxicity/mobility factor for the air migration pathway. Enter this value in table 6–1.

TABLE 6–11—GAS MOBILITY FACTOR VALUES

Vapor pressure (Torr)	Assigned value [a]
Greater than 10^{-1}	1.0
Greater than 10^{-3} to 10^{-1}	0.2
Greater than 10^{-5} to 10^{-3}	0.02
Greater than 10^{-7} to 10^{-5}	0.002
Less than or equal to 10^{-7}	0.0002

[a] Do not round to nearest integer.

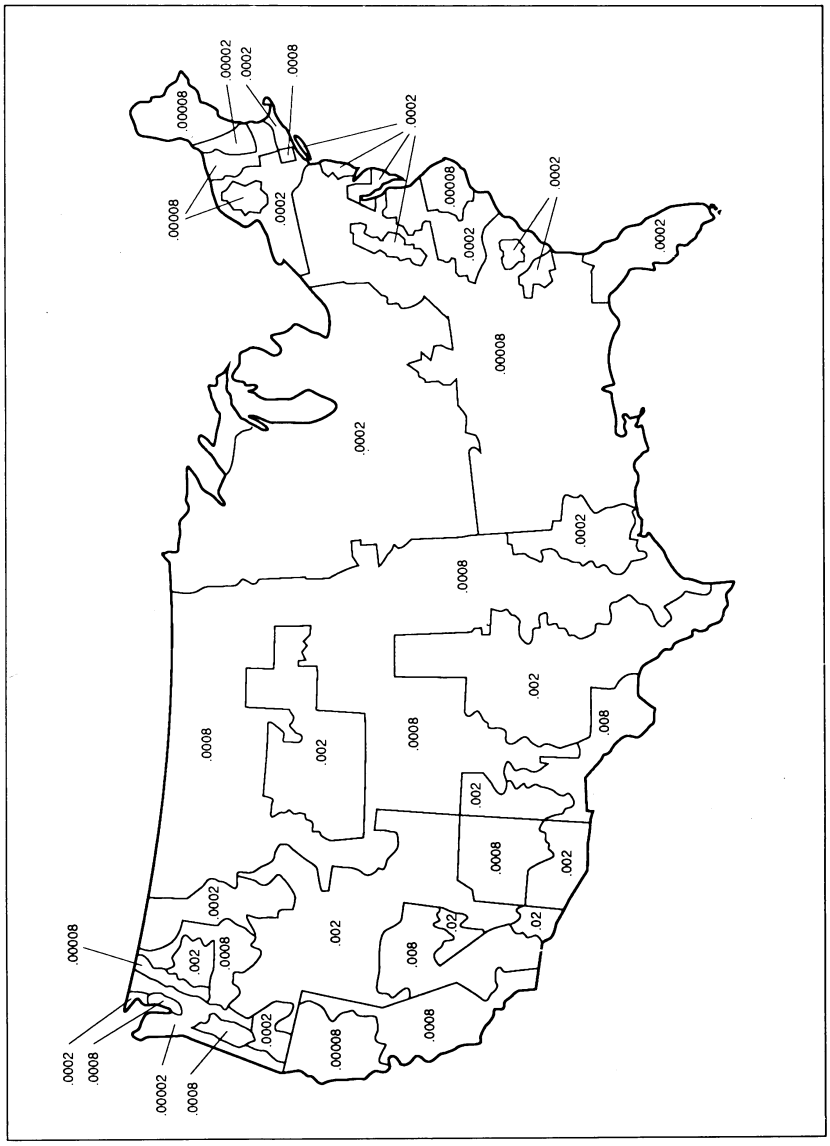


FIGURE 6-3
PARTICULATE MOBILITY FACTOR VALUES[a]

[a] Do not round to nearest integer.

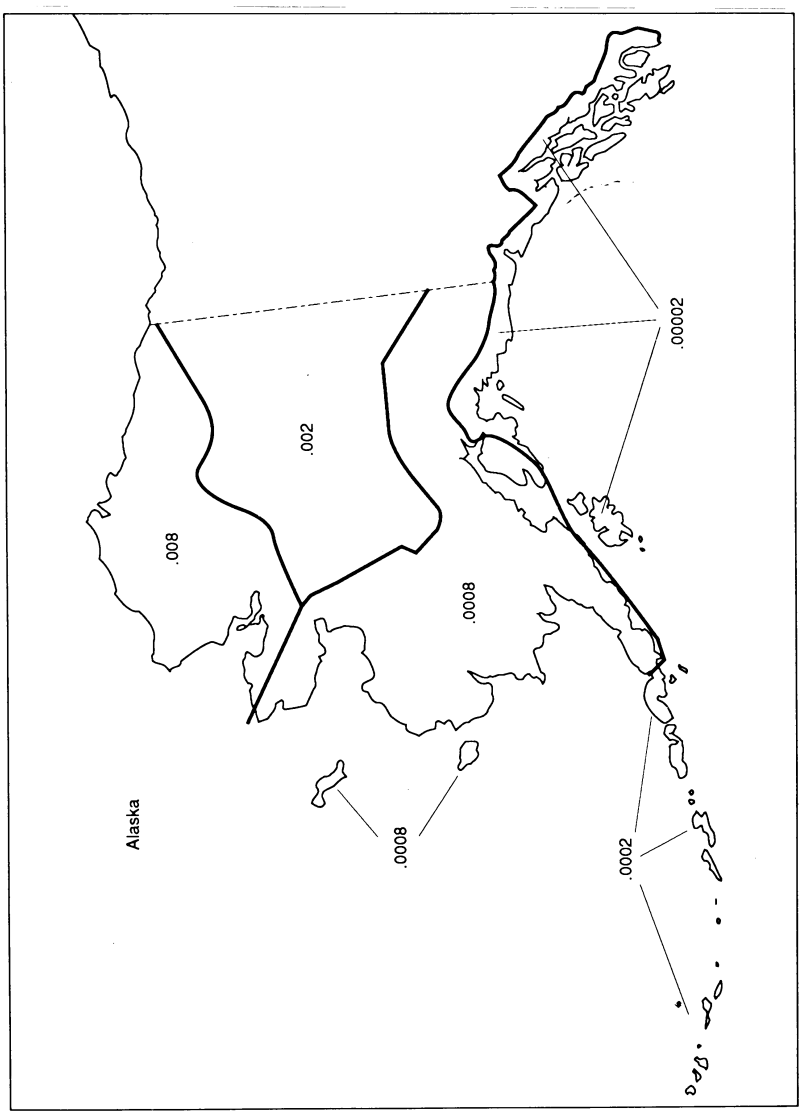
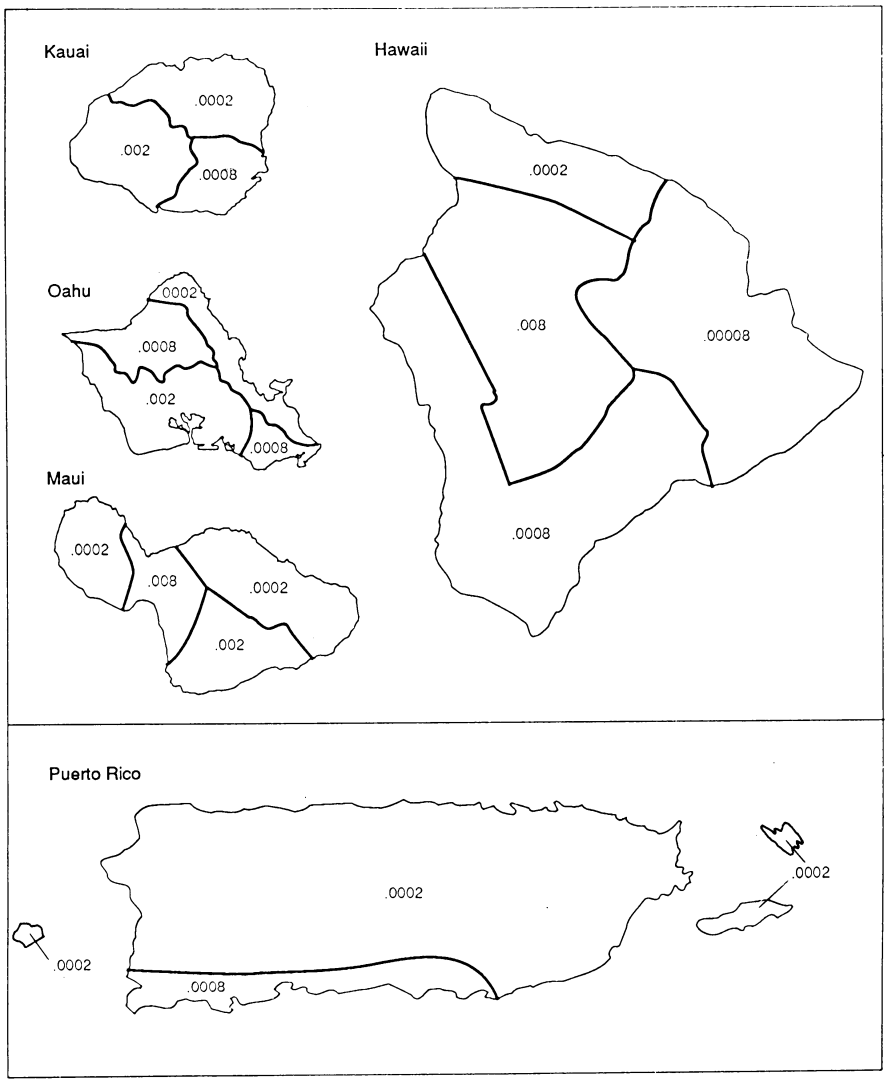


FIGURE 6-3
PARTICULATE MOBILITY FACTOR VALUES[a]
(CONTINUED)

[a] Do not round to nearest integer.



[a] Do not round to nearest integer.

FIGURE 6-3
PARTICULATE MOBILITY FACTOR VALUES[a]
(CONTINUED)

FIGURE 6–3—PARTICULATE MOBILITY FACTOR VALUES—CONCLUDED

Location	Particulated mobility assigned value
Pacific Islands	
Guam	0.0002
Johnston Island	0.002
Koror Island	0.00008
Kwajalein Island	0.0002
Mujuro, Marshall Islands	0.00008
Pago Pago, American Samoa	0.00008
Ponape Island	0.00002
Truk, Caroline Islands	0.00008
Wake Island	0.002
Yap Island	0.00008
American Virgin Islands	
St. Croix	0.0008
St. John	0.0002
St. Thomas	0.0002

TABLE 6–12—PARTICULATE MOBILITY FACTOR VALUES

M	Assigned value [a]
Greater than 1.4×10^{-2}	0.02
Greater than 4.4×10^{-3} to 1.4×10^{-2}	0.008
Greater than 1.4×10^{-3} to 4.4×10^{-3}	0.002
Greater than 4.4×10^{-4} to 1.4×10^{-3}	0.0008
Greater than 1.4×10^{-4} to 4.4×10^{-4}	0.0002
Greater than 4.4×10^{-5} to 1.4×10^{-4}	0.00008
Less than or equal to 4.4×10^{-5}	0.00002

[a] Do not round to nearest integer.

TABLE 6–13—TOXICITY/MOBILITY FACTOR VALUES [A]

Mobility factor value	Toxicity factor value					
	10,000	1,000	100	10	1	0
1.0	10,000	1,000	100	10	1	0
0.2	2,000	200	20	2	0.2	0
0.02	200	20	2	0.2	0.02	0
0.008	80	8	0.8	0.08	0.008	0
0.002	20	2	0.2	0.02	0.002	0
0.0008	8	0.8	0.08	0.008	0.0008	0
0.0002	2	0.2	0.02	0.002	0.0002	0
0.00008	0.8	0.08	0.008	0.0008	0.00008	0
0.00002	0.2	0.02	0.002	0.0002	0.00002	0

[a] Do not round to nearest integer.

6.2.2 *Hazardous waste quantity.* Assign a hazardous waste quantity factor value for the air migration pathway as specified in section 2.4.2. Enter this value in table 6–1.

6.2.3 *Calculation of waste characteristics factor category value.* Multiply the toxicity/mobility factor value and the hazardous waste quantity factor value, subject to a maximum product of 1×10^{8}. Based on this product, assign a value from table 2–7 (section 2.4.3.1) to the waste characteristics factor category. Enter this value in table 6–1.

6.3 *Targets.*

Evaluate the targets factor category based on four factors: nearest individual, population, resources, and sensitive environments. Include only those targets (for example, individuals, sensitive environments) located within the 4-mile target distance limit, except: if an observed release is established beyond the 4-mile target distance limit, include those additional targets that are specified below in this section and in section 6.3.4.

Evaluate the nearest individual and population factors based on whether the target populations are subject to Level I concentrations, Level II concentrations, or potential contamination. Determine which applies to a target population as follows.

If no samples meet the criteria for an observed release to air and if there is no observed release by direct observation, consider the entire population within the 4-mile target distance limit to be subject to potential contamination.

If one or more samples meet the criteria for an observed release to air or if there is an observed release by direct observation, evaluate the population as follows:

- Determine the most distant sample location that meets the criteria for Level I concentrations as specified in sections 2.5.1 and 2.5.2 and the most distant location (that is, sample location or direct observation location) that meets the criteria for Level II concentrations. Use the health-based benchmarks from table 6–14 in determining the level of contamination for sample locations. If the most distant Level II location is closer to a source than the most distant Level I sample location, do not consider the Level II location.
- Determine the single most distant location (sample location or direct observation location) that meets the criteria for Level I or Level II concentrations.

• If this single most distant location is within the 4-mile target distance limit, identify the distance categories from table 6–15 in which the selected Level I concentrations sample and Level II concentrations sample (or direct observation location) are located:

–Consider the target population anywhere within this furthest Level I distance category, or anywhere within a distance category closer to a source at the site, as subject to Level I concentrations.

–Consider the target population located beyond any Level I distance categories, up to and including the population anywhere within the furthest Level II distance category, as subject to Level II concentrations.

–Consider the remainder of the target population within the 4-mile target distance limit as subject to potential contamination.

• If the single most distant location is beyond the 4-mile target distance limit, identify the distance at which the selected Level I concentrations sample and Level II concentrations sample (or direct observation location) are located:

–If the Level I sample location is within the 4-mile target distance limit, identify the target population subject to Level I concentrations as specified above.

–If the Level I sample location is beyond the 4-mile target distance limit, consider the target population located anywhere within a distance from the sources at the site equal to the distance to this sample location to be subject to Level I concentrations and include them in the evaluation.

–Consider the target population located beyond the Level I target population, but located anywhere within a distance from the sources at the site equal to the distance to the selected Level II location, to be subject to Level II concentrations and include them in the evaluation.

–Do not include any target population as subject to potential contamination.

TABLE 6–14—HEALTH-BASED BENCHMARKS FOR HAZARDOUS SUBSTANCES IN AIR

- Concentration corresponding to National Ambient Air Quality Standard (NAAQS).
- Concentration corresponding to National Emission Standards for Hazardous Air Pollutants (NESHAPs).
- Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for inhalation exposures.
- Screening concentration for noncancer toxicological responses corresponding to the Reference Dose (RfD) for inhalation exposures.

TABLE 6–15—AIR MIGRATION PATHWAY DISTANCE WEIGHTS

Distance category (miles)	Assigned distance weight [a]
0	1.0
Greater than 0 to ¼	0.25
Greater than ¼ to ½	0.054
Greater than ½ to 1	0.016
Greater than 1 to 2	0.0051
Greater than 2 to 3	0.0023
Greater than 3 to 4	0.0014
Greater than 4	0

[a] Do not round to nearest integer.

6.3.1 *Nearest individual.* Assign the nearest individual factor a value as follows:

• If one or more residences or regularly occupied buildings or areas is subject to Level I concentrations as specified in section 6.3, assign a value of 50.

• If not, but if one or more a residences or regularly occupied buildings or areas is subject to Level II concentrations, assign a value of 45.

• If none of the residences and regularly occupied buildings and areas is subject to Level I or Level II concentrations, assign a value to this factor based on the shortest distance to any residence or regularly occupied building or area, as measured from any source at the site with an air migration containment factor value greater than 0. Based on this shortest distance, assign a value from table 6–16 to the nearest individual factor.

Enter the value assigned in table 6–1.

TABLE 6–16—NEAREST INDIVIDUAL FACTOR VALUES

Distance to nearest individual (miles)	Assigned value
Level I concentrations [a]	50
Level II concentrations [a]	45
0 to ⅛	20
Greater than ⅛ to ¼	7
Greater than ¼ to 1/2	2
Greater than ½ to 1	1
Greater than 1	0

[a] Distance does not apply.

6.3.2 *Population.* In evaluating the population factor, count residents, students, and workers regularly present within the target distance limit. Do not count transient populations such as customers and travelers passing through the area.

In estimating residential population, when the estimate is based on the number of residences, multiply each residence by the average number of persons per residence for the county in which the residence is located.

6.3.2.1 *Level of contamination.* Evaluate the population factor based on three factors: Level I concentrations, Level II concentrations, and potential contamination.

Evaluate the population subject to Level I concentrations (see section 6.3) as specified in section 6.3.2.2, the population subject to Level II concentrations as specified in section 6.3.2.3, and the population subject to potential contamination as specified in section 6.3.2.4.

For the potential contamination factor, use population ranges in evaluating the factor as specified in section 6.3.2.4. For the Level I and Level II concentrations factors, use the population estimate, not population ranges, in evaluating both factors.

6.3.2.2 *Level I concentrations.* Sum the number of people subject to Level I concentrations. Multiply this sum by 10. Assign the product as the value for this factor. Enter this value in table 6–1.

6.3.2.3 *Level II concentrations.* Sum the number of people subject to Level II concentrations. Do not include those people already counted under the Level I concentrations factor. Assign this sum as the value for this factor. Enter this value in table 6–1.

6.3.2.4 *Potential contamination.* Determine the number of people within each distance category of the target distance limit (see table 6–15) who are subject to potential contamination. Do not include those people already counted under the Level I and Level II concentrations factors.

Based on the number of people present within a distance category, assign a distance-weighted population value for that distance category from table 6–17. (Note that the distance-weighted population values in table 6–17 incorporate the distance weights from table 6–15. Do not multiply the values from table 6–17 by these distance weights.)

Calculate the potential contamination factor value (PI) as follows:

$$PI = \frac{1}{10}\sum_{i=1}^{n} W_i$$

where:

W_i=Distance-weighted population from table 6–17 for distance category i.

n=Number of distance categories.

If PI is less than 1, do not round it to the nearest integer; if PI is 1 or more, round to the nearest integer. Enter this value in table 6–1.

6.3.2.5 *Calculation of population factor value.* Sum the factor values for Level I concentrations, Level II concentrations, and potential contamination. Do not round this sum to the nearest integer. Assign this sum as the population factor value. Enter this value in table 6–1.

TABLE 6–17—DISTANCE-WEIGHTED POPULATION VALUES FOR POTENTIAL CONTAMINATION FACTOR FOR AIR PATHWAY[A]

Distance category (miles)	Number of people within the distance category												
	0	1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000	1,000,001 to 3,000,000
On a source	0	4	17	53	164	522	1,633	5,214	16,325	52,137	163,246	521,360	1,632,455
Greater than 0 to ¼	0	1	4	13	41	131	408	1,304	4,081	13,034	40,812	130,340	408,114
Greater than ¼ to ½	0	0.2	0.9	3	9	28	88	282	882	2,815	8,815	28,153	88,153
Greater than ½ to 1	0	0.06	0.3	0.9	3	8	26	83	261	834	2,612	8,342	26,119
Greater than 1 to 2	0	0.02	0.09	0.3	0.8	3	8	27	83	266	833	2,659	8,326
Greater than 2 to 3	0	0.009	0.04	0.1	0.4	1	4	12	38	120	375	1,199	3,755
Greater than 3 to 4	0	0.005	0.02	0.07	0.2	0.7	2	7	23	73	229	730	2,285

[a] Round the number of people present within a distance category to nearest integer. Do not round the assigned distance-weighted population value to nearest integer.

6.3.3 *Resources.* Evaluate the resources factor as follows:

• Assign a value of 5 if one or more of the following resources are present within one-half mile of a source at the site having an air migration containment factor value greater than 0:

–Commercial agriculture.

–Commercial silviculture.

–Major or designated recreation area.

• Assign a value of 0 if none of these resources is present.

Enter the value assigned in table 6–1.

6.3.4 *Sensitive environments.* Evaluate sensitive environments based on two factors: actual contamination and potential contamination. Determine which factor applies as follows.

If no samples meet the criteria for an observed release to air and if there is no observed release by direct observation, consider all sensitive environments located, partially or wholly, within the target distance limit to be subject to potential contamination.

If one or more samples meet the criteria for an observed release to air or if there is an observed release by direct observation, determine the most distant location (that is, sample location or direct observation location) that meets the criteria for an observed release:

• If the most distant location meeting the criteria for an observed release is within the 4-mile target distance limit, identify the distance category from table 6–15 in which it is located:

–Consider sensitive environments located, partially or wholly, anywhere within this distance category or anywhere within a distance category closer to a source at the site as subject to actual contamination.

–Consider all other sensitive environments located, partially or wholly, within the target distance limit as subject to potential contamination.

• If the most distant location meeting the criteria for an observed release is beyond the 4-mile target distance limit, identify the distance at which it is located:

–Consider sensitive environments located, partially or wholly, anywhere within a distance from the sources at the site equal to the distance to this location to be subject to actual contamination and include all such sensitive environments in the evaluation.

–Do not include any sensitive environments as subject to potential contamination.

6.3.4.1 *Actual contamination.* Determine those sensitive environments subject to actual contamination (i.e., those located partially or wholly within a distance category subject to actual contamination). Assign value(s) from table 4–23 (section 4.1.4.3.1.1) to each sensitive environment subject to actual contamination.

For those sensitive environments that are wetlands, assign an additional value from table 6–18. In assigning a value from table 6–18, include only those portions of wetlands located within distance categories subject to actual contamination. If a wetland is located partially in a distance category subject to actual contamination and partially in one subject to potential contamination, then solely for purposes of table 6–18, count the portion in the distance category subject to potential contamination under the potential contamination factor in section 6.3.4.2. Determine the total acreage of wetlands within those distance categories subject to actual contamination and assign a value from table 6–18 based on this total acreage.

Calculate the actual contamination factor value (EA) as follows:

$$EA = WA + \sum_{i=1}^{n} S_i$$

where:

WA=Value assigned from table 6–18 for wetlands in distance categories subject to actual contamination.

S_i=Value(s) assigned from table 4–23 to sensitive environment i.

n=Number of sensitive environments subject to actual contamination.

Enter the value assigned in table 6–1.

TABLE 6–18—WETLANDS RATING VALUES FOR AIR MIGRATION PATHWAY [A]

Wetland area (acres)	Assigned value
Less than 1	0
1 to 50	25
Greater than 50 to 100	75
Greater than 100 to 150	125
Greater than 150 to 200	175
Greater than 200 to 300	250
Greater than 300 to 400	350
Greater than 400 to 500	450
Greater than 500	500

[a] Wetlands as defined in 40 CFR section 230.3.

6.3.4.2 *Potential contamination.* Determine those sensitive environments located, partially or wholly, within the target distance limit that are subject to potential contamination. Assign value(s) from table 4–23 to each sensitive environment subject to potential contamination. Do not include those sensitive environments already counted for table 4–23 under the actual contamination factor.

For each distance category subject to potential contamination, sum the value(s) assigned from table 4–23 to the sensitive environments in that distance category. If a sensitive environment is located in more than one distance category, assign the sensitive

environment only to that distance category having the highest distance weighting value from table 6–15.

For those sensitive environments that are wetlands, assign an additional value from table 6–18. In assigning a value from table 6–18, include only those portions of wetlands located within distance categories subject to potential contamination, as specified in section 6.3.4.1. Treat the wetlands in each separate distance category as separate sensitive environments solely for purposes of applying table 6–18. Determine the total acreage of wetlands within each of these distance categories and assign a separate value from table 6–18 for each distance category.

Calculate the potential contamination factor value (EP) as follows:

$$EP = \frac{1}{10}\sum_{j=1}^{m}\left(\left[W_j + S_j\right]D_j\right)$$

$$S_j = \sum_{i=1}^{n} S_{ij}$$

S_{ij}=Value(s) assigned from table 4–23 to sensitive environment in distance category j.

n=Number of sensitive environments subject to potential contamination.

W_j=Value assigned from table 6–18 for wetland area in distance category j.

D_j=Distance weight from table 6–15 for distance category j.

m=Number of distance categories subject to potential contamination.

If EP is less than 1, do not round it to the nearest integer; if EP is 1 or more, round to the nearest integer. Enter the value assigned in table 6–1.

6.3.4.3 *Calculation of sensitive environments factor value.* Sum the factor values for actual contamination and potential contamination. Do not round this sum, designated as EB, to the nearest integer.

Because the pathway score based solely on sensitive environments is limited to a maximum of 60, use the value EB to determine the value for the sensitive environments factor as follows:

• Multiply the values assigned to likelihood of release (LR), waste characteristics (WC), and EB. Divide the product by 82,500.

–If the result is 60 or less, assign the value EB as the sensitive environments factor value.

–If the result exceeds 60, calculate a value EC as follows:

$$EC = \frac{(60)(82{,}500)}{(LR)(WC)}$$

Assign the value EC as the sensitive environments factor value. Do not round this value to the nearest integer.

Enter the value assigned for the sensitive environments factor in table 6–1.

6.3.5 *Calculation of targets factor category value.* Sum the nearest individual, population, resources, and sensitive environments factor values. Do not round this sum to the nearest integer. Assign this sum as the targets factor category value. Enter this value in table 6–1.

6.4 *Calculation of air migration pathway score.* Multiply the values for likelihood of release, waste characteristics, and targets, and round the product to the nearest integer. Then divide by 82,500. Assign the resulting value, subject to a maximum value of 100, as the air migration pathway score (S_a). Enter this score in table 6–1.

7.0 Sites Containing Radioactive Substances.

In general, radioactive substances are hazardous substances under CERCLA and should be considered in HRS scoring. Releases of certain radioactive substances are, however, excluded from the definition of ''release'' in section 101(22) of CERCLA, as amended, and should not be considered in HRS scoring.

Evaluate sites containing radioactive substances using the instructions specified in sections 2 through 6, supplemented by the instructions in this section. Those factors denoted with a ''yes'' in table 7–1 are evaluated differently for sites containing radioactive substances than for sites containing only nonradioactive hazardous substances, while those denoted with a ''no'' are not evaluated differently and are not addressed in this section.

TABLE 7–1—HRS FACTORS EVALUATED DIFFERENTLY FOR RADIONUCLIDES

Ground water pathway	Status [a]	Surface water pathway	Status [a]	Soil exposure pathway	Status [a]	Air pathway	Status [a]
Likelihood of Release		**Likelihood of Release**		**Likelihood of Exposure**		**Likelihood of Release.**	
Observed Release	Yes	Observed Release	Yes	Observed Contamination	Yes	Observed Release	Yes
Potential to Release	No	Potential to Release	No	Attractiveness/Accessibility to Nearby Residents	No	Gas Potential to Release	No
Containment	No	Overland Flow Containment	No			Gas Containment	No
Net Precipitation	No	Runoff	No	Area of Contamination	No	Gas Source Type	No
Depth to Aquifer	No	Distance to Surface Water	No			Gas Migration Potential	No
Travel Time	No	Flood Frequency	No			Particulate Potential to Release.	No
		Flood Containment	No			Particulate Containment	No
						Particulate Source Type	No
						Particulate Migration Potential	No
Waste Characteristics		**Waste Characteristics**		**Waste Characteristics**		**Waste Characteristics.**	
Toxicity	Yes	Toxicity/Ecotoxicity	Yes/Yes.	Toxicity	Yes	Toxicity	Yes
Mobility	No	Persistence/Mobility	Yes/No	Hazardous Waste Quantity	Yes	Mobility	No
Hazardous Waste Quantity	Yes	Bioaccumulation Potential	No			Hazardous Waste Quantity	Yes
		Hazardous Waste Quantity	Yes.				
Targets		**Targets**		**Targets**		**Targets.**	
Nearest Well	Yes [b]	Nearest Intake	Yes [b]	Resident Individual	Yes [b]	Nearest Individual	Yes [b]
Population	Yes [b]	Drinking Water Population	Yes [b]	Resident Population	Yes [b]	Population	Yes [b]
Resources	No	Resources	No	Workers	No	Resources	No
Wellhead Protection Area	No	Sensitive Environments	Yes [b]	Resources	No	Sensitive Environments	No
		Human Food Chain Individual	Yes [b]	Terrestrial Sensitive Environments	No		
		Human Food Chain Population	Yes [b]				
				Nearby Individual	No.		
				Population Within 1 Mile	No.		

[a] Factors evaluated differently are denoted by "yes"; factors not evaluated differently are denoted by "no."
[b] Difference is in the determination of Level I and Level II concentrations.

In general, sites containing mixed radioactive and other hazardous substances involve more evaluation than sites containing only radionuclides. For sites containing mixed radioactive and other hazardous substances, HRS factors are evaluated based on considerations of both the radioactive substances and the other hazardous substances in order to derive a single set of factor values for each factor category in each of the four pathways. Thus, the HRS score for these sites reflects the combined potential hazards posed by both the radioactive and other hazardous substances.

Section 7 is organized by factor category, similar to sections 3 through 6. Pathway-specific differences in evaluation criteria are specified under each factor category, as appropriate. These differences apply largely to the soil exposure pathway and to sites containing mixed radioactive and other hazardous substances. All evaluation criteria specified in sections 2 through 6 must be met, except where modified in section 7.

7.1 *Likelihood of release/likelihood of exposure.* Evaluate likelihood of release for the three migration pathways and likelihood of exposure for the soil exposure pathway as specified in sections 2 through 6, except: establish an observed release and observed contamination as specified in section 7.1.1. When an observed release cannot be established for a migration pathway, evaluate potential to release as specified in section 7.1.2. When observed contamination cannot be established, do not evaluate the soil exposure pathway.

7.1.1 *Observed release/observed contamination.* For radioactive substances, establish an observed release for each migration pathway by demonstrating that the site has released a radioactive substance to the pathway (or watershed or aquifer, as appropriate); establish observed contamination for the soil exposure pathway as indicated below. Base these demonstrations on one or more of the following, as appropriate to the pathway being evaluated:

• Direct observation:

–For each migration pathway, a material that contains one or more radionuclides has been seen entering the atmosphere, surface water, or ground water, as appropriate, or is known to have entered ground water or surface water through direct deposition, or

–For the surface water migration pathway, a source area containing radioactive substances has been flooded at a time that radioactive substances were present and one or more radioactive substances were in contact with the flood waters.

• Analysis of radionuclide concentrations in samples appropriate to the pathway (that is, ground water, soil, air, surface water, benthic, or sediment samples):

–For radionuclides that occur naturally and for radionuclides that are ubiquitous in the environment:

–Measured concentration (in units of activity, for example, pCi per kilogram [pCi/kg], pCi per liter [pCi/l], pCi per cubic meter [pCi/m^3]) of a given radionuclide in the sample are at a level that:

–Equals or exceeds a value 2 standard deviations above the mean site-specific background concentration for that radionuclide in that type of sample, or

–Exceeds the upper-limit value of the range of regional background concentration values for that specific radionuclide in that type of sample.

–Some portion of the increase must be attributable to the site to establish the observed release (or observed contamination), and

–For the soil exposure pathway only, the radionuclide must also be present at the surface or covered by 2 feet or less of cover material (for example, soil) to establish observed contamination.

–For man-made radionuclides without ubiquitous background concentrations in the environment:

–Measured concentration (in units of activity) of a given radionuclide in a sample equals or exceeds the sample quantitation limit for that specific radionuclide in that type of media and is attributable to the site.

–However, if the radionuclide concentration equals or exceeds its sample quantitation limit, but its release can also be attributed to one or more neighboring sites, then the measured concentration of that radionuclide must also equal or exceed a value either 2 standard deviations above the mean concentration of that radionuclide contributed by those neighboring sites or 3 times its background concentration, whichever is lower.

–If the sample quantitation limit cannot be established:

–If the sample analysis was performed under the EPA Contract Laboratory Program, use the EPA contract-required quantitation limit (CRQL) in place of the sample quantitation limit in establishing an observed release (or observed contamination).

–If the sample analysis is not performed under the EPA Contract Labatory Program, use the detection limit in place of the sample quantitation limit.

–For the soil exposure pathway only, the radionuclide must also be present at the surface or covered by 2 feet or less of cover material (for example, soil) to establish observed contamination.

• Gamma radiation measurements (applies only to observed contamination for the soil exposure pathway):

–The gamma radiation exposure rate, as measured in microroentgens per hour (μR/hr) using a survey instrument held 1 meter above the ground surface (or 1 meter away from an aboveground source), equals or exceeds 2 times the site-specific background gamma radiation exposure rate.

–Some portion of the increase must be attributable to the site to establish observed contamination. The gamma-emitting radionuclides do not have to be within 2 feet of the surface of the source.

For the three migration pathways, if an observed release can be established for the pathway (or aquifer or watershed, as appropriate), assign the pathway (or aquifer or watershed) an observed release factor value of 550 and proceed to section 7.2. If an observed release cannot be established, assign an observed release factor value of 0 and proceed to section 7.1.2.

For the soil exposure pathway, if observed contamination can be established, assign the likelihood of exposure factor for resident population a value of 550 if there is an area of observed contamination in one or more locations listed in section 5.1; evaluate the likelihood of exposure factor for nearby population as specified in section 5.2.1; and proceed to section 7.2. If observed contamination cannot be established, do not evaluate the soil exposure pathway.

At sites containing mixed radioactive and other hazardous substances, evaluate observed release (or observed contamination) separately for radionuclides as described in this section and for other hazardous substances as described in sections 2 through 6.

For the three migration pathways, if an observed release can be established based on either radionuclides or other hazardous substances, or both, assign the pathway (or aquifer or watershed) an observed release factor value of 550 and proceed to section 7.2. If an observed release cannot be established based on either radionuclides or other hazardous substances, assign an observed release factor value of 0 and proceed to section 7.1.2.

For the soil exposure pathway, if observed contamination can be established based on either radionuclides or other hazardous substances, or both, assign the likelihood of exposure factor for resident population a value of 550 if there is an area of observed contamination in one or more locations listed in section 5.1; evaluate the likelihood of exposure factor for nearby population as specified in section 5.2.1; and proceed to section 7.2. If observed contamination cannot be established based on either radionuclides or other hazardous substances, do not evaluate the soil exposure pathway.

7.1.2 *Potential to release.* For the three migration pathways, evaluate potential to release for sites containing radionuclides in the same manner as specified for sites containing other hazardous substances. Base the evaluation on the physical and chemical properties of the radionuclides, not on their level of radioactivity.

For sites containing mixed radioactive and other hazardous substances, evaluate potential to release considering radionuclides and other hazardous substances together. Evaluate potential to release for each migration pathway as specified in sections 3, 4, or 6, as appropriate.

7.2 *Waste characteristics.* For radioactive substances, evaluate the human toxicity factor, the ecosystem toxicity factor, the surface water persistence factor, and the hazardous waste quantity factor as specified in the following sections. Evaluate all other waste characteristic factors as specified in sections 2 through 6.

7.2.1 *Human toxicity.* For radioactive substances, evaluate the human toxicity factor as specified below, not as specified in section 2.4.1.1.

Assign human toxicity factor values to those radionuclides available to the pathway based on quantitative dose-response parameters for cancer risks as follows:

• Evaluate radionuclides only on the basis of carcinogenicity and assign all radionuclides to weight-of-evidence category A.

• Assign a human toxicity factor value from table 7–2 to each radionuclide based on its slope factor (also referred to as cancer potency factor).

–For each radionuclide, use the higher of the slope factors for inhalation and ingestion to assign the factor value.

–If only one slope factor is available for the radionuclide, use it to assign the toxicity factor value.

–If no slope factor is available for the radionuclide, assign that radionuclide a toxicity factor value of 0 and use other radionuclides for which a slope factor is available to evaluate the pathway.

• If all radionuclides available to a particular pathway are assigned a human toxicity factor value of 0 (that is, no slope factor is available for all the radionuclides), use a default human toxicity factor value of 1,000 as the human toxicity factor value for all radionuclides available to the pathway.

At sites containing mixed radioactive and other hazardous substances, evaluate the toxicity factor separately for the radioactive and other hazardous substances and assign each a separate toxicity factor value. This applies regardless of whether the radioactive and other hazardous substances are physically separated, combined chemically, or simply mixed together. Assign toxicity factor values to the radionuclides as specified above and to the other hazardous substances as specified in section 2.4.1.1.

At sites containing mixed radioactive and other hazardous substances, if all radionuclides available to a particular pathway

are assigned a human toxicity factor value of 0, use a default human toxicity factor value of 1,000 for all those radionuclides even if nonradioactive hazardous substances available to the pathway are assigned human toxicity factor values greater than 0. Similarly, if all nonradioactive hazardous substances available to the pathway are assigned a human toxicity factor value of 0, use a default human toxicity factor value of 100 for all these nonradioactive hazardous substances even if radionuclides available to the pathway are assigned human toxicity factor values greater than 0.

7.2.2 Ecosystem toxicity. For the surface water environmental threat (see sections 4.1.4 and 4.2.4). assign an ecosystem toxicity factor value to radionuclides (alone or combined chemically or mixed with other hazardous substances) using the same slope factors and procedures specified for the human toxicity factor in section 7.2.1, except: use a default of 100, not 1,000, if all radionuclides eligible to be evaluated for ecosystem toxicity receive an ecosystem toxicity factor value of 0.

TABLE 7–2—TOXICITY FACTOR VALUES FOR RADIONUCLIDES

Cancer slope factor[a] (SF) $(pCi)^{-1}$	Assigned value
$3\times10^{-11} \leq SF$	10,000
$3\times10^{-12} \leq SF < 3\times10^{-11}$	1,000
$SF < 3\times10^{-12}$	100
SF not available for the radionuclide	0

[a] Radionuclide slope factors are estimates of age-averaged, individual lifetime total excess cancer risk per picocurie of radionuclide inhaled or ingested.

At sites containing mixed radioactive and other hazardous substances, evaluate the ecosystem toxicity factor separately for the radioactive and other hazardous substances and assign each a separate ecosystem toxicity factor value. This applies regardless of whether the radioactive and other hazardous substances are physically separated, combined chemically, or simply mixed together. Assign ecosystem toxicity factor values to the radionuclides as specified above and to the other hazardous substances as specified in sections 4.1.4.2.1.1 and 4.2.4.2.1.1. If all radionuclides available to a particular pathway are assigned an ecosystem toxicity factor value of 0, use a default ecosystem toxicity factor value of 100 for all these radionuclides even if nonradioactive hazardous substances available to the pathway are assigned ecosystem toxicity factor values greater than 0. Similarly, if all nonradioactive hazardous substances available to the pathway are assigned an ecosystem toxicity factor value of 0, use a default ecosystem toxicity factor value of 100 for all these nonradioactive hazardous substances even if radionuclides available to the pathway are assigned ecosystem toxicity factor values greater than 0.

7.2.3 *Persistence.* For radionuclides, evaluate the surface water persistence factor based solely on half-life; do not include sorption to sediments in the evaluation as is done for nonradioactive hazardous substances. Assign a persistence factor value from table 4–10 (section 4.1.2.2.1.2) to each radionuclide based on half-life ($t_{1/2}$) calculated as follows:

$$t_{1/2} = \frac{1}{1/r + 1/v}$$

where:

r=Radioactive half-life.

v=Volatilization half-life.

If the volatilization half-life cannot be estimated for a radionuclide from available data, delete it from the equation. Select the portion of table 4–10 to use in assigning the persistence factor value as specified in section 4.1.2.2.1.2.

At sites containing mixed radioactive and other hazardous substances, evaluate the persistence factor separately for each radionuclide and for each nonradioactive hazardous substance, even if the available data indicate that they are combined chemically. Assign a persistence factor value to each radionuclide as specified in this section and to each nonradioactive hazardous substance as specified in section 4.1.2.2.1.2. When combined chemically, assign a single persistence factor value based on the higher of the two values assigned (individually) to the radioactive and nonradioactive components.

7.2.4 *Selection of substance potentially posing greatest hazard.* For each migration pathway (threat, aquifer, or watershed, as appropriate), select the radioactive substance or nonradioactive hazardous substance that potentially poses the greatest hazard based on its toxicity factor value, combined with the applicable mobility, persistence, and/or bioaccumulation (or ecosystem bioaccumulation) potential factor values. Combine these factor values as specified in sections 2, 3, 4, and 6. For the soil exposure pathway, base the selection on the toxicity factor alone (see sections 2 and 5).

7.2.5 *Hazardous waste quantity.* To calculate the hazardous waste quantity factor value for sites containing radioactive substances, evaluate source hazardous waste quantity (see section 2.4.2.1) using only the following two measures in the following hierarchy (these measures are consistent with Tiers A and B for nonradioactive hazardous substances in sections 2.4.2.1.1 and 2.4.2.1.2):

- Radionuclide constituent quantity (Tier A).
- Radionuclide wastestream quantity (Tier B).

7.2.5.1 *Source hazardous waste quantity for radionuclides.* For each migration pathway, assign a source hazardous waste quantity value to each source having a containment factor value greater than 0 for the pathway being evaluated. For the soil exposure pathway, assign a source hazardous waste quantity value to each area of observed contamination, as applicable to the threat being evaluated. Allocate hazardous substances and hazardous wastestreams to specific sources (or areas of observed contamination) as specified in section 2.4.2.

7.2.5.1.1 *Radionuclide constituent quantity (Tier A).* Evaluate radionuclide constituent quantity for each source (or area of observed contamination) based on the activity content of the radionuclides allocated to the source (or area of observed contamination) as follows:

• Estimate the net activity content (in curies) for the source (or area of observed contamination) based on:

–Manifests, or

–Either of the following equations, as applicable:

$$N = 9.1 \times 10^{-7} (V) \sum_{i=1}^{n} AC_i$$

where:

N=Estimated net activity content (in curies) for the source (or area of observed contamination).

V=Total volume of material (in cubic yards) in a source (or area of observed contamination) containing radionuclides.

AC_i=Activity concentration above the respective background concentration (in pCi/g) for each radionuclide i allocated to the source (or area of observed contamination).

n=Number of radionuclides allocated to the source (or area of observed contamination) above the respective background concentrations.

or,

$$N = 3.8 \times 10^{-12} (V) \sum_{i=1}^{n} AC_i$$

where:

N=Estimated net activity content (in curies) for the source (or area of observed contamination).

V=Total volume of material (in gallons) in a source (or area of observed contamination) containing radionuclides.

AC_i=Activity concentration above the respective background concentration (in pCi/1) for each radionuclide i allocated to the source (or area of observed contamination).

n=Number of radionuclides allocated to the source (or area of observed contamination) above the respective background concentrations.

–Estimate volume for the source (or volume for the area of observed contamination) based on records or measurements.

–For the soil exposure pathway, in estimating the volume for areas of observed contamination, do not include more than the first 2 feet of depth, except: for those types of areas of observed contamination listed in Tier C of table 5–2 (section 5.1.2.2). Include the entire depth, not just that within 2 feet of the surface.

• Convert from curies of radionuclides to equivalent pounds of nonradioactive hazardous substances by multiplying the activity estimate for the source (or area of observed contamination) by 1,000.

• Assign this resulting product as the radionuclide constituent quantity value for the source (or area of observed contamination).

If the radionuclide constituent quantity for the source (or area of observed contamination) is adequately determined (that is, the total activity of all radionuclides in the source and releases from the source [or in the area of observed contamination] is known or is estimated with reasonable confidence), do not evaluate the radionuclide wastestream quantity measure in section 7.2.5.1.2. Instead, assign radionuclide wastestream quantity a value of 0 and proceed to section 7.2.5.1.3. If the radionuclide constituent quantity is not adequately determined, assign the source (or area of observed contamination) a value for radionuclide constituent quantity based on the available data and proceed to section 7.2.5.1.2.

7.2.5.1.2 *Radionuclide wastestream quantity (Tier B).* Evaluate radionuclide wastestream quantity for the source (or area of observed contamination) based on the activity content of radionuclide wastestreams allocated to the source (or area of observed contamination) as follows:

• Estimate the total volume (in cubic yards or in gallons) of wastestreams containing radionuclides allocated to the source (or area of observed contamination).

• Divide the volume in cubic yards by 0.55 (or the volume in gallons by 110) to convert to the activity content expressed in terms of equivalent pounds of nonradioactive hazardous substances.

• Assign the resulting value as the radionuclide wastestream quantity value for the source (or area of observed contamination).

7.2.5.1.3 *Calculation of source hazardous waste quantity value for radionuclides.* Select the higher of the values assigned to the source (or area of observed contamination) for radionuclide constituent quantity and radionuclide wastestream quantity. Assign this value as the source hazardous waste quantity value for the source (or area of observed contamination). Do not round to the nearest integer.

7.2.5.2 *Calculation of hazardous waste quantity factor value for radionuclides.* Sum the source hazardous waste quantity values assigned to all sources (or areas of observed contamination) for the pathway being evaluated and round this sum to the nearest integer, except: if the sum is greater than 0, but less than 1, round it to 1. Based on this value, select a hazardous waste quantity factor value for this pathway from table 2–6 (section 2.4.2.2).

For a migration pathway, if the radionuclide constituent quantity is adequately determined (see section 7.2.5.1.1) for all sources (or all portions of sources and releases remaining after a removal action), assign the value from table 2–6 as the hazardous waste quantity factor value for the pathway. If the radionuclide constituent quantity is not adequately determined for one or more sources (or one or more portions of sources or releases remaining after a removal action), assign a factor value as follows:

• If any target for that migration pathway is subject to Level I or Level II concentrations (see section 7.3), assign either the value from table 2–6 or a value of 100, whichever is greater, as the hazardous waste quantity factor value for that pathway.

• If none of the targets for that pathway is subject to Level I or Level II concentrations, assign a factor value as follows:

–If there has been no removal action, assign either the value from table 2–6 or a value of 10, whichever is greater, as the hazardous waste quantity factor value for that pathway.

–If there has been a removal action:

–Determine values from table 2–6 with and without consideration of the removal action.

–If the value that would be assigned from table 2–6 without consideration of the removal action would be 100 or greater, assign either the value from table 2–6 with consideration of the removal action or a value of 100, whichever is greater, as the hazardous waste quantity factor value for the pathway.

–If the value that would be assigned from table 2–6 without consideration of the removal action would be less than 100, assign a value of 10 as the hazardous waste quantity factor value for the pathway.

For the soil exposure pathway, if the radionuclide constituent quantity is adequately determined for all areas of observed contamination, assign the value from table 2–6 as the hazardous waste quantity factor value. If the radionuclide constituent quantity is not adequately determined for one or more areas of observed contamination, assign either the value from table 2–6 or a value of 10, whichever is greater, as the hazardous waste quantity factor value.

7.2.5.3 *Calculation of hazardous waste quantity factor value for sites containing mixed radioactive and other hazardous substances.* For each source (or area of observed contamination) containing mixed radioactive and other hazardous substances, calculate two source hazardous waste quantity values—one based on radionuclides as specified in sections 7.2.5.1 through 7.2.5.1.3 and the other based on the nonradioactive hazardous substances as specified in sections 2.4.2.1 through 2.4.2.1.5 (that is, determine each value as if the other type of substance was not present). Sum the two values to determine a combined source hazardous waste quantity value for the source (or area of observed contamination). Do not round this value to the nearest integer.

Use this combined source hazardous waste quantity value to calculate the hazardous waste quantity factor value for the pathway as specified in section 2.4.2.2, except: if either the hazardous constituent quantity or the radionuclide constituent quantity, or both, are not adequately determined for one or more sources (or one or more portions of sources or releases remaining after a removal action) or for one or more areas of observed contamination, as applicable, assign the value from table 2–6 or the default value applicable for the pathway, whichever is greater, as the hazardous waste quantity factor value for the pathway.

7.3 *Targets.* For radioactive substances, evaluate the targets factor category as specified in section 2.5 and sections 3 through 6, except: establish Level I and Level II concentrations at sampling locations as specified in sections 7.3.1 and 7.3.2.

For all pathways (and threats), use the same target distance limits for sites containing radioactive substances as is specified in sections 3 through 6 for sites containing nonradioactive hazardous substances. At sites containing mixed radioactive and other hazardous substances, include all sources (or areas of observed contamination) at the site in identifying the applicable targets for the pathway.

7.3.1 *Level of contamination at a sampling location.* Determine whether Level I or Level II concentrations apply at a sampling location (and thus to the associated targets) as follows:

• Select the benchmarks from section 7.3.2 applicable to the pathway (or threat) being evaluated.

• Compare the concentrations of radionuclides in the sample (or comparable samples) to their benchmark concentrations for the pathway (or threat) as specified in section 7.3.2. Treat comparable samples as specified in section 2.5.1.

• Determine which level applies based on this comparison.

• If none of the radionuclides eligible to be evaluated for the sampling location have an

applicable benchmark, assign Level II to the actual contamination at that sampling location for the pathway (or threat).

• In making the comparison, consider only those samples, and only those radionuclides in the sample, that meet the criteria for an observed release (or observed contamination) for the pathway, except: tissue samples from aquatic human food chain organisms may also be used for the human food chain threat of the surface water pathway as specified in sections 4.1.3.3 and 4.2.3.3.

7.3.2 *Comparison to benchmarks.* Use the following media specific benchmarks (expressed in activity units, for example, pCi/l for water, pCi/kg for soil and for aquatic human food chain organisms, and pCi/m^3 for air) for making the comparisons for the indicated pathway (or threat):

• Maximum Contaminant Levels (MCLs)—ground water migration pathway and drinking water threat in surface water migration pathway.

• Uranium Mill Tailings Radiation Control Act (UMTRCA) standards—soil exposure pathway only.

• Screening concentration for cancer corresponding to that concentration that corresponds to the 10^{-6} individual cancer risk for inhalation exposures (air migration pathway) or for oral exposures (ground water migration pathway; drinking water or human food chain threats in surface water migration pathway; and soil exposure pathway).

–For the soil exposure pathway, include two screening concentrations for cancer—one for ingestion of surface materials and one for external radiation exposures from gamma-emitting radionuclides in surface materials.

Select the benchmark(s) applicable to the pathway (or threat) being evaluated. Compare the concentration of each radionuclide from the sampling location to its benchmark concentration(s) for that pathway (or threat). Use only those samples and only those radionuclides in the sample that meet the criteria for an observed release (or observed contamination) for the pathway, except: tissue samples from aquatic human food chain organisms may be used as specified in sections 4.1.3.3 and 4.2.3.3. If the concentration of any applicable radionuclide from any sample equals or exceeds its benchmark concentration, consider the sampling location to be subject to Level I concentrations for that pathway (or threat). If more than one benchmark applies to the radionuclide, assign Level I if the radionuclide concentration equals or exceeds the lowest applicable benchmark concentration. In addition, for the soil exposure pathway, assign Level I concentrations at the sampling location if measured gamma radiation exposure rates equal or exceed 2 times the background level (see section 7.1.1).

If no radionuclide individually equals or exceeds its benchmark concentration, but more than one radionuclide either meets the criteria for an observed release (or observed contamination) for the sample or is eligible to be evaluated for a tissue sample (see sections 4.1.3.3 and 4.2.3.3), calculate a value for index I for these radionuclides as specified in section 2.5.2. If I equals or exceeds 1, assign Level I to the sampling location. If I is less than 1, assign Level II.

At sites containing mixed radioactive and other hazardous substances, establish the level of contamination for each sampling location considering radioactive substances and nonradioactive hazardous substances separately. Compare the concentration of each radionuclide and each nonradioactive hazardous substance from the sampling location to its respective benchmark concentration(s). Use only those samples and only those substances in the sample that meet the criteria for an observed release (or observed contamination) for the pathway except: tissue samples from aquatic human food chain organisms may be used as specified in sections 4.1.3.3 and 4.2.3.3. If the concentration of one or more applicable radionuclides or other hazardous substances from any sample equals or exceeds its benchmark concentration, consider the sampling location to be subject to Level I concentrations. If more than one benchmark applies to a radionuclide or other hazardous substance, assign Level I if the concentration of the radionuclide or other hazardous substance equals or exceeds its lowest applicable benchmark concentration.

If no radionuclide or other hazardous substance individually exceed a benchmark concentration, but more than one radionuclide or other hazardous substance either meets the criteria for an observed release (or observed contamination) for the sample or is eligible to be evaluated for a tissue sample, calculate an index I for both types of substances as specified in section 2.5.2. Sum the index I values for the two types of substances. If the value, individually or combined, equals or exceeds 1, assign Level I to the sample location. If it is less than 1, calculate an index J for the nonradioactive hazardous substances as specified in section 2.5.2. If J equals or exceeds 1, assign Level I to the sampling location. If J is less than 1, assign Level II.

[55 FR 51583, Dec. 14, 1990]

APPENDIX B TO PART 300—NATIONAL PRIORITIES LIST

TABLE 1—GENERAL SUPERFUND SECTION

State	Site name	City/County	Notes(a)
AL	American Brass	Headland.	
AL	Ciba-Geigy Corp. (McIntosh Plant)	McIntosh.	
AL	Interstate Lead Co. (ILCO)	Leeds.	
AL	Olin Corp. (McIntosh Plant)	McIntosh.	
AL	Perdido Ground Water Contamination	Perdido	C
AL	Redwing Carriers, Inc. (Saraland)	Saraland.	
AL	Stauffer Chemical Co. (Cold Creek Plant)	Bucks.	
AL	Stauffer Chemical Co. (LeMoyne Plant)	Axis.	
AL	T.H. Agriculture & Nutrition (Montgomery)	Montgomery.	
AL	Triana/Tennessee River	Limestone/Morgan	C
AR	Arkwood, Inc	Omaha	C
AR	Industrial Waste Control	Fort Smith	C
AR	Mid-South Wood Products	Mena	C
AR	Midland Products	Ola/Birta	C
AR	Monroe Auto Equipment (Paragould Pit)	Paragould.	
AR	Mountain Pine Pressure Treating, Inc	Plainview.	
AR	Ouachita Nevada Wood Treater	Reader..	
AR	Popile, Inc	El Dorado.	
AR	Rogers Road Municipal Landfill	Jacksonville	C
AR	Vertac, Inc.	Jacksonville.	
AZ	Apache Powder Co.	St. David.	
AZ	Hassayampa Landfill	Hassayampa.	
AZ	Indian Bend Wash Area	Scottsdale/Tempe/Phoenix	P
AZ	Litchfield Airport Area	Goodyear/Avondale.	
AZ	Motorola, Inc. (52nd Street Plant)	Phoenix.	
AZ	Tucson International Airport Area	Tucson.	
CA	Advanced Micro Devices, Inc	Sunnyvale	C
CA	Advanced Micro Devices, Inc. (Bldg. 915)	Sunnyvale	C
CA	Aerojet General Corp	Rancho Cordova.	
CA	Alark Hard Chrome	Riverside.	
CA	AMCO Chemical	Oakland.	
CA	Applied Materials	Santa Clara	C
CA	Atlas Asbestos Mine	Fresno County.	
CA	Beckman Instruments (Porterville Plant)	Porterville	C
CA	Brown & Bryant, Inc (Arvin Plant)	Arvin.	
CA	CTS Printex, Inc.	Mountain View	C
CA	Casmalia Resources	Casmalia.	
CA	Coast Wood Preserving	Ukiah.	
CA	Cooper Drum Company	South Gate..	
CA	Crazy Horse Sanitary Landfill	Salinas.	
CA	Del Amo	Los Angeles.	
CA	Fairchild Semiconductor Corp. (Mt View)	Mountain View.	
CA	Fairchild Semiconductor Corp. (S San Jose)	South San Jose	C
CA	Fresno Municipal Sanitary Landfill	Fresno.	
CA	Frontier Fertilizer	Davis.	
CA	Hewlett-Packard (620–640 Page Mill Road)	Palo Alto.	
CA	Industrial Waste Processing	Fresno.	
CA	Intel Corp. (Mountain View Plant)	Mountain View.	
CA	Intel Corp. (Santa Clara III)	Santa Clara	C
CA	Intel Magnetics	Santa Clara	C
CA	Intersil Inc./Siemens Components	Cupertino	C
CA	Iron Mountain Mine	Redding.	
CA	J.H. Baxter & Co	Weed.	
CA	Jasco Chemical Corp	Mountain View.	
CA	Klau/Buena Vista Mine	San Luis Obispo County.	
CA	Koppers Co., Inc. (Oroville Plant)	Oroville.	
CA	Lava Cap Mine	Nevada City.	
CA	Leviathan Mine	Alpine County..	
CA	Lorentz Barrel & Drum Co	San Jose.	
CA	MGM Brakes	Cloverdale	C
CA	McColl	Fullerton.	
CA	McCormick & Baxter Creosoting Co	Stockton.	
CA	Modesto Ground Water Contamination	Modesto.	
CA	Monolithic Memories	Sunnyvale	C
CA	Montrose Chemical Corp	Torrance.	
CA	National Semiconductor Corp	Santa Clara.	
CA	Newmark Ground Water Contamination	San Bernardino.	
CA	Omega Chemical Corporation	Whittier.	
CA	Operating Industries, Inc., Landfill	Monterey Park.	
CA	Pacific Coast Pipe Lines	Fillmore	C

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
CA	Pemaco Maywood	Maywood.	
CA	Purity Oil Sales, Inc	Malaga.	
CA	Raytheon Corp	Mountain View.	
CA	San Fernando Valley (Area 1)	Los Angeles.	
CA	San Fernando Valley (Area 2)	Los Angeles/Glendale.	
CA	San Fernando Valley (Area 3)	Glendale.	
CA	San Fernando Valley (Area 4)	Los Angeles.	
CA	San Gabriel Valley (Area 1)	El Monte.	
CA	San Gabriel Valley (Area 2)	Baldwin Park Area.	
CA	San Gabriel Valley (Area 3)	Alhambra.	
CA	San Gabriel Valley (Area 4)	La Puente.	
CA	Selma Treating Co	Selma.	
CA	Sola Optical USA, Inc	Petaluma	C
CA	South Bay Asbestos Area	Alviso.	
CA	Southern California Edison Co. (Visalia)	Visalia.	
CA	Spectra-Physics, Inc	Mountain View	C
CA	Stringfellow	Glen Avon Heights	S
CA	Sulphur Bank Mercury Mine	Clear Lake.	
CA	Synertek, Inc. (Building 1)	Santa Clara	C
CA	TRW Microwave, Inc (Building 825)	Sunnyvale	C
CA	Teledyne Semiconductor	Mountain View	C
CA	United Heckathorn Co	Richmond.	
CA	Valley Wood Preserving, Inc	Turlock.	
CA	Waste Disposal, Inc	Santa Fe Springs.	
CA	Watkins-Johnson Co. (Stewart Division)	Scotts Valley	C
CA	Westinghouse Elecetric Corp. (Sunnyvale)	Sunnyvale.	
CO	Broderick Wood Products	Denver	C
CO	California Gulch	Leadville	P
CO	Captain Jack Mill	Ward.	
CO	Central City-Clear Creek	Idaho Springs.	
CO	Chemical Sales Co	Denver.	
CO	Denver Radium Site	Denver.	
CO	Eagle Mine	Minturn/Redcliff.	
CO	Lincoln Park	Canon City.	
CO	Lowry Landfill	Arapahoe County.	
CO	Marshall Landfill	Boulder County	C,S
CO	Standard Mine	Gunnison National Forest.	
CO	Summitville Mine	Rio Grande County.	
CO	Uravan Uranium Project (Union Carbide)	Uravan	P
CO	Vasquez Boulevard and I–70	Denver.	
CT	Barkhamsted-New Hartford Landfill	Barkhamsted.	
CT	Beacon Heights Landfill	Beacon Falls.	
CT	Durham Meadows	Durham.	
CT	Gallup's Quarry	Plainfield.	
CT	Kellogg-Deering Well Field	Norwalk	C
CT	Laurel Park, Inc	Naugatuck Borough	S
CT	Linemaster Switch Corp	Woodstock.	
CT	Old Southington Landfill	Southington.	
CT	Precision Plating Corp	Vernon.	
CT	Raymark Industries, Inc	Stratford	A
CT	Scovill Industrial Landfill	Waterbury.	
CT	Solvents Recovery Service New England	Southington.	
CT	Yaworski Waste Lagoon	Canterbury.	
DE	Army Creek Landfill	New Castle County	C
DE	Chem-Solv, Inc	Cheswold.	
DE	Coker's Sanitation Service Landfills	Kent County	C
DE	Delaware City PVC Plant	Delaware City.	
DE	Delaware Sand & Gravel Landfill	New Castle County.	
DE	Dover Gas Light Co	Dover.	
DE	E.I.Du Pont de Nemours (Newport Landfill)	Newport.	
DE	Halby Chemical Co	New Castle.	
DE	Harvey & Knott Drum, Inc	Kirkwood	C
DE	Koppers Co., Inc. (Newport Plant)	Newport.	
DE	NCR Corp. (Millsboro Plant)	Millsboro	C
DE	Standard Chlorine of Delaware, Inc	Delaware City.	
DE	Tybouts Corner Landfill	New Castle County	C,S
FL	Agrico Chemical Co	Pensacola.	
FL	Airco Plating Co	Miami.	
FL	Alaric Area Ground Water Plume	Tampa.	
FL	American Creosote Works (Pensacola Plt)	Pensacola.	
FL	Anodyne, Inc	North Miami Beach.	
FL	B&B Chemical Co., Inc	Hialeah	C

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
FL	Cabot/Koppers	Gainesville.	
FL	Callaway & Son Drum Service	Lake Alfred..	
FL	Chevron Chemical Co. (Ortho Division)	Orlando.	
FL	City Industries, Inc	Orlando	C
FL	Coleman-Evans Wood Preserving Co	Whitehouse.	
FL	Escambia Wood—Pensacola	Pensacola.	
FL	Florida Petroleum Reprocessors	Fort Lauderdale..	
FL	Florida Steel Corp	Indiantown.	
FL	Harris Corp. (Palm Bay Plant)	Palm Bay.	
FL	Helena Chemical Co. (Tampa Plant)	Tampa.	
FL	Hipps Road Landfill	Duval County	C
FL	Hollingsworth Solderless Terminal	Fort Lauderdale	C
FL	Landia Chemical Company	Lakeland..	
FL	MRI Corp (Tampa)	Tampa.	
FL	Madison County Sanitary Landfill	Madison	C
FL	Miami Drum Services	Miami	C
FL	Peak Oil Co./Bay Drum Co	Tampa.	
FL	Pepper Steel & Alloys, Inc	Medley	C
FL	Petroleum Products Corp	Pembroke Park.	
FL	Pickettville Road Landfill	Jacksonville.	
FL	Piper Aircraft/Vero Beach Water & Sewer	Vero Beach.	
FL	Reeves Southeast Galvanizing Corp	Tampa.	
FL	Sapp Battery Salvage	Cottondale.	
FL	Sherwood Medical Industries	Deland.	
FL	Solitron Microwave	Port Salerno.	
FL	Southern Solvents, Inc	Tampa.	
FL	Standard Auto Bumper Corp	Hialeah	C
FL	Stauffer Chemical Co. (Tampa)	Tampa.	
FL	Stauffer Chemical Co. (Tarpon Springs)	Tarpon Springs.	
FL	Sydney Mine Sludge Ponds	Brandon.	
FL	Taylor Road Landfill	Seffner.	
FL	Tower Chemical Co	Clermont.	
FL	Trans Circuit, Inc.	Lake Park.	
FL	United Metals, Inc	Marianna..	
FL	Whitehouse Oil Pits	Whitehouse.	
FL	Wingate Road Municipal Incinerator Dump	Fort Lauderdale.	
FL	Zellwood Ground Water Contamination	Zellwood.	
GA	Alternate Energy Resources	Augusta.	
GA	Brunswick Wood Preserving	Brunswick.	
GA	Camilla Wood Preserving Company	Camilla.	
GA	Diamond Shamrock Corp. Landfill	Cedartown	C
GA	Firestone Tire & Rubber Co. (Albany Plant)	Albany.	
GA	Hercules 009 Landfill	Brunswick.	
GA	LCP Chemicals Georgia	Brunswick	S
GA	Marzone Inc./Chevron Chemical Co	Tifton.	
GA	Mathis Brothers Landfill	Kensington.	
GA	Peach Orchard Road PCE Ground Water Plume	Augusta.	
GA	Powersville Site	Peach County	C
GA	T.H. Agriculture & Nutrition (Albany)	Albany.	
GA	Woolfolk Chemical Works, Inc	Fort Valley.	
GU	Ordot Landfill	Guam	C,S
HI	Del Monte Corp. (Oahu Plantation)	Honolulu County	P
IA	Des Moines TCE	Des Moines.	
IA	Electro-Coatings, Inc	Cedar Rapids.	
IA	Fairfield Coal Gasification Plant	Fairfield	C
IA	Lawrence Todtz Farm	Camanche	C
IA	Mason City Coal Gasification Plant	Mason City.	
IA	Midwest Manufacturing/North Farm	Kellogg	C
IA	Peoples Natural Gas Co	Dubuque.	
IA	Railroad Avenue Groundwater Contamination	Des Moines.	
IA	Shaw Avenue Dump	Charles City.	
IA	Vogel Paint & Wax Co	Orange City	C
ID	Bunker Hill Mining & Metallurgical	Smelterville.	
ID	Eastern Michaud Flats Contamination	Pocatello.	
ID	Kerr-McGee Chemical Corp. (Soda Springs)	Soda Springs.	
ID	Monsanto Chemical Co. (Soda Springs)	Soda Springs.	
IL	A & F Material Reclaiming, Inc	Greenup	C
IL	Acme Solvent Reclaiming (Morristown Plant)	Morristown.	
IL	Adams County Quincy Landfills 2&3	Quincy.	
IL	Amoco Chemicals (Joliet Landfill)	Joliet.	
IL	ASARCO Taylor Springs	Taylor Springs.	
IL	Beloit Corp	Rockton.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
IL	Belvidere Municipal Landfill	Belvidere	C
IL	Byron Salvage Yard	Byron.	
IL	Central Illinois Public Service Co	Taylorville	C
IL	Cross Brothers Pail Recycling (Pembroke)	Pembroke Township	C
IL	DePue/New Jersey Zinc/Mobil ChemCorp	DePue.	
IL	DuPage County Landfill/Blackwell Forest	Warrenville.	
IL	Galesburg/Koppers Co	Galesburg.	
IL	H.O.D. Landfill	Antioch.	
IL	Hegeler Zinc	Danville.	
IL	Indian Refinery—Texaco Lawrenceville	Lawrenceville.	
IL	Interstate Pollution Control, Inc	Rockford.	
IL	Jennison-Wright Corporation	Granite City.	
IL	Johns-Manville Corp	Waukegan	C
IL	Kerr-McGee (Kress Creek/W Branch DuPage)	DuPage County.	
IL	Kerr-McGee (Reed-Keppler Park)	West Chicago.	
IL	Kerr-McGee (Residential Areas)	West Chicago/DuPage County.	
IL	Kerr-McGee (Sewage Treatment Plant)	West Chicago.	
IL	LaSalle Electric Utilities	LaSalle	C
IL	Lenz Oil Service, Inc	Lemont.	
IL	Matthiessen and Hegeler Zinc Company	LaSalle.	
IL	MIG/Dewane Landfill	Belvidere.	
IL	NL Industries/Taracorp Lead Smelter	Granite City.	
IL	Ottawa Radiation Areas	Ottawa.	
IL	Outboard Marine Corp	Waukegan	S
IL	Pagel's Pit	Rockford.	
IL	Parsons Casket Hardware Co	Belvidere.	
IL	Southeast Rockford Gd Wtr Contamination	Rockford.	
IL	Tri-County Landfill/Waste Mgmt Illinois	South Elgin.	
IL	Velsicol Chemical Corp. (Illinois)	Marshall	C
IL	Wauconda Sand & Gravel	Wauconda	C
IL	Woodstock Municipal Landfill	Woodstock.	
IL	Yeoman Creek Landfill	Waukegan.	
IN	American Chemical Service, Inc	Griffith.	
IN	Bennett Stone Quarry	Bloomington.	
IN	Cam-Or Inc	Westville..	
IN	Columbus Old Municipal Landfill #1	Columbus	C
IN	Conrail Rail Yard (Elkhart)	Elkhart.	
IN	Continental Steel Corp	Kokomo.	
IN	Douglass Road/Uniroyal, Inc., Landfill	Mishawaka.	
IN	Elm Street Ground Water Contamination	Terre Haute.	
IN	Envirochem Corp	Zionsville.	
IN	Fisher-Calo	LaPorte.	
IN	Fort Wayne Reduction Dump	Fort Wayne	C
IN	Galen Myers Dump/Drum Salvage	Osceola.	
IN	Himco Dump	Elkhart.	
IN	Jacobsville Neighborhood Soil Contamination	Evansville.	
IN	Lake Sandy Jo (M&M Landfill)	Gary	C
IN	Lakeland Disposal Service, Inc	Claypool.	
IN	Lemon Lane Landfill	Bloomington.	
IN	MIDCO I	Gary.	
IN	MIDCO II	Gary.	
IN	Main Street Well Field	Elkhart	C
IN	Marion (Bragg) Dump	Marion.	
IN	Neal's Landfill (Bloomington)	Bloomington.	
IN	Ninth Avenue Dump	Gary	C
IN	Northside Sanitary Landfill, Inc	Zionsville	C
IN	Prestolite Battery Division	Vincennes.	
IN	Reilly Tar & Chemical (Indianapolis Plant)	Indianapolis.	
IN	Seymour Recycling Corp	Seymour	C,S
IN	Tippecanoe Sanitary Landfill, Inc	Lafayette.	
IN	Waste, Inc., Landfill	Michigan City.	
IN	Wayne Waste Oil	Columbia City	C
KS	57th and North Broadway Streets Site	Wichita Heights.	
KS	Ace Services	Colby.	
KS	Chemical Commodities, Inc	Olathe.	
KS	Cherokee County	Cherokee County.	
KS	Doepke Disposal (Holliday)	Johnson County.	
KS	Obee Road	Hutchinson.	
KS	Pester Refinery Co	El Dorado.	
KS	Strother Field Industrial Park	Cowley County.	
KS	Wright Ground Water Contamination	Wright.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
KY	Airco	Calvert City.	
KY	B.F. Goodrich	Calvert City.	
KY	Brantley Landfill	Island.	
KY	Caldwell Lace Leather Co., Inc	Auburn	C
KY	Distler Brickyard	West Point	C
KY	Distler Farm	Jefferson County	C
KY	Fort Hartford Coal Co. Stone Quarry	Olaton.	
KY	Green River Disposal, Inc	Maceo.	
KY	Maxey Flats Nuclear Disposal	Hillsboro.	
KY	National Electric Coil/Cooper Industries	Dayhoit.	
KY	National Southwire Aluminum Co	Hawesville.	
KY	Smith's Farm	Brooks.	
KY	Tri-City Disposal Co	Shepherdsville	C
LA	Agriculture Street Landfill	New Orleans	P
LA	American Creosote Works, Inc (Winnfield)	Winnfield.	
LA	Bayou Bonfouca	Slidell.	
LA	Central Wood Preserving Co	Slaughter.	
LA	Combustion, Inc	Denham Springs.	
LA	Madisonville Creosote Works	Madisonville.	
LA	Marion Pressure Treating	Marion.	
LA	Old Inger Oil Refinery	Darrow	S
LA	Petro-Processors of Louisiana Inc	Scotlandville.	
LA	Ruston Foundry	Alexandria.	
MA	Atlas Tack Corp	Fairhaven.	
MA	Baird & McGuire	Holbrook.	
MA	Blackburn & Union Privileges	Walpole.	
MA	Cannon Engineering Corp. (CEC)	Bridgewater	C
MA	Charles-George Reclamation Landfill	Tyngsborough.	
MA	Groveland Wells	Groveland.	
MA	Hatheway and Patterson Company	Mansfield.	
MA	Haverhill Municipal Landfill	Haverhill.	
MA	Hocomonco Pond	Westborough.	
MA	Industri-Plex	Woburn.	
MA	Iron Horse Park	Billerica.	
MA	New Bedford Site	New Bedford	S
MA	Norwood PCBs	Norwood.	
MA	Nuclear Metals, Inc	Concord..	
MA	Nyanza Chemical Waste Dump	Ashland.	
MA	Olin Chemical	Wilmington.	
MA	PSC Resources	Palmer.	
MA	Re-Solve, Inc	Dartmouth.	
MA	Rose Disposal Pit	Lanesboro	C
MA	Shpack Landfill	Norton/Attleboro.	
MA	Silresim Chemical Corp	Lowell.	
MA	Sullivan's Ledge	New Bedford.	
MA	Sutton Brook Disposal Area	Tewksbury..	
MA	W.R. Grace & Co Inc (Acton Plant)	Acton.	
MA	Wells G&H	Woburn.	
MD	Bush Valley Landfill	Abingdon.	
MD	Central Chemical	Hagerstown.	
MD	Kane & Lombard Street Drums	Baltimore.	
MD	Limestone Road	Cumberland.	
MD	Ordnance Products, Inc.	Cecil County.	
MD	Sand, Gravel & Stone	Elkton.	
MD	Spectron, Inc	Elkton.	
MD	Woodlawn County Landfill	Woodlawn.	
ME	Callahan Mine	Brooksville.	
ME	Eastern Surplus	Meddybemps.	
ME	Eastland Woolen Mill	Corinna.	
ME	McKin Co	Gray	C
ME	O'Connor Co	Augusta.	
ME	Saco Municipal Landfill	Saco.	
ME	Union Chemical Co., Inc	South Hope.	
ME	West Site/Hows Corners	Plymouth.	
ME	Winthrop Landfill	Winthrop.	
MI	Adam's Plating	Lansing	C
MI	Aircraft Components (D & L Sales)	Benton Harbor	A
MI	Albion-Sheridan Township Landfill	Albion.	
MI	Allied Paper/Portage Ck/Kalamazoo River	Kalamazoo.	
MI	American Anodco, Inc	Ionia	C
MI	Auto Ion Chemicals, Inc	Kalamazoo	C
MI	Barrels, Inc	Lansing.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
MI	Bendix Corp./Allied Automotive	St. Joseph.	
MI	Bofors Nobel, Inc	Muskegon.	
MI	Burrows Sanitation	Hartford	C
MI	Butterworth #2 Landfill	Grand Rapids.	
MI	Cannelton Industries, Inc	Saulte Saint Marie.	
MI	Chem Central	Wyoming Township	C
MI	Clare Water Supply	Clare.	
MI	Duell & Gardner Landfill	Dalton Township.	
MI	Electrovoice	Buchanan.	
MI	Forest Waste Products	Otisville.	
MI	G&H Landfill	Utica.	
MI	Grand Traverse Overall Supply Co	Greilickville	C
MI	Gratiot County Landfill	St. Louis	C,S
MI	H. Brown Co., Inc	Grand Rapids.	
MI	Hedblum Industries	Oscoda	C
MI	Hi-Mill Manufacturing Co	Highland	C
MI	Ionia City Landfill	Ionia.	
MI	J & L Landfill	Rochester Hills.	
MI	K&L Avenue Landfill	Oshtemo Township.	
MI	Kaydon Corp	Muskegon.	
MI	Kentwood Landfill	Kentwood	C
MI	Kysor Industrial Corp	Cadillac	C
MI	Liquid Disposal, Inc	Utica.	
MI	McGraw Edison Corp	Albion.	
MI	Metamora Landfill	Metamora.	
MI	Michigan Disposal (Cork Street Landfill)	Kalamazoo.	
MI	Motor Wheel	Lansing	P
MI	Muskegon Chemical Co	Whitehall.	
MI	North Bronson Industrial Area	Bronson.	
MI	Northernaire Plating	Cadillac	C
MI	Organic Chemicals, Inc	Grandville.	
MI	Ott/Story/Cordova Chemical Co	Dalton Township.	
MI	Packaging Corp. of America	Filer City.	
MI	Parsons Chemical Works, Inc	Grand Ledge.	
MI	Peerless Plating Co	Muskegon.	
MI	Petoskey Municipal Well Field	Petoskey.	
MI	Rasmussen's Dump	Green Oak Township	C
MI	Rockwell International Corp. (Allegan)	Allegan.	
MI	Rose Township Dump	Rose Township	C
MI	Roto-Finish Co., Inc	Kalamazoo.	
MI	SCA Independent Landfill	Muskegon Heights.	
MI	Shiawassee River	Howell.	
MI	South Macomb Disposal (Landfills 9 & 9A)	Macomb Township.	
MI	Southwest Ottawa County Landfill	Park Township	C
MI	Sparta Landfill	Sparta Township.	
MI	Spartan Chemical Co	Wyoming.	
MI	Spiegelberg Landfill	Green Oak Township	C
MI	Springfield Township Dump	Davisburg.	
MI	State Disposal Landfill, Inc	Grand Rapids.	
MI	Sturgis Municipal Wells	Sturgis.	
MI	Tar Lake	Antrim	P
MI	Thermo-Chem, Inc	Muskegon.	
MI	Torch Lake	Houghton	P
MI	U.S. Aviex	Howard Township	C
MI	Velsicol Chemical Corp. (Michigan)	St. Louis	C
MI	Verona Well Field	Battle Creek.	
MI	Wash King Laundry	Pleasant Plains Twp.	
MI	Waste Management of Michigan (Holland)	Holland.	
MN	Arrowhead Refinery Co	Hermantown	C
MN	Baytown Township Ground Water Plume	Baytown Township.	
MN	Burlington Northern (Brainerd/Baxter)	Brainerd/Baxter	C
MN	FMC Corp. (Fridley Plant)	Fridley	C
MN	Freeway Sanitary Landfill	Burnsville.	
MN	Fridley Commons Park Well Field	Fridley.	
MN	General Mills/Henkel Corp	Minneapolis	C
MN	Joslyn Manufacturing and Supply Co	Brooklyn Center	P
MN	Koppers Coke	St. Paul.	
MN	Kurt Manufacturing Co	Fridley	C
MN	Lehillier/Mankato Site	Lehillier/Mankato	C
MN	Long Prairie Ground Water Contamination	Long Prairie.	
MN	MacGillis & Gibbs/Bell Lumber & Pole C	New Brighton.	
MN	Nutting Truck & Caster Co	Faribault	C

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
MN	Oakdale Dump	Oakdale	C
MN	Perham Arsenic Site	Perham.	
MN	Reilly Tar&Chem (St. Louis Park Plant)	St. Louis Park	S
MN	Ritari Post & Pole	Sebeka.	
MN	South Andover Site	Andover	P
MN	St. Louis River Site	St. Louis County.	
MN	St. Regis Paper Co	Cass Lake.	
MN	Waite Park Wells	Waite Park.	
MO	Annapolis Lead Mine	Annapolis.	
MO	Armour Road	North Kansas City.	
MO	Bee Cee Manufacturing Co	Malden.	
MO	Big River Mine Tailings/St. Joe Minerals	Desloge.	
MO	Conservation Chemical Co	Kansas City	C
MO	Ellisville Site	Ellisville	S
MO	Fulbright Landfill	Springfield	C
MO	Lee Chemical	Liberty	C
MO	Madison County Mines	Fredericktown.	
MO	Minker/Stout/Romaine Creek	Imperial.	
MO	Missouri Electric Works	Cape Girardeau.	
MO	Newton County Mine Tailings	Newton County.	
MO	Newton County Wells	Newton County.	
MO	Oak Grove Village Well	Oak Grove Village.	
MO	Oronogo-Duenweg Mining Belt	Jasper County.	
MO	Pools Prairie	Neosho.	
MO	Quality Plating	Sikeston.	
MO	Riverfront	New Haven.	
MO	Solid State Circuits, Inc	Republic	C
MO	St. Louis Airport/HIS/Futura Coatings Co	St. Louis County.	
MO	Syntex Facility	Verona.	
MO	Valley Park TCE	Valley Park.	
MO	Westlake Landfill	Bridgeton.	
MS	American Creosote Works, Inc	Louisville.	
MS	Davis Timber Company	Hattiesburg.	
MS	Picayune Wood Treating	Picayune.	
MS	Sonford Products	Flowood.	
MT	Anaconda Co. Smelter	Anaconda.	
MT	Barker Hughesville Mining District	Barker.	
MT	Basin Mining Area	Basin.	
MT	Carpenter Snow Creek Mining District	Neihart.	
MT	East Helena Site	East Helena.	
MT	Idaho Pole Co	Bozeman.	
MT	Libby Asbestos	Libby	S
MT	Libby Ground Water Contamination	Libby	C
MT	Lockwood Solvent Ground Water Plume	Billings.	
MT	Milltown Reservoir Sediments	Milltown.	
MT	Montana Pole and Treating	Butte.	
MT	Mouat Industries	Columbus	C
MT	Silver Bow Creek/Butte Area	Sil Bow/Deer Lodge.	
MT	Upper Tenmile Creek Mining Area	Lewis and Clark.	
NC	ABC One Hour Cleaners	Jacksonville.	
NC	Aberdeen Pesticide Dumps	Aberdeen.	
NC	Barber Orchard	Waynesville.	
NC	Benfield Industries, Inc.	Hazelwood.	
NC	Blue Ridge Plating	Arden.	
NC	Bypass 601 Ground Water Contamination	Concord	P
NC	Cape Fear Wood Preserving	Fayetteville.	
NC	Carolina Transformer Co	Fayetteville.	
NC	Celanese Corp. (Shelby Fiber Operations)	Shelby/Cleveland	P
NC	Charles Macon Lagoon & Drum Storage	Cordova	C
NC	Chemtronics, Inc	Swannanoa	C
NC	Davis Park Road TCE	Gastonia.	
NC	FCX, Inc. (Statesville Plant)	Statesville.	
NC	FCX, Inc. (Washington Plant)	Washington.	
NC	Geigy Chemical Corp. (Aberdeen Plant)	Aberdeen.	
NC	General Electric Co/Shepherd Farm	East Flat Rock	P
NC	JFD Electronics/Channel Master	Oxford.	
NC	Jadco-Hughes Facility	Belmont	C
NC	Koppers Co., Inc. (Morrisville Plant)	Morrisville	P
NC	Martin-Marietta, Sodyeco, Inc	Charlotte.	
NC	NC State University (Lot 86,Farm Unit #1)	Raleigh.	
NC	National Starch & Chemical Corp	Salisbury.	
NC	New Hanover Cnty Airport Burn Pit	Wilmington.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
NC	North Belmont PCE	North Belmont.	
NC	Potter's Septic Tank Service Pits	Maco.	
NC	Ram Leather Care	Charlotte.	
NC	Reasor Chemical Company	Castle Hayne.	
NC	Sigmon's Septic Tank	Statesville.	
NC	Ward Transformer	Raleigh..	
NE	10th Street Site	Columbus.	
NE	Bruno Co-op Association/Associated Prop	Bruno.	
NE	Cleburn Street Well	Grand Island.	
NE	Garvey Elevator	Hastings.	
NE	Hastings Ground Water Contamination	Hastings.	
NE	Lindsay Manufacturing Co	Lindsay	C
NE	Nebraska Ordnance Plant (Former)	Mead.	
NE	Ogallala Ground Water Contamination	Ogallala.	
NE	Omaha Lead	Omaha..	
NE	Parkview Well	Grand Island.	
NE	Sherwood Medical Co	Norfolk.	
NE	West Highway 6 & Highway 281	Hastings.	
NH	Auburn Road Landfill	Londonderry.	
NH	Beede Waste Oil	Plaistow.	
NH	Chlor-Alkali Facility (Former)	Berlin.	
NH	Coakley Landfill	North Hampton.	
NH	Dover Municipal Landfill	Dover.	
NH	Fletcher's Paint Works & Storage	Milford.	
NH	Kearsarge Metallurgical Corp	Conway	C
NH	Keefe Environmental Services	Epping	C
NH	Mottolo Pig Farm	Raymond	C
NH	New Hampshire Plating Co	Merrimack.	
NH	Ottati & Goss/Kingston Steel Drum	Kingston.	
NH	Savage Municipal Water Supply	Milford.	
NH	Somersworth Sanitary Landfill	Somersworth.	
NH	South Municipal Water Supply Well	Peterborough	C
NH	Sylvester	Nashua	C,S
NH	Tibbetts Road	Barrington.	
NH	Tinkham Garage	Londonderry	C
NH	Town Garage/Radio Beacon	Londonderry	C
NH	Troy Mills Landfill	Troy.	
NJ	A. O. Polymer	Sparta/Sussex	P
NJ	American Cyanamid Co.	Bound Brook	P
NJ	Asbestos Dump	Millington	P
NJ	Atlantic Resources Corporation	Sayreville.	
NJ	Bog Creek Farm	Howell Township	C
NJ	Brick Township Landfill	Brick Township.	
NJ	Bridgeport Rental & Oil Services	Bridgeport.	
NJ	Brook Industrial Park	Bound Brook.	
NJ	Burnt Fly Bog	Marlboro Township.	
NJ	CPS/Madison Industries	Old Bridge Township.	
NJ	Caldwell Trucking Co	Fairfield.	
NJ	Chemical Control	Elizabeth	C
NJ	Chemical Insecticide Corp	Edison Township.	
NJ	Chemical Leaman Tank Lines, Inc	Bridgeport.	
NJ	Chemsol, Inc	Piscataway.	
NJ	Ciba-Geigy Corp	Toms River.	
NJ	Cinnaminson Ground Water Contamination	Cinnaminson Township.	
NJ	Combe Fill South Landfill	Chester Township.	
NJ	Cornell Dubilier Electronics Inc	South Plainfield.	
NJ	Cosden Chemical Coatings Corp	Beverly.	
NJ	Crown Vantage Landfill	Alexandria Township.	
NJ	Curcio Scrap Metal, Inc	Saddle Brook Township.	
NJ	D'Imperio Property	Hamilton Township.	
NJ	Dayco Corp./L.E Carpenter Co	Wharton Borough.	
NJ	De Rewal Chemical Co	Kingwood Township.	
NJ	Delilah Road	Egg Harbor Township.	
NJ	Diamond Alkali Co	Newark.	
NJ	Diamond Head Oil Refinery Div	Kearny.	
NJ	Dover Municipal Well 4	Dover Township.	
NJ	Ellis Property	Evesham Township.	
NJ	Emmell's Septic Landfill	Galloway Township.	
NJ	Evor Phillips Leasing	Old Bridge Township.	
NJ	Ewan Property	Shamong Township.	
NJ	Fair Lawn Well Field	Fair Lawn.	
NJ	Federal Creosote	Manville Borough.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
NJ	Franklin Burn	Franklin Township.	
NJ	Fried Industries	East Brunswick Township.	
NJ	GEMS Landfill	Gloucester Township.	
NJ	Garden State Cleaners Co	Minotola.	
NJ	Glen Ridge Radium Site	Glen Ridge.	
NJ	Global Sanitary Landfill	Old Bridge Township.	
NJ	Goose Farm	Plumstead Township	C
NJ	Grand Street Mercury	Hoboken	A
NJ	Helen Kramer Landfill	Mantua Township	C
NJ	Hercules, Inc. (Gibbstown Plant)	Gibbstown.	
NJ	Higgins Disposal	Kingston.	
NJ	Higgins Farm	Franklin Township.	
NJ	Horseshoe Road	Sayreville.	
NJ	Iceland Coin Laundry Area Ground Water Plume	Vineland.	
NJ	Imperial Oil Co., Inc./Champion Chemicals	Morganville.	
NJ	JIS Landfill	Jamesburg/S. Brnswck.	
NJ	Kauffman & Minteer, Inc	Jobstown.	
NJ	Kin-Buc Landfill	Edison Township.	
NJ	King of Prussia	Winslow Township	C
NJ	LCP Chemicals Inc	Linden.	
NJ	Landfill & Development Co	Mount Holly.	
NJ	Lang Property	Pemberton Township	C
NJ	Lightman Drum Company	Winslow Township.	
NJ	Lipari Landfill	Pitman.	
NJ	Lone Pine Landfill	Freehold Township	C
NJ	Mannheim Avenue Dump	Galloway Township	C
NJ	Martin Aaron, Inc	Camden.	
NJ	Maywood Chemical Co	Maywood/Rochelle Park.	
NJ	Matteo & Sons, Inc.	Thorofare.	
NJ	Metaltec/Aerosystems	Franklin Borough.	
NJ	Monitor Devices/Intercircuits Inc	Wall Township.	
NJ	Montclair/West Orange Radium Site	Montclair/W Orange.	
NJ	Montgomery Township Housing Development	Montgomery Township.	
NJ	Myers Property	Franklin Township.	
NJ	NL Industries	Pedricktown.	
NJ	Nascolite Corp	Millville.	
NJ	PJP Landfill	Jersey City.	
NJ	Pohatcong Valley Ground Water Contaminat	Warren County.	
NJ	Price Landfill	Pleasantville	S
NJ	Puchack Well Field	Pennsauken Township..	
NJ	Quanta Resources	Edgewater.	
NJ	Radiation Technology, Inc	Rockaway Township.	
NJ	Reich Farms	Pleasant Plains.	
NJ	Ringwood Mines/Landfill	Ringwood.	
NJ	Rockaway Borough Well Field	Rockaway Township.	
NJ	Rockaway Township Wells	Rockaway.	
NJ	Rocky Hill Municipal Well	Rocky Hill Borough.	
NJ	Roebling Steel Co	Florence.	
NJ	Rolling Knolls Landfill	Chatham Township.	
NJ	Sayreville Landfill	Sayreville.	
NJ	Scientific Chemical Processing	Carlstadt.	
NJ	Sharkey Landfill	Parsippany/Troy Hls.	
NJ	Shieldalloy Corp	Newfield Borough.	
NJ	South Jersey Clothing Co	Minotola.	
NJ	Swope Oil & Chemical Co	Pennsauken.	
NJ	Syncon Resins	South Kearny.	
NJ	Tabernacle Drum Dump	Tabernacle Township	C
NJ	U.S. Radium Corp	Orange	P
NJ	United States Avenue Burn	Gibbsboro.	
NJ	Universal Oil Products (Chemical Division	East Rutherford.	
NJ	Ventron/Velsicol	Wood Ridge Borough.	
NJ	Vineland Chemical Co., Inc	Vineland.	
NJ	Waldick Aerospace Devices, Inc	Wall Township.	
NJ	Welsbach & General Gas Mantle (Camden)	Camden and Gloucester City.	
NJ	White Chemical Corp	Newark	A
NJ	White Swan Cleaners/Sun Cleaners Area Ground Water Contamination.	Wall Township.	
NJ	Williams Property	Swainton	C
NJ	Wilson Farm	Plumstead Township	C
NJ	Woodbrook Road Dump	South Plainfield..	
NJ	Woodland Route 532 Dump	Woodland Township.	
NJ	Woodland Route 72 Dump	Woodland Township.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
NJ	Zschiegner Refining	Howell Township..	
NM	AT&SF (Albuquerque)	Albuquerque.	
NM	Cimarron Mining Corp	Carrizozo	P
NM	Fruit Avenue Plume	Albuquerque.	
NM	Grants Chlorinated Solvents Plume	Grants.	
NM	Griggs & Walnut Ground Water Plume	Las Cruces..	
NM	Homestake Mining Co	Milan	C
NM	McGaffey and Main Groundwater Plume	Roswell.	
NM	North Railroad Avenue Plume	Espanola.	
NM	Prewitt Abandoned Refinery	Prewitt	P
NM	South Valley	Albuquerque	C, S
NM	United Nuclear Corp	Church Rock.	
NV	Carson River Mercury Site	Lyon/Churchill Cnty.	
NY	American Thermostat Co	South Cairo.	
NY	Applied Environmental Services	Glenwood Landing	C
NY	Brewster Well Field	Putnam County.	
NY	Byron Barrel & Drum	Byron.	
NY	Carroll & Dubies Sewage Disposal	Port Jervis.	
NY	Cayuga County Ground Water Contamination	Cayuga County.	
NY	Circuitron Corp	East Farmingdale.	
NY	Claremont Polychemical	Old Bethpage.	
NY	Colesville Municipal Landfill	Town of Colesville.	
NY	Computer Circuits	Hauppauge.	
NY	Consolidated Iron and Metal	Newburgh..	
NY	Cortese Landfill	Village of Narrowsburg.	
NY	Crown Cleaners of Watertown, Inc	Carthage.	
NY	Diaz Chemical Corporation	Holley.	
NY	Ellenville Scrap Iron and Metal	Ellenville.	
NY	Endicott Village Well Field	Village of Endicott.	
NY	FMC Corp. (Dublin Road Landfill)	Town of Shelby.	
NY	Facet Enterprises, Inc	Elmira.	
NY	Forest Glen Mobile Home Subdivision	Niagara Falls	A
NY	Fulton Avenue	North Hempstead..	
NY	Fulton Terminals	Fulton.	
NY	GCL Tie & Treating Inc	Village of Sidney.	
NY	GE Moreau	South Glen Falls.	
NY	General Motors (Central Foundry Division)	Massena.	
NY	Genzale Plating Co	Franklin Square.	
NY	Goldisc Recordings, Inc	Holbrook.	
NY	Haviland Complex	Town of Hyde Park.	
NY	Hertel Landfill	Plattekill.	
NY	Hiteman Leather	West Winfield.	
NY	Hooker (Hyde Park)	Niagara Falls.	
NY	Hooker (S Area)	Niagara Falls.	
NY	Hooker Chemical/Ruco Polymer Corp	Hicksville.	
NY	Hopewell Precision Area Contamination	Hopewell Junction.	
NY	Hudson River PCBs	Hudson River.	
NY	Islip Municipal Sanitary Landfill	Islip.	
NY	Jackson Steel	Mineola/North Hempstead.	
NY	Johnstown City Landfill	Town of Johnstown.	
NY	Jones Chemicals, Inc	Caledonia.	
NY	Kentucky Avenue Well Field	Horseheads.	
NY	Lawrence Aviation Industries, Inc.	Port Jefferson Station.	
NY	Lehigh Valley Railroad	Le Roy.	
NY	Li Tungsten Corp	Glen Cove.	
NY	Liberty Industrial Finishing	Farmingdale.	
NY	Little Valley	Little Valley	A
NY	Ludlow Sand & Gravel	Clayville.	
NY	MacKenzie Chemical Works, Inc	Central Islip.	
NY	Malta Rocket Fuel Area	Malta.	
NY	Mattiace Petrochemical Co., Inc	Glen Cove.	
NY	Mercury Refining, Inc	Colonie.	
NY	Mohonk Road Industrial Plant	High Falls.	
NY	Nepera Chemical Co., Inc	Maybrook.	
NY	Niagara Mohawk Power Co (Saratoga Spings)	Saratoga Springs.	
NY	Old Bethpage Landfill	Oyster Bay	C
NY	Old Roosevelt Field Contaminated Ground Water Area	Garden City..	
NY	Olean Well Field	Olean.	
NY	Onondaga Lake	Syracuse.	
NY	Pasley Solvents & Chemicals, Inc	Hempstead.	
NY	Peninsula Boulevard Ground Water Plume	Hewlett.	
NY	Peter Cooper	Gowanda..	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
NY	Peter Cooper Corporation (Markhams)	Winslow Township.	
NY	Pfohl Brothers Landfill	Cheektowaga.	
NY	Pollution Abatement Services	Oswego	S
NY	Port Washington Landfill	Port Washington.	
NY	Preferred Plating Corp	Farmingdale.	
NY	Ramapo Landfill	Ramapo.	
NY	Richardson Hill Road Landfill/Pond	Sidney Center.	
NY	Robintech, Inc./National Pipe Co	Town of Vestal.	
NY	Rosen Brothers Scrap Yard/Dump	Cortland.	
NY	Rowe Industries Gnd Water Contamination	Noyack/Sag Harbor.	
NY	SMS Instruments, Inc	Deer Park	C
NY	Sarney Farm	Amenia.	
NY	Sealand Restoration, Inc	Lisbon.	
NY	Shenandoah Road Ground Water Contamination	East Fishkill..	
NY	Sidney Landfill	Sidney.	
NY	Sinclair Refinery	Wellsville.	
NY	Smithtown Ground Water Contamination	Smithtown.	
NY	Solvent Savers	Lincklaen.	
NY	Stanton Cleaners Area Ground Water Contamination	Great Neck.	
NY	Tri-Cities Barrel Co., Inc	Port Crane.	
NY	Vestal Water Supply Well 1–1	Vestal.	
NY	Volney Municipal Landfill	Town of Volney.	
NY	York Oil Co	Moira.	
OH	Allied Chemical & Ironton Coke	Ironton.	
OH	Big D Campground	Kingsville	C
OH	Buckeye Reclamation	St. Clairsville.	
OH	Chem-Dyne	Hamilton	C,S
OH	Copley Square Plaza	Copley.	
OH	E.H. Schilling Landfill	Hamilton Township	C
OH	Fields Brook	Ashtabula.	
OH	Fultz Landfill	Jackson Township.	
OH	Industrial Excess Landfill	Uniontown.	
OH	Lammers Barrel	Beavercreek.	
OH	Miami County Incinerator	Troy	C
OH	Nease Chemical	Salem.	
OH	New Lyme Landfill	New Lyme	C
OH	North Sanitary Landfill	Dayton.	
OH	Old Mill	Rock Creek	C
OH	Ormet Corp	Hannibal.	
OH	Powell Road Landfill	Dayton.	
OH	Pristine, Inc	Reading.	
OH	Reilly Tar & Chemical (Dover Plant)	Dover.	
OH	Sanitary Landfill Co. (Industrial Waste)	Dayton.	
OH	Skinner Landfill	West Chester.	
OH	South Point Plant	South Point.	
OH	Summit National	Deerfield Township	C
OH	TRW, Inc. (Minerva Plant)	Minerva	C
OH	United Scrap Lead Co., Inc	Troy.	
OH	Van Dale Junkyard	Marietta.	
OH	Zanesville Well Field	Zanesville	C
OK	Double Eagle Refinery Co	Oklahoma City.	
OK	Fourth Street Abandoned Refinery	Oklahoma City	C
OK	Hardage/Criner	Criner.	
OK	Hudson Refinery	Cushing.	
OK	Imperial Refining Company	Ardmore.	
OK	Mosley Road Sanitary Landfill	Oklahoma City.	
OK	Oklahoma Refining Co	Cyril.	
OK	Tar Creek (Ottawa County)	Ottawa County.	
OK	Tulsa Fuel and Manufacturing	Collinsville.	
OR	Harbor Oil	Portland.	
OR	McCormick & Baxter Creos. Co (Portland)	Portland.	
OR	Northwest Pipe & Casing/Hall Process Company	Clackamas.	
OR	Portland Harbor	Portland.	
OR	Reynolds Metals Company	Troutdale.	
OR	Taylor Lumber and Treating	Sheridan..	
OR	Teledyne Wah Chang	Albany.	
OR	Union Pacific Railroad Tie Treatment	The Dalles.	
OR	United Chrome Products, Inc	Corvallis	C
PA	A.I.W. Frank/Mid-County Mustang	Exton.	
PA	Avco Lycoming (Williamsport Division)	Williamsport.	
PA	Bally Ground Water Contamination	Bally Borough.	
PA	Bell Landfill	Terry Township.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
PA	Bendix Flight Systems Division	Bridgewater Township	C
PA	Berks Landfill	Spring Township.	
PA	Berks Sand Pit	Longswamp Township	C
PA	Blosenski Landfill	West Caln Township.	
PA	Boarhead Farms	Bridgeton Township.	
PA	Breslube-Penn, Inc	Coraopolis.	
PA	Brown's Battery Breaking	Shoemakersville.	
PA	Butler Mine Tunnel	Pittston.	
PA	Butz Landfill	Stroudsburg.	
PA	C & D Recycling	Foster Township.	
PA	Centre County Kepone	State College Borough	P
PA	Commodore Semiconductor Group	Lower Providence Township.	
PA	Craig Farm Drum	Parker	C
PA	Crater Resources/Keystone Coke/Alan Wood	Upper Merion Township.	
PA	Crossley Farm	Hereford Township.	
PA	Croydon TCE	Croydon.	
PA	CryoChem, Inc	Worman.	
PA	Delta Quarries & Disp./Stotler Landfill	Antis/Logan Twps	C
PA	Dorney Road Landfill	Upper Macungie Township.	
PA	Douglassville Disposal	Douglassville.	
PA	Drake Chemical	Lock Haven.	
PA	Dublin TCE Site	Dublin Borough.	
PA	East Mount Zion	Springettsbury Township.	
PA	Eastern Diversified Metals	Hometown.	
PA	Elizabethtown Landfill	Elizabethtown.	
PA	Fischer & Porter Co	Warminster.	
PA	Foote Mineral Co	East Whiteland Township.	
PA	Franklin Slag Pile (MDC)	Philadelphia.	
PA	Havertown PCP	Haverford.	
PA	Heleva Landfill	North Whitehall Township.	
PA	Hellertown Manufacturing Co	Hellertown	C
PA	Henderson Road	Upper Merion Township	C
PA	Hunterstown Road	Straban Township.	
PA	Industrial Lane	Williams Township.	
PA	Jacks Creek/Sitkin Smelting and Refinery	Maitland.	
PA	Jackson Ceramix	Falls Creek.	
PA	Keystone Sanitation Landfill	Union Township.	
PA	Kimberton Site	Kimberton Borough	C
PA	Lindane Dump	Harrison Township.	
PA	Lord-Shope Landfill	Girard Township	C
PA	Lower Darby Creek Area	Delaware/Philadelphia Counties..	
PA	MW Manufacturing	Valley Township.	
PA	Malvern TCE	Malvern.	
PA	Metal Banks	Philadelphia.	
PA	Mill Creek Dump	Erie.	
PA	Modern Sanitation Landfill	Lower Windsor Township.	
PA	Moyers Landfill	Eagleville.	
PA	North Penn—Area 1	Souderton.	
PA	North Penn—Area 12	Worcester.	
PA	North Penn—Area 2	Hatfield.	
PA	North Penn—Area 5	Montgomery Township.	
PA	North Penn—Area 6	Lansdale.	
PA	North Penn—Area 7	North Wales.	
PA	Novak Sanitary Landfill	South Whitehall Township.	
PA	Occidental Chemical Corp./Firestone Tire	Lower Pottsgrove Township.	
PA	Ohio River Park	Neville Island.	
PA	Old City of York Landfill	Seven Valleys	C
PA	Old Wilmington Road Ground Water Contamination	Sadsburyville.	
PA	Osborne Landfill	Grove City.	
PA	Palmerton Zinc Pile	Palmerton.	
PA	Paoli Rail Yard	Paoli.	
PA	Price Battery	Hamburg.	
PA	Raymark	Hatboro	C
PA	Recticon/Allied Steel Corp	East Coventry Twp.	
PA	Revere Chemical Co	Nockamixon Township.	
PA	Rodale Manufacturing Co., Inc	Emmaus Borough.	
PA	Ryeland Road Arsenic	Heidelberg Township.	
PA	Saegertown Industrial Area	Saegertown.	P
PA	Safety Light Corporation	Bloomsburg.	
PA	Sharon Steel Corp. (Farrell Wks Disp Area)	Hickory Township.	
PA	Shriver's Corner	Straban Township.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
PA	Stanley Kessler	King of Prussia.	
PA	Strasburg Landfill	Newlin Township.	
PA	Tobyhanna Army Depot	Tobyhanna	P
PA	Tonolli Corp	Nesquehoning.	
PA	Tysons Dump	Upper Merion Twp.	
PA	UGI Columbia Gas Plant	Columbia.	
PA	Valmont TCE	Hazle Township and West Hazleton.	
PA	Walsh Landfill	Honeybrook Township.	
PA	Watson Johnson Landfill	Richland Township.	
PA	Westinghouse Electronic (Sharon Plant)	Sharon.	
PA	Westinghouse Elevator Co. Plant	Gettysburg.	
PA	Whitmoyer Laboratories	Jackson Township.	
PA	William Dick Lagoons	West Caln Township.	
PR	Barceloneta Landfill	Florida Afuera.	
PR	Cidra Ground Water Contamination	Cidra.	
PR	Fibers Public Supply Wells	Jobos.	
PR	Juncos Landfill	Juncos.	
PR	Maunabo Area Ground Water Contamination	Maunabo.	
PR	Pesticide Warehouse I	Arecibo.	
PR	Pesticide Warehouse III	Manati..	
PR	Scorpio Recycling, Inc.	Candeleria Ward.	
PR	Upjohn Facility	Barceloneta.	
PR	Vega Alta Public Supply Wells	Vega Alta.	
PR	Vega Baja Solid Waste Disposal	Vega Baja.	
RI	Central Landfill	Johnston.	
RI	Centredale Manor Restoration Project	North Providence.	
RI	Davis Liquid Waste	Smithfield.	
RI	Landfill & Resource Recovery, Inc. (L&RR)	North Smithfield.	
RI	Peterson/Puritan, Inc	Lincoln/Cumberland	P
RI	Picillo Farm	Coventry	S
RI	Rose Hill Regional Landfill	South Kingston.	
RI	Stamina Mills, Inc	North Smithfield.	
RI	West Kingston Town Dump/URI Disposal	South Kingston.	
RI	Western Sand & Gravel	Burrillville	C
SC	Aqua-Tech Environmental Inc (Groce Labs)	Greer.	
SC	Beaunit Corp. (Circular Knit & Dye)	Fountain Inn.	
SC	Brewer Gold Mine	Jefferson.	
SC	Carolawn, Inc	Fort Lawn.	
SC	Elmore Waste Disposal	Greer.	
SC	Geiger (C & M Oil)	Rantoules.	
SC	Helena Chemical Co Landfill	Fairfax.	
SC	Kalama Specialty Chemicals	Beaufort.	
SC	Koppers Co., Inc. (Charleston Plant)	Charleston.	
SC	Koppers Co., Inc. (Florence Plant)	Florence.	
SC	Leonard Chemical Co., Inc	Rock Hill.	
SC	Lexington County Landfill Area	Cayce.	
SC	Macalloy Corporation	North Charleston.	
SC	Medley Farm Drum Dump	Gaffney	C
SC	Palmetto Wood Preserving	Dixiana.	
SC	Para-Chem Southern, Inc	Simpsonville	P
SC	Rochester Property	Travelers Rest	C
SC	Rock Hill Chemical Co	Rock Hill	C
SC	SCRDI Bluff Road	Columbia	S
SC	SCRDI Dixiana	Cayce	C
SC	Sangamo Weston	Pickens	P
SC	Shuron Inc	Barnwell.	
SC	Townsend Saw Chain Co	Pontiac.	
SC	Wamchem, Inc	Burton.	
SD	Gilt Edge Mine	Lead.	
TN	American Creosote Works, (Jackson Plant)	Jackson.	
TN	Arlington Blending & Packaging	Arlington.	
TN	Carrier Air Conditioning Co	Collierville	C
TN	Mallory Capacitor Co	Waynesboro	C
TN	Murray-Ohio Dump	Lawrenceburg.	
TN	Ross Metals Inc	Rossville.	
TN	Smalley-Piper	Collierville.	
TN	Tennessee Products	Chattanooga	A
TN	Velsicol Chemical Corp (Hardeman County)	Toone.	
TN	Wrigley Charcoal Plant	Wrigley.	
TX	ALCOA (Point Comfort)/Lavaca Bay	Point Comfort.	
TX	Bailey Waste Disposal	Bridge City.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
TX	Bandera Road Ground Water Plume	Leon Valley.	
TX	Brine Service Company	Corpus Christi.	
TX	City of Perryton Well No. 2	Perryton.	
TX	Conroe Creosoting Company	Conroe.	
TX	Crystal Chemical Co	Houston.	
TX	East 67th Street Ground Water Plume	Odessa.	
TX	French, Ltd	Crosby	C
TX	Garland Creosoting	Longview.	
TX	Geneva Industries/Fuhrmann Energy	Houston	P
TX	Gulfco Marine Maintenance	Freeport..	
TX	Hart Creosoting Company	Jasper.	
TX	Highlands Acid Pit	Highlands	C
TX	Jasper Creosoting Company Inc	Jasper County.	
TX	Jones Road Ground Water Plume	Harris County.	
TX	Koppers Co Inc (Texarkana Plant)	Texarkana.	
TX	Malone Service Company, Inc	Texas City..	
TX	Many Diversified Interests, Inc	Houston.	
TX	Motco, Inc	La Marque	S
TX	North Cavalcade Street	Houston.	
TX	Odessa Chromium #1	Odessa	C
TX	Palmer Barge Line	Port Arthur.	
TX	Patrick Bayou	Deer Park.	
TX	Petro-Chemical Systems, (Turtle Bayou)	Liberty County.	
TX	RSR Corp	Dallas.	
TX	Rockwool Industries Inc	Bell County.	
TX	Sandy Beach Road Ground Water Plume	Azle.	
TX	Sheridan Disposal Services	Hempstead.	
TX	Sikes Disposal Pits	Crosby	C
TX	Sol Lynn/Industrial Transformers	Houston	C
TX	South Cavalcade Street	Houston.	
TX	Sprague Road Ground Water Plume	Odessa.	
TX	Star Lake Canal	Port Neches.	
TX	State Marine of Port Arthur	Jefferson County.	
TX	State Road 114 Ground Water Plume	Levelland.	
TX	Texarkana Wood Preserving Co	Texarkana.	
TX	Tex-Tin Superfund	Texas City, Galveston	P
TX	United Creosoting Co	Conroe.	
UT	Bountiful/Woods Cross 5th South PCE Plume	Bountiful/Woods Cross.	
UT	Davenport and Flagstaff Smelters	Sandy City	P
UT	Eureka Mills	Eureka.	
UT	Intermountain Waste Oil Refinery	Bountiful..	
UT	International Smelting and Refining	Tooele.	
UT	Jacobs Smelters	Tooele County	P
UT	Midvale Slag	Midvale.	
UT	Portland Cement (Kiln Dust 2 & 3)	Salt Lake City.	
UT	Utah Power & Light/American Barrel Co	Salt Lake City	C
UT	Wasatch Chemical Co. (Lot 6)	Salt Lake City.	
VA	Abex Corp	Portsmouth.	
VA	Arrowhead Associates/Scovill Corp	Montross.	
VA	Atlantic Wood Industries, Inc	Portsmouth.	
VA	Avtex Fibers, Inc	Front Royal.	
VA	Buckingham County Landfill	Buckingham.	
VA	C & R Battery Co., Inc	Chesterfield County	C
VA	Chisman Creek	York County	C
VA	Culpeper Wood Preservers, Inc	Culpeper.	
VA	First Piedmont Rock Quarry (Route 719)	Pittsylvania County	C
VA	Former Nansemond Ordnance Depot	Suffolk	P
VA	Greenwood Chemical Co	Newtown.	
VA	H & H Inc., Burn Pit	Farrington.	
VA	Kim-Stan Landfill	Selma.	
VA	L.A. Clarke & Son	Spotsylvania County.	
VA	Rentokil, Inc. (VA Wood Preserving Div)	Richmond.	
VA	Saltville Waste Disposal Ponds	Saltville.	
VA	Saunders Supply Co	Chuckatuck.	
VA	U.S. Titanium	Piney River.	
VI	Island Chemical Corp/V.I. Chemical Corp	Christiansted.	
VI	Tutu Wellfield	Tutu.	
VT	BFI Sanitary Landfill (Rockingham)	Rockingham	C
VT	Bennington Municipal Sanitary Landfill	Bennington.	
VT	Burgess Brothers Landfill	Woodford.	
VT	Commerce Street Plume	Williston.	
VT	Elizabeth Mine	Strafford..	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
VT	Ely Copper Mine	Vershire.	
VT	Old Springfield Landfill	Springfield	C
VT	Parker Sanitary Landfill	Lyndon.	
VT	Pike Hill Copper Mine	Corinth.	
VT	Pine Street Canal	Burlington	S
VT	Pownal Tannery	Pownal.	
WA	American Crossarm & Conduit Co	Chehalis	C
WA	Boomsnub/Airco	Vancouver	S
WA	Centralia Municipal Landfill	Centralia.	
WA	Colbert Landfill	Colbert.	
WA	Commencement Bay, Near Shore/Tide Flats	Pierce County	P
WA	Commencement Bay, South Tacoma Channel	Tacoma	P
WA	FMC Corp. (Yakima Pit)	Yakima	C
WA	Frontier Hard Chrome, Inc	Vancouver.	
WA	General Electric Co. (Spokane Shop)	Spokane.	
WA	Greenacres Landfill	Spokane County.	
WA	Hamilton/Labree Roads Ground Water Contamination	Chehalis.	
WA	Harbor Island (Lead)	Seattle	P
WA	Hidden Valley Landfill (Thun Field)	Pierce County.	
WA	Kaiser Aluminum Mead Works	Mead.	
WA	Lakewood Site	Lakewood	C,P
WA	Lockheed West Seattle	Seattle.	
WA	Lower Duwamish Waterway	Seattle.	
WA	Mica Landfill	Mica.	
WA	Midnite Mine	Wellpinit..	
WA	Midway Landfill	Kent.	
WA	Moses Lake Wellfield Contamination	Moses Lake.	
WA	North Market Street	Spokane.	
WA	Northside Landfill	Spokane	C
WA	Oeser Co.	Bellingham.	
WA	Pacific Car & Foundry Co	Renton	C
WA	Pacific Sound Resources	Seattle.	
WA	Palermo Well Field Ground Water Contam	Tumwater.	
WA	Pasco Sanitary Landfill	Pasco.	
WA	Queen City Farms	Maple Valley.	
WA	Quendall Terminals	Renton.	
WA	Seattle Municipal Landfill (Kent Hghlnds)	Kent	C
WA	Vancouver Water Station #1 Contamination	Vancouver.	
WA	Vancouver Water Station #4 Contamination	Vancouver.	
WA	Western Processing Co., Inc	Kent	C
WA	Wyckoff Co./Eagle Harbor	Bainbridge Island.	
WI	Algoma Municipal Landfill	Algoma	C
WI	Ashland/Northern States Power Lakefront	Ashland.	
WI	Better Brite Plating Chrome & Zinc Shops	DePere.	
WI	City Disposal Corp. Landfill	Dunn.	
WI	Delavan Municipal Well #4	Delavan.	
WI	Eau Claire Municipal Well Field	Eau Claire	C
WI	Hagen Farm	Stoughton	C
WI	Hechimovich Sanitary Landfill	Williamstown.	
WI	Hunts Disposal Landfill	Caledonia.	
WI	Janesville Ash Beds	Janesville.	
WI	Janesville Old Landfill	Janesville.	
WI	Kohler Co. Landfill	Kohler.	
WI	Lauer I Sanitary Landfill	Menomonee Falls.	
WI	Lemberger Landfill, Inc	Whitelaw	C
WI	Lemberger Transport & Recycling	Franklin Township	C
WI	Madison Metropolitan Sewerage District	Blooming Grove.	
WI	Master Disposal Service Landfill	Brookfield.	
WI	Mid-State Disposal, Inc. Landfill	Cleveland Township	C
WI	Moss-American(Kerr-McGee Oil Co.)	Milwaukee.	
WI	Muskego Sanitary Landfill	Muskego.	
WI	N.W. Mauthe Co., Inc	Appleton	S
WI	National Presto Industries, Inc	Eau Claire.	
WI	Oconomowoc Electroplating Co. Inc	Ashippin	C
WI	Onalaska Municipal Landfill	Onalaska	C
WI	Penta Wood Products	Daniels.	
WI	Refuse Hideaway Landfill	Middleton.	
WI	Ripon City Landfill	Ripon	C
WI	Sauk County Landfill	Excelsior	C
WI	Schmalz Dump	Harrison	C
WI	Scrap Processing Co., Inc	Medford.	
WI	Sheboygan Harbor & River	Sheboygan.	

TABLE 1—GENERAL SUPERFUND SECTION—Continued

State	Site name	City/County	Notes(a)
WI	Spickler Landfill	Spencer.	
WI	Stoughton City Landfill	Stoughton.	
WI	Tomah Armory	Tomah.	
WI	Tomah Municipal Sanitary Landfill	Tomah.	
WI	Waste Mgmt of WI (Brookfield Sanit LF)	Brookfield.	
WI	Wausau Ground Water Contamination	Wausau	C
WV	Big John Salvage—Hoult Road	Fairmont.	
WV	Fike Chemical, Inc	Nitro.	
WV	Hanlin-Allied-Olin	Moundsville.	
WV	Ordnance Works Disposal Areas	Morgantown.	
WV	Ravenswood PCE Ground Water Plume	Ravenswood.	
WV	Sharon Steel Corp (Fairmont Coke Works)	Fairmont.	
WV	Vienna Tetrachloroethene	Vienna.	
WY	Mystery Bridge Rd/U.S. Highway 20	Evansville	C

(a) A = Based on issuance of health advisory by Agency for Toxic Substances and Disease Registry (if scored, HRS score need not be ≤ 28.50).
C = Sites on construction completion list.
S = State top priority (included among the 100 top priority sites regardless of score).
P = Sites with partial deletion(s).

TABLE 2—FEDERAL FACILITIES SECTION

St	Site name	City/County	Notes(a)
AK	Adak Naval Air Station	Adak.	
AK	Eielson Air Force Base	Fairbanks N Star Borough.	
AK	Elmendorf Air Force Base	Greater Anchorage Borough.	
AK	Fort Richardson (USARMY)	Anchorage.	
AK	Fort Wainwright	Fairbanks N Star Borough.	
AL	Alabama Army Ammunition Plant	Childersburg.	
AL	Anniston Army Depot (SE Industrial Area)	Anniston.	
AL	Redstone Arsenal (USARMY/NASA)	Huntsville.	
AZ	Williams Air Force Base	Chandler.	
AZ	Yuma Marine Corps Air Station	Yuma.	
CA	Alameda Naval Air Station	Alameda.	
CA	Barstow Marine Corps Logistics Base	Barstow.	
CA	Camp Pendleton Marine Corps Base	San Diego County.	
CA	Castle Air Force Base	Merced.	
CA	Concord Naval Weapons Station	Concord.	
CA	Edwards Air Force Base	Kern County.	
CA	El Toro Marine Corps Air Station	El Toro.	
CA	Fort Ord	Marina.	
CA	George Air Force Base	Victorville.	
CA	Jet Propulsion Laboratory (NASA)	Pasadena.	
CA	LEHR/Old Campus Landfill (USDOE)	Davis.	
CA	Lawrence Livermore Lab Site 300 (USDOE)	Livermore.	
CA	Lawrence Livermore Laboratory (USDOE)	Livermore.	
CA	March Air Force Base	Riverside.	
CA	Mather Air Force Base	Sacramento.	
CA	McClellan Air Force Base (GW Contam)	Sacramento.	
CA	Moffett Naval Air Station	Sunnyvale.	
CA	Norton Air Force Base	San Bernardino.	
CA	Riverbank Army Ammunition Plant	Riverbank.	
CA	Sacramento Army Depot	Sacramento.	
CA	Sharpe Army Depot	Lathrop.	
CA	Tracy Defense Depot (USARMY)	Tracy.	
CA	Travis Air Force Base	Solano County.	
CA	Treasure Island Naval Station-Hun Pt An	San Francisco	P
CO	Air Force Plant PJKS	Waterton.	
CO	Rocky Flats Plant (USDOE)	Jefferson and Boulder Counties.	P
CO	Rocky Mountain Arsenal (USARMY)	Adams County	P
CT	New London Submarine Base	New London.	
DC	Washington Navy Yard	Washington DC.	
DE	Dover Air Force Base	Dover.	
FL	Cecil Field Naval Air Station	Jacksonville	P
FL	Homestead Air Force Base	Homestead.	
FL	Jacksonville Naval Air Station	Jacksonville.	
FL	Pensacola Naval Air Station	Pensacola.	
FL	Tyndall Air Force Base	Panama City.	
FL	Whiting Field Naval Air Station	Milton.	
GA	Marine Corps Logistics Base	Albany.	

TABLE 2—FEDERAL FACILITIES SECTION—Continued

St	Site name	City/County	Notes(a)
GA	Robins Air Force Base(Lf#4/Sludge Lagoon	Houston County.	
GU	Andersen Air Force Base	Yigo.	
HI	Naval Computer & Telecommunications Area	Oahu.	
HI	Pearl Harbor Naval Complex	Pearl Harbor.	
IA	Iowa Army Ammunition Plant	Middletown.	
ID	Idaho National Engineering Lab (USDOE)	Idaho Falls.	
ID	Mountain Home Air Force Base	Mountain Home.	
IL	Joliet Army Ammunition Plant (LAP Area)	Joliet.	
IL	Joliet Army Ammunition Plant (Mfg Area)	Joliet.	
IL	Sangamo Electric/Crab Orchard NWR (USDOI)	Carterville.	
IL	Savanna Army Depot Activity	Savanna.	
KS	Fort Riley	Junction City.	
KY	Paducah Gaseous Diffusion Plant (USDOE)	Paducah.	
LA	Louisiana Army Ammunition Plant	Doyline.	
MA	Fort Devens	Fort Devens.	
MA	Hanscom Field/Hanscom Air Force Base	Bedford.	
MA	Natick Laboratory Army Research, D&E Cntr	Natick.	
MA	Naval Weapons Industrial Reserve Plant	Bedford.	
MA	Otis Air National Guard (USAF)	Falmouth.	
MA	South Weymouth Naval Air Station	Weymouth.	
MD	Aberdeen Proving Ground (Edgewood Area)	Edgewood.	
MD	Aberdeen Proving Ground (Michaelsville LF)	Aberdeen.	
MD	Andrews Air Force Base	Camp Springs.	
MD	Beltsville Agricultural Research (USDA)	Beltsville.	
MD	Brandywine DRMO	Brandywine.	
MD	Curtis Bay Coast Guard Yard	Anne Arundel County.	
MD	Fort George G. Meade	Odenton	P
MD	Indian Head Naval Surface Warfare Center	Indian Head.	
MD	Patuxent River Naval Air Station	St. Mary's County.	
ME	Brunswick Naval Air Station	Brunswick.	
ME	Loring Air Force Base	Limestone.	
ME	Portsmouth Naval Shipyard	Kittery.	
MN	Naval Industrial Reserve Ordnance Plant	Fridley.	
MN	New Brighton/Arden Hills/TCAAP (USARMY)	New Brighton.	
MO	Lake City Army Ammu. Plant (NW Lagoon)	Independence.	
MO	Weldon Spring Former Army Ordnance Works	St. Charles County.	
MO	Weldon Spring Quarry/Plant/Pitts (USDOE)	St. Charles County.	
NC	Camp Lejeune Military Res. (USNAVY)	Onslow County.	
NC	Cherry Point Marine Corps Air Station	Havelock.	
NE	Cornhusker Army Ammunition Plant	Hall County.	
NH	Pease Air Force Base	Portsmouth/Newington.	
NJ	Federal Aviation Admin. Tech. Center	Atlantic County.	
NJ	Fort Dix (Landfill Site)	Pemberton Township.	
NJ	McGuire Air Force Base #1	Wrightstown.	
NJ	Middlesex Sampling Plant (USDOE)	Middlesex.	
NJ	Naval Air Engineering Center	Lakehurst.	
NJ	Naval Weapons Station Earle (Site A)	Colts Neck.	
NJ	Picatinny Arsenal (USARMY)	Rockaway Township.	
NJ	W.R. Grace/Wayne Interim Storage (USDOE)	Wayne Township.	
NM	Lee Acres Landfill (USDOI)	Farmington.	
NY	Brookhaven National Laboratory (USDOE)	Upton.	
NY	Griffiss Air Force Base	Rome.	
NY	Plattsburgh Air Force Base	Plattsburgh.	
NY	Seneca Army Depot	Romulus.	
OH	Feed Materials Production Center (USDOE)	Fernald.	
OH	Mound Plant (USDOE)	Miamisburg	P
OH	Wright-Patterson Air Force Base	Dayton.	
OK	Tinker Air Force (Soldier Cr/Bldg 300)	Oklahoma City.	
OR	Fremont Nat. Forest Uranium Mines (USDA)	Lakeview.	
OR	Umatilla Army Depot (Lagoons)	Hermiston.	
PA	Letterkenny Army Depot (PDO Area)	Franklin County.	
PA	Letterkenny Army Depot (SE Area)	Chambersburg.	
PA	Naval Air Development Center (8 Areas)	Warminster Township.	
PA	Navy Ships Parts Control Center	Mechanicsburg.	
PA	Tobyhanna Army Depot	Tobyhanna	P
PA	Willow Grove Naval Air & Air Res. Stn.	Willow Grove.	
PR	Atlantic Fleet Weapons Training Area—Vieques	Island of Vieques[1]	S
RI	Davisville Naval Construction Batt Cent	North Kingston.	
RI	Newport Naval Education/Training Center	Newport.	
SC	Parris Island Marine Corps Recruit Depot	Parris Island.	
SC	Savannah River Site (USDOE)	Aiken.	
SD	Ellsworth Air Force Base	Rapid City	P

TABLE 2—FEDERAL FACILITIES SECTION—Continued

St	Site name	City/County	Notes(a)
TN	Memphis Defense Depot (DLA)	Memphis.	
TN	Milan Army Ammunition Plant	Milan.	
TN	Oak Ridge Reservation (USDOE)	Oak Ridge.	
TX	Air Force Plant #4 (General Dynamics)	Fort Worth.	
TX	Lone Star Army Ammunition Plant	Texarkana.	
TX	Longhorn Army Ammunition Plant	Karnack.	
TX	Pantex Plant (USDOE)	Pantex Village.	
UT	Hill Air Force Base	Ogden.	
UT	Monticello Mill Tailings (USDOE)	Monticello	P
UT	Ogden Defense Depot (DLA)	Ogden.	
UT	Tooele Army Depot (North Area)	Tooele.	
VA	Defense General Supply Center (DLA)	Chesterfield County.	
VA	Fort Eustis (US Army)	Newport News.	
VA	Langley Air Force Base/NASA Langley Cntr	Hampton.	
VA	Marine Corps Combat Development Command	Quantico.	
VA	Naval Amphibious Base Little Creek	Virginia Beach.	
VA	Naval Surface Warfare—Dahlgren	Dahlgren.	
VA	Naval Weapons Station—Yorktown	Yorktown.	
VA	Naval Weapons Station Yorktown—Cheatham Annex	Williamsburg.	
VA	Norfolk Naval Base (Sewells Pt Nvl Cmpx)	Norfolk.	
VA	Norfolk Naval Shipyard	Portsmouth.	
VA	St. Juliens Creek Annex (U.S. Navy)	Chesapeake.	
WA	American Lake Gardens/McChord AFB	Tacoma.	
WA	Bangor Naval Submarine Base	Silverdale.	
WA	Bangor Ordnance Disposal (USNAVY)	Bremerton.	
WA	Fairchild Air Force Base (4 Waste Areas)	Spokane County.	
WA	Fort Lewis Logistics Center	Tillicum.	
WA	Hanford 100-Area (USDOE)	Benton County	P
WA	Hanford 200-Area (USDOE)	Benton County.	
WA	Hanford 300-Area (USDOE)	Benton County.	
WA	Jackson Park Housing Complex (USNAVY)	Kitsap County.	
WA	Naval Air Station, Whidbey Island (Ault)	Whidbey Island.	
WA	Naval Undersea Warfare Station (4 Areas)	Keyport.	
WA	Old Navy Dump/Manchester Lab (USEPA/NOAA)	Manchester.	
WA	Puget Sound Naval Shipyard Complex	Bremerton.	
WV	Allegany Ballistics Laboratory (USNAVY)	Mineral.	
WV	West Virginia Ordnance (USARMY)	Point Pleasant	P
WY	F.E. Warren Air Force Base	Cheyenne.	

[1] Only the Vieques portions of the AFWTA are included in Appendix B to Part 300, the National Priorities List. The Culebra portions of the AFWTA (that were included in the NPL proposal AFWTA on August 13, 2004) are not included at this time due to ongoing negotiations between the Commonwealth of Puerto Rico and the Department of the Army.

Notes:

(a) A=Based on issuance of health advisory by Agency for Toxic Substances and Disease Registry (if scored, HRS score need not be >28.50).

C=Sites on construction completion list.

S=State top priority (included among the 100 top priority sites regardless of score).

P=Sites with partial deletion(s).

[62 FR 15576, Apr. 1, 1997]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting part 300, appendix B, see the List of CFR Sections Affected, which appears in the Finding Aids section of the printed volume and on GPO Access.

EDITORIAL NOTE: At 71 FR 36019, June 23, 2006, the amendment to Table 1 of Appendix B to Part 300 could not be incorporated because of inaccurate amendatory language.

EFFECTIVE DATE NOTE: At 72 FR 35364, June 28, 2007, Table 1 of Appendix B to Part 300 was amended under New Jersey (NJ) by removing the site name ''Mannheim Avenue Dump'' and the corresponding city/county designation ''Galloway Township.'', effective August 27, 2007.

APPENDIX C TO PART 300—SWIRLING FLASK DISPERSANT EFFECTIVENESS TEST, REVISED STANDARD DISPERSANT TOXICITY TEST, AND BIOREMEDIATION AGENT EFFECTIVENESS TEST

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1.0 Introduction

1.1 *Scope and Application.* The methods described below apply to ''dispersants, surface washing agents, surface collecting agents, bioremediation agents, and miscellaneous oil spill control agents'' involving subpart J (Use of Dispersants and Other Chemicals) in 40 CFR part 300 (National Oil and Hazardous Substances Pollution Contingency Plan). They are revisions and additions to the EPA's Standard Dispersant Effectiveness and Toxicity Tests (1). The new Swirling Flask Dispersant Effectiveness Test is used only for testing dispersants. The Revised Standard Dispersant Toxicity Test is used for testing dispersants, as well as surface washing agents, surface collecting agents, and miscellaneous oil spill control agents. The bioremediation agent effectiveness test is used for testing bioremediation agents only.

1.2 *Definitions.* The definitions of dispersants, surface washing agents, surface collecting agents, bioremediation agents, and miscellaneous oil spill control agents are provided in 40 CFR 300.5.

2.0 Swirling Flask Dispersant Effectiveness Test

2.1 *Summary of Method.* This protocol was developed by Environment Canada to provide a relatively rapid and simple testing procedure for evaluating dispersant effectiveness (2). It uses a modified Erlenmeyer flask to which a side spout has been added for removing subsurface samples of water near the bottom of the flask without disturbing a surface oil layer. Seawater and a surface layer of oil are added to the flask. Turbulent mixing is provided by placing the flask on a standard shaker table at 150 rpm for 20 minutes to induce a swirling motion to the liquid contents. Following shaking, the flask is immediately removed from the shaker table and maintained in a stationary position for 10 minutes to allow the oil that will reform a slick to return to the water's surface. A sample of water for chemical analysis is then removed from the bottom of the flask through the side spout, extracted with methylene chloride (dichloromethane-DCM), and analyzed for oil content by UV-visible absorption spectrophotometry at wavelengths of 340, 370, and 400 nm (2).

2.2 *Apparatus.*

2.2.1 Modified Erlenmeyer Flask. Use 125-ml glass Erlenmeyer flasks that have been modified to include an attachment of a glass side spout that extends from the bottom of the flask upward to the neck region, as shown in Figure 1.

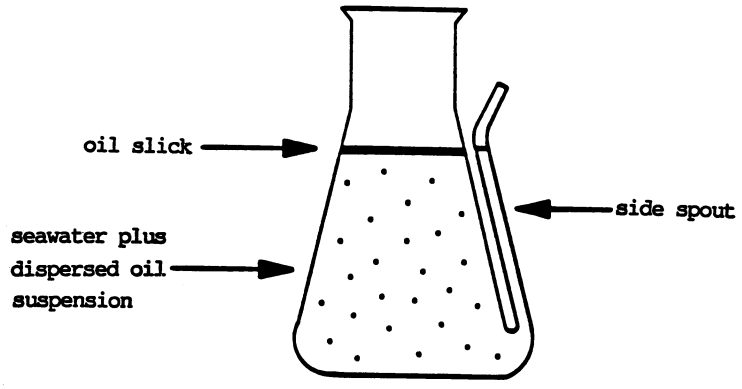
2.2.2 *Shaker Table.* Use a shaker table with speed control unit with variable speed (40–400 rpm) and an orbital diameter of approximately 0.75 inches (2 cm) to provide turbulence to solutions in test flasks.

2.2.3 *Spectrophotometer.* Use a UV-visible spectrophotometer capable of measuring absorbance at 340, 370, and 400 nm. A Hitachi Model U–2000 or equivalent is acceptable for this purpose.

2.2.4 *Glassware.* Glassware should consist of 5-, 10-, 25-, 100-, and 500-ml graduated cylinders; 125-ml separatory funnels with Teflon stopcocks; and 10-, 100-, and 1,000-ml volumetric flasks and micropipettes.

Figure 1

Swirling Flask Test Apparatus



2.3 *Reagents.* 2.3.1 *Synthetic seawater.* The synthetic sea salt ''Instant Ocean,'' manufactured by Aquarium Systems of Mentor, OH, can be used for this purpose. The synthetic seawater solution is prepared by dissolving 34 g of the salt mixture in 1 liter of distilled water (i.e., a salinity of 34 ppt). Table 1 provides a list of the ion composition of the seasalt mixture.

TABLE 1—MAJOR ION COMPOSITION OF ''INSTANT OCEAN'' SYNTHETIC SEA SALT

Major Ion	% Total Weight	Ionic Concentration at 34 ppt salinity (mg/1)
Chloride (Cl^-)	47.470	18,740
Sodium ($NA^=$)	26.280	10,454
Sulfate (SO_4-)	6.602	2,631
Magnesium ($Mg^=$)	3.230	1,256
Calcium ($Ca^=$)	1.013	400
Potassium ($K^=$)	1.015	401
Bicarbonate (HCO_3-)	0.491	194
Boron (B)	0.015	6.0
Strontium ($Sr^=$)	0.001	7.5
SOLIDS TOTAL	86.11%	34,089.50
Water	13.88	
TOTAL	99.99%	

Following the preparation, the saltwater solution is allowed to equilibrate to the ambient temperature of the laboratory and should be in the range of 22±3 °C.

2.3.2 *Test oil.* Two EPA/American Petroleum Institute (API) standard reference oils,

Prudhoe Bay and South Louisiana crude, should be used for this test. These oils can be obtained from the Resource Technology Corporation, 2931 Soldier Springs Road, P.O. Box 1346, Laramie, WY 82070, (307) 742–5452. These oils have been thoroughly homogenized, as well as characterized physically and chemically for previous EPA and API studies. Various selected parameters are presented in table 2.

TABLE 2—TEST OIL CHARACTERISTICS

	Prudhoe Bay crude oil	South Louisiana crude oil
Specific gravity [1]	0.894 kg/1	0.840 kg/1
API gravity [1]	26.8 degrees	37.0 degrees
Sulfur	1.03 wt%	0.23 wt%
Sulfur compounds, profile.		
Nitrogen	0.20 wt%	0.031 wt%
Vanadium	21 mg/1	0.95 mg/1
Nickel	11 mg/1	1.1 mg/1
Simulated distillation profile.		
Infrared spectrum		
UV fluorescence spectrum.		
Pour Point	+25 °F	0 °F
Viscosity		
at 40 °C	14.09 cST	3.582 cST
at 100 °C	4.059 cST	1.568 cST
Index	210	([2])

[1] At 15 °C
[2] Not calculable when viscosity at 100 °C is less than 2.0.

2.3.3 *Methylene Chloride (Dichloromethane-DCM), pesticide quality*. For extraction of all sample water and oil-standard water samples.

2.4 *Pretest preparation*. 2.4.1 *Preparation and analysis of oil standards*. 2.4.1.1 Standard solutions of oil for calibrating the UV-visible spectrophotometer are prepared with the specific reference oils and dispersant used for a particular set of experimental test runs. For experiments with no dispersant, only oil is used to make the standard solution. For experiments with the oil plus dispersant, the standard is made with a 1:10 (v:v) mixture of the dispersant to the test oil (i.e., a dispersant-to-oil ratio of 1:10). This ratio is used in the test tank with dispersant added. The presence of water and certain dispersants in DCM extracts can affect absorbance readings in a spectrophotometer. All standard solutions of oil (and dispersant, if present) should be prepared in a stepwise manner that reflects the analytical protocol used for the experimental water samples.

2.4.1.2 To prepare the standards, prepare a parent oil-DCM standard by mixing 1 part oil (plus 1/10 part premixed dispersant, if applicable) to 9 parts DCM (i.e., 1:10 dilution of the oil v:v). Add a specific volume of the parent oil-DCM standard to 30 ml of synthetic seawater in a separatory funnel. Extract the oil-water mixture with 5-ml volumes of DCM after 15 seconds of vigorous shaking followed by a 2 minute stationary period to allow for phase separation for each extraction. Repeat the extraction using a total of three 5-ml portions of DCM. Adjust the final DCM volume for the combined extracts to 20 ml with DCM in a 25-ml graduated cylinder.

2.4.1.3 The quantities of oil used to achieve the desired concentrations in the final 20-ml DCM extracts for the standard oil-solutions are summarized in table 3. Specific masses for oil amounts in standards are determined as volumes of oil multiplied by the density of the oil.

2.4.2 *Linear stability calibration of UV-Visible spectrophotometer*.

2.4.2.1 Before DCM-extracts of dispersed oil-water samples can be analyzed for their oil content, the UV-visible spectrophotometer must meet an instrument stability calibration criterion. This criterion is determined with the six oil standards identified in table 3. Determine the absorbance of standards at each of the three analytical wavelengths (i.e., 340, 370, and 400 nm). Determine the response factors (RFs) for the test oil at each of the three analytical wavelengths using the following equation:

$$RF_x = C/A_x \qquad (1)$$

where:

RF_x=Response factor at wavelength x (x=340, 370, or 400 nm)
C=Oil concentration, in mg of oil/ml of DCM in standard solution
A_x=Spectrophotometric absorbance of wavelength x

TABLE 3—OIL STANDARD SOLUTIONS: CONCENTRATIONS IN FINAL DCM EXTRACTIONS [1]

Final oil concentration (mg/ml of DCM)	Final extract volume (ml of DCM)	Total amount of oil in standard (mg)	Volume of parent oil-DCM std (µl) added to saltwater
4.0	20.0	80.0	890
2.0	20.0	40.0	440
1.0	20.0	20.0	220
0.50	20.0	10.0	110
0.10	20.0	2.0	22
0.05	20.0	1.0	11

[1] Assuming an oil density of 0.9 g/ml and an extraction efficiency of 100% for oil from the 30-ml of seawater.

2.4.2.2 Instrument stability for the initial calibration is acceptable when the RFs for the five highest standard extracts of oil are <20% different from the overall mean value for the five standards. If this criterion is satisfied, analysis of sample extracts can begin. RFs for the lowest concentration (0.05 mg oil/ml DCM) are not included in the consideration because the absorbance is close to the detection limit of the spectrophotometer (with associated high variability in the value) for the 1-cm path-length cell used for measurements. Absorbances ≥3.5 are not included because absorbance saturation occurs at and above this value.

2.4.2.3 If one or more of the standard oil extracts do not meet this linear-stability criterion, then the ''offending'' standard(s) can be prepared a second time (i.e., extraction of the specified amount of oil from 30-ml or seawater for the ''offending'' standard according to the pretest preparation procedure). If replacement of the reanalyzed standard solution(s) in the standard curve meets the linear-stability criterion (i.e., no RF >20% different from the overall mean), then analysis of sample extracts can begin.

2.4.2.4 If the initial-stability criterion is still not satisfied, analysis of sample extract cannot begin and the source of the problem (e.g., preparation protocol for the oil standards, spectrophotometer stability, etc.) must be corrected.

2.4.2.5 The initial six-point calibration of the UV-visible spectrophotometer at the oil concentrations identified is required at least once per test day.

2.5 *Test procedure.* 2.5.1 *Preparation of premixed dispersant oil.* Prepare a premixed dispersant oil by mixing 1 part dispersant to 10 parts oil. Store this mixture in a glass container. The dispersant effectiveness test procedures are listed in steps 1–20:

1. Prepare 4 replicates (same test oil and dispersant), one control (i.e., no dispersant), and one method blank and run at the same time on the shaker table.

2. Add 120±2 ml of synthetic seawater to each of the modified 125-ml glass Erlenmeyer flasks. Measure and record the water temperature.

3. Place the flasks securely into the attached slot on the shaker table.

4. Carefully add 100 µl of an oil-dispersant solution onto the center of the water's surface using a positive displacement pipette.

5. Agitate the flasks for 20±1 minutes at 150±10 rpm on the shaker table.

6. After the 20±1 minutes shaking, remove the flasks from the shaker table and allow them to remain stationary for 10±1 minutes for oil droplet ''settling.''

7. At the conclusion of the 10-minute settling period, carefully decant a 30-ml sample through the side spout of the test flasks into a 50-ml graduated cylinder.

NOTE: Discard the first 1–2 ml of sample water to remove nonhomogeneous water-oil initially contained in the spout.

8. Transfer the samples from the graduated cylinder into a 125- or 250-ml glass separatory funnel fitted with a Teflon stopcock.

9. Add 5 ml of pesticide-quality DCM to the separatory funnel and shake vigorously for 15 seconds. Release the pressure carefully from the separatory funnel through the stopcock into a fume hood.

10. Allow the funnel to remain in a stationary position for 2 minutes to allow phase-separation of the water and DCM.

11. Drain the DCM layer from the separatory funnel into a glass-stoppered, 25-ml graduated glass cylinder.

12. Repeat the DCM-extraction process two additional times.

13. Combine the three extracts in the graduated cylinder and adjust the final volume to 20-ml with additional DCM.

14. Analyze the samples using a UV-spectrophotometer at 340, 370, and 400 nm-wavelengths and determine the quantity of oil as follows:

$$C_x=(A_x)x(RF_x)x(V_{DCM})x(V_{tw}/V_{ew}) \quad (2)$$

where:

C_x=Total mass of dispersed oil in swirling flask at wavelength x (x=340, 370, or 400 nm)

A_x=Spectrophotometric absorbance at wavelength x

RF_x=Mean response factor at wavelength x (determined from equation 1)

V_{DCM}=Final volume of DCM-extract of water sample (20 ml)

V_{tw}=Total water volume in swirling flask vessel (120 ml)

V_{ew}=Volume of water extracted for dispersed oil content (30 ml)

15. Obtain three concentration values for oil in each experimental water sample (340, 370, and 400 nm).

16. Determine the mean of three values as follows:

$$C_{mean}=(C_{340}+C_{370}+C_{400})/3 \quad (3)$$

NOTE: Means will be used for all dispersion-performance calculations. Samples where one of the values for C_{340}, C_{370}, or C_{400} is more than 30% different from C_{mean} will be flagged. Whenever oil measurements are flagged as having a concentration based on one wavelength as >30% different from C_{mean}, raw data will be evaluated to establish that the measurements are valid. In addition, attempts will be made to correlate the difference to oil type, dispersant test, or dispersant used. If no errors or correlations are apparent and >10% of all oil measurements are flagged, the mean concentration data will be used in the calculation for dispersant performance and the subject data will be flagged.

17. Determine the dispersant performance (i.e., percent of oil that is dispersed, or EFF) based on the ratio of oil dispersed in the test system to the total oil added to the system as follows:

$$EFF\ (in\ \%)=(C_{mean}/C_{TOT})\times 100 \quad (4)$$

where:

C_{mean}=Mean value for total mass of dispersed oil in the swirling flask determined by spectrophotometric analysis

C_{TOT}=Total mass of oil initially added to the experimental swirling flask

18. Calculate EFF using equation 4 for coupled experiments with and without dispersant (EFF_c and EFF_d, respectively). EFF_c is the effectiveness of the control and represents natural dispersion of the oil in the

test apparatus. EFF_d is the measured uncorrected value.

19. Calculate the final dispersant performance of a chemical dispersant agent after correcting for natural dispersion using equation 5.

$$EFF_D = EFF_d — EFF_c \quad (5)$$

where:

EFF_D=% dispersed oil due to dispersant only
EFF_d=% dispersed oil with dispersant added
EFF_c= % dispersed oil with no dispersant added

20. Calculate the average dispersant effectiveness value by summing the corrected values (EFF_D) for each of the four replicates for each of the two test oils and dividing this sum by eight.

2.6 *Performance criterion.* The dispersant product tested will remain in consideration for addition to the NCP Product Schedule if the average dispersant effectiveness, as calculated in section 2.5 above, is at least 45% (i.e., 50%±5%).

2.7 *Quality Control (QC) procedures for measurements of oil concentrations.* 2.7.1 *UV-visible spectrophotometric measurements.* At least 5% of all UV-visible spectrophotometric measurements will be performed in duplicate as a QC check on the analytical measurement method. The absorbance values for the duplicates should agree within ±5% of their mean value.

2.7.2 *Method blanks.* Analytical method blanks involve an analysis of seawater blanks (i.e., seawater but no oil or dispersant in a swirling flask vessel) through testing and analytical procedures (3, pp 79–80). Method blanks are analyzed with a frequency of at least 1 for every 12 experimental swirling flask samples. Oil concentrations in method blanks must be <5% of that occurring for 100% dispersion of oil in testing apparatus.

3.0 Revised standard dispersant toxicity test

3.1 *Summary of method.* The standard toxicity test for dispersants and other products involves exposing two species (Menidia beryllina (silversides) and Mysidopsis bahia (mysid shrimp)) to five concentrations of the test product and No. 2 fuel oil alone and in a 1:10 mixture of product to oil. To aid in comparing results from assays performed by different workers, reference toxicity tests are conducted using dodecyl sodium sulfate (DSS) as a reference toxicant. The test length is 96 hours for Menidia and 48 hours for Mysidopsis. LC_{50} s are calculated based on mortality data at the end of the exposure period (for method of calculation, see section 3.6 below).

3.2 *Selection and preparation of test materials.*

3.2.1 *Test organisms.*

3.2.1.1 *Menidia beryllina.* Obtain fish (silversides) from a single source for each series of toxicity tests. In-house cultures are recommended wherever it is cost-effective; however, organisms are available from commercial suppliers. Information on the source of test organisms and any known unusual condition to which fish were exposed before use should be included in the data report. Use of animals previously treated with pesticides or chemotherapeutic agents should be avoided. Organisms should not be used if they appear to be unhealthy, discolored, or show signs of stress. Use 7-day old larval fish. Fish should be cultured in accordance with the methods outlined in Middaugh, et al. (5). There should be no need to acclimate organisms to the 25±1 °C temperature recommended for the toxicity tests if laboratory stock cultures of Menidia are maintained at the recommended culture temperature of 25±1 °C. If test organisms must be obtained from a commercial source, it may become necessary to acclimate test fish to the test temperature of 25±1 °C, a pH of 8.0±0.2, and 20±2 ppt salinity since changes in temperature may occur during shipping. Eliminate groups of fish having a mortality of more than 10% during the first 48 hours, and more than 5% thereafter. During acclimation, organisms should be maintained on a diet of freshly hatched Artemia (brine shrimp) nauplii. Feed the fish daily to satiation during the acclimation period, and once daily during the 96-hour test. Care should be taken daily to remove excess food and fecal material from beakers during the test. Use only those organisms that feed actively and that appear to be healthy. Organisms should be free of disease, external parasites, and any signs of physical damage or stress. Discard any fish injured or dropped while handling.

3.2.1.2 *Mysidopsis bahia.* Several methods for culturing Mysidopsis bahia (mysid shrimp) may be used and are noted in appendix A of Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms (6). To ensure uniformity of mysids, recently hatched mysids should be collected daily from stock cultures and identified by the date of hatch. Mysids used in 48-hour tests should be from a single day's collection, but may have an age range of 5–7 days old. In cases where in-house cultures of mysids are unavailable, organisms may be purchased from a commercial source. Information on the source of test organisms should be submitted in the data report.

3.2.2 *Preparation of experimental water.* Filtered natural seawater is recommended for use since it represents a natural source of saltwater containing an inherent population of microorganisms. Synthetic seawater formulated according to the following method can serve as an acceptable alternative to filtered, natural seawater for toxicity tests performed in laboratories in which natural seawater is unavailable.

3.2.3 *Synthetic seawater formation.* To prepare standard seawater, mix technical-grade salts with 900 liters of distilled or demineralized water in the order and quantities listed in table 4. These ingredients must be added in the order listed and each ingredient must be dissolved before another is added. Stir constantly after each addition during preparation until dissolution is complete. Add distilled or demineralized water to make up to 1,000 liters. The pH should now be 8.0±0.2. To attain the desired salinity of 20±1 ppt, dilute again with distilled or demineralized water at time of use.

3.3 *Sampling and storage of test materials.* Toxicity tests are performed with No. 2 fuel oil having the characteristics defined in table 5. Store oil used for toxicity tests in sealed containers to prevent the loss of volatiles and other changes. For ease in handling and use, it is recommended that 1,000-ml glass containers be used. To ensure comparable results in the bioassay tests, use oils packaged and sealed at the source. Dispose of unused oil in each open container on completion of dosing to prevent its use at a later date when it may have lost some of its volatile components. Run all tests in a bioassay series with oil from the same container and with organisms from the same group collected or secured from the same source.

TABLE 4—SYNTHETIC SEAWATER

[Toxicity Test]

Salt	(g) [1]
NaF	1.9
$SrCl_2 \cdot 6H_2O$	13.0
$H_3 BO_2$	20.0
KBr	67.0
KCl	466.0
$CaC1_2 \cdot 2H_2O$	733.0
$Na_2 SO_4$	2,660.0
$MgCl_2 \cdot 6H_2O$	3,330.0
NaCl	15,650.0
$Na_2SiO_3 \cdot 9H_2O$	13.0
EDTA [2]	0.4
$NaHCO_3$	133.0

[1] Amount added to 900 liters of water, as described in the text.

[2] Ethylenediaminetetraacetate tetrasodium salt.

3.4 *General test conditions and procedures for toxicity tests.*

3.4.1 *Temperature.* For these toxicity tests, use test solutions with temperatures of 25±1 °C.

3.4.2 *Dissolved oxygen and aeration.*

3.4.2.1 *Menidia.* Because oils contain toxic, volatile materials, and because the toxicity of some water-soluble fractions of oil and degradation products are changed by oxidation, special care must be used in the oxygenation of test solutions. Aeration during the test is generally not recommended but should be used to maintain the required dissolved oxygen (DO) in cases where low DO is observed. The DO content of test solutions must not drop below 60% saturation during the first 48 hours of a static acute (96-hour) test and must remain between 40–100% after the first 48 hours of the test. Aeration at a rate of 100±15 bubbles per minute is supplied by a serological pipette as needed for maintenance of DO. If aeration is necessary, all test chambers should be aerated. At this rate, and with the proper weight of fish, DO concentration should remain slightly above 4 ppm over a 96-hour period. Take DO measurements daily.

TABLE 5—TEST OIL CHARACTERISTICS: NO. 2 FUEL OIL

Characteristic	Minimum	Maximum
Gravity (°API)	32.1	42.8
Viscosity kinematic at 100 °F (cs)	2.35	3.00
Flash point (°F)	150	..
Pour point (°F)	..	0
Cloud point (°F)	..	10
Sulfur (wt %)	..	0.35
Aniline point (°F)	125	180
Carbon residue (wt %)	..	0.16
Water (vol %)	..	0
Sediment (wt %)	..	0
Aromatics (vol %)	10	15
Distillation:		
IBP (°F)	347	407
10% (°F)	402	456
50% (°F)	475	530
90% (°F)	542	606
End Point (°F)	596	655
Neutralization No	..	0.05

3.4.2.2 *Mysidopsis.* Achieve sufficient DO by ensuring that the surface area to volume ratio of the test solution exposed is large enough. Oxygen content should remain high throughout the test because of the low oxygen demand of the organisms. Aeration is not recommended during 48-hour acute toxicity tests unless the DO falls below 60% saturation.

3.4.3 *Controls.* With each fish or mysid test or each series of simultaneous tests of different solutions, perform a concurrent control test in exactly the same manner as the other tests and under the conditions prescribed or selected for those tests. Use the diluent water alone as the medium in which the controls are held. There must be no more than 10% mortality among the controls during the course of any valid test.

3.4.4 *Reference toxicant.* To aid in comparing results from tests performed by different workers and to detect changes in the condition of the test organisms that might lead to different results, perform reference toxicity tests with reagent grade DSS in addition to the usual control tests. Prepare a stock solution of DSS immediately before use by adding 1 gram of DSS per 500 ml of test water solution. Use exploratory tests before the full scale tests are begun to determine the amount of reference standard to be used in each of the five different concentrations.

3.4.5 *Number of organisms.* At a minimum, 20 organisms of a given species are exposed for each test concentration. For the toxicity test procedures using Menidia, place 10 fish in each of two jars. For the toxicity tests using Mysidopsis, place 10 larvae in each of two containers.

3.4.6 *Transfer of organisms.* Organisms should be handled as little as possible in order to minimize stress. Transfer Menidia and Mysidopsis from the acclimatization aquaria to the test chambers with a pipette or a wide-bore, smooth glass tube (4 to 8 mm internal diameter) fitted with a rubber bulb. Dip nets should be avoided when handling larval fish and mysids. Do not hold fish out of the water longer than necessary and discard any specimen accidentally dropped or otherwise mishandled during transfer.

3.4.6.1 *Mysidopsis.* To have the mysids ready for study, mysids may be sorted 24 hours prior to initiation of the 48-hour test. Transfer the mysids to a beaker containing a small volume of water; this vessel serves as a holding chamber during randomized transfer of the organisms to test solutions. Mysids are randomly selected from the batch of mysids in the holding chamber, and transferred to 50-ml beakers containing a small volume of seawater. One mysid is added per beaker using a small piece of flexible 500-μm screening until all of the beakers contain one mysid. The process of random selection and sorting is continued until the appropriate number of mysids has been delivered to each of the 50-ml beakers. The mysids are gently released from the 50-ml beakers into larger beakers filled with an appropriate volume of 20-ppt seawater (25 °C) to bring the total volume to 200 ml. The beakers are randomly placed into a temperature-controlled water bath to acclimate overnight at 25 °C. The mysids are transferred to larger beakers (1-liter) for the 48-hour test after the addition of 800 ml of the test solution. A total of 10 mysids per beaker are used for 48-hour acute toxicity tests. A minimum of two replicate chambers are used for each test concentration and control.

3.4.6.2 *Menidia and Mysidopsis* are fed 50 brine shrimp nauplii/organism daily during the 96-hour and 48-hour tests. Excess food should be removed daily by aspirating with a pipette.

3.4.7 *Test duration and observations.* 3.4.7.1 *Menidia.* Observe the number of dead fish in each test container and record at the end of each 24-hour period. Fish are considered dead upon cessation of respiratory and all other overt movements, whether spontaneous or in response to mild mechanical prodding. Remove dead fish as soon as observed. Also note and report when the behavior of test fish deviates from that of control fish. Such behavioral changes would include variations in opercular movement, coloration, body orientation, movement, depth in container, schooling tendencies, and others. Abnormal behavior of the test organisms (especially during the first 24 hours) is a desirable parameter to monitor in a toxicity test because changes in behavior and appearance may precede mortality. Toxicants can reduce an organism's ability to survive natural stresses. In these cases, the mortality is not directly attributed to the toxicant, but most certainly is an indirect effect. Reports on behavioral changes during a toxicity test can give insight into the non-acute effects of the tested material. At the end of the 96-hour period, terminate the fish tests and determine the LC_{50} values. The acute toxicity test is terminated after four days of exposure. The number of surviving fish are counted and recorded for each chamber in accordance with standard EPA methods (6). The LC_{50} is calculated using survival data from the test in accordance with the methods described in the guidelines (6).

3.4.7.2 *Mysidopsis.* Terminate the mysid test after 48 hours of incubation. To count the dead animals accurately, place the exposure vessels on a light table such that light passes through the bottom of the vessel. Most of the dead mysids will be on the bottom of the beaker and can readily be seen against the background of the light table. Also search the top of the liquid for mysids trapped there by surface tension. Exercise caution when determining death of the animals. Occasionally, an animal appears dead, but closer observation shows slight movement of an appendage or a periodic spasm of its entire body. For these tests, animals exhibiting any movement when touched with a pipette tip are considered alive. Account for all test animals to ensure accuracy since *Mysidopsis bahia* may disintegrate or be cannibalized by other mysids. Consider individuals not accounted for as dead. At the end of 48 hours of exposure, terminate the mysid assay and determine the LC_{50} values in accordance with the methods described in the guidelines (6).

3.4.8 *Physical and chemical determinations.* 3.4.8.1 *Menidia.* Determine the temperature, DO, and pH of the test solutions before the fish are added and at 24-, 48-, 72-, and 96-hour exposure intervals. It is necessary to take measurements from only one of the replicates of each of the toxicant series.

3.4.8.2 *Mysidopsis.* Determine the temperature, DO, and pH of the test solutions before the nauplii are added and at the 24- and 48-hour exposure interval. Measure DO and pH in only one of the replicates of each of the toxicant series.

3.4.9 *Testing laboratory.* An ordinary heated or air-conditioned laboratory room with thermostatic controls suitable for maintaining the prescribed test temperatures generally will suffice to conduct the toxicity tests. Where ambient temperatures cannot

be controlled to 25±1 °C, use water baths with the necessary temperature controls.

3.4.10 *Test containers.* For tests with fish or mysids, use 1-liter glass beakers measuring approximately 10 cm in diameter. In conducting the test, add to each beaker 1 liter of the test solution or seawater formulation aerated to saturation with DO. To add the liter volume easily and accurately, use a large volume (1-liter) graduated cylinder. Process all required glassware before each test. Immerse in normal hexane for 10 minutes. Follow this with a thorough rinse with hot tap water; three hot detergent scrubs; an additional hot tap-water rinse; and three rinses with distilled water. Oven or air dry the glassware in a reasonably dust-free atmosphere.

3.5 *Preparation of test concentrations.* 3.5.1 *Menidia.* Place test jars (approximately 22.5 cm in height, 15 cm in diameter, 11 cm in diameter at the mouth) containing 2 liters of synthetic seawater on a reciprocal shaker. The shaker platform should be adapted to hold firmly six of the toxicity test jars. Add the desired amount of the petroleum product (if applicable) under test directly to each test jar. Dispense the appropriate amount of toxicant (if applicable) into the jars with a pipette. Tightly cap the test jars and shake for 5 minutes at approximately 315 to 333 2-cm (0.75-inch) strokes per minute in a reciprocal shaker or at approximately 150 to 160 rpm on orbital shakers. At the completion of shaking, remove the jars from the shaker and dispense 1 liter of the mixture to each of the 1-liter glass beakers. Randomly place beakers in a constant-temperature water bath or room, take water quality measurements, add fish, and initiate aeration.

3.5.2 *Mysidopsis.* 3.5.2.1 To prepare test solutions for products and oil/product mixtures, blend or mix the test solutions with an electric blender having: speeds of 10,000 rpm or less; a stainless-steel cutting assembly; and a 1-liter borosilicate jar. To minimize foaming, blend at speeds below 10,000 rpm.

3.5.2.2 For the product test solution, add 550 ml of the synthetic seawater to the jar, then with the use of a gas-tight calibrated glass syringe with a Teflon-tipped plunger, add 0.55 ml of the product and mix for 5 seconds.

3.5.2.3 For the oil test solution, add 550 ml of the synthetic seawater to the jar. Then with the use of a gas-tight calibrated glass syringe equipped with a Teflon-tipped plunger, add 0.55 ml of the oil and mix for 5 seconds.

3.5.2.4 For the oil/product mixture, add 550 ml of the synthetic seawater to the mixing jar. While the blender is in operation, add 0.5 ml of the oil under study with the use of a calibrated syringe with a Teflon-tipper plunger and then 0.05 ml of the product as indicated above. Blend for 5 seconds after addition of product. These additions provide test solutions of the product, oil, and the oil/product mixture at concentrations of 1,000 ppm.

3.5.2.5 Immediately after the test solutions are prepared, draw up the necessary amount of test solution with a gas-tight Teflon-tipped glass syringe of appropriate size and dispense into each of the five containers in each series. If the series of five concentrations to be tested are 10, 18, 32, 56, and 100 ppm, the amount of the test solution in the order of the concentrations listed above would be as follows: 10, 18, 32, 56, and 100 ml.

3.5.2.6 Each time a syringe is to be filled for dispensing to the series of test containers, start the mixer and withdraw the desired amount in the appropriate syringe while the mixer is in operation. Turn off immediately after the sample is taken to limit the loss of volatiles.

3.5.2.7 Use exploratory tests before the full-scale test is set up to determine the concentration of toxicant to be used in each of the five different concentrations. After adding the required amounts of liquid, bring the volume in each of the test containers up to 800 ml with the artificial seawater. To ensure keeping each of the series separate, designate on the lid of each container the date, the material under test, and its concentration.

3.5.2.8 When the desired concentrations are prepared, gently release into each beaker the 10 test *Mysidopsis* (previously transferred into 200 ml of medium). This provides a volume of 1 liter in each test chamber. A pair of standard cover glass forceps with flat, bent ends is an ideal tool for handling and tipping the small beaker without risk of contaminating the medium.

3.5.2.9 After adding the test animals, incubate the test beakers at 25±1 °C for 48 hours. Recommended lighting is 2,000 lumens/m^2 (200 ft-c) of diffused, constant, fluorescent illumination.

3.5.2.10 Wash the blender thoroughly after use and repeat the above procedures for each series of tests. Wash the blender as follows: rinse with normal hexane; pour a strong solution of laboratory detergent into the blender to cover the blades; fill the container to about half of its volume with hot tap water; operate the blender for about 30 seconds at high speed; remove and rinse twice with hot tap water, mixing each rinse for 5 seconds at high speed; and then rinse twice with distilled water, mixing each rinse for 5 seconds at high speed.

3.6 *Calculating and reporting.* At the end of the test period, the toxicity tests are terminated and the LC_{50} values are determined.

3.6.1 *Calculations.* The LC_{50} is the concentration lethal to 50% of the test population. It can be calculated as an interpolated value based on percentages of organisms surviving at two or more concentrations, at which less than half and more than

half survived. The LC_{50} can be estimated with the aid of computer programs or graphic techniques (log paper). The 95% confidence intervals for the LC_{50} estimate should also be determined.

3.6.2 *Reporting.* The test product and oil and their source and storage are described in the toxicity test report. Note any observed changes in the experimental water or the test solutions. Also include the species of fish used; the sources, size, and condition of the fish; data of any known treatment of the fish for disease or infestation with parasites before their use; and any observations on the fish behavior at regular intervals during the tests. In addition to the calculated LC_{50} values, other data necessary for interpretation (e.g., DO, pH, other physical parameters, and the percent survival at the end of each day of exposure at each concentration of toxicant) should be reported.

3.7 *Summary of procedures.* 3.7.1 *Menidia:*

1. Prepare adequate stocks of the appropriate standard dilution water.

2. Add 2 liters of the standard dilution water to the test jars. Each test consists of 5 replicates of each of 5 concentrations of the test material, a control series of 5 beakers, and a standard reference series of 5 different concentrations for a total of 35 beakers. Simultaneous performance of toxicity tests on the oil, product, and oil/product mixture requires a total of 105 beakers.

3. Add the determined amount (quarter points on the log scale) of test material to the appropriate jars. Preliminary tests will be necessary to define the range of definitive test concentrations.

4. Cap the jars tightly with the Teflon-lined screw caps and shake for 5 minutes at 315 to 333 2-cm (0.75-inch) strokes per minute on a reciprocal shaker.

5. Remove the jars from the shaker, take water quality data, dispense 1 liter of solution to the 1-liter glass beaker, and add 10 acclimated fish per beaker.

6. Aerate with 100±15 bubbles per minute through a 1-ml serological pipette, as needed, to maintain DO above 4.0 mg/l.

7. Observe and record mortalities, water quality, and behavioral changes every 24 hours.

8. After 96 hours, terminate the test, and calculate LC_{50} values and corresponding confidence limits.

3.7.2 *Mysidopsis:*

1. Initiate the procedure for hatching the Mysidopsis in sufficient time before the toxicity test is to be conducted so that 5–7 day old larvae are available.

2. With the use of a small pipette, transfer 10 Mysidopsis into small beakers, each containing 200 ml of the proper synthetic seawater.

3. To prepare the test stock product and oil solutions, add 550 ml of the artificial seawater to the prescribed blender jar. By means of a gas-tight glass syringe with a Teflon-tipped plunger, add 0.55 ml of the product (or oil) and mix at 10,000 rpm for 5 seconds. To prepare the test stock oil/product mixture, add 550 ml of the standard seawater to the blender jar. While the blender is in operation (10,000 rpm), add 0.5 ml of the oil, then 0.05 ml of the product with the use of a calibrated syringe with a Teflon-tipped plunger. Blend for 5 seconds after adding the product. One ml of these stock solutions added to the 100 ml of standard seawater in the test containers yields a concentration of 10 ppm product, oil, or oil/product combination (the test will be in a ratio of 1 part product to 10 parts of oil).

4. Each test consists of 5 replications of each of 5 concentrations of the material under study, a control series of 5 beakers and a standard reference series of 5 different concentrations, for a total of 35 beakers. Simultaneous performance of toxicity tests on the oil, product, and oil/product mixture requires a total of 105 beakers. Immediately after preparing the test solution of the product or oil/product solution, and using an appropriately sized syringe, draw up the necessary amount of test solution and dispense into each of the five containers in each series. Each time a syringe is to be filled for dispensing to the series of test containers, start the mixer and withdraw the desired amount in the appropriate syringe while the mixer is in operation. Turn mixer off immediately after the sample is taken to limit the loss of volatiles. After adding the required amount of the test oil/product or product mixture, bring the volume of liquid in each of the test containers up to 800 ml with the artificial seawater. When the desired concentrations have been prepared, gently release into each beaker the 10 mysids previously transferred into 200 ml of medium. This provides a volume of 1 liter in each test chamber.

5. Wash the blender as prescribed for each series of tests.

6. Incubate the test beakers at 25±1 °C for 48 hours with the prescribed lighting.

7. Terminate the experiment after 48 hours, observe and record the mortalities, and determine the LC_{50} s and corresponding confidence limits.

4.0 Bioremediation agent effectiveness test

4.1 *Summary of method.* The bioremediation agent effectiveness testing protocol is designed to determine a product's ability to biodegrade oil by quantifying changes in the oil composition resulting from biodegradation. The protocol tests for microbial activity and quantifies the disappearance of saturated hydrocarbons and polynuclear aromatic hydrocarbons (PAHs). The sample preparation procedure extracts the oil phase into dichloromethane (DCM), with a subsequent solvent exchange into hexane. To effectively accomplish the goals of the testing

protocol, it is necessary to normalize the concentration of the various analytes in oil to a non-biodegradable marker, either C_2-or C_3-phenanthrene, C_2-chrysene, or hopane[1] (7). The test method targets the relatively easy to degrade normal alkanes and the more resistant and toxic PAHs. It normalizes their concentrations to C_2-or C_3-phenanthrene, C_2-chrysene, or $C_{30}17\alpha$(H), 21β (H)-hopane on an oil weight basis (mg marker/kg oil, mg target analyte/kg oil). The analytical technique uses a high resolution gas chromatograph/mass spectrometer (GC/MS) because of its high degree of chemical separation and spectral resolution. GC/MS has long been used to study the weathering and fate of oil spilled into the environment. For quantitative analyses, the instrument is operated in the selective ion detection (SIM) mode at a scan rate of greater than 1.5 scans per second to maximize the linear quantitative range and precision of the instrument. The sample preparation method does not exclude analysis of selected samples by GC/MS in the full scanning mode of operation to qualitatively assess changes in the oil not accounted for by the SIM approach. Performed concurrently with the chemical analysis described above is a microbiological analysis. The microbiological analysis is performed to determine and monitor the viability of the microbial cultures being studied. Under this procedure, microbial enumerations of hydrocarbon degraders are performed at each sampling event using a microtiter Most Probable Number (MPN) determination.

4.2 *Apparatus.* The following materials and equipment are required for the protocol: Appropriate flasks and other glassware; sterile tubes; graduated cylinders (100-ml); deionized water; p-iodonitrotetrazolium violet dye; weighing pans or paper; 250-ml borosilicate glass Erlenmeyer flasks with screw tops; Pasteur pipettes; laboratory notebook; microtiter MPN plates (24-well) multi-channel pipetting device; dilution tube and caps; autoclave; environmental room or incubator; balance accurate to 0.1 mg (XD–400); GC/MS instrument equipped with a DB–5 capillary column (30 m, 0.25-mm I.D., and 0.25-μm film thickness) and a split/splitless injection port operating in the splitless mode, such as Hewlett-Packard 5890/5971 GC/MS (recommended for use); and an autosampler for testing multiple samples.

4.3 *Reagents and culture medium.* 4.3.1 *Preparation of seawater.* All products are tested in clean natural seawater. Clean natural seawater means that the source of this seawater must not be heavily contaminated with industrial or other types of effluent. For example, seawater should not be obtained from a source near shipping channels or discharges of industrial or municipal wastewater, or with high turbidity. The seawater is used within seven days of collection. No microbial inoculum is added.

4.3.2 *Preparation of oil.* A medium weight crude oil, Alaska North Slope (ANS), is artificially weathered by heating to 521 °F to remove the light end hydrocarbons prior to experimental start-up (ANS 521). The method is described in the Draft International Standard ISO/DIS 8708 ''Crude Petroleum Oil—Determination of Distillation Characteristics Using 15 Theoretical Plates Columns'' by the International Organization for Standardization (8). The ANS521 crude oil can be obtained from the National Environmental Technology Applications Center's (NETAC) Bioremediation Products Evaluation Center (BPEC), University of Pittsburgh Applied Research Center, 615 William Pitt Way, Pittsburgh, PA, 15238, (412) 826–5511. The crude oil is heated to 190 °C (374 °F) under atmospheric pressure. The system is then cooled and placed under vacuum (or under an atmospheric pressure of 20 mm Hg) for the final distillation to an atmospheric equivalent boiling point of 272 °C (521 °F).

4.3.3 *Preparation of mineral nutrient solution.* If a commercial product is strictly a microbial agent and does not contain its own nutrients, a mineral nutrient solution will be provided if requested by the product manufacturer or vendor. If a commercial product contains its own nutrients, no further nutrients will be added. The nutrient solution is a modified salt solution and is described below.

4.3.3.1 *Nutrient preparation:*

1. N&P Salts. The following salts are added to distilled water and made up to a 1,000-ml volume. Adjust final pH to 7.8. The solution is sterilized by autoclaving at 121 °C at 15 psig for 20 minutes or by filtering through a sterile 0.22 μm membrane filter.

Na_2 $HPO_4.2H_2$—18.40 g
KNO_3—76.30 g

2. $MgSO_4.7H_2$ O solution. Dissolve 22.50 g in 1,000 ml distilled water. The solution is sterilized by autoclaving at 121 °C at 15 psig for 20 minutes.

3. $CaCl_2$ solution. Dissolve 27.50 g in 1,000 ml of distilled water. The solution is sterilized by autoclaving at 121 °C at 15 psig for 20 minutes.

4. $FeCl_3 \bullet 6H_2$ O solution. Dissolve 0.25 g in 1,000 ml of distilled water. The solution is sterilized by autoclaving at 121 °C at 15 psig for 20 minutes.

5. Trace Element Solution. The following salts are added to distilled water and made up to a 1,000-ml volume. The solution is sterilized by autoclaving at 121 °C at 15 psig for 20 minutes.

$MnSO_4.H_2$ O—30.2 mg
H_3 BO_3—57.2 mg

[1] Although any of these biomarkers can be used to conduct this test, it is recommended that hopane be used.

$ZnSO_4.7H_2O$—42.8 mg
$(NH_4)6Mo_7(O_2)_4$—34.7 mg

The pH of the nutrient solution is adjusted with a pH meter calibrated at room temperature (approximately 25 °C) using commercial buffers of pH 4.0, 7.0, and 10.0 (Fisher Scientific), as appropriate, prior to use. The pH is adjusted with concentrated HCl or 10 M NaOH, as appropriate.

4.3.3.2 *Final concentrations:* Ten (10) ml of solution 1 and 2 ml of solutions 2–5 are added to non-sterile seawater and made up to a 1,000-ml volume immediately prior to test start-up. This seawater/mineral nutrient solution is used for all flasks containing products requiring nutrient supplements and for the flasks containing no commercial additive. Seawater without the above nutrient solutions is used for products containing their own source of nutrients.

4.4 *Pretest preparation.*

4.4.1 *Experimental setup.*

4.4.1.1 The procedure consists of an experimental shaker flask setup and the specific set of microbiological and chemical analyses that are performed on individual product samples. The following test flasks (labeled with unique identifiers) are prepared and set up on a gyratory shaker at day 0 to reflect the following treatment design:

Treatment	No. of samples at sampling times			Total No. of analytical determinations		
	Day 0	Day 7	Day 28	Microbial counts	Gravimetric	GC/MS
Control	3	3	3	9	9	9
Nutrient	3	3	3	9	9	9
Product	3	3	3	9	9	9

Control = Oil + Seawater
Nutrient = Oil + Seawater + Nutrient
Product = Oil + Seawater + Product (+ Nutrient, if required).

4.4.1.2 For each test, a sheet listing the number of flasks, types of controls, number of replicates, product to be tested, and other information is prepared. The following steps should be adhered to for the experimental setup:

1. Borosilicate glass Erlenmeyer flasks (250–ml) are thoroughly cleaned and autoclaved for 20 minutes at 120 °C at 15 psi, then dried in the drying oven.

2. Flasks are labeled with the appropriate code: product or control, sample day, and letter indicating replicate.

3. 100 ml of seawater is added to each flask.

4. For nutrient and product treatments that require the addition of nutrients, seawater containing the nutrient solution is prepared.

5. Pasteur pipettes should be sterilized in advance. Break off the tip to provide a larger opening prior to sterilization.

6. Pour the approximate amount of oil to be used from the large stock bottle into a sterile beaker. Keep the beaker covered when oil is not being removed.

7. The labeled flasks containing seawater and other additions, as necessary, are placed on the balance. The flask is tared. The appropriate amount of oil (0.5 g) is added drop by drop using a sterile Pasteur pipette with the tip broken off to provide a wider opening. Care is taken to avoid splashing the oil or getting it on the sides of flasks. Precautions are taken when handling and charging the flasks to minimize the likelihood of contamination by exogenous microbes. This includes using a new sterile pipette for each series of flasks.

8. The weight of the oil is recorded in the laboratory notebook.

9. The product is prepared and added to the appropriate flasks according to the manufacturer's or vendor's instructions.

10. Flasks are carried upright and carefully placed in the holders on the shaker table to minimize the amount of oil that might adhere to the side of the flasks. Flasks in which a significant amount of oil is splashed on the sides are redone.

11. The prepared flasks are shaken at 200 rpm at 20 °C until such time that they will be removed for sampling.

4.4.2 *Sampling.* The control and treatments (nutrient and product flasks) are sampled three times over a 28-day period: day 0, day 7, and day 28. The entire flask is sacrificed for analysis; a 0.5–ml aliquot is removed from each flask for the microbiological analysis and the remainder of each flask is used for the chemical analysis. Specific procedures for both the microbiological and chemical analysis are described below. At the time of each sampling event, physical observations of each flask should be recorded.

4.5 *Microbiological analysis.* To monitor the viability of the microbial cultures being studied, microbial enumerations of hydrocarbon degraders are performed at each sampling event using a microtiter MPN determination. This is used as an indicator of the relative change in biomass. This test design relies on using growth response as an indication of enhanced activity as compared to a ''no addition'' control.

4.5.1 *Media preparation.* Media for microbial enumerations are carefully prepared according to manufacturer's or other instructions and sterilized using appropriate methods.

4.5.1.1 *General media treatment:* Buy Bushnell-Haas (B-H) broth in quantities to last no longer than one year. Use media on a first-in, first-out basis. When practical, buy media in quarter-pound multiples, rather than one-pound multiples to keep supply sealed as long as possible. Keep an inventory of media, including kind, amount, lot number, expiration date, date received, and date opened. Check inventory before reordering media. Discard media that are caked, discolored, or show other deterioration.

4.5.1.2 *Sterile saline (pH adjusted):*

1. Weigh 30 g of NaCl.

2. Dissolve in enough water to make 1,000 ml.

3. Adjust pH to 8.0 with NaOH (10M and 0.5M).

4. Sterilize by autoclaving for 15 minutes at 15 psig.

4.5.1.3 *Standard nutrient concentrate (add 1 ml to each 100 ml of Bushnell-Haas medium for MPNs):*

1. Weigh compounds listed below, dissolve in DIH_2 O, dilute to 1 liter.

Potassium Phosphate, monobasic KH_2 PO_4—0.633 g

Potassium Phosphate, dibasic K_2 HPO_4—1.619 g

Sodium Phosphate, dibasic Na_2 HPO_4—2.486 g

Ammonium Chloride NH_4 Cl—3.850 g

Magnesium Sulfate, heptahydrate $MgSO_4 \cdot 7H_2$ O—4.500 g

Calcium Chloride, dihydrate $CaCl_2 \cdot 2H_2$ O—7.290 g

Ferric Chloride, hexahydrate $FeCl_3 \cdot 6H_2$ O—0.250 g

Trace Elements

Manganese Sulfate, monohydrate $MnSO_2 \cdot H_2$ O—6.04 mg

Boric Acid H_3 Bo_3—11.44 mg

Zinc Sulfate, heptahydrate $ZnSO_4 \cdot 7H_2$ O—8.56 mg

Ammonium Moybdate, tetrahydrate $(NH_4)6Mo_7$ $O_{24} \cdot 4H_2$ O—6.94 mg

2. Adjust pH to 6.0.

3. Stir solution for approximately 3 hours, then filter through a Buchner funnel using #1 paper, which will retain approximately 3.8 g of insolubles.

4. Then filter through a 0.45 micron filter into sterile bottles.

5. Cap bottles, label, and store in refrigerator until used.

4.5.1.4 *Quality assurance/Quality control (QA/QC):*

1. Periodically check the effectiveness of sterilization using commercially available tapes or *Bacillus stearothermophilus* spore suspensions, following the instructions with these products.

2. Maintain a media log book that includes the dates, kinds and amounts of media made, pH, and any problems or observations.

3. Before use, check plates and tubes for signs of contamination, drying, or other problems.

4.5.1.5 *Safety/Special precautions:*

1. Note any safety or other precautions for particular media.

2. Note precautions to be followed when using the autoclave.

3. Use gloves and other protective clothes when handling media.

4. Use care in handling hot media.

4.5.2 *Microbial enumeration.* Standardized techniques for performing Most Probable Number microbial enumerations are described below.

4.5.2.1 *Dilutions:*

1. Prior to sacrificing each flask, remove 0.5 ml of water from each flask and add it to a tube of 4.5 ml sterile phosphate buffer (1:10 dilution) as prepared in the *Standard Methods for the Examination of Water and Wastewater* (9). Using sterile technique, mix and perform serial dilutions (0.5 ml of previous dilution to 4.5 ml of sterile phosphate buffer) to 10^{-9} dilution.

4.5.2.2 *Inoculating MPN plates (oil degrader):*

1. Prepare sufficient sterile 0.4 M NaCl (23.4 g NaCl/1,000 ml B-H) and B-H at pH 7.0 to fill the number of wells required for the test (1.75 ml/well).

2. Using sterile technique, add 1.75 ml of B-H broth to each well.

3. Label the top of the plate with the proper dilution for each row.

4. Add 0.1 ml of fluid from each dilution tube to each well in the appropriate row, starting with the most dilute.

5. After adding the fluid to all the wells, add 20 µl of sterilized No. 2 fuel oil to the top of each well.

6. Incubate each plate at 20 °C.

7. After 14 days of incubation, add 100 µl of p-iodotetrazolium violet dye (50 mg/10 ml of D.I. water) to each well to determine growth.

8. View plates against a white background to determine if color is present. Development of a purple or pink color upon standing for 45 minutes constitutes a positive test.

9. Record the number of positive wells and the dilutions at which they occur.

10. Enter data into a computerized enumeration method using ''MPN Calculator'' software program (version 2.3 or higher) by Albert J. Klee, U.S. EPA Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH.

4.5.2.3 *Quality assurance/Quality control:*

1. Check pH of medium before preparing wells (pH should be approximately 8.0). Adjust pH, if necessary, with dilute NaOH.

2. Keep prepared tetrazolium violet dye solution in the refrigerator in an amber bottle when not in use.

3. Have all laboratory personnel periodically run MPNs on the same sample to test precision.

4.5.2.4 *Safety/Special precautions:*

1. Use sterile technique in preparing solutions, dilutions, plates, and MPN wells.

2. Do not pipette potentially hazardous solutions by mouth.

3. Autoclave all plates and wells before discarding.

4.6 *Chemical analysis of oil composition.*

4.6.1 *Sample procedure.* After 0, 7, and 28 days of incubation on a rotary shaker, the appropriate flasks are sacrificed and extracted with dichloromethane and spiked with a surrogate recovery standard. A 10-ml aliquot of the DCM layer is used for the gravimetric analysis. If significant biodegradation is evident in the results of the gravimetric analysis, then a solvent exchange into hexane takes place prior to the GC/MS analysis. Follow steps 1–19 below when preparing for the chemical analysis.

1. After 0, 7, and 28 days of rotary shaking and incubating at 20 °C, the reaction vessels are sacrificed. Prior to the chemical analysis, a 0.5-ml sample of the aqueous phase is removed for the microbiological analysis (see Microbial Enumeration above).

2. A surrogate recovery standard is prepared in the following manner: 1,000 mg of d_{10}-phenanthrene and 1,000 mg of 5α-androstane are measured into a 500-ml volumetric flask and DCM is added to the mark to produce a 2,000-ng/µl stock solution.

3. A 100-µl aliquot of the surrogate solution is added to each test flask. The final concentration of surrogates in each flask is approximately 4 ng/µl of solvent in the final extract. The aliphatics and marker data should be corrected for percent recovery of the 5α-androstane surrogate and the aromatics for the d_{10}-phenanthrene surrogate.

4. The contents of the flask are placed into a 250-ml separatory funnel.

5. Measure a total volume of 50 ml DCM for use in the extraction. Use 3 10-ml fractions to rinse the flask into the funnel and transfer the remaining aliquot of DCM to the funnel.

6. Stopper and mix vigorously by shaking (approximately 50 times) while ventilating properly.

7. Each funnel is set aside to allow the DCM and water layers to partition. This may take 5–10 minutes for some products, or up to 3 hours if the product has caused the formation of an emulsion.

8. Drain the first 10 ml of the DCM (bottom) layer, collect, cap, uniquely label, and use for gravimetric analysis (see below). Drain the remaining 40 ml and dry it by passing it through a funnel packed with anhydrous sodium sulfate.

9. Assemble a Kuderna-Danish (KD) concentrator by attaching a Snyder column to an evaporation flask with a graduated concentrator tube. Align vertically and partially immerse concentrator tube in a water bath (10). Set the water bath to the appropriate temperature to maintain proper distillation.

10. Collect the de-watered extract into the KD concentrator.

11. Evaporate DCM to approximately 10 ml, then add approximately 50 ml of the exchange solvent (hexane) and concentrate the volume to 10 ml.

12. Rinse the flask into the concentrator tube with 50 ml hexane and concentrate to 10 ml. Repeat one more time with 50 ml of hexane.

13. Remove concentrator tube with the recovered 10 ml of sample volume. The heavier residual material should be present as a precipitate (bottom layer).

14. Centrifuge to aid the separation of the hexane from the precipitant fraction.

15. Place hexane-soluble fraction (top layer)—approximately 1.0 ml—into a GC/MS vial for analysis (see GC/MS Analysis Procedure below). If column fouling and deterioration of separation characteristics occur, an alumina column sample cleanup method can be considered (see Alternative GC/MS Sample Cleanup Procedure below).

16. Analyze by GC/MS using the conditions determined by the U.S. EPA Risk Reduction Engineering Laboratory, Water and Hazardous Waste Treatment Research Division, in Cincinnati, OH, which follows U.S. EPA Method 8270 (see GC/MS Analysis Procedure below).

17. Calculate surrogate recovery. If surrogate recovery is less than 85 percent for the marker relative to the surrogate recovery standard (d_{10}-phenanthrene), then the water layer should be extracted again using three separate extractions with DCM. Pool the three extractions with original extract and concentrate to 10 ml, and reanalyze by GC/MS.

18. Drain the seawater into a storage sample vial/container.

19. Seal the vial with a Teflon-lined cap and store frozen. This water layer is kept in case additional extractions are necessary.

4.6.2 *Gravimetric analysis.* The initial means to evaluate the effectiveness of a bioremediation agent for oil spill response is through gravimetric analysis. A statistically significant difference ($p < 0.05$) in analytical weight of the oil from the control system as compared to the analytical weight of the oil treated with a bioremediation agent indicates biodegradation has successfully occurred. Hence, the disappearance of oil should be accompanied by significant decreases in total oil residue weight of extractable materials versus a control. If no significant decrease in oil residue weight is observed, the need to perform further chemical analysis should be evaluated. Follow steps 1–3 to conduct the gravimetric analysis.

1. The 10 ml of DCM extract (from Sample Procedure step 8 above) is placed in a small vial and concentrated to dryness by nitrogen blowdown techniques using a steady stream of nitrogen (pre-purified gas). If the oil is severely biodegraded, a larger volume of DCM (>10 ml) may be necessary for the gravimetric analysis.

2. The residue is weighed 3 times for the gravimetric weight of oil. Record the weight of the oil.

3. Compare statistically ($p < 0.05$) the weight of the product treatment versus the weight of the control from each respective time period. If a significant decrease is observed in the sampling (flask containing bioremediation agent) weight, then proceed with the remainder of the sample procedure.

4.6.3 *GC/MS analysis.* Often, analysis of saturated and aromatic hydrocarbons by capillary gas chromatography of DCM extracts leads to column fouling and deterioration of separation characteristics. An alternative, simple ''one-step'' alumina sample cleanup procedure can be performed on oil before injection; this cleanup removes both asphaltenes and polar compounds and can be applied to DCM extracts as well. This procedure is described in steps 1–11 below.

4.6.3.1 Alternative GC/MS sample cleanup procedure:

1. Weigh 4.0 g alumina (neutral, 80–200 mesh) into scintillation vials covered loosely with aluminum foil caps. Prepare one scintillation vial per sample. Heat for 18 hours at 300 °C or longer. Place in a desiccator of silica until needed.

2. Add 5.0 ml of DCM to a glass luerlok multi-fit syringe (e.g., BD #2471) with stopcock (e.g., Perfectum #6021) in closed position, stainless steel syringe needle (18 gauge), and PTFE frits. Clamp in a vertical position.

3. Transfer 4.0 g of prepared alumina to a plastic weighing boat and fill syringe slowly while applying continuous vibration (e.g., Conair # HM 11FF1).

4. Add a second PTFE frit and push into place on top of the alumina bed.

5. Drain 5.0 ml DCM to the top level of the column frit to await sample addition and discard DCM.

6. Weigh 50 mg ±0.1 mg ANS521 oil into a tared vial.

7. Premeasure 10 ml of DCM into a graduated cylinder. Add 0.2 to 0.3 ml of the DCM to the tared oil vial. Mix and transfer solvent to the column bed with a Pasteur pipette. Open stopcock and collect in a 10-ml volumetric flask. Repeat until approximately 1.0 ml (do not exceed 1.0 ml) of DCM has rinsed the vial and inner walls of the syringe body into the 10-ml flask.

8. Transfer balance of DCM from the graduated cylinder to the column and regulate the solvent flow rate to approximately 1 to 2 ml/minute. Collect all eluent in the 10-ml flask.

9. Transfer a known volume of eluent to another scintillation vial and blow down to dryness (nitrogen).

10. Determine and record weight.

11. Dissolve in 1.0 ml hexane for the GC/MS analysis procedure (see below).

4.6.3.2 GC/MS analysis procedure:

Immediately prior to injection, an internal standard solution of four deuterated compounds is spiked into the sample extracts and injected. Samples are quantified using the internal standard technique (10) for both the aliphatic and aromatic fractions of the oil extracts in order to provide sufficient information that the oil is being degraded. To help ensure that the observed decline in target analytes is caused by biodegradation rather than by physical loss from mishandling or inefficient extraction, it is necessary to normalize the concentrations of the target analytes via a ''conserved internal marker.'' Conserved internal markers that have been found useful for quantification are C_2- or C_3-phenanthrene, C_2-chrysene, and $C_{30}17\alpha(H),21\beta(H)$-hopane. Deuterated internal standards are used to calculate the relative response factor (RRF) for the target analyte(s). To compute the ''normalized concentrations,'' the target analyte concentration at a given sampling time is simply divided by the selected conserved analyte concentration at the same sampling time (11). Conduct the GC/MS analysis using the following procedure.

1. One (1) ml of the hexane extract (from Sample Procedure step 15 above) is placed into a 1.5-ml vial for use on the autosampler of the GC/MS instrument.

2. To this solution, 20 µl of a 500-ng/µl solution of the internal standards is added and the vial is capped for injection. The final concentration of the internal standards in each sample is 10 ng/µl. This solution contains 4 deuterated compounds: d_8-naphthalene, d_{10}-anthracene, d_{12}-chrysene, and d_{12}-perylene.

3. At the start of any analysis period, the mass spectrometer (MS) is tuned to PFTBA by an autotune program, such as the Hewlett-Packard quicktune routine, to reduce operator variability. Set the GC/MS in the SIM mode at a scan rate of 1.5 scans/second to maximize the linear quantitative range and precision of the instrument. Set all other conditions to those specified in Instrument Configuration and Calibration section below.

4. An instrument blank and a daily standard are analyzed prior to analysis of unknowns. Internal standards are combined with the sample extracts and coinjected with each analysis to monitor the instrument's performance during each run.

5. Information that should be included on the acquisition form include operator's name

and signature, date of extraction, date and time of autotune, date of injection(s), instrument blank, daily standard mix injection, GC column number, and standards for the 5-point calibration curve.

6. If the instrument is operated for a period of time greater than 12 hours, the tune will be checked and another daily standard analyzed prior to continuing with analyses.

TABLE 6—ANALYTES LISTED UNDER THE CORRESPONDING INTERNAL STANDARD USED FOR CALCULATING RRFS

Internal Standard	d_8-naphthalene	d_{10}-anthracene	d_{12}-chrysene	d_{12}-perylene
Alkanes	nC10–nC15	nC16–nC23	nC24-nC29	nC30-nC35.
		Pristane		$C_{30}17\beta(H)$, 21α(H)-hopane.
		Phytane		
		5α-androstane		
Aromatics	Naphthalene	Dibenzothiophene.	Fluoranthene	Benzo(b)fluoranthene.
		Fluorene	Pyrene	Benzo(k)fluoranthene.
		Anthracene	Chrysene	Benzo(e)pyrene.
		Phenanthrene		Benzo(a)pyrene.
				Perylene.
				Indeno(g,h,i)pyrene.
				Dibenzo(a,h) anthracene.
				Benzo(1,2,3-cd)perylene.

7. The MS is calibrated using a modified version of EPA Method 8270 (10). Specifically, the concentrations of internal standards are 10 ng/µl instead of 40 ng/µl. A five-point calibration curve is obtained for each compound listed in table 6 prior to sample analysis at 1, 5, 10, 25, and 50 ng/µl. A 5-point calibration must be conducted on a standard mix of compounds to determine RRFs for the analytes. The standard mix (excluding the marker) for this calibration curve may be obtained from Absolute Standards, Inc., 498 Russell St., New Haven, CT, 06513, (800) 368–1131. If $C_{30}17\beta(H),21\alpha(H)$-hopane is used, it may be obtained from Dr. Charles Kennicutt II, Geochemical and Environmental Research Group, Texas A&M University, 833 Graham Rd., College Station, TX, 77845, (409) 690–0095.

8. Calculate each compound's relative response factor to its corresponding deuterated internal standard indicated above, using the following equation:

$$RRF=(A_x\ C_{is})/(A_{is}\ C_x) \quad (6)$$

where:

RRF=relative response factor

A_x=peak area of the characteristic ion for the compound being measured (analyte)

A_{is}=peak area of the characteristic ion for the specific internal standard

C_x=concentration of the compound being measured (ng/µl)

C_{is}=concentration of the specific internal standard (10 ng/µl). (This concentration is a constant in this equation for the calibration curve.)

9. Identify each analyte based on the integrated abundance from the primary characteristic ion indicated in table 7.

10. Quantitate each analyte using the internal standard technique. The internal standard used shall be the one nearest the retention time of that of a given analyte (Table 8).

TABLE 7—PRIMARY IONS MONITORED FOR EACH TARGET ANALYTE DURING GC/MS ANALYSIS

Compound	Ion
n-alkanes (C_{10}–C_{35})	85
Pristane	85
Phytane	85
Naphthalene	128
C1-naphthalenes	142
C2-naphthalenes	156
C3-naphthalenes	170
C4-naphthalenes	184
Fluorene	166
C1-fluorenes	180
C2-fluorenes	194
C3-fluorenes	208
Dibenzothiophenes	184
C1-dibenzothiophenes	198
C2-dibenzothiophenes	212
C3-dibenzothiophenes	226
Anthracene	178
Phenanthrene	178
C1-phenanthrenes	192
C2-phenanthrenes	206
C3-phenanthrenes	220
Fluoranthene/pyrene	202
C1-pyrenes	216
C2-pyrenes	230
Chrysene	228
C1-chrysenes	242
C2-chrysenes	256
Hopanes (177 family)	177
Hopanes (191 family)	191
Steranes (217 family)	217
Benzo(b)fluoranthene	252
Benzo(k)fluoranthene	252
Benzo(e)pyrene	252
Benzo(a)pyrene	252
Perylene	252
Ideno(g,h,i)pyrene	276
Dibenzo(a,h)anthracene	278
Benzo(1,2,3-cd)perylene	276
d_8-naphthalene	136
d_{10}-anthracene	188

TABLE 7—PRIMARY IONS MONITORED FOR EACH TARGET ANALYTE DURING GC/MS ANALYSIS—Continued

Compound	Ion
d_{10}-phenanthrene	188
d_{12}-chrysene	240

TABLE 7—PRIMARY IONS MONITORED FOR EACH TARGET ANALYTE DURING GC/MS ANALYSIS—Continued

Compound	Ion
d_{12}-perylene	264
α-androstane	260

TABLE 8—ANALYTES AND REFERENCE COMPOUNDS

Compound	Reference compound	Compound	Reference compound
n-C10	n-C10	C2-naphthalene	Naphthalene.
n-C11	n-C11	C3-naphthalene	Naphthalene.
n-C12	n-C12	C4-naphthalene	Naphthalene.
n-C13	n-C13	Fluorene	Fluorene.
n-C14	n-C14	C1-fluorene	Fluorene.
n-C15	n-C15	C2-fluorene	Fluorene.
n-C16	n-C16	C3-fluorene	Fluorene.
n-C17	n-C17	Dibenzothiophene	Dibenzothiophene.
Pristane	Pristane	C1-dibenzothiophene	Dibenzothiophene.
n-C18	n-C18	C2-dibenzothiophene	Dibenzothiophene.
Phytane	Phytane	C3-dibenzothiophene	Dibenzothiophene.
n-C19	n-C19	Phenanthrene	Phenanthrene.
n-C20	n-C20	Anthracene	Anthracene.
n-C21	n-C21	C1-phenanthrene	Phenanthrene.
n-C22	n-C22	C2-phenanthrene	Phenanthrene.
n-C23	n-C23	C3-phenanthrene	Phenanthrene.
n-C24	n-C24	Fluoranthene	Fluoranthene.
n-C25	n-C25	Pyrene	Pyrene.
n-C26	n-C26	C1-pyrene	Pyrene.
n-C27	n-C27	C2-pyrene	Pyrene.
n-C28	n-C28	Chrysene	Chrysene.
n-C29	n-C29	C1-chrysene	Chrysene.
n-C30	n-C30	C2-chrysene	Chrysene.
n-C31	n-C31	Benzo(b)fluoranthene	Benzo(b)fluoranthene.
n-C32	n-C32	Benzo(k)fluoranthene	Benzo(k)fluoranthene.
n-C33	n-C33	Benzo(e)pyrene	Benzo(e)pyrene.
n-C34	n-C34	Benzo(a)pyrene	Benzo(a)pyrene.
n-C35 $C_{30}17\alpha,21\beta$-hopane	n-C35 $C_{30}17\alpha,21\beta$-hopane	Perylene ideno(g,h,i)pyrene	Perylene ideno(g,h,i)pyrene.
5α-androstane	5α-androstane	Dibenzo(a,h)anthracene	Dibenzo(a,h)anthracene.
C1-naphthalene	Naphthalene	Benzo(1,2,3-cd)perylene	Benzo(1,2,3-cd)perylene.

11. Use equation 7 to calculate the concentration of analytes in ng/mg (ppm) oil:

$$\text{Concentration (ng/mg)} = (A_x\ I_s\ V_t \times 1{,}000)/(A_{is}(RRF)V_i\ M_o) \quad (7)$$

where:

A_x=peak area of characteristic ion for compound being measured
I_s=amount of internal standard injected, in ng (i.e., 20 ng)
V_t=volume of the total DCM extract (50 ml)
A_{is}=peak area of the characteristic ion of the internal standard
RRF=relative response factor
V_i=volume of the extract injected (2 µl)
M_o=total mass of the oil added to the flask, mg

12. Compute the ''normalized concentrations'' for each target analyte concentration at a given sampling time (equation 7) by simply dividing by the conserved internal marker concentration at the same sampling time.

4.6.4 *Generally accepted laboratory procedures.* Samples are immediately logged into the laboratory, where they will be given a unique sample identification based on Julian data and the number logged in. Prior to the analysis of any experimental samples, a five-point standard curve is prepared. One of the mid-range standard curve concentration levels is analyzed daily before sample analysis as a continuing standard. RRFs for all target analytes *should* be within 25% of the standard curve response values at day 0, and at any sampling event the check standard percent difference from the initial five-point calibration must not exceed 20% between the before and after daily standard mix (see below). The collected GC/MS data are initially processed by a macro routine, which performs extracted chromatographic plots of the target compounds, integrates the target compounds, and shows integration results to include tabular numbers. The integration values are then transferred to a spreadsheet format to be quantified. Because of the complexity of the analyte matrix (oil), a very high degree of manual verification and reintegration of the spectral data is required.

4.6.5 *QA/QC procedures.* The reliability of this method is dependent on the QA/QC procedures followed. Before and after each analytical batch (approximately 10 samples), analyze one procedural blank, one duplicate, and one calibration verification standard (10 ng/µl). Analyze one reference crude oil standard. The instrument's performance and reproducibility are validated routinely in this manner. Surrogate recoveries should be within 70 to 120%, and duplicate relative percent difference values should be ±20%. A control chart of the standard oil should be prepared and monitored. Variations of analytes in the control chart should be no more than 25% from the historical averages. Injection port discrimination for n-C25 and greater alkanes must be carefully monitored; the ratio of RRF n-C32/RRF n-C21 alkanes should not be allowed to fall below 80%. The mass discrimination can be reduced by replacing the quartz liner in the injection port after every analytical batch. The instrument's performance and reproducibility are validated routinely by analyzing the reference crude oil standard. All analyses are recorded in instrument logs detailing operating conditions, date and time, file name, etc. After analysis, the sample extracts are archived at refrigeration temperatures. To document QA/QC, the following information is contained in the detailed quantitative reports: average RRF derived from the standard curve; RRF from the daily standard; percent relative standard deviation; area of target analyte; concentration determined both on a weight and volume basis; and values for any surrogates and internal standards.

4.6.6 *Instrument configuration and calibration.* A 2-ml aliquot of the hexane extract prepared by the above procedure is injected into a GC/MS instrument, such as the Hewlett-Packard 5890/5971 GC/MS (recommended for use). This instrument should be equipped with a DB–5 capillary column (30 m, 0.25-mm I.D., and 0.25-µm film thickness) and a split/splitless injection port operating in the splitless mode. Table 9 summarizes the temperature program used for the analysis. This temperature program has been optimized to give the best separation and sensitivity for analysis of the desired compounds on the instrument. Prior to the sample analysis, a five-point calibration must be conducted on a standard mix of the compounds listed in table 7 to determine RRFs for the analyses.

TABLE 9—OPERATING CONDITIONS AND TEMPERATURE PROGRAM OF GC/MS

Operating conditions
Injector port—290 °C
Transfer line—320 °C
Total run time—73 minutes
Column flow rate (He)—1.0 ml/minute

Temperature Program

Level	Temp. 1, °C	Time 1, minutes	Rate, °C/minute	Temp 2, °C	Time 2, minutes
Level 1	55	3	5	280	5
Level 2	280	0	3	310	10

4.7 *Statistical analysis.* The determination of a bioremediation agent's effectiveness will be partially based upon the results of a statistical analysis of the shaker flask experiment. The experimental design for this test is a two factorial design. This two-way analysis of variance (ANOVA) will be used to determine data trends. The statistical method is designed to test various types of bioremediation treatments including microbial, nutrient, enzyme, and combination products. The following is a summary of the statistical methods to be used to evaluate the analytical data obtained from all product tests. The experimental design, data analysis methodology, interpretation of results, required documentation, and a numeric example are outlined below.

4.7.1 *Experimental design.* The experimental design for this test is known as a factorial experiment with two factors. The first factor is product/control group; the second factor is time (measured in days). For example, if two groups (product A and a non-nutrient control) are tested at each of three points in time (day 0, 7, and 28), the experiment is called a 2×3 factorial experiment. There will be three replications (replicated shaker flasks) of each group-time combination.

4.7.2 *Data analysis methods.* For each analyte and each product used, a product is considered a success by the demonstration of a statistically significant difference between the mean analyte degradation by the product and the mean analyte degradation by the non-nutrient control. Such a determination will be made by performing an ANOVA on the sample data. The technical aspects of this procedure are outlined in Snedecor and Cochran (12). Most statistical software packages support the use of two-way ANOVA. However, the format required for the input data differs among the various commercial packages. Whichever package is used, the following ANOVA table will be provided as part of the output. In the Degree of Freedom column of table 10, p = the number of product/control groups, t = the number of days at which each group is analyzed, and n = the number of replications. For the example of the 2×3 factorial experiment discussed above, p=2, t=3, and n=3. The significance of the F-statistics (as indicated by their corresponding p-values) are used to interpret the analysis.

TABLE 10—TWO-WAY ANOVA TABLE

Source	Degree of freedom (df)	Sum of squares	Mean square	F-Statistic	p-Value
Group	p-1	SSG	MSG-MSG/MSE	MSG/MSE	[1]
Time	t-1	SST	MST-MST/MSE	MST/MSE	[1]
Interaction	(p–1)(t–1)	SSI	MSI-MSI/MSE	MSI/MSE	[1]
Error	pt(n–1)	SSE	MSE-SSE		
Total	npt–1	SSTOT			

[1] To be determined from the value of the F-statistic.

4.7.3 *Interpretation*. 4.7.3.1 If the F-statistic for the interaction is significant at the 0.05 level (i.e., p-value is less than 0.05), the data indicate that the mean response of at least two groups being tested differ for at least one point in time. In order to find out which groups and at which points in time the difference occurs, pairwise comparisons between the group means should be conducted for all time points. These comparisons can be made using protected least squared difference (LSD) or Dunnett mean separation techniques. The protected LSD procedure is detailed in Snedecor and Cochran (12); the Dunnett procedure is outlined in Montgomery (13). For both methods, the mean square error (MSE) from the two-way ANOVA table should be used to compute the separation values.

4.7.3.2 If the F-statistic for the interaction is not significant at the 0.05 level (i.e., p-value not less than 0.05), but the F-statistic for the group is significant (i.e., p-value is less than 0.05), the data indicate that any differences that exist among the group means are consistent across time. To find out which group means differ, a pairwise comparison of the group means should be carried out by pooling data across all points in time. Again, the MSE from the two-way ANOVA table should be used to compute the separation values.

4.7.3.3 If the F-statistic corresponding to both interaction and group are not significant at the 0.05 level, the data indicate no difference between the group means at any point in time. In this case, no further analysis is necessary.

4.7.3.4 Finally, Snedecor and Cochran (12) use caution concerning the use of multiple comparisons. If many such comparisons are being conducted, then about 5% of the tested differences will erroneously be concluded as significant. The researcher must guard against such differences causing undue attention.

4.7.4 *Required documentation*. 4.7.4.1 The following documents should be included to summarize the findings from a product test.

1. Data listings for each analyte that was analyzed. These should show all raw data.

2. A table of summary statistics for each analyte. The table should include the mean, standard deviation, and sample size for each group at each day.

3. An ANOVA table for each analyte. The table should be of the same format as table 10.

4. A clear summary of the mean separations (if mean separations were necessary). The mean separation methods (LSD or Dunnett), the significance level, the minimum significant difference value, and the significant differences should be clearly marked on each output page.

5. All computer outputs should be included. No programming alterations are necessary. The specific computer package used to analyze the data should be included in the report.

Example. An analysis of the total aromatic data (in ppm) was conducted for the following three groups:

Group 1: Non-nutrient Control
Group 2: Nutrient Control
Group 3: Test Product

4.7.4.2 The raw data are shown in table 11. Note the three replications for each group-time combination.

TABLE 11—PRODUCT TEST DATA, TOTAL AROMATICS (PPM)

	Group 1	Group 2	Group 3
Day 0	8153	7912	7711
	8299	8309	8311
	8088	8111	8200
Day 7	8100	7950	6900
	8078	8200	6702
	7999	8019	5987
Day 28	8259	8102	4000
	8111	7754	3875
	8344	7659	3100

4.7.4.3 Table 12 gives the summary statistics (number of observations, means, and standard deviations) for each group-time combination.

TABLE 12—SUMMARY STATISTICS FOR PRODUCT TEST DATA TOTAL AROMATICS (PPM)

Time	Product	n	Mean	Standard deviation
Day 0	Group 1	3	8,180.0	108.1

TABLE 12—SUMMARY STATISTICS FOR PRODUCT TEST DATA TOTAL AROMATICS (PPM)—Continued

Time	Product	n	Mean	Standard deviation
	Group 2	3	8,110.7	198.5
	Group 3	3	8,074.0	319.2
Day 7	Group 1	3	8,059.0	53.1
	Group 2	3	8,056.3	129.1
	Group 3	3	6,529.7	480.3
Day 28	Group 1	3	8,238.0	117.9
	Group 2	3	7,838.3	233.2
	Group 3	3	3,658.3	487.6

4.7.4.4 Table 13 shows the results of the two-way ANOVA.

TABLE 13—EXAMPLE TWO-WAY ANOVA TABLE

Source	df	Sum of squares	Mean square	F-statistic	p-value
Group	2	23,944,856.41	11,972,428.70	151.94	0.0001
Time	2	10,954,731.19	5,477,365.59	69.51	0.0001
Interaction	4	19,347,589.04	4,836,897.26	61.39	0.0001
Error	18	1,418,303.33	78,794.63	.....	.....
Total	26	55,665,480.96	.....	.....	.....

4.7.4.5 From table 13, it can be seen that the F-statistic for interaction is significant (F=61.39, p=0.0001). This indicates that group differences exist for one or more days. Protected LSD mean separations were then conducted for each day to determine which group differences exist. The results are summarized in table 14. Note that means with the same letter (T grouping) are not significantly different.

TABLE 14—PAIRWISE PROTECTED LSD MEAN SEPARATION

T grouping	Mean	n	Interaction
A	8,338.0	3	Group 1, Day 28.
A	8,180.0	3	Group 1, Day 0.
A	8,110.7	3	Group 2, Day 0.
A	8,074.0	3	Group 3, Day 0.
A	8,059.0	3	Group 1, Day 7.
A	8,056.3	3	Group 2, Day 7.
A	7,838.3	3	Group 2, Day 28.
B	6,529.7	3	Group 3, Day 7.
C	3,658.3	3	Group 3, Day 28.

Significant Level = 0.05.
Degrees of Freedom = 18.
Mean Square Error = 78794.63.
Critical Value = 2.10.
Least Significant Difference = 481.52.

4.7.4.6 The grouping letters indicate that the product mean values (group 3) at day 7 and day 28 are significantly different from those of both the nutrient control (group 2) and the non-nutrient control (group 1) for those days. No other significant differences are shown. Therefore, in terms of total aromatic degradation, the test indicates the desired statistically significant difference between the mean of the product and the mean of the non-nutrient control.

5.0 Bioremediation agent toxicity test

[Reserved]

6.0 Summary technical product test data format.

The purpose of this format is to summarize in a standard and convenient presentation the technical product test data required by the U.S. Environmental Protection Agency before a product may be added to EPA's NCP Product Schedule, which may be used in carrying out the National Oil and Hazardous Substances Pollution Contingency Plan. This format, however, is not to preclude the submission of all the laboratory data used to develop the data summarized in this format. Sufficient data should be presented on both the effectiveness and toxicity tests to enable EPA to evaluate the adequacy of the summarized data. A summary of the technical product test data should be submitted in the following format. The numbered headings should be used in all submissions. The subheadings indicate the kinds of information to be supplied. The listed subheadings, however, are not exhaustive; additional relevant information should be reported where necessary. As noted, some subheadings may apply only to particular types of agents.

I. *Name, Brand, or Trademark*

II. *Name, Address, and Telephone Number of Manufacturer*

III. *Name, Address, and Telephone Numbers of Primary Distributors*

IV. *Special Handling and Worker Precautions for Storage and Field Application*

1. Flammability.

2. Ventilation.

3. Skin and eye contact; protective clothing; treatment in case of contact.

4. Maximum and minimum storage temperatures; optimum storage temperature range; temperatures of phase separations and chemical changes.

V. *Shelf Life*

VI. *Recommended Application Procedure*

1. Application method.

2. Concentration, application rate (e.g., gallons of dispersant per ton of oil).

3. Conditions for use: water salinity, water temperature, types and ages of pollutants.

VII. *Toxicity (Dispersants, Surface Washing Agents, Surface Collecting Agents, and Miscellaneous Oil Spill Control Agents)*

Materials Tested	Species	LC_{50} (ppm)
Product	Menidia beryllina	96-hr.
	Mysidopsis bahia 2	48-hr.
No. 2 fuel oil	Menidia beryllina	96-hr.
	Mysidopsis bahia	48-hr.
Product and No. 2 fuel oil (1:10)	Menidia beryllina	96-hr.
	Mysidopsis bahia	48-hr.

VIII.(a). *Effectiveness (bioremediation agents)*. Raw data must be reported according to the format shown below. The first column lists the names of the analytes measured by GC/MS (SIM), the surrogate standards, and various ratios and sums. In the next three columns, the concentration of the analytes (ng/mg oil), the concentration of the analytes corrected for the recovery of the surrogate standard (α-androstane for alkanes, d_{10}-phenanthrene for aromatics), and the concentration of corrected analytes normalized against the conserved internal marker, respectively, are reported for the first replicate from the first sampling event. These three columns are each repeated for the next two replicates, giving 9 total columns for the product of interest. The next 9 columns are the same as the product columns except they are for the non-nutrient control. The last nine columns are for the nutrient control. Thus, a total of 28 columns are needed in the spreadsheet. This spreadsheet is for the first sampling event (day 0). Two more identical spreadsheets will be needed for each of the next two sampling events (days 7 and 28). For the statistical analysis, a report showing the two-way analysis of variance (ANOVA) table created by the software used by the investigator must be shown in its entirety along with the name of the software package used. Another printout showing the mean separation table (protected LSD test results) generated by the software must be reported. The statistical analyses are conducted using the sum of the alkane concentrations and the sum of the aromatics concentrations from the raw data table. Thus, two ANOVAs are run for each sampling event, one for total alkanes and one for total aromatics, giving a total of 6 ANOVAs for a product test (2 ANOVAs × 3 sampling events). Only if significant differences are detected by a given ANOVA will it be necessary to run a protected LSD test.

BIOREMEDIATION AGENT EFFECTIVENESS TEST RAW DATA

[Date: . Testing Date: 0, 7, 28 (Circle One). Initial Oil Weight: .]

	Product Replicate 1			Product Replicate 2
	Concentration ng/mg	Surrogate corrected ng/mg	Normalized to marker ng/mg	
Alkane Analyte				
n-C10				
n-C11				
n-C12				
n-C13				
n-C14				
n-C15				
n-C16				
n-C17				
pristane				
n-C18				
phytane				
n-C19				
n-C20				
n-C21				
n-C22				
n-C23				
n-C24				
n-C25				
n-C26				
n-C27				
n-C28				
n-C29				
n-C30				
n-C31				
n-C32				
n-C33				
n-C34				
n-C35				

BIOREMEDIATION AGENT EFFECTIVENESS TEST RAW DATA—Continued

[Date: . Testing Date: 0, 7, 28 (Circle One). Initial Oil Weight: .]

	Product Replicate 1			Product Replicate 2
	Concentration ng/mg	Surrogate corrected ng/mg	Normalized to marker ng/mg	
n-C36				
α-androstane				
Total alkanes				
n-C17:pristane				
n-C18:phytane				
Aromatic Analyte:				
naphthalene				
C1-naphthalenes				
C2-naphthalenes				
C3-naphthalenes				
C4-naphthalenes				
dibenzothiophene				
fluorene				
C1-fluorenes				
C2-fluorenes				
C3-fluorenes				
C1-dibenzothiophenes				
C2-dibenzothiophenes				
C3-dibenzothiophenes				
phenanthrene				
anthracene				
C1-phenanthrenes				
C2-phenanthrenes				
C3-phenanthrenes				
naphthobenzothio				
C1-naphthobenzothio				
C2-naphthobenzothio				
C3-naphthobenzothio				
fluoranthene				
pyrene				
C1-pyrenes				
C1-pyrenes				
chrysene				
benzo(a)anthracene				
C1-chrysenes				
c2-chrysenes				
benzo(b)fluoranth				
benzo(k)fluoranth				
benzo(e)pyrene				
benzo(a)pyrene				
perylene				
indeno(1,2,3-cd)per				
benzo(g,h,i)pyrene				
dibenz(ah)anthrac				
α,β-hopane				
d8-naphthalene				
d10-phenanthrene				
d12-chrysene				
d12-perylene				
Total aromatics				
Grav. weight oil				
No. oil degraders/ml				

VIII.(b). *Toxicity (Bioremediation Agents)* [Reserved]

IX. *Microbiological Analysis (Bioremediation Agents)*

X. *Physical Properties of Dispersant/Surface Washing Agent/Surface Collecting Agent/Miscellaneous Oil Spill Control Agent:*

1. Flash Point: (°F)

2. Pour Point: (°F)

3. Viscosity: _____ at _____ °F (furol seconds)

4. Specific Gravity: _____ at _____ °F

5. pH: (10% solution if hydrocarbon based)

6. Surface Active Agents (Dispersants and Surface Washing Agents)[2]

[2]If the submitter claims that the information presented under this subheading is confidential, this information should be submitted on a separate sheet of paper clearly

7. Solvents (Dispersants and Surface Washing Agents)
8. Additives (Dispersants and Surface Washing Agents)
9. Solubility (Surface Collecting Agents)

XI. *Analysis for Heavy Metals, Chlorinated Hydrocarbons, and Cyanide (Dispersants, Surface Washing Agents, Surface Collecting Agents, and Miscellaneous Oil Spill Control Agents):*

Compounds	Concentration (ppm)
Arsenic	
Cadmium	
Chromium	
Copper	
Lead	
Mercury	
Nickel	
Zinc	
Cyanide	
Chlorinated Hydrocarbons	

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[59 FR 47458, Sept.15, 1994]

APPENDIX D TO PART 300—APPROPRIATE ACTIONS AND METHODS OF REMEDYING RELEASES

(a) This appendix D to part 300 describes types of remedial actions generally appropriate for specific situations commonly found at remedial sites and lists methods for remedying releases that may be considered by the lead agency to accomplish a particular response action. This list shall not be considered inclusive of all possible methods of remedying releases and does not limit the lead agency from selecting any other actions deemed necessary in response to any situation.

(b) In response to contaminated soil, sediment, or waste, the following types of response actions shall generally be considered: removal, treatment, or containment of the soil, sediment, or waste to reduce or eliminate the potential for hazardous substances or pollutants or contaminants to contaminate other media (ground water, surface water, or air) and to reduce or eliminate the potential for such substances to be inhaled, absorbed, or ingested.

(1) Techniques for removing contaminated soil, sediment, or waste include the following:

(i) Excavation.

(ii) Hydraulic dredging.

(iii) Mechanical dredging.

labeled according to the subheading and entitled ''Confidential Information.''

(2) Techniques for treating contaminated soil, sediment, or waste include the following:

(i) Biological methods, including the following:

(A) Treatment via modified conventional wastewater treatment techniques.

(B) Anaerobic, aerated, and facultative lagoons.

(C) Supported growth biological reactors.

(D) Microbial biodegradation.

(ii) Chemical methods, including the following:

(A) Chlorination.

(B) Precipitation, flocculation, sedimentation.

(C) Neutralization.

(D) Equalization.

(E) Chemical oxidation.

(iii) Physical methods, including the following:

(A) Air stripping.

(B) Carbon absorption.

(C) Ion exchange.

(D) Reverse osmosis.

(E) Permeable bed treatment.

(F) Wet air oxidation.

(G) Solidification.

(H) Encapsulation.

(I) Soil washing or flushing.

(J) Incineration.

(c) In response to contaminated ground water, the following types of response actions will generally be considered: Elimination or containment of the contamination to prevent further contamination, treatment and/or removal of such ground water to reduce or eliminate the contamination, physical containment of such ground water to reduce or eliminate potential exposure to such contamination, and/or restrictions on use of the ground water to eliminate potential exposure to the contamination.

(1) Techniques that can be used to contain or restore contaminated ground water include the following:

(i) Impermeable barriers, including the following:

(A) Slurry walls.

(B) Grout curtains.

(C) Sheet pilings.

(ii) Permeable treatment beds.

(iii) Ground-water pumping, including the following:

(A) Water table adjustment.

(B) Plume containment.

(iv) Leachate control, including the following:

(A) Subsurface drains.

(B) Drainage ditches.

(C) Liners.

(2) Techniques suitable for the control of contamination of water and sewer lines include the following:

(i) Grouting.

(ii) Pipe relining and sleeving.

(iii) Sewer relocation.

(d)(1) In response to contaminated surface water, the following types of response actions shall generally be considered: Elimination or containment of the contamination to prevent further pollution, and/or treatment of the contaminated water to reduce or eliminate its hazard potential.

(2) Techniques that can be used to control or remediate surface water include the following:

(i) Surface seals.

(ii) Surface water diversions and collection systems, including the following:

(A) Dikes and berms.

(B) Ditches, diversions, waterways.

(C) Chutes and downpipes.

(D) Levees.

(E) Seepage basins and ditches.

(F) Sedimentation basins and ditches.

(G) Terraces and benches.

(iii) Grading.

(iv) Revegetation.

(e) In response to air emissions, the following techniques will be considered:

(1) Pipe vents.

(2) Trench vents.

(3) Gas barriers.

(4) Gas collection.

(5) Overpacking.

(6) Treatment for gaseous emissions, including the following:

(i) Vapor phase adsorption.

(ii) Thermal oxidation.

(f) Alternative water supplies can be provided in several ways, including the following:

(i) Individual treatment units.

(ii) Water distribution system.

(iii) New wells in a new location or deeper wells.

(iv) Cisterns.

(v) Bottled or treated water.

(vi) Upgraded treatment for existing distribution systems.

(g) Temporary or permanent relocation of residents, businesses, and community facilities may be provided where it is determined necessary to protect human health and the environment.

[55 FR 8865, Mar. 8, 1990]

APPENDIX E TO PART 300—OIL SPILL RESPONSE

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