Washington Ranking Method

Scoring Manual

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Nothing
would be done at all
if a man waited
til he could do it so well
that no one could
find fault with it

- Cardinal Newman

SUMMARY TABLE OF CONTENTS

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 EXECUTIVE SUMMARY

A quantitative method for ranking hazardous waste sites has been developed for the state of Washington to satisfy the requirements of the Model Toxics Control Act. The model relies on information available from site hazard assessments to assess the potential for risks posed by contaminated sites. The ranking of sites provides a basis for program planning and priority assessment for those sites identified as potential threats to human health or the environment.

The model has four routes: surface water, air, ground water, and marine sediment. Within each route, data elements are evaluated in three main subcategories. These are:

- Substance characteristics,
- Site characteristics or migration potential,
- Exposure targets.

Site scores can be generated for seven pathways:

- Surface Water - Human Health,
- Surface Water- Environmental,
- Air - Human Health,
- Air - Environmental,
- Ground Water - Human Health,
- Sediment - Human Health,
- Sediment - Environmental.

A multiplicative and additive algorithm combines the values from these subcategories, resulting in a numerical route score between 1 and 100. The subsequent combination of all applicable pathway scores (e.g., surface water, air, ground water and sediment), using a simple scaling method, produces a single priority value for human health and/or for environment. These two priority values are further combined in a matrix to provide a final single rank for the site.

Thus, the ranking method provides several types of information about the relative risks posed by a site. It provides individual exposure pathway scores and a more general overall relative risk ranking. This information can be used by Ecology, along with other established factors, in setting its priorities for cleanup actions.

This manual includes a general introduction and background information on the programmatic framework and objectives of the model. The manual explains the structure of the algorithm and the data elements required to generate scores for surface water, air, and ground water routes. Procedures for scoring the sediment pathways are included in the Appendix, "Sediment Scoring Route". Site file information can be supplemented by data acquisition activities described in the manual. Worksheets are provided to guide scorers through a screening process to select hazardous substances and waste management practices to be used for scoring each route. After data collection and initial screening activities are completed, pathway scores for surface water, air, and ground water routes are generated by following the instructions provided in this manual. To score pathways involving contaminated Puget Sound marine sediments, refer to the Sediment Route Scoring Procedure Appendix.

The model has been developed to avoid reliance on specialists and sophisticated data interpretation; instead, scoring teams should comprise individuals with scientific training and experience in hazardous waste investigations who can exercise professional judgement where needed. Consistency in the scoring effort will require that the scoring team be kept small (no more than five people) with an equally small quality assurance team.

1.2 LEGAL AND REGULATORY FRAMEWORK

The 1987 Hazardous Waste Cleanup Act passed by the Washington State Legislature contained a directive for the development of a hazard ranking system to be adopted by July 1988:

> *"The department shall adopt rules ... to establish criteria for determining priorities among hazardous substance sites. These criteria shall assure that sites are ranked by a system that objectively and numerically assesses the relative degree of risk at such sites."*

The Department of Ecology (Ecology) subsequently adopted a Hazard Ranking System Regulation (WAC 173-338) on July 15, 1988, which established criteria for evaluating sites, and established the basis for developing a detailed scoring procedure.

In November 1988, the people of the state of Washington passed a citizens' initiative for a new hazardous waste cleanup law, called the Model Toxics Control Act (MTCA), repealing the Hazardous Waste Cleanup Act. The new law also called for the development of a ranking system.

> *"The department ... shall adopt ... rules under chapter 34.04 RCW to ... establish a hazard ranking system for hazardous waste sites."*

Ecology contracted with Science Applications International Corporation (SAIC) to assist in the development and field testing of a ranking model in October 1988. On January 3, 1990, Ecology filed a comprehensive regulation to implement major portions of the Model Toxics Control Act. This rule, entitled the Model Toxics Control Act Cleanup Regulation (Chapter 173-340 WAC), adopts the Washington Ranking Method (WARM) for the assessment of relative potential risk posed by sites to human health and the environment. The rule states that if the department determines that further action is required at a site, the site shall be ranked and placed on the state hazardous sites list. Notice shall be given by Ecology to the site owner and/or operator, and any other known potentially liable person(s), prior to publication of the site's rank on the state site register.

Before the state initiates action at a site, the department has the discretion to rerank it if the department receives additional information which indicates that a significant change may result in the site's rank.

1.3 OBJECTIVES

Major objectives in the development of the Washington Ranking Method (WARM) were as follows:

- To provide a consistent, objective means for assessing the relative potential risk posed by contaminated sites to human health and the environment, differentiating between those sites where there may be an environmental threat without a human health threat;
- To provide a model which would be scientifically defensible, and yet easy to use;
- To provide a model which would maximize accuracy and reproducibility with minimum data;

- To provide relative site rankings which would adequately distinguish between potential human health and environmental risks posed by contaminated sites;

- To utilize data which would be reasonably obtainable at moderate cost;

- To provide a model which required relatively simple documentation

The model is not intended to duplicate the federal Hazard Ranking System (HRS) model used to nominate sites to the National Priorities List, nor is it intended to provide a quantitation of the absolute risk posed by a site. The model is designed to be a tool for agency decision makers, and to provide a consistent framework to organize and compare information on contaminated sites.

The model is intended to be used as part of Ecology's pre-remedial efforts. Currently, these efforts consist of the following elements (also shown in Figure 1):

- Site identification or discovery.

- An initial investigation is conducted to determine where there is evidence of a release of hazardous substances, and to determine whether the site requires further investigation, warrants interim response measures, or should be referred to another program. This investigation must be conducted within 90 days of site identification.

- If the site requires further investigation, a site hazard assessment is conducted to determine what compounds are present in what quantities and how they are contained, and what basic site characteristics may influence contaminants' ability to migrate and potential for exposure.

- WARM ranking is then to be conducted, following the site hazard assessment phases or any interim or emergency action taken.

- Following the hazard ranking, program planning and prioritization then take place.

With these elements of the pre-remedial program in mind, the reader is reminded that the model is not intended to be used to determine whether emergency or interim remedial measures are required at a site. Actions such as these are based on determinations more quickly and appropriately made as a result of initial site investigations by qualified agency staff. Thus, the model is not intended to determine whether immediate danger or emergency conditions exist which require mitigation. As a result, the potential for exposure through direct contact with hazardous substances on-site has been deliberately omitted from the model. The assumption made during model development was that interim response actions such as fencing, covering waste piles, drum removal, etc., would occur prior to any site ranking efforts (see Figure 1).

In addition, the reader is reminded that WARM ranking is not equivalent to a risk assessment. WARM ranking provides an objective comparison of sites based on relative risk, e.g., Site A poses higher risks than Site B. Risk assessment provides an estimate of absolute risk, usually expressed as a probability that one incidence of disease or other adverse effects in one hundred thousand persons (or one million, etc.) may occur, attributable to the contamination at a particular site.

Cleanup standards are likewise not directly tied to hazard ranking. The Washington Ranking Method employs a "general" look at potential exposure from a site with a limited set of data. Cleanup standards are established as specific concentrations of a chemical in a particular medium which will be protective of human health and the environment.

1.4 DEVELOPMENT OVERVIEW

The department reviewed a number of existing ranking models early in 1988 and began discussions with its Science Advisory Board (established by the Hazardous Waste Cleanup Act of 1987). A new model was developed to more clearly reflect Washington's concern for risks to, and potential impacts on, environmental resources and other state objectives.

To field test the draft model, twenty-eight sites were selected for scoring to represent a variety of site conditions and potential hazards. Further modifications were made to the model based on the field test results and internal reviews of the model performed by Ecology.

In July 1989, Ecology published a Public Review Draft of the Washington Ranking Method. The department received comments on the model until September 15, 1989. Responses to the comments and proposed modifications to the model were reviewed by the Science Advisory Board. Finalized modifications are included in the initial version of the Washington Ranking Method Scoring Manual (April 1990). For further details on model development, the reader is referred to "Final Report - Washington Ranking Method Development and Field Testing," Ecology publication No. 89-32, June 1989.

The purpose of this April, 1992 revision is three-fold:

- Incorporation of contaminated marine sediments route pathway scores into overall human health and environmental priorities. The sediment route is only for contaminated Puget Sound sediments at this time, and the scoring procedures for this route will be published as a separate appendix to this manual.

- Revise the ambient air standards table to reflect newly promulgated (Chapter 173-460-WAC) Washington Acceptable Source Impact Levels (ASILs), rather than the formerly used Massachusetts Acceptable Ambient Levels (MA-AALs).

- Perform other necessary typographical and editorial changes to correct and clarify text, based on comments received during the assessment, scoring and ranking activities on approximately 300 sites during 1990-92.

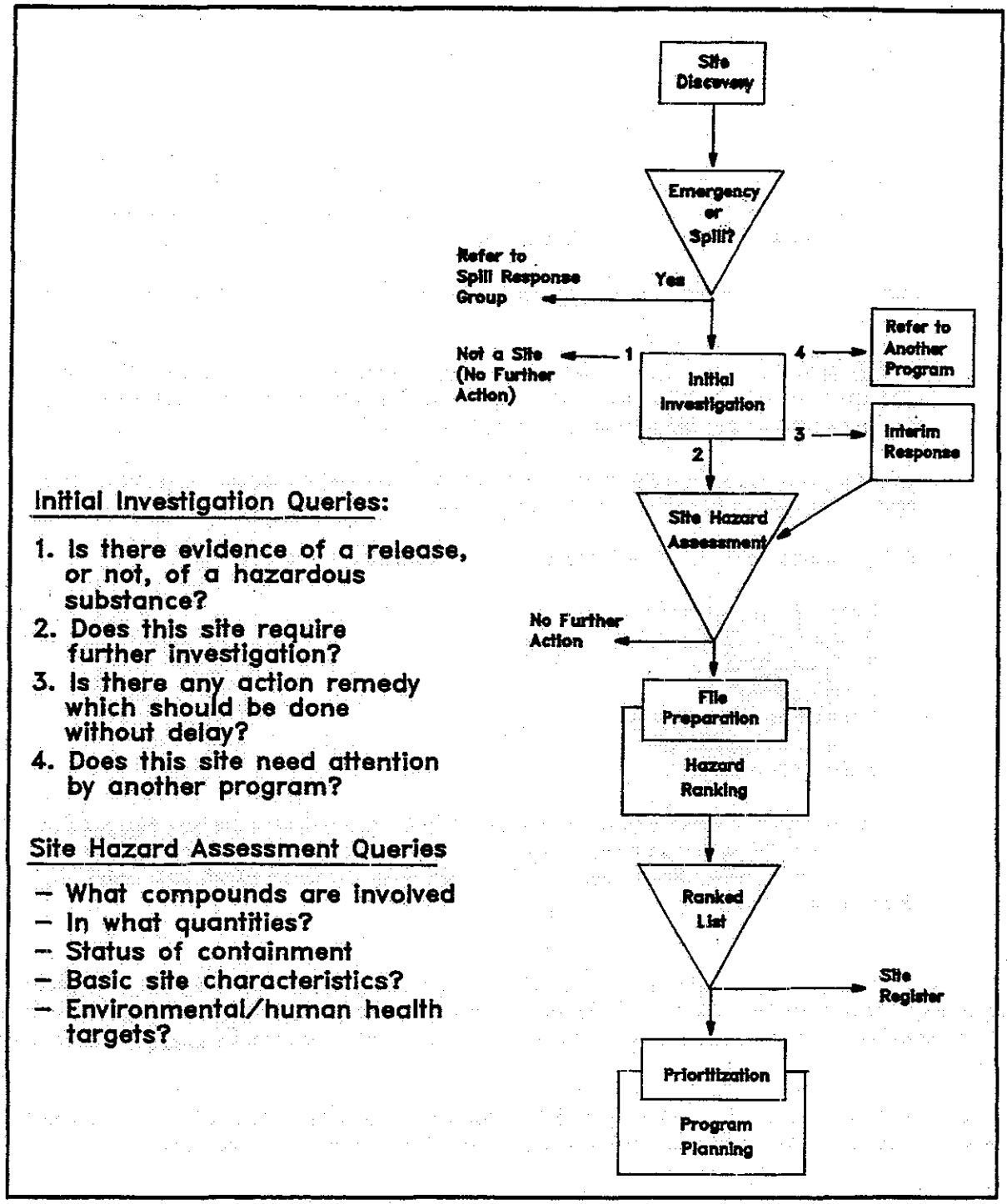

Figure 1
PRE-REMEDIAL PROCESS

7/1/91

2.0 MODEL COMPONENTS

2.1 TERMINOLOGY

The model has the following hierarchy of terms for ease of understanding its various parts.

- Routes: The model has four routes: surface water, air, ground water, and marine sediment. (For the sediment route, the reader is referred to the Sediment Route Scoring Procedure Appendix. The following discussion covers only surface water, air, and ground water.)

- Modules: Each route contains four modules: Substance Characteristics, Migration, Targets, and Release.

- Data Elements: Each module contains a series of data elements shown in Table 1. These data elements are the basic building blocks of the model from which route scores can be calculated. Each data element has a value which enters into the route score calculation.

- Components: Some data elements, such as toxicity and containment, contain components which must be combined to obtain a value for the data element.

- Pathway Scores: Up to seven pathway scores are calculated for each site:

  - Surface Water-Human Health
  - Surface Water-Environmental
  - Air-Human Health
  - Air-Environmental
  - Ground Water-Human Health
  - Sediment-Human Health
  - Sediment-Environmental

  No environmental score is calculated for the ground water route because it has been assumed that any environmental (not human health) targets would be impacted by the contaminated ground water reaching either surface water or air. The algorithms used to generate the pathway scores are described in Section 3.0.

Site worksheets 1 and 2 have been provided to assist in answering questions about the site, its history, and surroundings. These worksheets also assist the scorer in organizing information so that, when scoring is conducted, it can be accomplished efficiently. In order to score a site, information must be available for each data element in each route.

Worksheets 4, 5, and 6 are the actual data entry worksheets for site scoring for the surface water, air, and ground water routes, respectively. Worksheet 3 is supplemental, designed to be used for sites with multiple units.

2.2 SUBSTANCE CHARACTERISTICS MODULE

The Source Characteristics module includes characteristics of the hazardous substances present at the site: their toxicity and their containment and quantity.

Table 1

DATA ELEMENTS CONTRIBUTING TO THE SURFACE WATER, AIR, AND GROUND WATER ROUTE SCORES IN THE MODEL

MODULE	SURFACE WATER ROUTE		AIR ROUTE		GROUND WATER ROUTE
	Human Health	Environmental	Human Health	Environmental	Human Health
1 Substance Characteristics	Human Toxicity Hazardous Substance Quantity Containment	Environmental Toxicity Hazardous Substance Quantity Containment	Human Toxicity Mobility Hazardous Substance Quantity Containment	Environmental Toxicity Mobility Hazardous Substance Quantity Containment	Human Toxicity Mobility Hazardous Substance Quantity Containment
2. Migration Potential	Surface Soil Permeability Total Annual Precipitation 2-yr, 24-hr Rainfall Flood Plain Terrain Slope	Surface Soil Permeability Total Annual Precipitation 2-yr, 24-hr Rainfall Flood Plain Terrain Slope			Net Precipitation Subsurface Hydraulic Conductivity Vertical Depth to Ground Water
3 Targets	Distance to Surface Water Population Served by Drinking Water Intakes Area Irrigated by Surface Water Intakes within 2 miles	Distance to Surface Water Distance to Nearest Fishery Resource Distance to Nearest Sensitive Environment	Nearest Population Population within 1/2 mile	Nearest Sensitive Environment	Ground Water Usage Distance to Nearest Drinking Water Well Population Served by Wells within 2 miles Area Irrigated by Wells within 2 miles
4. Release	Evidence	Evidence	Evidence	Evidence	Evidence

2.2.1 Substances of Concern

In order to score a site, the hazardous substances present at a site and the management practices (including any history of spills or releases at the site) must be identified, based on information available in the file or gathered during a site hazard assessment. Guidance for conducting such site assessments for WARM scoring/ranking purposes is available (Site Hazard Assessment Guidance/Procedures for Washington Ranking Method, Ecology, April 1992). Hazardous substances present at a site may be identified based on any of a number of information sources. Identification of hazardous substances based on direct information (such as waste analyses or environmental monitoring data) are preferred over indirect information sources such as process knowledge or estimates of waste stream properties based on that type of industry. Data sources that can be used to identify and develop an inclusive list of hazardous substances present at a site include:

- Waste analyses - chemical composition of wastes present at the site as determined through chemical analyses.

- Hazardous substance identification - wastes or substances present at the site that can be identified as hazardous substances based on the material identification (e.g., degreasing solvent identified as trichloroethene)

- Process knowledge or process control information - information that provides an indication of hazardous substances present at a site. For example, an electroplater generates a wastewater treatment sludge during wastewater treatment operations. Based on knowledge of site processes and discharge limitations for the wastewater treatment system, chromium, cadmium, zinc, and cyanide are identified as hazardous substances present in the wastewater treatment sludges.

- Waste characterization information based on site activities and characterization of waste streams for the industrial segment. For example, spent potliners from primary aluminum production may contain cyanides, polynuclear aromatic hydrocarbons and fluoride.

Once an initial list of hazardous substances of concern has been determined, the toxicity values and selection of substances for scoring can be assigned for the site, using the Toxicity Database for Use in WARM Scoring (SAIC, 1992).

In addition to the determination of hazardous substances present at the site, the waste/substance management activities must be identified. Waste/substance management practices may include:

- Disposal:
  - Landfills
  - Surface impoundments
  - Waste piles
  - Dry wells
  - Drain fields

- Storage and/or treatment:
  - Tanks
  - Containers, including drums, tank trucks, and other portable storage units
  - Surface impoundments
  - Stock piles, outdoor storage areas, waste piles

- Spills, releases:
  - Spills to soil, surface water
  - Contaminated soil, ground water, or surface water due to spillage or leakage from a source that has been removed or not identified
  - Unpermitted discharges to soil/ground water, surface water, or air
  - Releases or spills from process or operating areas to any environmental medium

For each management activity identified at the site, the hazardous substances managed in each unit/activity should be identified. In addition, the total quantity of hazardous substances or materials containing hazardous substances present at the site should be determined or estimated as accurately as possible. Any containment measures present are to be characterized to the extent possible, based on file information (e.g., presence and type of liners, secondary containment, automatic volume controls, etc.).

2.2.2 Toxicity Data Element

Human toxicity scores incorporate information on four types of toxicity-based measures. These include drinking water or acute toxicity, chronic toxicity, and carcinogenicity. Any substance used to score toxicity may have data available for none to all four of these measures. Therefore, toxicity scoring has been designed to accommodate a potentially wide range of available information. In order to determine the subscore for human toxicity to enter on the score sheets, the scorer should undertake the following steps (see example following):

1. Determine one to six substances which appear to be the main source of problem in the route (surface water, air, and ground water) being scored; use professional judgement in making this determination. The substances need not be the same for each route, but they have to be available to the route through less than perfect containment.

2. For each substance chosen enter the name of the substance in Worksheet 2 and provide the basis for your choice.

3. For route scoring, enter the substance names in the appropriate boxes in Worksheets 4, 5, and 6. Look up the corresponding values in the Toxicity Database (SAIC, 1992), or use the toxicity tables in each route and peer review references to determine the toxicity values to use in scoring.

4. The human toxicity subscore is then determined by finding the highest of any values on the chart. This forms the base for the toxicity value. If any other substances other than the one in which the highest number is located have any score greater than 5, add 2 bonus points to the subscore. Thus, the maximum human toxicity score can be 12, with any single number in the chart being as high as 10.

Environmental toxicity values for air and water (inhalation and ingestion measures of toxicity) are assigned as described in the scoring instructions for each route. For a measure of environmental toxicity in the air route, the model utilizes non-human mammalian acute inhalation LC_{LO} and LC_{50} data. Where standards for protection of aquatic life are not available for compounds being examined in the surface water route, non-human mammalian acute oral toxicity values are also used to determine a value for environmental toxicity. Enter the substance and its corresponding value in the appropriate boxes on Worksheets 4, 5, and 6.

Examples for this scoring procedure are shown below

Example 1:

Substances	Air Standard	Inhalation Acute Tox	Inhalation Chronic Tox	Inhalation Carcinogenicity	Highest Value
Cadmium	10	10	ND	ND	10
Trichloro-ethylene	10	3	ND	4	10
Acetone	1	3	ND	ND	3

+2 Bonus Points
12 = Final Subscore

Example 2:

Substances	Water Standard	Oral Acute Toxicity	Oral Chronic Toxicity	Carcino-genicity	Highest Value
Cadmium	8	5	5	ND	8
Trichloro-ethylene	8	3	ND	4	8
Acetone	ND	3	1	ND	3

+2 Bonus Points
10 = Final Subscore

2.2.3 Mobility Data Element

Mobility in the WARM model may be defined as the inherent chemical/physical characteristics of a hazardous substance which govern its tendency to move into and through environmental media. Thus, factors such as vapor pressure, solubility, and coefficients of aqueous migration are considered in the various routes.

In the air route, determination is first made as to whether transport of a substance is more likely to occur as a particulate or a gaseous substance. For particulates, the mobility value is based on the type of soil and a climatic factor that reflects average soil moisture values. This determines the erodibility of the matrix containing the substance. If gaseous transport is determined to be the primary method of mobilizing a substance, then mobility is based on a measure of volatility of the substance. Rules are given in the instructions as to when to use the vapor pressure of a substance or Henry's Law Constant as a measure of the mobility of a gaseous substance in air.

For the air route, the mobility value selected for the hazardous substance is combined in a matrix with the toxicity of the substance to provide a single value for toxicity/mobility.

In the ground water route, substance mobility is determined separately for dissolved inorganic species (cations and anions), and for organic substances. Cations and anions are assigned mobility values based on their coefficient of aqueous migration. The index is based on the expected geochemical behavior of these cations and anions under moderately anaerobic and slightly acidic to slightly alkaline conditions. The mobility of all other compounds (including

organics) is dependent on their solubility in water. These mobility values reflect broad classes of expected mobility in ground water systems. Unlike the ground water and air routes, the hazardous substance module for surface water does not include a data element for mobility.

2.2.4 Substance Quantity Data Element

The model includes substance quantity as an important element of the substance characteristic module. Quantity calculations are the same for each route. The total hazardous substance quantities available to the route of concern are determined by reading through the site file, determining how substances are contained in management units/activities on the site, and assigning a value based on the total quantity of hazardous substances available in the route to be scored.

The scorer is instructed to provide a best professional estimate of the total volume of hazardous substances available to the route, and to determine the substance quantity value based on that estimate. Equivalent tables are provided for typical expressions of measurement such as tons, gallons, drums, and cubic yards of material. Estimates of hazardous substance quantity should be based on the total amount of the substance, not on each of its constituents as measured. For example, it is better to determine a volume of petroleum in a tank or spilled on the ground, rather than the quantity of benzene, toluene, xylene, and lead present. Typically, site hazard assessment data cannot support calculations of this type.

Estimates of quantity, in the case of spilled substances, should be made on the basis of the quantity spilled, not the total volume of contaminated soil. Where there is no information at all regarding quantities spilled, the scorer is instructed in the model to assign values based on the quantity of contaminated soil known or estimated to be present at the site, using a value-assignment table developed for this purpose.

Model instructions direct the scorer to make a best estimate of substance volume where little or no information is available in the site file, to record the basis for that judgement on the scoring sheet, and to use the estimate for scoring. The scorer may select a default value of 1 (indicating that hazardous substances were known to be present, but in unknown volumes). This would reflect a waste volume of 200 gallons or 1 cubic yard, a quantity known to be exceeded in many cases where a total waste quantity still cannot be determined.

2.2.5 Containment Data Element

The containment data element refers to the methods by which hazardous substances are contained or managed on the site. Components of this data element for each route include the following:

- Landfills
- Surface Impoundments
- Aboveground Containers and Tanks
- Waste Piles
- Spills, Discharges, and Contaminated Soil

Questions are posed to the scorer regarding each of these components which enable the scorer to obtain a value for the data element. The situation where containment is unknown for a given container or substance management unit type (for instance, unknown if there is a liner for a landfill), is provided for in the scoring instructions. In addition, the scorer is provided guidance for scoring unusual situations which may not occur very often, such as dry wells and septic drain field discharges.

The air route containment data element has provisions for potential migration of substances in both gaseous and particulate states. The scorer is required to assign a value to containment based on the most likely type of release, as determined in the substance characteristics module of the model.

In WARM, the scorer is instructed to score containment conditions as they exist at the time the Site Hazard Assessment is conducted, taking into account any actions which have occurred to mitigate releases from the site. In this way, a realistic assessment is made of the potential for substances to continue to migrate from the site.

If multiple waste management units contain wastes with different toxicity values at a site, it will be necessary to use Worksheet 3 to determine the combination of toxicity and containment values to be used for scoring.

Within each route score, toxicity and containment values are multiplied in the Source Characteristics Module. Toxicity and containment value combinations must be compared using Worksheet 3 under the following conditions:

- Multiple units or management practices present at a site, with different hazardous substances managed in each; and
- The unit with the poorest containment (for the route under consideration) does not contain the substance with the highest toxicity value among these present at the site.

If these conditions are not met (i.e., the site has single units with a single hazardous substance, or the unit with the poorest containment also contains the most toxic substance), the scorer simply selects the maximum value for containment and toxicity among those present at the site for each route.

The following example illustrates the procedure for selecting toxicity, containment, and quantity values at sites with multiple hazardous substances and containment types. For example, a site exists where two units are present that contain different wastes available to the surface water route. Unit A provides good containment for a small amount of highly toxic waste while Unit B provides poor containment for a large amount of low toxicity wastes. Individual value assignments for the data are:

	Toxicity	Containment	Quantity
Unit A	10	1	1
Unit B	1	10	10

The unit and waste used for the containment and toxicity values are based on the combination which provides the higher product of these two data elements and their adjustment factors:

(Toxicity Value + Constant) * (Containment + Constant) = Product Value

Unit A:	(10 + 3)	*	(1 + 1)	=	26
Unit B:	(1 + 3)	*	(10 + 1)	=	44

Unit B produces a higher combined score. Therefore, data elements should be assigned the following values:

	Toxicity	Containment	Hazardous Substance Quantity
Unit B	1	10	10

(NOTE: The hazardous substance quantity is selected based on the total quantity determined to be available to the route being scored.)

In selecting the units to be used for containment scoring in each route, the scorer must determine if the substances present in the unit are available to the route of concern. This is a two-step process. First, the containment measure used to protect the route of concern is identified. Second, the scorer determines if there would be a release to the route of concern if containment fails. If failure of the containment would not result in release, the substance is not available to the route of concern (from the unit under consideration).

For example, consider two container storage areas used to manage drums of spent solvents. One is an accumulation area within a manufacturing facility and another is an outdoor storage area at a treatment facility. Both areas have concrete containment areas that can hold 110 percent of the volume of the largest container. If the indoor containment fails, solvents may flow to sumps in the plant or discharge to the POTW via floor drains, but would not result in soil or ground water contamination. If the containment for the outdoor storage area fails, a release to soil, and potentially ground water, would occur. Therefore, the accumulation area is not available to the ground water route, while the outdoor storage area is. Therefore, the former could not be used in scoring the ground water route at the site.

2.3 MIGRATION MODULE

The migration module is used to evaluate containment parameters and environmental parameters which were measured or described for sites at the site hazard assessment phase. Table 1 lists the various data elements of the migration for each route. The air route does not include data elements for this module; the other three routes include a number of environmental factors that may affect migration of hazardous substances in the respective media. No environmental elements were included for the air route due to the typical lack of data for wind direction and speed, and due to lack of data for other factors affecting both gaseous and particulate transport of substances from a site.

2.3.1 Surface Water Environmental Data Elements

The migration module for the surface water route contains the following data elements:

- Surface soil permeability
- Total annual precipitation
- Maximum 2-year, 24-hour precipitation
- Flood plain
- Terrain slope

Surface soil permeability was chosen, in combination with the terrain slope and rainfall data, to demonstrate the tendency of a substance to infiltrate site soils or to run off into nearby surface water. The surface soil permeability is based on soil types; these data should be obtained from on-site soil samples or from Soil Conservation Service Soil Surveys for the state.

Total annual precipitation and 2-year, 24-hour precipitation data are available from National Weather Service publications for the state of Washington. These are look-up values for the weather station or area nearest to or most representative of the site.

Instructions are given in the model for calculation of the slope between the site and the nearest downslope surface water. This data element in combination with the other data elements in the migration module provides a measure of how quickly a substance would be likely to reach surface water.

Flood plain information for the state of Washington is available from the Department of Ecology Flood Insurance Rate Maps. Most communities or counties in the state participate in the federal flood insurance program and, as such, have to provide maps showing the areas within the community subject to 100-year or 500-year floods. For some communities, more detailed information is available; however, because 100-year and 500-year data were available for most areas of the state, these values were chosen for use in the model. If this information is not available, scorers are instructed to use best professional judgment in making this determination.

2.3.2 Ground Water Environmental Data Elements

The Migration Module for the ground water route includes the following data elements:

- Net precipitation
- Subsurface hydraulic conductivity
- Vertical depth to the aquifer

This element measures how effectively a substance may be driven into the ground water based on infiltration rates from precipitation alone. Net precipitation values are to be scored in the model so that the value is maximized. Thus, where available, monthly (November to April) precipitation and mean lake or pan evapotranspiration values are to be used in scoring. Monthly values were chosen for use to take into account the areas throughout the state (particularly in eastern Washington) where evaporation exceeds precipitation for at least six months of the year, but where precipitation may provide a significant driving force for contaminant migration in the winter months. These data are available from National Weather Service publications for the state of Washington.

The subsurface hydraulic conductivity data element is a measure of the ease with which a substance may travel between the land surface and the water table based on the geologic materials which underlay the site. In combination with net precipitation values, this element describes the potential for subsurface migration through site soils. Information regarding this data element is found in site files and in Washington State and U.S. Geological Survey water resources and geologic reports.

The vertical depth to ground water also affects how quickly a substance might reach the water table, based solely on the distance a substance must travel. The distance is not measured automatically from the ground surface, but from the bottom of the waste management unit, or the greatest depth of soil contamination known for a site. For those sites for which releases have been confirmed to ground water, the distance is automatically 0 feet, and the value for this data element is maximized.

2.4 TARGETS MODULE

The targets module for each route evaluates the proximity of human and environmental receptors to a contaminated site. The targets module, like other portions of the model, is not designed to evaluate potential for direct contact. It has been assumed that response to any imminent hazard, such as restrictions to site access, removal actions, etc., have been undertaken prior to any scoring efforts.

2.4.1 Surface Water Route Target Data Elements

The targets chosen for the surface water route include:

- Distance to the nearest surface water body
- Population served by surface water drinking water sources
- Acres irrigated by surface water intakes
- Fishery resources
- Sensitive environments

Each of these targets reflects a different concern for human health or the environment. The population served by drinking water sources within two miles is designed to protect human health. Scoring instructions include all sources within two miles for lakes, and those within two miles downstream of the site for rivers and streams. This information is available for public water supplies from the DSHS Public Water Supply System database, and from the Washington Water Rights Information System (WRIS) for private supplies for which water rights have been filed.

The acreage irrigated by surface water sources is designed to take into account the possible contamination of human or livestock food crops by hazardous substances. This information is available from the WRIS database.

Fishery resources within two miles of the site are counted as areas which are vital for spawning, feeding or migration of fish and shellfish. For western Washington, this information is directly available from the Washington Department of Fisheries, "A Catalog of Washington Streams and Salmon Utilization," published in 1975. This two-volume set includes Puget Sound and coastal Washington. No such catalog exists for the eastern portion of the state. In this case, information must be obtained directly from the Department of Fisheries Habitat Management section, or by utilizing best professional judgement. Information on shellfish areas can be obtained from DSHS, Annual Inventory of Commercial and Recreational Shellfish Areas in Puget Sound.

Sensitive environments other than fishery resources are discussed in Section 2.4.2.

2.4.2 Air Route Target Data Elements

The targets chosen for inclusion in the air route are those human and environmental targets which may be directly affected by release of airborne gases or particulates from hazardous substance sites. These targets include:

- Nearest population
- Total population within 1/2 mile
- Sensitive environments

Information regarding the nearest population may be obtained either from the site file, site hazard assessment or from a USGS topographic map. Total population within 1/2 mile may be obtained by counting buildings within a 1/2 mile of the site, or by utilizing the most recent Federal Census data, updated by later state information, available from the State library in Olympia. In some cases, the local city or county planning department or town clerk may be the best source of this information.

Sensitive environments are listed in the model as federal, state, and locally designated natural areas, parks and wetlands, and critical habitats for endangered species. There are critical habitats for federally endangered species in the state. Information regarding Federal and state endangered species must be obtained directly from the Department of Wildlife, Nongame Section, where an information request will yield maps and information regarding the utilization of an area by any state endangered species. Other sensitive environment information may be obtained from USGS topographic maps, the Washington Atlas and Gazetteer, and road maps.

2.4.3 Ground Water Route Target Data Elements

Similar to the other two routes, the ground water route targets are designed to take into account human targets which may be affected by the release of hazardous substances into the environment. Targets for this route include:

- Distance to the nearest well
- Ground water usage types
- Total population served by wells within two miles
- Acreage irrigated by wells within 2 miles

Sources of information for well locations and population served, and irrigation are the same as for surface water (i.e., Washington Public Water Supply and WRIS databases). In addition, private well log information is filed with Ecology Regional Offices. Ground water usage includes seven choices, ranging from federal sole source aquifer designation (as in the Spokane-Rathdrum Prairie Aquifer), to ground water not usable due to naturally occurring substances. This information may generally be found in site files and from the databases utilized for determining the population served. In rural areas, no alternate supplies are typically available, thus scores reflect this situation. The state of Washington has seven federally designated sole source aquifers, including Island County and the Spokane-Rathdrum Prairie Aquifer in the Spokane area. Other aquifers in the state are also being considered for this designation. Additional information regarding sole source aquifers may be obtained from EPA Region 10 offices in Seattle, at (206) 553-2579.

2.5 RELEASE MODULE

The release module for each route has been designed to add bonus points to a score should a definable release be documented.

In the surface water route, visual or analytical evidence must be available. Visual evidence may include documentation of overland flow or the observance of a discolored plume from an identifiable source entering the surface water. Releases from outfalls are only included where the outfall is not permitted under the National Pollutant Discharge Elimination System (NPDES) program or where discharges from a permitted outfall are not in compliance with permit conditions. Instructions may be found in the surface water route to score sites where contaminated ground water discharges directly to surface water, where no other surface water route would be scored (i.e., leaking underground storage tank).

In the air route, evidence must include direct visual evidence of particulate or gaseous releases, analytical evidence or detectable odors which may be quantified by analytical evidence.

In the ground water route, evidence of release can include evidence of direct dumping, such as an injection or dry well, the presence of the bottom of a waste management unit below the water table (i.e., the bottom of a landfill in the water table), or analytical evidence from ground water monitoring wells.

In all three routes, analytical evidence must demonstrate that the concentration of the hazardous substance measured is at least three times expected or measured background (if the compounds are expected to be present in the environment, such as metals) Releases from sources other than the site being scored are not to be scored as a release for the site.

3.0 MODEL ALGORITHM

Each pathway score is calculated by an algorithm which combines module values for substance characteristics, migration, targets, and release. The scoring formulae are presented in Table 2.

In the Substance Characteristics Module, the toxicity and containment data element values are added to adjustment factors and then multiplied. The product of these values is added to the value for substance quantity to generate the Substance Characteristics subscore. Because containment and toxicity values are multiplied, the Substance Characteristics subscore is proportional to both data elements. Therefore, well contained substances will generate relatively low subscores, even if they have significant toxicity values. Moderately or poorly contained substances will generate higher subscores for a given toxicity value, with the highest subscores due to poorly contained, highly toxic substances.

The substance quantity value is added to the product of containment and toxicity to elevate the subscore of sites that have greater quantities of hazardous substances relative to sites with similar conditions with lesser quantities. This reflects the lower degree of reliability often associated with quantity determinations for sites, and the consideration that risk may be impacted more by exposure factors not included in the model than the total quantity of hazardous substance(s) present at a site.

For both Migration and Target Modules, the data elements in each are added together to produce module subscores. (The Migration module is not present in the air route formulae). Each module subscore is multiplied by a weighting factor to assure each module contributes a consistent proportion to each route score. In the surface water and ground water routes, the weighted Migration and Target module subscores are added together and multiplied by the Substance Characteristics subscore. This operation generates high route scores only when the subscores for all three modules are high. Intermediate scores are generated only when both the substance characteristics subscore and the sum of the migration and targets subscores are above the lower part of their possible ranges. Therefore, a site with a low substance characteristics subscore or low migration and targets or available receptors will have a low score. For air route scores, the substance characteristics subscore is multiplied by the targets subscore.

Table 2

PATHWAY SCORING FORMULAE WITH WEIGHTING AND NORMALIZATION FACTORS

Air Route - Human Health Pathway

$$AIR_H = (SUB_{AH} \bullet 60/329) \bullet [REL_A + (TAR_{AH} \bullet 35/85)] / 24$$

where,

AIR_H =	Pathway Score for Air-Human Health
SUB_{AH} =	(Human Toxicity Value + 5) • (Containment + 1) + Substance Quantity
REL_A =	Release to Air
TAR_{AH} =	Nearest Population + Population within 1/2 mile

Air Route - Environmental Pathway

$$AIR_E = (SUB_{AE} \bullet 60/329) \bullet [REL_A + (TAR_{AE} \bullet 35/7)] / 24$$

where,

AIR_E =	Pathway Score for Air-Environmental
SUB_{AE} =	(Env. Toxicity + 5) • (Containment + 1) + Substance Quantity
REL_A =	Release to Air
TAR_{AE} =	Nearest Sensitive Environment

Surface Water Route - Human Health Pathway

$$SW_H = (SUB_{SH} \bullet 40/175) \bullet [(MIG_S \bullet 25/24) + REL_S + (TAR_{SH} \bullet 30/115)] / 24$$

where,

SW_H =	Pathway Score for Surface Water-Human Health
SUB_{SH} =	(Human Toxicity + 3) • (Containment + 1) + Substance Quantity
MIG_S =	Soil Permability + Annual Precip. + Rainfall Frequency + Floodplain + Slope
REL_S =	Release to the Surface Water
TAR_{SH} =	Distance to Surface Water + Population Served by Surface Water + Area Irrigated

Table 2 (Continued)

Surface Water Route – Environmental Pathway

$$SW_E = (SUB_{SE} \bullet 40/153) \bullet [(MIG_S \bullet 25/24) + REL_S + (TAR_{SE} \bullet 30/34)] / 24$$

where,

$SW_E =$	Pathway Score for Surface Water-Environmental
$SUB_{SE} =$	(Env. Toxicity Value + 3) • (Containment + 1) + Substance Quantity
$MIG_S =$	Soil Permability + Annual Precip. + Rainfall Frequency + Floodplain + Slope
$REL_S =$	Release to Surface Water
$TAR_{SE} =$	Distance to Nearest Surface Water + Distance to Fisheries Resource + Distance to Sensitive Environment

Ground Water Route – Human Health Pathway

$$GW_H = (SUB_{GH} \bullet 40/208) \bullet [(MIG_G \bullet 25/17) + REL_G + (TAR_{GH} \bullet 30/165)] / 24$$

where,

$GW_H =$	Pathway Score for Ground Water-Human Health
$SUB_{GH} =$	(Human Toxicity + Mobility + 3) • (Containment + 1) + Substance Quantity
$MIG_G =$	Depth to Aquifer + Net Precipitation + Hydraulic Conductivity
$REL_G =$	Release to the Ground Water
$TAR_{GH} =$	Aquifer Use + Well Distance + Population Served + Area Irrigated

After all pathways have been scored for a site, overall priority ranking for human health and environmental concerns must be determined. The sites are placed into an ordinal ranking for each pathway score and divided into five equal groups, or quintiles, with the highest route scores in quintile group number five and the lowest route scores in quintile group number one. The quintile grouping values assigned for each of the route pathways scored are used to determine the overall human health and environmental priorities.

The following formulae are used for sites where the sediment route is not applicable:

Human Health Priority = $(H^2 + 2M + L)/8$
Environmental Priority = $(H^2 + 2L)/7$

where: H = Highest quintile group number for a pathway score
M = Middle quintile group number for a pathway score
L = Lowest quintile group number for a pathway score

The following is an example of human health and environmental priority calculations, using hypothetical quintile values. All fractional values are rounded up to the next highest whole number.

Route	Human Health	Environment
Surface Water	4	5
Air	3	3
Ground Water	2	--

Human Health Priority = $[4^2 + 2(3) + 2]/8 = \underline{3.0} \rightarrow 3$
Environmental Priority = $[5^2 + 2(3)\ ]/7 = \underline{4.4} \rightarrow 5$

For sites where the sediment route is scored, the following formulae should be used:

Human Health Priority = $(H^2 + 2S + 2I + L)/10$
Environmental Priority = $(H^2 + 2S + L)/8$

where: H = Highest quintile group number for a pathway score
S = Second highest quintile group number for a pathway score
I = Third highest quintile group number for a pathway score
L = Lowest quintile group number for a pathway score

Below is an example of the quintile score assignments for a site with the sediment route scored. All fractional values are rounded up to the next highest whole number.

Route	Human Health	Environment
Surface water	4	5
Air	3	2
Ground water	2	--
Sediment	5	1

Human health priority = $[5^2 + 2(4) + 2(3) + 2] / 10 = \underline{4.1} \rightarrow 5$

Environmental priority = $[5^2 + 2(2) + 1] / 8 = \underline{3.75} \rightarrow 4$

The Human Health and Environmental Priorities calculated in this manner thus provide whole number values between one and five. To obtain the final site rank, the priority values resulting from the previous step are used in the following matrix (use the NA column when only the human health priority value is applicable, e.g. for ground water route only sites):

HUMAN HEALTH PRIORITY	ENVIRONMENT PRIORITY					
	5	4	3	2	1	NA
5	1	1	1	1	1	1
4	1	2	2	2	3	2
3	1	2	3	4	4	3
2	2	3	4	4	5	3
1	2	3	4	5	5	5
NA	3	4	5	5	5	NFA

NFA = No Further Action
NA = Not Applicable

From these site rankings, and other significant factors, Ecology will establish its program plan priorities for further site activities.

4.0 IMPLEMENTATION

During the scoring of sites, the user of the model may be required to use some sources of information other than those specified in the model instructions. The user will also be required to exercise professional judgement in assignment of values for certain data elements in the model. In both of these cases, it is important that the scorer provide documentation for data sources and score assignments. Spaces are provided on the worksheets for additional documentation for these areas. In addition, the user may be aware of special site conditions which indicate that relative risk is not accurately represented by the route score(s). In these cases, the special characteristics and potential under- or over-representation of site risks should be provided by the user under Special Considerations on the Summary Score Sheet.

GLOSSARY

Container: Any portable vessel used to contain hazardous substances (may include lab chemical containers, drums, portable tanks, etc.)

Contamination: Polluting or rendering unclean or impure the air, land, or waters of the state, or making the same injurious to public health, harmful for commercial or recreational use, or harmful to fish, bird, or other animal or plant life.

Facility: Any building, structure, installation, equipment, pipe, or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, vessel or aircraft; or any site or area where a hazardous substance, other than a consumer product in consumer use, has been deposited, stored, disposed of, or placed, or otherwise come to be located.

Food crop: Any domestic plant which is produced for the purpose of, or may be used in whole or in part for, consumption by people or livestock. This shall include nursery, root or feedstock to be used for the production of food crops.

Ground water: Water in a saturated zone or stratum beneath the surface of land or water.

Hazardous substance: Any material that is a hazardous substance as defined by section 101(14) of CERCLA, petroleum products, any pesticide product requiring registration under FIFRA, any dangerous or extremely hazardous waste as defined by 70.105 RCW, and other substances as designated by the Director of the Department of Ecology.

Site hazard assessment: An on-site survey of a site which, in most cases, will include collection of samples. The purpose is to gather sufficient data at a site or facility and in its vicinity to determine the existence and type of contamination at the site and its potential and actual threat to public health and the environment, (see Chapter 173-340-320 WAC for complete description).

Release: Any intentional or unintentional entry of any hazardous substance into the environment, including but not limited to the abandonment or disposal of containers of hazardous substances.

Sensitive environment: An area of particular environmental value, where a release could pose a greater threat than in other areas, including: wetlands, critical habitat for endangered or threatened species, national or state wildlife refuge, critical habitat, breeding or feeding area for fish or shellfish, wild or scenic river, rookery, riparian area, big game winter range.

Surface water: Lakes, rivers, ponds, streams, inland waters, salt water, and all other surface waters and water courses within the state of Washington or its jurisdiction.

Tank: Any stationary vessel constructed of non-earthen materials used to contain hazardous substances.

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Water Rights Information System (WRIS) database. Washington Department of Ecology. Contact: Linda Kiefer (206) 438-7618.

SURFACE WATER ROUTE

TABLE OF CONTENTS

SURFACE WATER ROUTE

LIST OF TABLES AND FIGURE

1.0 SUBSTANCE CHARACTERISTICS

1.1 HUMAN TOXICITY

Components of the human toxicity route for surface water include drinking water standards, acute and chronic oral toxicity, and carcinogenic potency factors for ingestion. Use Tables SW-1, SW-2, SW-3, and SW-4 to determine the values for this data element. Enter the toxicity values for each substance chosen on Worksheet 4 as described in the general instructions. If data are not available from the specified sources for the compound(s) of interest, use other databases (such as Medline, etc.) or published toxicological studies of the compounds and reference these sources of information on the worksheet.

Table SW-1

DRINKING WATER STANDARDS

Drinking Water Toxicity	Guideline for Drinking Water Quality (µg/l)	Value
Very High	≤ 1.0	10
High	> 1 to 10	8
Medium	> 10 to 10^2	6
Low	> 10^2 to 10^3	4
Very Low	> 10^3	2

Use the following data types in order of preference: Maximum Contaminant Level Goal (MCLG), Recommended Maximum Contaminant Level (MCL), or Long Term Health Advisory. Note: For compounds assigned an MCLG of zero based on carcinogenicity, do not use the MCLG for value assignment. Use the MCL for these compounds (carcinogenicity is evaluated in a separate portion of the toxicity value assignment). If none of the above data types are available, mark "X" in the matrix on Worksheet 4. Data Source: For MCLGs and MCLs, use 40 CFR 141 and 40 CFR 142. For Long-Term Health Advisories, use EPA Office of Drinking Water Health Advisories, or EPA's Integrated Risk Information System (IRIS).

Table SW-2 CHRONIC TOXICITY			
Chronic Toxicity	Guideline for RfD (mg/kg/day)	Guideline for NOAEL or LOAEL (mg/kg/day)	Oral Value
Extremely High	$\leq 10^{-5}$	$\leq 10^{-3}$	10
High	$> 10^{-5}$ to 10^{-4}	$> 10^{-3}$ to 10^{-2}	8
Medium	$> 10^{-4}$ to 10^{-3}	$> 10^{-2}$ to 10^{-1}	5
Low	$> 10^{-3}$ to 10^{-2}	> 0.1 to 10	3
Very Low	$> 10^{-2}$	> 10	1

Use the following data types in preferential order: Reference Doses (RfDs), No Observed Adverse Effect Level (NOAEL), and the Lowest Observed Adverse Effect Level (LOAEL). Use human data or non-human mammalian data (rats and mice only). If neither is available, mark an "X" on the matrix on Worksheet 4. Data Source: IRIS.

Table SW-3 ACUTE TOXICITY		
Acute Toxicity	Acute Oral LD_{50} or LD_{LO} (mg/kg-body weight)	Oral Value
Very High	≤ 50	10
High	> 50 to ≤ 100	8
Medium	> 100 to $\leq 1{,}000$	5
Low	$> 1{,}000$ to $\leq 5{,}000$	3
Very Low	> 5,000	1

Use human LD_{50} or LD_{LO} data followed by non-human mammalian LD_{50} or LD_{LO} data (rats and mice only). If neither is available, mark an "X" in the matrix on Worksheet 4.

Data Source: Registry of Toxic Effects of Chemical Substances, NIOSH.

Table SW-4

CARCINOGENICITY

A Weight of Evidence: Use EPA weight of evidence rating to determine if substance will be scored as a carcinogen or will not be scored. If EPA weight of evidence is "D" or there is no rating available, the substance in question should not be scored as a carcinogen. Mark an "X" in the matrix on Worksheet 4. Data Source: EPA's Integrated Risk Information System (IRIS).

Weight of Evidence	EPA Weight of Evidence Rating	Carcinogenic Weight of Evidence
Known human carcinogen	A	1.0
Probable human carcinogen	B1 or B2	0.8
Possible human carcinogen	C	0.5
Not classified as to human carcinogenicity	D	Mark an "X" in the matrix
Evidence of non-carcinogenicity	E	0
No Rating Available	None available	Mark an "X" in the matrix

B. Carcinogenic Potency: To obtain the carcinogenicity value for the matrix on Worksheet 4, multiply Potency Factor Value by the Carcinogenic Weight of Evidence.

Carcinogenic Potency	EPA CAG Carcinogenic Potency Factor $(mg/kg/day)^{-1}$	Carcinogenic Potency Value
Very High	$> 10^2$	10
High	> 10 to 10^2	9
Medium	> 1 to 10	7
Low	$> 10^{-2}$ to 1	5
Very Low	$\leq 10^{-2}$	3

Data Source: IRIS

1.2 ENVIRONMENTAL TOXICITY Environmental toxicity for the surface water route is based on the Clean Water Act Criteria for Protection of Aquatic Life. Because acute criteria are more often available than chronic criteria, use only the acute criteria. Use Table SW-5 to determine the environmental toxicity of the substances listed in the matrix on Worksheet 4. Use the value of the substance with the lowest acute criteria. If no criteria have been promulgated for a substance, identify the non-human mammalian acute toxicity of the substance, and use the range of values from Table SW-3 to determine the value to enter on Worksheet 5

Table SW-5 ENVIRONMENTAL TOXICITY		
Toxicity	Acute Standard for Protection of Aquatic Life (µg/l)	Value
Very High	≤ 1.0	10
High	> 1.0 to 10	8
Medium	> 10 to 10^2	6
Low	$> 10^2$ to 10^3	4
Very Low	$> 10^3$	2

Data Source: Quality Criteria for water. EPA, Office of Water Regulations and Standards. 1986. EPA 440/5-86-001. Washington, D.C.

1.3 SUBSTANCE QUANTITY

Consider quantities of substances present and available to the route of concern. Do not use substances which do not have a potential for release via the surface water route.

Use Worksheets 2 and 3 to determine which waste management areas to use in scoring each route. Then, use the total amount of wastes in the area(s) available to the route. Do not try to calculate the volume of a specific substance within a complex mixture.

For tanks or impoundments which are periodically filled and emptied, depending on the kind of information available in the file, calculate the volumes based on usage or on the once filled volume of the unit.

If no information is available regarding waste volume, use best professional judgement to estimate a minimum volume, and document the reasoning for the choice of value on Worksheet 4. Assign values for substance quantity as shown on Table SW-6. For quantity determinations based on contaminated soils, refer to the following discussion and Table SW-6A.

Use the following assumptions: 1.5 tons = 1 cubic yard = 4 drums = 200 gallons

Table SW-6

SUBSTANCE QUANTITY

Gallons	Tons	Cubic Yards	Drums	Value
1 - 200	<2	<1.3	1 - 4	1
201 - 500	2 - 3	1.3 - 2.6	5 - 12	2
501 - 1,000	3.1 - 5	2.7 - 3.3	13 - 20	3
1,001 - 5,000	5.1 - 25	3.4 - 16.7	21 - 100	4
5,001 - 25,000	25.1 - 125	16.8 - 83	101 - 500	5
25,001 - 125,000	126 - 625	84 - 415	501 - 2,500	6
125,002 - 625,000	626 - 3,125	416 - 2,100	2501 - 12,500	7
625,001 - 3,125,000	3,126 - 15,625	2,101 - 10,400	12,501 - 62,500	8
3,125,001 - 15,625,000	15,626 - 78,125	10,401 - 52,000	62,501 - 312,500	9
> 15,625,000	> 78,125	> 52,000	> 312,500	10

Quantity Determinations for Contaminated Soils

The following instructions are to be used when the hazardous substance quantity is based on the amount of contaminated soil present at a site.

Where hazardous substances have been spilled, discharged, or dumped, and the quantity of material discharged to soil is known or can be estimated, then assign a value to the hazardous substance quantity based on the quantity of the substance discharged that resulted in soil contamination.

If the quantity of material causing soil contamination cannot be determined or estimated from existing information on the site, then the substance quantity value assignment should be made based on Table SW-6A. If the area of contaminated soil at the site is not in the existing site information, the area must be estimated by the scorer. This estimation should be made using the best professional judgement of the scorer. Factors that should be considered in estimating the area of contaminated soil include: areal extent of indication of contamination (such as discolored soil or stressed vegetation), the practice that resulted in soil contamination and distribution of site features (e.g., drums emptied onto the ground would probably have occurred in an open area with ease of access rather than areas with physical barriers or covering vegetation such as woods or overgrowth) or the extent of contamination inferred from sampling performed at the site.

Table SW-6A

SUBSTANCE QUANTITY SCORES BASED ON
AREAL EXTENT OF SURFACE SOIL CONTAMINATION

Area in Square Feet	Value
≤ 11	1
> 11 - 16	2
> 16 - 27	3
> 27 - 135	4
> 135 - 675	5
> 675 - 3,400	6
> 3,400 - 16,900 (> 0.08-0.39 acres)	7
> 16,900 - 82,500 (> 0.39-1.9 acres)	8
> 82,500 - 420,000 (> 1.9-10 acres)	9
> 420,000 (> 10 acres)	10

2.0 MIGRATION POTENTIAL

2.1 CONTAINMENT

Containment values should be determined using the criteria outlined in Table SW-7. Evaluate containment values for those hazardous substances available to the surface water route. If you cannot decide whether a waste is available to the route, score it using a containment score of 0. This will not "zero out" the route, but will produce a very low route score. Record value obtained on Worksheet 4.

Table SW-7

SURFACE WATER CONTAINMENT

A. LANDFILLS	
1. What type of run-on/runoff control systems are present?	
	Value
Engineered, maintained run-on/runoff control system or engineered/maintained cover	0
Unmaintained run-on/runoff control system or cover	5
No run-on/runoff control or no cover	10

B SURFACE IMPOUNDMENTS

Containment values for surface impoundments are based on two aspects of unit conditions: dike integrity and freeboard. Use the following definitions and matrix on the following page to assign containment scores.

1. Definitions

Dike Integrity

Regularly Inspected and Maintained - actions taken at the site to assure dike integrity, including inspection and repair of any weaknesses or potential problems, such as erosion, slumping, or other failure of dike materials

Unmaintained, Apparently Sound - regular inspection and maintenance activities to not occur, but there are no indications of dike failure, such as erosion or slumping of dike material or seepage.

Unsound - evidence of dike failure exists; erosion, or slumping of dike materials or release of contents due to seepage or breaching of the dike.

Freeboard

Automatic Freeboard Maintained - automatic level control devices are present to assure at least 2 feet of freeboard are maintained in the unit.

Manual Freeboard Maintained - flow is manually controlled to the unit to assure that at least 2 feet of freeboard is maintained in the unit.

Insufficient Freeboard - less than 2 feet of freeboard maintained in the unit. Evidence of insufficient freeboard may include overtopping due to overfilling or wave action, observed stains on dikes marking past fluid levels in the impoundment.

	Dike Condition		
Freeboard	Inspected Maintained	Apparently Sound	Unsound
Automatically Maintained	0	2	6
Manually Maintained	2	4	8
Insufficient	6	8	10

C. DRUMS AND SMALL CONTAINERS

Add component scores for the following two questions to obtain a value for containment.

1. What type of secondary containment system is present?

	Value
Secondary containment with capacity for total volume of containers	0
Secondary containment with capacity for at least 110% of volume of the largest container	2
No secondary containment, or secondary containment for < 110% of volume of the largest container	5

2. How are containers managed?

	Value
Containers stored in single or double layers on pallets or in racks, not leaking	0
Containers in multiple layers, unstable stacks, not leaking	2
Containers open, leaking, or over-turned	5

D STORAGE TANKS

Add component scores for the following two questions to obtain a value for containment.

1. What type of secondary containment system is present?

	Value
Secondary containment with capacity for 110% of total volume of tanks	0
Secondary containment with capacity for at least 50% of volume of all tanks	2
No secondary containment, or secondary containment for < 50% of volume of tanks	5

2. How are tanks managed?

	Value
Tanks maintained with automatic level controls	0
Tanks maintained without automatic level controls	2
Tanks are unmaintained or ineffectively maintained (evidence may include overfilling, corrosion, tank failure of ancillary equipment such as pipes and pumps)	5

E. WASTE PILES	
What type of run-on/runoff control system is present?	
	Value
Maintained, engineered run-on/runoff control or waste pile is located in an enclosed structure	0
Run-on-runoff control present, but in unknown condition; waste pile located outside	4
No run-on-runoff control; waste pile located outside	10
F. SPILLS, DISCHARGES, AND CONTAMINATED SOIL	
Containment values for spills, discharges or contaminated soil are based on the presence of surface contamination at a site and run-on/runoff controls for contaminated areas. (**Note:** Dry wells, drains fields, or leaking underground storage tanks are to be scored as surface contamination if spills/discharges have seeped to the surface. If contaminated soil has been excavated or disturbed and stored above grade, score the contamination as a waste pile.)	
	Value
Spill, discharge, or contaminated soil occurs only in the subsurface at the site (including dry wells, drain fields, leaking underground storage tanks, or soil contamination that has been covered or partially excavated and filled with clean soil)	0
Spill, discharge, or contaminated soil is present at the surface in an area with maintained run-on-runoff controls (Note: storm drains that discharge to surface water without treatment are not runoff controls)	2
Spill, discharge, or contaminated soil at the surface with unmaintained or ineffectively maintained run-on/runoff control	4
Spill, discharge, or contaminated soil at the surface with no run-on/runoff control or unknown controls	10

2.2 SURFACE SOIL PERMEABILITY

This is a measure of the tendency of a liquid (usually water) to permeate the soil. Obtain values for this data element from Table SW-8. Soil types should correspond to surface soil information as observed on the site or to Soil Conservation Service soil types. If a site is completely paved, the route of runoff should be determined and soils between the site and surface water used to determine the value. If a paved site is directly adjacent to the surface water or run-off from the site enters a storm drain that discharges to surface water, the maximum value (7) should be used. If a site is partially paved, has culverts, or soil types vary, determine the most likely route to surface water and use the soil type which is most prevalent over that route. Record the value on Worksheet 4.

Table SW-8 SOIL PERMEABILITY		
Soil Type	Permeability	Value
Sand, gravel, sandy gravel, poorly-graded sand, poorly-graded gravel, gravelly sand, gravelly sand loam, sandy, loam, silty sandy loam	High	1
Well-graded sands with fines, silt-sand mixtures, loam, silt loam, sandy silt loam, clayey sand, clay sand loam	Medium	3
Clayey gravels, clay-sand-gravel mixtures, inorganic silts, clayey silt loam, silty clay loam, porous rock outcrop, sandy silty clay, sandy clay, sandy clay loam	Low	5
Clay (organic and inorganic), clay loam, rock outcrop, peat, peaty clay	Very Low	7
Piped to, adjacent to surface water	Very Low	7

2.3 TOTAL ANNUAL PRECIPITATION

Determine this value from Table SW-9, using climatic information from the weather station nearest to or most representative of the site Record value on Worksheet 4.

Table SW-9 TOTAL ANNUAL PRECIPITATION	
Precipitation (inches)	Value
0 - 12	1
> 12 - 30	2
> 30 - 48	3
> 48- 66	4
> 66	5

2.4 MAXIMUM 2-YEAR 24-HOUR PRECIPITATION

Determine this value using Figure SW-1 and Table SW-10 (NOAA Atlas 2, Volume IX, "Isopluvials of 2-yr, 24-hr Precipitation in Tenths of an Inch", U.S. Dept. of Commerce). Record value on Worksheet 4.

Table SW-10

MAXIMUM 2-YEAR, 24-HOUR PRECIPITATION

Precipitation (inches)	Value
≤ 1	1
> 1 - 2	2
> 2 - 4	3
> 4 - 6	4
> 6	5

2.5 FLOOD PLAIN

Determine whether the site is in a flood plain as designated by Flood Insurance Rate Maps (FIRM) for the area. If FIRM does not cover the area of concern, use judgment and document your reasoning. The value should be determined from Table SW-11, and recorded on Worksheet 4.

Table SW-11

FLOOD PLAIN

Classification	Value
Not in flood plain	0
In 500 yr flood plain	1
In 100 yr flood plain	2

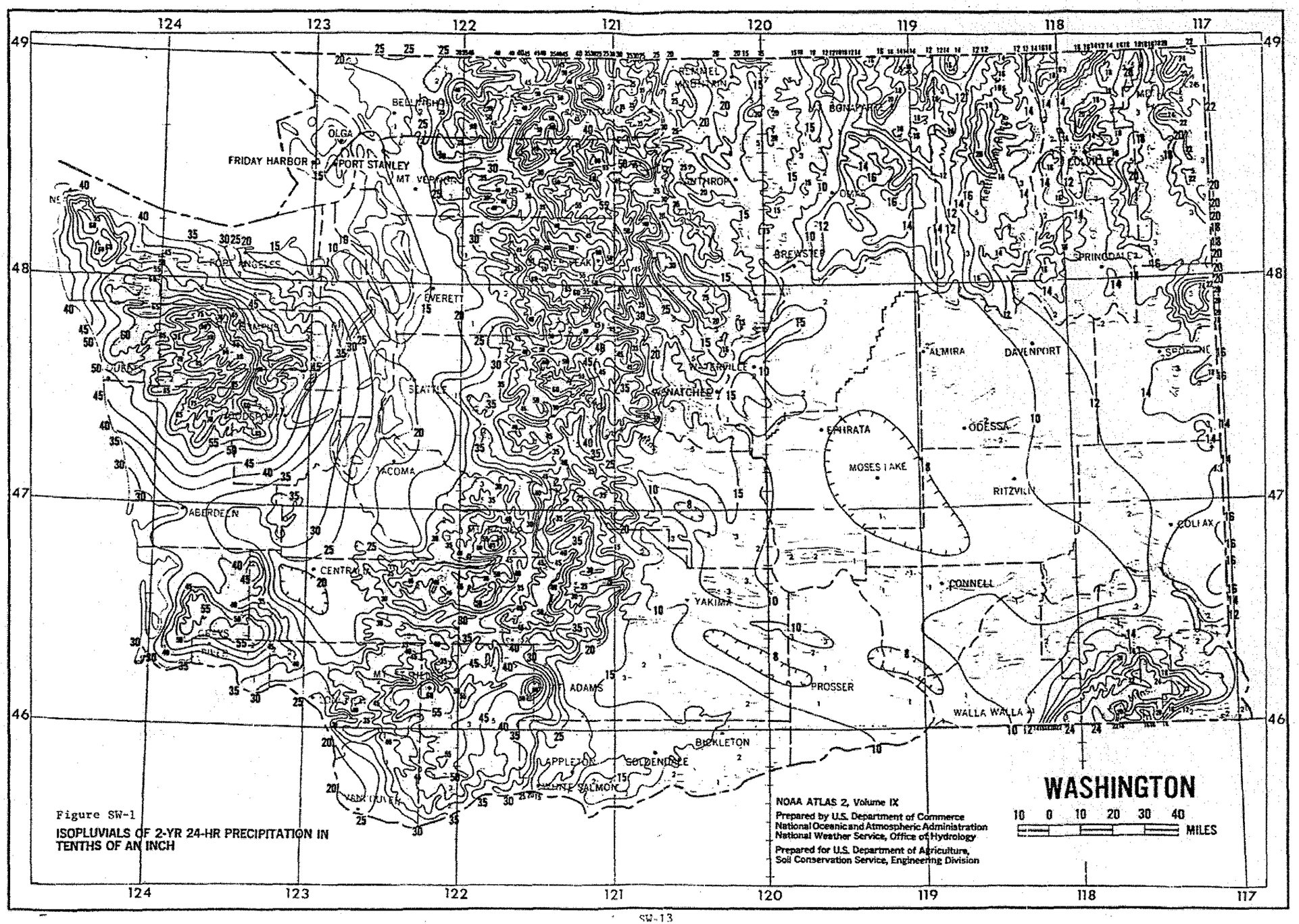


Figure SW-1
ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

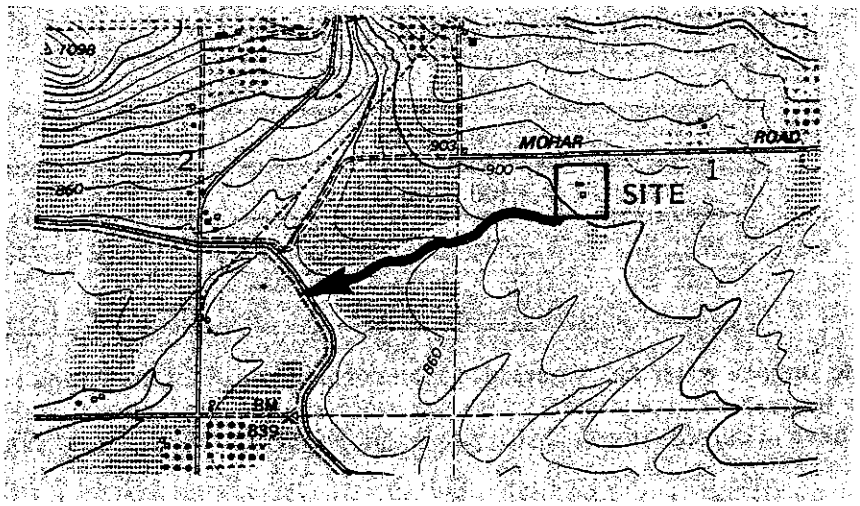
2.6 TERRAIN SLOPE

To assign the value for terrain slope, the slope must be determined from a topographic map. The slope between the site and the nearest downgradient body of surface water is then used to determine the value. Surface water may be defined as any natural permanent or ephemeral (seasonal) body of water, including man-made tributaries (storm ditches) to those waters. Man-made lakes, irrigation canals or ditches are considered surface waters. If more than one surface water body is present, utilize the one for which the shortest downgradient distance can be calculated. Record the value on Worksheet 4

Terrain Slope Determination

The slope of the terrain between the site and the nearest downgradient body of surface water is determined by the following steps:

- Determine the pathway which runoff will follow from the site to surface water (i.e., downhill, perpendicular to topographic contours - see example sketch).



- Measure the distance along the flow path, assign this value to X.
- Subtract the surface water elevation from the site elevation (in the example above = 900 - 830 = 70 ft.) Assign this value to Y.
- Calculate the slope by the formula:
  Slope (percent) = $\frac{Y}{X} * 100$
- Assign the slope value using Table SW-12 and record on Worksheet 4.

Table SW-12
TERRAIN SLOPE

Terrain Slope	Value
≤ 2%	1
> 2% to 5%	2
> 5% to 8% (or piped/culverted)	3
> 8%	5

3.0 TARGETS

3.1 DISTANCE TO NEAREST SURFACE WATER

Distance to the nearest fresh or marine surface water should be determined using a topographic map and following the overland flow route from a contaminant source to the nearest downgradient surface water. This should be the same distance used to determine terrain slope. Surface water is defined as lakes, rivers, ponds, streams, inland waters, salt waters, and all other surface waters and water courses within the state of Washington or its jurisdiction. Man-made lakes, irrigation canals or ditches are considered surface waters. If more than one surface water body is potentially in the overland flow path, utilize the one for which the shortest distance can be calculated. Use Table SW-13 to determine the value and record on Worksheet 4.

Table SW-13
DISTANCE TO NEAREST SURFACE WATER

Distance (feet)	Value
≤ 1,000	10
> 1,000 - 2,500	7
> 2,500 - 5,000	4
> 5,000 - 10,000	2
> 10,000	0

When a release to surface water has occurred, do not consider this fact in making a determination of distance to the nearest surface water. Use the method described above, unless the release is documented to have occurred by contaminated ground water (then refer to Section 5.0).

3.2 POPULATION SERVED BY DRINKING WATER-INTAKES WITHIN 2 MILES

Note all drinking water intakes within 2 miles of the site. Consider all intakes located in lakes, and only those downstream of the site for intakes located in rivers. Determine the population served by drinking water from these intakes. Record the square root of the total population served on Worksheet 4. If the total population served is greater than 5,625, mark "75" on Worksheet 4.

3.3 AREA IRRIGATED BY SURFACE WATER-SOURCES LOCATED WITHIN 2 MILES

Determine the acreage irrigated by surface water sources located within a 2 mile radius of the site from the Washington Department of Ecology Water Rights Information System (WRIS). The value to be recorded on Worksheet 4 is:

$$0.75 \sqrt{\text{acreage}}$$

Round to the nearest whole number. If more than 1,600 acres are irrigated, record a score of 30 on Worksheet 4. Note that the surface water intakes must be within 2 miles of the site and in the downstream direction for flowing surface water bodies; the acreage can be anywhere. The WRIS database notes that location of the intake, not the location of the acreage. The total acreage irrigated by each intake is listed in the WRIS database.

3.4 DISTANCE TO NEAREST FISHERY

A fishery resource is defined by the Washington Department of Fisheries as an area necessary for the maintenance of spawning or migratory pathways for a fish or shellfish species. Distances are calculated as the overland flow to the nearest downgradient surface water (distance used in Section 3.1). Record the value from Table SW-14 on Worksheet 4.

Table SW-14

DISTANCE TO NEAREST FISHERY RESOURCE

Distance (feet)	Value
≤ 1,000	12
> 1,000 - 2,500	9
> 2,500 - 5,000	6
> 5,000 - 10,000	3
> 10,000	0

Data source: "A Catalog of Streams and Salmon Utilization", Vol. 1 & 2, Washington Department of Fisheries; Inventory of Commercial and Recreational Shellfish Areas in Puget Sound, Washington Department of Social and Health Services, 1989 (updated annually). For additional information contact, Washington Department of Fisheries, Habitat Management, (206) 753-6618.

3.5 DISTANCE TO NEAREST SENSITIVE ENVIRONMENT

Sensitive environments are listed in Table SW-15. Determine the distance to the nearest sensitive environment according to the method described for fishery resources in Section 3.4. Use Table SW-16 to determine the value for the distance calculated and record on Worksheet 4.

In the surface water route, fisheries resources are to be double-counted as sensitive environments. Therefore, if a fishery resource is located <1,000 ft from the site a value of 12 will be recorded for distance to sensitive environment, even if there are no other sensitive environments near the site.

Table SW-15 TYPES OF SENSITIVE ENVIRONMENTS
Critical habitat for Federally designated endangered or threatened species
National Park, Monument, National Marine Sanctuary, National Recreation Area, National Wildlife Refuge, National Forest (campgrounds, recreation areas, game management areas, wildlife management areas)
Designated Federal Wilderness Area
Wetlands (freshwater, estuarine, or coastal)
State Parks
State Wildlife Refuges
Habitat designated for State endangered species
State-designated areas for protection and maintenance of aquatic life
State-designated natural areas
State Game Lands
County or Municipal parks
Fisheries Resource

DATA SOURCES:

A Catalog of Streams and Salmon Utilization, Volumes 1 and 2. Washington Department of Fisheries, 1975.

Annual Inventory of Commercial and Recreational Shellfish Areas in Puget Sound Washington Department of Social and Health Services, Office of Environmental Health Programs (updated annually).

U.S. Fish and Wildlife Service Regional Office, Portland, Oregon. Information number (503) 231-6828.

U.S. Geological Survey. Topographic Maps.

Washington Endangered Species. Department of Wildlife, Non-game Division. Information number (206) 586-1449

Table SW-16

DISTANCE TO NEAREST SENSITIVE ENVIRONMENT

Distance (feet)	Value
≤ 1,000	12
> 1,000 - 2,500	9
> 2,500 - 5,000	6
> 5,000 - 10,000	3
> 10,000	0

4.0 RELEASE

A confirmed release of a hazardous substance to surface water may be determined using visual or analytical evidence

- Visual evidence: may include direct observation of overland flow and discharge to a surface water or the observance of a discolored plume whose source can be confirmed as a hazardous substance from the site. Observation of discharges from outfall may constitute a confirmed release only if the discharge is not in accordance with a permit under the NPDES program

- Analytical evidence: may be determined using surface water or aquatic sediment samples. Analytical evidence must demonstrate the presence of a hazardous substance at 3 times expected or measured background. For compounds such as most metals, where the environmental background concentration is expected to be greater than detection limits, a site specific or regional background should be determined. A release may be confirmed when the substance is present at 3 times the site specific or regional background or more. Where the background concentration of a compound is expected to be below detection limits (e.g., most organic compounds), a release may be confirmed when the substance is present in surface water or sediment at 3 times the quantification limit. In riverine systems, care should be taken to utilize those analytes for which there is no other suspected upgradient source.

- Seeps: evidence may also include a seep entering marine or freshwater which can be documented as contaminated and whose source can be documented either visually or analytically.

- Documented Releases: reports of spills or discharges that have reached surface waters and are not in accordance with permit limits, that are found in the operating record or regulatory documents of the facility can be used as documentation of releases to surface water, if materials that are hazardous substances were present in the release.

(NOTE: Discharges to surface water in accordance with a permit under the NPDES program are not to be scored as releases. If permitted discharges are found to be potential violations of permit conditions, NPDES permitting and enforcement officials should be notified.)

If a confirmed release is determined to have occurred, record a value of 5 on Worksheet 4. If there is no confirmed release, record a value of 0 on Worksheet 4.

5.0 SCORING THE SURFACE WATER ROUTE WHEN GROUND WATER RELEASES IMPACT SURFACE WATER

When wastes are entirely underground (as in UST, injection well) and subsurface releases have occurred, ground water is impacted, and a contaminated ground water has discharged to surface water, use the following special instructions to score the surface water route. The discharge of contaminated ground water must be attributable to the source/site being scored, and be accompanied by on-site soil and ground water sampling evidence. The discharge to surface water must also be documented by sampling or confirmable physical evidence. If these conditions are met, then the following values apply:

1.0 Substance Characteristics - no change

2.0 Migration Potential

Containment - use a value of 10
Other elements - no change

3.0 Targets

Distance to surface water - use a value of 10
Distance to Fishery Resource and Sensitive Environment - use the distance from the ground water discharge to the resource or environment

4.0 Release - score a value of 5.

AIR ROUTE

TABLE OF CONTENTS

AIR ROUTE

LIST OF TABLES AND FIGURES

1.0 SUBSTANCE CHARACTERISTICS

1.1 TOXICITY/MOBILITY INTRODUCTION

The air route uses a matrix (Table A-7) to determine the combination of human toxicity of a substance and its mobility as a particulate or a gas (whichever is appropriate) To score this part of the air route:

- Fill out the toxicity matrix on Worksheet 5, as described in general instructions, using Tables A-1, A-2, A-3, and A-4 below.
- For the substance or substances with the highest toxicity values, determine a gaseous or particulate mobility value from Tables A-5 and A-6. Rules for using gaseous or particulate mobility may be found on page A-5.
- Go to Table A-7. Determine the matrix scalar for the substances chosen above. Enter the highest scalar from Table A-7 on Worksheet 6.

Example: Site has surface impoundment containing toluene, xylene, and tetrachloroethylene.

Toxicity:

Substance	Ambient Standard (Table A-1)	Chronic Toxicity (Table A-2)	Acute Toxicity (Table A-3)	Carcino-genicity (Table A-4)
Toluene	1	1	X	X
Xylene	1	1	3	X
Tetrachloroethylene	9	X	X	X

Mobility (using Henry's Law Constant) (Table A-5):

Toluene:	4
Xylene:	4
Tetrachloroethylene:	4

Toxicity/Mobility Value (Table A-7):

Toluene:	1 x 4 = 2
Xylene:	3 x 4 = 6
Tetrachloroethylene:	9 x 4 = 18

Therefore, use tetrachloroethylene to score this portion of the route

1.2 HUMAN TOXICITY

Components of the human toxicity route for air include acute and chronic inhalation toxicity, carcinogenic potency factors for inhalation, as well as ambient air quality standards or guidelines Tables A-1, A-2, A-3, and A-4 should be used to determine the values for this data element. Enter the toxicity values for each substance chosen on Worksheet 5 as described above and in the General Instructions.

Table A-1

AMBIENT AIR STANDARDS

Toxicity	Ambient Air Standard ($\mu g/m^3$)	Value
Extremely High	≤ 1	10
Very High	> 1.0 to 10	9
Medium	> 10 to 10^2	7
Low	$> 10^2$ to 10^3	4
Very Low	$> 10^3$	1

Data types in order of preference: National Emissions Standards for Hazardous Air Pollutants (NESHAPS), Washington ASILs; If none are available, mark an "X" on the matrix on Worksheet 5.

Table A-2

CHRONIC TOXICITY

Chronic Toxicity	Guideline for RfD (mg/kg/day)	Guideline for NOAEL or LOAEL (mg/kg/day)	Inhalation Value
Extremely High	$\leq 10^{-5}$	$\leq 10^{-3}$	10
High	$> 10^{-5}$ to 10^{-4}	$> 10^{-3}$ to 10^{-2}	8
Medium	$> 10^{-4}$ to 10^{-3}	$> 10^{-2}$ to 10^{-1}	5
Low	$> 10^{-3}$ to 10^{-2}	$> 10^{-1}$ to 10	3
Very Low	$> 10^{-2}$	> 10	1

Data types to be used in preferential order are as follows: Reference Doses (RfDs), No Observed Adverse Effect Level (NOAEL), Low Observed Adverse Effect Levels (LOAEL). If none of these are available, mark "X" on the matrix on Worksheet 5. Data Source: IRIS

Table A-3 ACUTE TOXICITY		
Acute Toxicity	Acute Inhalation LC_{50} or LC_{LO} (mg/m^3)	Inhalation Value
Very High	$\leq 10^2$	10
High	$> 10^2$ to 10^3	8
Medium	$> 10^3$ to 10^4	5
Low	$> 10^4$ to 10^5	3
Very Low (i.e., simple asphyxiant)	$> 10^5$	1

Determine LC_{50} or LC_{LO}. Human data are preferred. If human data are not available, non-human mammalian data from rats and mice only are to be used. If neither is available, mark "X" on the matrix on Worksheet 5.

Data Source to be used: RTECS.

Table A-4
CARCINOGENICITY

A. Weight of Evidence: Use EPA weight of evidence rating to determine if substance will be scored as a carcinogen or will not be scored. If EPA weight of evidence is "D" or there is no rating available, the substance in question should not be scored as a carcinogen. An "X" should be marked in the matrix on Worksheet 5. Data Source: Integrated Risk Information System (IRIS).

Weight of Evidence	EPA Weight of Evidence Rating	Carcinogenic Weight of Evidence
Known human carcinogen	A	1.0
Probable human carcinogen	B1 or B2	0.8
Possible human carcinogen	C	0.5
Not classified as to human carcinogenicity	D	Mark an "X" in the matrix
Evidence of non-carcinogenicity	E	0
No Rating Available	None available	Mark an "X" in the matrix

B. Carcinogenic Potency: To obtain the carcinogenicity value for the matrix on Worksheet 5, multiply the Potency Factor Value by the Carcinogenic Weight of Evidence. Data Source: Exhibit A-4, Superfund Public Health Evaluation Manual, or IRIS.

Carcinogenic Potency	EPA CAG Carcinogenic Potency Factor $(mg/kg/day)^{-1}$	Carcinogenic Potency Value
Very High	$> 10^2$	10
High	> 10 to 10^2	9
Medium	> 1 to 10	7
Low	$> 10^{-2}$ to 1	5
Very Low	$\leq 10^{-2}$	3

1.3 MOBILITY

- Determine whether emissions from the site will be gaseous or particulate. Metals should be considered for particulate transport: use Tables A-6 and A-6A. For organic compounds, use the following rule of thumb: If the vapor pressure is $\geq 10^{-4}$ mm Hg, the compound will exist almost entirely in the vapor phase. If the vapor pressure is $\leq 10^{-8}$ mm Hg, the compound will exist almost entirely in the particulate phase. Compounds with vapor pressures from $> 10^{-8}$ to 10^{-4} mm Hg will be increasingly in the gaseous phase; use best judgment on mode of transport. If the emissions are gaseous, use Table A-5 to determine mobility value

- To use Table A-5:

  - If the substance is in an aqueous solution (dilute wastewater, surface water, ground water), use Henry's Law Constant.

  - If the substance is a concentrated solution (e.g., a drum of trichloroethylene), use the vapor pressure.

  - If soil is contaminated, and gaseous transport appears more important than particulate transport, use the vapor pressure.

  - If you are not sure in what matrix the substance is contained, use the vapor pressure.

Table A-5
MOBILITY POTENTIAL FOR GASES
Data Source: SuperFund Public Health Evaluation Manuel

Vapor Pressure (mm Hg at 20°C)	Henry's Law Constant	Value
> 10	$> 10^{-3}$	4
$> 10^{-3}$ to 10	$> 10^{-5}$ to 10^{-3}	3
$> 10^{-5}$ to 10^{-3}	$> 10^{-7}$ to 10^{-5}	2
$\leq 10^{-5}$	$\leq 10^{-7}$	1

- To use Table A-6:

  - Determine the soil type at the site and look up its erodibility factor on Table A-6A.

  - Use Figure A-1 to determine the climatic factor.

  - Look the resulting value up in Table A-6.

Table A-6

ERODIBILITY FACTOR

Data Source: Onsite soil samples or USDA Soil Conservation Service Soil Survey for the area.

Predominant Soil Textural Class	Erodibility (tons/acre/yr)
Very fine, fine, or medium sand	220
Loamy sand	134
Sandy loam	86
Clay	86
Silty clay	86
Coarse sand	73
Loam	56
Sandy clay loam	56
Sandy clay	56
Silt loam	47
Clay loam	47
Silty clay loam	38
Silt	38
Gravelly sand	22

Table A-6A

PARTICULATE MOBILITY POTENTIAL

	Climatic Factor			
Erodibility (tons/acre/yr)	< 1	1 - 10	10 - 30	30 - 50
0 - 30	0	0	0	1
>30 - 80	1	1	1	2
>80 - 130	1	1	2	3
>130 - 170	1	2	3	4
>170 - 220	2	3	4	4

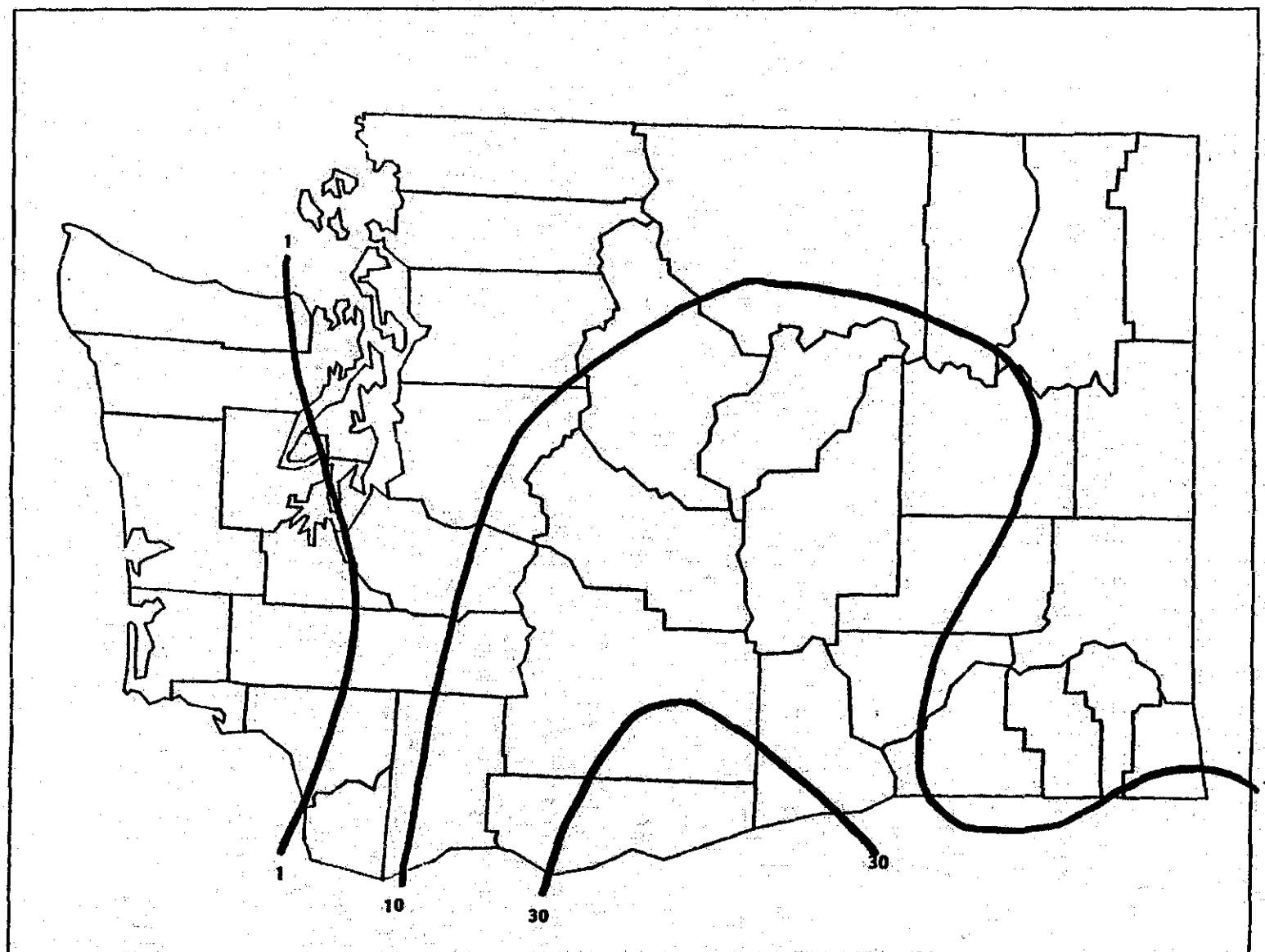


Figure A-1

CLIMATIC FACTOR TO BE USED IN PARTICULATE MOBILITY MATRIX
(From Cowherd, et al, 1988)

1.4 FINAL TOXICITY/MOBILITY VALUE

Determine the final toxicity/mobility value using the following matrix. Enter this value on Worksheet 5.

Table A-7

TOXICITY/MOBILITY MATRIX

Toxicity	Mobility				
	0	1	2	3	4
1	1	1	1	2	2
2	1	1	2	3	4
3	1	2	3	5	6
4	1	2	4	6	8
5	2	3	5	8	10
6	2	3	6	9	12
7	2	4	7	11	14
8	2	4	8	12	16
9	3	5	9	14	18
10	3	5	10	15	20
11	3	6	11	17	22
12	3	6	12	18	24

1.5 ENVIRONMENTAL TOXICITY/MOBILITY

List the same substances to score this data element as listed in human health toxicity. Enter values on Worksheet 5 for non-human mammalian acute inhalation toxicity from Table A-3. For those substances for which data are available, enter mobility values on Worksheet 5. Enter the matrix scalar for the substance having the highest toxicity. Note: this may not be the same substance chosen for the human health toxicity/mobility matrix.

If no toxicity data are available, do not score the Air-Environmental pathway

1.6 SUBSTANCE QUANTITY

Consider the quantities of substances present and available to the route of concern. Do not use quantities for which there is no potential for release via the air route.

Use Worksheets 2 and 3 to determine which waste management areas to use in scoring each route. Then, use the total amount of wastes in the area(s) available to the route. Do not try to calculate the volume of a specific substance within a complex mixture.

For tanks or impoundments which are periodically filled and emptied, depending on the kind of information available in the file, calculate the volumes based on usage or on the once filled volume of the unit.

If no information is available regarding waste volume, use best professional judgement to estimate a minimum volume and document the reason for the choice of value on Worksheet 5. If the quantity determination is based on the quantity of contaminated soil at the site, follow the instructions in the section on contaminated soil below and Table A-8A in making value assignments.

Use the following assumptions: 1.5 tons = 1 cubic yard = 4 drums = 200 gallons

Table A-8

SUBSTANCE QUANTITY

Gallons	Tons	Cubic Yards	Drums	Value
1 - 200	<2	<1.3	1 - 4	1
201 - 500	2 - 3	1.3 - 2.6	5 - 12	2
501 - 1,000	3.1 - 5	2.7 - 3.3	13 - 20	3
1,001 - 5,000	5.1 - 25	3.4 - 16.7	21 - 100	4
5,001 - 25,000	25.1 - 125	16.8 - 83	101 - 500	5
25,001 - 125,000	126 - 625	84 - 415	501 - 2,500	6
125,001 - 625,000	626 - 3,125	416 - 2,100	2,501 - 12,500	7
625,001 - 3,125,000	3,126 - 15,625	2,101 - 10,400	12,501 - 62,500	8
3,125,001 - 15, 625,000	15,626 - 78,125	10,401 - 52,000	62,501 - 312,500	9
> 15,625,000	> 78,125	> 52,000	> 312,500	10

Quantity Determinations for Contaminated Soils

The following instructions are to be used when the hazardous substance quantity is based on the amount of contaminated soil present at a site.

Where hazardous substances have been spilled, discharged, or dumped, and the quantity of material discharged to soil is known or can be estimated, assign a value to the hazardous substance quantity based on the quantity of the substance discharged that resulted in soil contamination.

If the quantity of material causing soil contamination cannot be determined or estimated from existing information on the site, the substance quantity value assignment should be made based on Table A-8A. If the area of contaminated soil at the site is not in the existing site information, the area must be estimated by the scorer. This estimation should be

made using best professional judgement Factors that should be considered in estimating the area of contaminated soil include: areal extent of indication of contamination (such as discolored soil or stressed vegetation), the practice that resulted in soil contamination and distribution of site features (e g., drums emptied onto the ground would probably have occurred in an open area with ease of access rather than areas with physical barriers or covering vegetation such as woods or overgrowth) or the extent of contamination inferred from sampling performed at the site.

Table A-8A

SUBSTANCE QUANTITY SCORES BASED ON AREAL EXTENT OF SURFACE SOIL CONTAMINATION

Area (in square feet)	Area (in acres)	Value
≤ 110	≤ 0.0025	1
>110 - 325	>0.0025 - 0.0075	2
>325 - 540	>0.0075 - 0.0124	3
>540 - 2,700	>0.0124 - 0.062	4
>2,700 - 13,500	>0.062 - 0.31	5
>13,500 - 67,500	>0.31 - 1.55	6
>67,500 - 340,000	>1.55 - 7.8	7
>340,000 - 1,690,000	>7.8 - 39	8
>1,690,000 - 8,440,000	>39 - 194	9
> 8,440,000	> 194	10

2.0 MIGRATION POTENTIAL

Score only those units which have substances available to the air route, i.e., do not score containment values for surface impoundments with no volatile substances present.

2.1 CONTAINMENT

Assign a containment value in Worksheet 6 based on those factors outlined in Table A-9.

Table A-9

AIR CONTAINMENT

A. ABOVEGROUND TANKS AND CONTAINERS (NOTE: Evaluate intact below-ground containers or tanks as a landfill. Evaluate leaking underground storage tanks as spills/discharges).	
	Value
Containers sealed and in sound condition and protected from deterioration by weather. Unvented tank or tank equipped with automatically controlled/alarm-equipped vapor control system.	0
Containers sealed and in sound condition, but not protected from weather. Tank with manually controlled vents, which may or may not have alarms.	3
Containers deteriorated (including: evidence of corrosion that may affect structural integrity, evidence of mechanical damage such as dents or punctures, evidence of improper unit construction such as poorly fitted joints or seals), but no evidence of leakage. Containers may or may not be protected from weather. Vented or uncovered tank; material undisturbed in tank.	8
Containers leaking or liquid visible. Containers may or may not be protected from weather. Uncovered tank with aeration, mixing or heating of tank contents.	10

B. LANDFILLS	
The containment score assignment for landfills is based on the method of transport in the air route. If hazardous substance mobility has been assigned based on particulate transport, use the containment scoring methods below for particulates. For cases where hazardous substance mobility has been assigned due to vapor pressure or Henry's Law Constant, use the containment scoring method below for vapor migration. (NOTE: If contaminated materials have been excavated or disturbed and are stored above grade, the contaminated material is to be scored as a waste pile.)	
Particulates	Value
Uncontaminated soil cover >6 inches thick present or discharge or spill occurred in subsurface only -- (including dry wells, drain fields, and leaks from underground storage tanks)	0
Uncontaminated soil cover <6 inches thick	5
No cover or contaminated soil used as cover	10
Vapors	
Cover >6 inches thick and a functioning vapor collection system	0
Cover >6 inches thick with no functioning vapor collection system	2
No cover or cover <6 inches thick, with a functioning vapor collection system	4
Cover <6 inches thick with no (or non-functional) vapor collection system	6
No cover and no vapor collection system	10

C. WASTE PILE	
	Value
Waste Pile located in fully enclosed, intact building	0
Waste Pile outdoors with intact, maintained cover	2
Waste Pile in non-intact building or three-sided, roofed structure	4
Waste Pile outdoors, with partial or unmaintained cover	8
Waste Pile outdoors, and uncovered	10

D. SURFACE IMPOUNDMENTS (Note: Score a dry surface impoundment as a waste pile.)	
	Value
Surface Impoundment with maintained cover. (Cover may include enclosure on top of the impoundment, floating objects used to decrease surface area or a floating additive [such as non-volatile floating liquid] used to control volatilization.)	0
Surface Impoundment with no cover, and no mixing or agitation processes used.	8
Surface Impoundment with no cover, and mixing or agitation processes are present; these may include aeration, spraying, or other circulation processes.	10

E. SPILLS, DISCHARGES, AND SOIL CONTAMINATION To determine the containment score for spills or areas of soil contamination at a site, the score assignment is based on the method of transport in the air route. If the hazardous substance mobility has been assigned based on particulate transport, use the containment scoring methods below for particulates. For cases where hazardous substance mobility has been assigned due to vapor pressure or Henry's Law Constant, use the containment scoring method below for vapor migration. (NOTE: If contaminated materials have been excavated or disturbed and are stored above grade, the contaminated material is to be scored as a waste pile.)	
Particulates	Value
Uncontaminated soil cover >2 feet thick present, or discharge or spill occurred in subsurface only (including dry wells, drain fields, and leaks from underground storage tanks)	0
Uncontaminated soil cover <2 feet thick	5
No cover or discharges/spills directly onto ground surface (including percolation to surface from dry wells, drain fields, or underground tanks)	10
Vapors	
Cover >2 feet thick or discharge/spill occurred in subsurface only (including dry wells, drain fields, and leaks from underground storage tanks) and a functioning vapor collection system is present	0
Cover >2 feet thick or spill/discharge occurred in subsurface only with no or non-functional vapor collection system	5
Cover <2 feet thick or surface spill/discharge and no vapor collection system	10

3.0 TARGETS

The proximity of hazardous substances to humans and potentially sensitive environments is scored for three targets. In determining distance, use the shortest straight line distance from the contaminant's location, not the property boundary, to the target of concern.

3.1 NEAREST POPULATION

The distance to the nearest population is the distance to the nearest dwelling, public building, park, or other area outside the facility boundary where people may potentially be exposed to hazardous substances on a daily or seasonal (as in the case of parks) basis. Use the distances on Table A-10 to determine this value. Enter the value of Worksheet 5.

Table A-10

DISTANCE TO NEAREST POPULATION

Distance	Value
≤ 1,000 ft	10
> 1,000 - 2,000 ft	8
> 2,000 - 3,000 ft	6
> 3,000 - 4,000 ft	4
> 4,000 - 5,280 ft	2
> 5,280 ft	0

3.2 NEAREST SENSITIVE ENVIRONMENT

Sensitive environments are listed in Table A-11. Determine the distance from the substance to the nearest sensitive environment and select the value from Table A-12 to enter on Worksheet 5. Note: Do not count fisheries resources as sensitive environments in this route.

Table A-11 TYPES OF SENSITIVE ENVIRONMENTS
Critical habitat for Federally designated endangered or threatened species
National Park, Monument, National Marine Sanctuary, National Recreation Area, National Wildlife Refuge, National Forest (campgrounds, recreation areas, game management areas, wildlife management areas
Designated Federal Wilderness Area
Wetlands (freshwater, estuarine, or coastal)
State Parks
State Wildlife Refuges
Habitat designated for State endangered species
State-designated areas for protection and maintenance of aquatic life
State-designated natural areas
State Game Lands
County or Municipal parks

Data Sources:

A Catalog of Streams and Salmon Utilization, Volumes 1 and 2. Washington Department of Fisheries, 1975.

Second Annual Inventory of Commercial and Recreational Shellfish Areas in Puget Sound. Washington Department of Social and Health Services, Office of Environmental Health Programs, 1989.

U.S. Fish and Wildlife Service Regional Office, Portland, Oregon. Information number (503) 231-6828.

U.S. Geological Survey. Topographic Maps.

Washington Endangered Species. Department of Wildlife, Non-game Division. Contact: Tom Owens, (206) 586-1449.

Table A-12

DISTANCE TO NEAREST SENSITIVE ENVIRONMENT

Distance	Value
≤ 1,000 ft	7
> 1,000 - 2,000 ft	6
> 2,000 - 3,000 ft	5
> 3,000 - 4,000 ft	3
> 4,000 - 5,280 ft	1
> 5,280 ft	0

3.3 POPULATION WITHIN ONE-HALF MILE

The population within a 1/2 mile radius of the hazardous substances should be determined using most recent U.S. Census data available or by counting buildings on a 7.5 minute topographic map and assuming 3.0 people per building. Enter the square root of this population on Worksheet 5. If more than 5,625 people are located in the target area, enter a maximum value of 75.

4.0 RELEASE

Release of a hazardous substance to air from substances present at the site may be defined as follows:

- Direct visual evidence: Examples include colored gases being released from a waste pile containing known hazardous substances, dead or stressed vegetation that can be linked with a substance release, or windblown dust from a waste pile containing known hazardous substances. Direct evidence of releases may also include documented discharges to air from vessels or containers due to failure of valves, pipes, venting systems, or related equipment used to contain pressurized contents or volatile substances containing hazardous constituents.

- Analytical evidence: The release documented must be at least 3 times the expected or measured background concentration. Expected background concentrations may be obtained using regional air monitoring data. For compounds where the environmental background is expected to be greater than detection limits, a release may be confirmed when the substance is present at 3 times the site specific or regional background or more. Where the background concentration of a compound is expected to be below detection limits, a release may be confirmed when the substance is present at a minimum of 3 times the quantification limit. Samples must include specific substance characterization or evidence from a field analytical screening device. If field analytical devices such as an organic vapor analyzer or photoionization detector are used, evidence must be provided that the source of total organic vapors detected is from hazardous substances at the site and not from interference sources, such as motor vehicle exhaust.

- Detectable odors: Known sources must be identifiable and analytical data must be available.

(NOTE: Discharges in accordance with a permit by a regional air pollution control authority are not to be scored as releases. If information available during scoring indicates that discharges may be in violation of existing permits or other applicable requirements, the discharge of hazardous substances is scored as a release.)

Where a release has occurred, enter a value of 5 on Worksheet 5. Where no confirmed release is documented, enter a value of 0

GROUND WATER ROUTE

TABLE OF CONTENTS

GROUND WATER ROUTE

LIST OF TABLES

1.0 SUBSTANCE CHARACTERISTICS

1.1 TOXICITY

Components of the human toxicity data element include drinking water standards, acute and chronic oral toxicities, and carcinogenic potency factors. Tables GW-1, GW-2, GW-3, and GW-4 are used to determine the values for this data element. Enter the substances chosen for scoring on Worksheet 2. Follow the general instructions for toxicity scoring to fill out this table. Enter the final toxicity value on Worksheet 6. If available, use the Toxicity Database for determining substance toxicity values.

Table GW-1

DRINKING WATER STANDARDS

Drinking Water Toxicity	Guideline for Drinking Water Quality (µg/l)	Toxicity Value
Very High	≤ 1.0	10
High	> 1 to 10	8
Medium	> 10 to 10^2	6
Low	> 100 to 10^3	4
Very Low	$> 10^3$	2

Data types should be used in the following order of preference: Maximum Contaminant Level Goal (MCLG), Recommended Maximum Contaminant Level (RMCL), Maximum Contaminant Level, or Long-Term Health Advisory. NOTE: For compounds assigned on MCLG of zero based on carcinogenicity, do not use the MCLG for value assignment. Use the MCL for these compounds (carcinogenicity is evaluated in a separate portion of the toxicity value assignment). If none of the above data types are available, Mark "X" in the matrix on Worksheet 6. Data Sources: For MCLGs and MCLs, use 40 CFR 141 and 40 CFR 142. For Long-Term Health Advisories, use EPA Office of Drinking Water Health Advisories, or EPA Integrated Risk Information System (IRIS).

Table GW-2 CHRONIC TOXICITY			
Chronic Toxicity	Guideline for AIC-Oral or RfD (mg/kg/day)	Guideline for NOAEL or LOAEL (mg/kg/day)	Oral Value
Extremely High	$\leq 10^{-5}$	$\leq 10^{-3}$	10
High	$> 10^{-5}$ to 10^{-4}	$> 10^{-3}$ to 10^{-2}	8
Medium	$> 10^{-4}$ to 10^{-3}	$> 10^{-2}$ to 10^{-1}	5
Low	$> 10^{-3}$ to 10^{-2}	$>10^{-1}$ to 10	3
Very Low	$> 10^{-2}$	> 10	1

Use human data or non-human mammalian (rats and mice only). Data types to be used in order of preference are: Oral Acceptable Chronic Intake Levels (AIC-Oral) Reference Doses (RfDs), No Observed Adverse Effect Levels (NOAEL), Low Observed Adverse Effect Level (LOAEL). If none of these are available, mark an "X" on the matrix on Worksheet 6. Data Source: IRIS, RTECS.

Table GW-3 ACUTE TOXICITY		
Acute Toxicity	Acute Oral LD50 (mg/kg-body weight)	Acute Oral Value
Very High	≤ 50	10
High	> 50 to ≤ 100	8
Medium	> 100 to $\leq 1{,}000$	5
Low	$> 1{,}000$ to $\leq 5{,}000$	3
Very Low	> 5,000	1

Use human LD_{50} or LD_{LO} data. If human data are not available, use only non-human mammalian data for rats and mice. If neither is available, mark "X" on the matrix on Worksheet 6. Data source: Registry of Toxic Effects of Chemical Substances (RTECS).

Table GW-4

CARCINOGENICITY

A. Weight of Evidence: Use EPA weight of evidence rating to determine if substance will be scored as a carcinogen or will not be scored. If EPA weight of evidence is "D" or there is no rating available, the substance in question should not be scored as a carcinogen. Mark an "X" in the matrix on Worksheet 4. Data Source: EPA's Integrated Risk Information System (IRIS).

Weight of Evidence	EPA Weight of Evidence Rating	Ca-WOE Value
Known human carcinogen	A	1.0
Probable human carcinogen	B1 or B2	0.8
Possible human carcinogen	C	0.5
Not classified as to human carcinogenicity	D	Mark an "X" in the matrix
Evidence of non-carcinogenicity	E	0
No Rating Available	None available	Mark an "X" in the matrix

B. Carcinogenic Potency: To obtain the carcinogenicity value for Worksheet 6, multiply Potency Value by the Carcinogenic Weight of Evidence Value. Data Source: IRIS.

Carcinogenic Potency	EPA CAG Carcinogenic Potency Factor $(mg/kg/day)^{-1}$	Carcinogenic Potency Value
Very High	$> 10^2$	10
High	> 10 to 10^2	9
Medium	> 1 to 10	7
Low	$> 10^{-2}$ to 1	5
Very Low	$\leq 10^{-2}$	3

1.2 MOBILITY

Mobility is a measure of the tendency of a substance to migrate through soil to ground water. Use Table GW-5 to score mobility for inorganic contaminants, and Table GW-6 for organic contaminants and inorganic contaminants not listed in Table GW-5. Enter the value obtained on Worksheet 6

Table GW-5

MOBILITY VALUES FOR CATIONS AND ANIONS

Cations and Anions	Coefficient of Aqueous Migration (K)	Mobility Value
Aluminum, Chromium, Thallium, Thorium, Tin	Less than 0.1	1
Barium, Beryllium, Cobalt, Copper, Lead, Manganese, Nickel, Phosphorus	0.1 to 1.0	2
Antimony, Arsenic, Boron, Bromine, Cadmium, Fluorine, Iodine, Magnesium, Mercury, Molybdenum, Radium, Selenium, Silver, Uranium, Vanadium, Zinc	Greater than 1.0	3

Note:

A For chromium, nickel, lead, cobalt, and copper, increase the mobility factor by one point if:

- Evidence of acidic leachate is present (pH < 3)

OR

- The metals are present in solution in liquid hazardous substances at the site (e.g., plating wastes).

B. Decrease by one, the assigned mobility value for a metal in areas with alkaline soils (pH > 8), if it can be determined that the metal is present in solid form. Do not assign a value less than 1. **(Note: This does not apply to selenium and arsenic, which are more mobile under alkaline conditions).**

Table GW-6 MOBILITY VALUES FOR ORGANIC SUBSTANCES AND FOR INORGANIC SUBSTANCES NOT LISTED IN TABLE GW-5	
Water Solubility Range (mg/l)	Mobility Value
≤ 10	0
$> 10 - 100$	1
$> 100 - 1{,}000$	2
$> 1{,}000$	3

Note:

A. If the concentration of a substance in a mixture is known, and indicates a higher concentration than the solubility in water, substitute the substance concentration (mg/l) for the solubility in the above table.

B. If the substance or material is present as a free liquid (i.e., a separate film or layer) in aquifer, always assign the maximum value (3), regardless of the compound's solubility.

1.3 SUBSTANCE QUANTITY

Consider the quantities of substances present and available to the route of concern. Do not use substances which do not have a potential for release via the ground water route.

Use Worksheet 3 to determine which waste management areas to use in scoring each route. Then, use the total amount of wastes in the area(s) available to the route. Do not try to calculate the volume of a specific substance within a complex mixture.

For tanks or impoundments which are periodically filled and emptied, depending on the kind of information available in the file, calculate the volumes based on usage or on the once filled volume of the unit.

If no information is available regarding waste volume, use best professional judgement to estimate a minimum volume, and document the reasoning for the choice of value on Worksheet 6.

Use the following assumptions: 1.5 tons = 1 cubic yard = 4 drums = 200 gallons

Table GW-7 SUBSTANCE QUANTITIES				
Gallons	Tons	Cubic Yards	Drums	Value
1 - 200	<2	<1.3	1 - 4	1
201 - 500	2 - 3	1.3 - 2.6	5 - 12	2
501 - 1,000	3.1 - 5	2.7 - 3.3	13 - 20	3
1,001 - 5,000	5.1 - 25	3.4 - 16.7	21 - 100	4
5,001 - 25,000	25.1 - 125	16.8 - 83	101 - 500	5
25,001 - 125,000	126 - 625	84 - 415	501 - 2,500	6
125,002 - 625,000	626 - 3,125	416 - 2,100	2501 - 12,500	7
625,001 - 3,125,000	3,126 - 15,625	2,101 - 10,400	12,501 - 62,500	8
3,125,001 - 15,625,000	15,626 - 78,125	10,401 - 52,000	62,501 - 312,500	9
> 15,625,000	> 78,125	> 52,000	> 312,500	10

QUANTITY DETERMINATIONS FOR CONTAMINATED SOILS

The following instructions are to be used when the hazardous substance quantity is based on the amount of contaminated soil present at a site.

Where hazardous substances have been spilled, discharged, or dumped, and the quantity of material discharged to soil is known or can be estimated, assign a value to the hazardous substance quantity based on the quantity of the substance discharged that resulted in soil contamination.

If the quantity of material causing soil contamination cannot be determined or estimated from existing information on the site, the substance quantity value assignment should be made based on Table GW-7. If the area of contaminated soil at the site is not in the existing site information, the area must be estimated by the scorer. This estimation should be made using best professional judgement. Factors that should be considered in estimating the area of contaminated soil include: areal extent of indication of contamination (such as discolored soil or stressed vegetation), the practice that resulted in soil contamination and distribution of site features (e.g., drums emptied onto the ground would probably have occurred in an open area with ease of access rather than areas with physical barriers or covering vegetation such as woods or overgrowth) or the extent of contamination inferred from sampling performed at the site. An assumption of 3 foot depth of contamination should then be made to calculate the volume of soil, if depth is unknown. If the total quantity of contaminated soil can be estimated, the quantity value should be assigned using Table GW-7A.

Table GW-7A

SUBSTANCE QUANTITIES FOR CONTAMINATED SOILS

Cubic Yards	Value
≤ 10	1
>10 - 100	2
>100 - 1,000	3
>1,000 - 5,000	4
>5,000 - 50,000	5
>50,000 - 100,000	6
>100,000 - 250,000	7
>250,000 - 500,000	8
>500,000 - 1,000,000	9
> 1,000,000	10

2.0 MIGRATION POTENTIAL

2.1 CONTAINMENT

Containment should be evaluated using the criteria outlined in Table GW-8.

If the scorer cannot decide whether a waste is available to the route, score it using a containment score of 0; this will not "zero out" the route, but will calculate a very low route score.

Evaluate containment scores only for those hazardous substances available to the ground water route. Record the containment value on Worksheet 6.

Table GW-8

GROUND WATER CONTAINMENT

A. LANDFILLS	
Add component scores for questions 1-4 to determine a containment value (maximum of 10) for landfills.	
1. What type of liner system is present?	
	Value
Double liner system, no evidence of improper installation or failure	0
Single liner with no evidence of improper installations or failures	1
No liner; or unknown if liner is present; or installed liners are defective or failing	3
2. What type of cover is present?	
	Value
Maintained Engineered cover without ponding	0
Compacted soil or low permeability cover installed, but with poor or unknown maintenance performed	1
No cover; or ponding of water observed on top of unit; or unknown if cover is present	2
3. What type of leachate collection system is present?	
	Value
Maintained, functioning	0
Present, but in unknown condition or not functioning effectively	1
None, or unknown if any collection system is present	2

4. Are containers of liquids or bulk liquids (such as from a tank truck) known to have been disposed in the landfill?	
	Value
No liquids present	0
Possible free liquids in landfill	1
Free/bulk liquids documented to have been disposed	3

B. SURFACE IMPOUNDMENTS

Add component scores for questions 1-4 to determine a containment value (maximum of 10), for surface impoundments.

1. What type of liner system is present?	
	Value
Double liner system, no evidence of improper installation or failure	0
Single liner with no evidence of improper installations or failures	1
No liner; or unknown if liner is present; or installed liners are defective or failing	3

2. What is the condition of diking for the impoundment?	
	Value
Regularly inspected and maintained	0
Unmaintained, but apparently sound	1
Unsound, evidence of failure or leakage present or imminent	3

3. Is adequate freeboard maintained in the unit?	
	Value
Sufficient freeboard (>2 ft) automatically maintained	0
Sufficient freeboard (>2 ft) manually maintained	1
Insufficient freeboard (liquid level within 2 feet of top of diking)	2

4. Is there any evidence of loss of fluid contents, other than through evaporation?	
	Value
No evidence of losses	0
Mass balance or observed changes in fluid levels indicate possible releases to	2

subsurface,; complete loss of contents	

C. ABOVEGROUND CONTAINERS AND TANKS

Add component scores for questions 1-3 to determine a containment value (maximum of 10) for aboveground containers or tanks.

1. What type of container system is present?	
	Value
Containment system with capacity for total volume of containers or tanks	0
Containment system with capacity for at least 10% of volume of containers or tanks	1
No containment system present, or containment with capacity less than 10% of volume of containers or tanks	3

2. What type of base is present for the containment system?	
	Value
Impervious base; regularly inspected and maintained	0
Impervious base; no evidence of failure, but not known to be regularly inspected or maintained	1
Impervious base with some evidence of problems (e.g , cracks), or semi-permeable construction (e.g., asphalt)	2
No base material present; or permeable base such as gravel; or base materials unknown	4

3. How are containers on tanks managed?	
	Value
Containers are stored in single layer, or in racks designed to hold containers. Tanks with overflow controls	0
Containers stored in multiple layers, or overturned; open containers present, unstable stacking. Tanks without overflow controls	1
Containers or tanks leaking in containment area	3

D. WASTE PILES

Add component scores for questions 1-4 to determine a containment value (maximum of 10) for waste piles.

1. What type of liner/base is present?

	Value
Double liner, or waste pile located in a fully enclosed building with an impervious base	0
Single geomembrane or clay liner	1
No liner, or unknown whether liner is present	3

2. What type of cover is present?

	Value
Maintained cover or waste pile is located in a fully enclosed structure	0
Unmaintained cover, or waste pile is located in a roofed structure with three or fewer walls	1
No cover	2

3. What type of leachate collection system is present?

	Value
Maintained, functioning leachate collection system, or waste pile is located in a fully enclosed building	0
Present; unknown condition or not functioning effectively	1
None; or unknown if collection system is present	2

4. What type of run-on/runoff control system is present?

	Value
Maintained, functioning system, or waste pile is located in a fully enclosed building	0
Present, unknown condition or not functioning effectively	1
None, or unknown if collection system is present	3

E Spills, Discharges, and Contaminated Soil

1. For all spills, discharges, and contaminated soil (including dry wells, drain fields, and leaking underground storage tanks) assign a containment value of 10

2. If a contaminated area has been capped, score as a landfill with a cover and no liner or leachate collection system.

3. If contaminated soil has been excavated and stored above grade, score the stored soil as a waste pile.

2.2 NET PRECIPITATION

This is a measure of total precipitation minus total evapotranspiration. Use monthly values for calculation of this value, using the total precipitation and evapotranspiration from November - April if available, in order to maximize this value. Use mean annual precipitation and evapotranspiration values if monthly values are not available. Ranges of net annual precipitation are shown on Table GW-9. Record the value on the Worksheet 6.

Table GW-9

NET PRECIPITATION

Inches	Value
0 - 0.1	0
> 0.1 - 10	1
> 10 - 20	2
> 20 - 30	3
> 30 - 40	4
> 40	5

2.3 SUBSURFACE HYDRAULIC CONDUCTIVITY

This value is a measure of the ease with which substances may move from the land surface to the aquifer. Where information regarding multiple subsurface layers is available, use the least permeable layer to score if it appears to be continuous under the site and free of fractures, faults and has minimum thickness of 15 feet. If this layer is not thought to be continuous, use information regarding the most prevalent geologic materials at the site. Use Table GW-10 to determine a value for this data element. Enter the value on Worksheet 6.

Table GW-10

SUBSURFACE HYDRAULIC CONDUCTIVITY

Score	Hyd. Cond. (cm/sec)	Description
1	$\leq 10^{-7}$	Unfractured igneous or metamorphic rock (including dense, competent basalt) unfractured shales, claystones, mudstones, clay, slightly silty clay, low permeability till
2	$> 10^{-7}$ to 10^{-5}	Clayey silt, silty clay, moderately permeable till, silty shale, siltstone, slightly fractured igneous or metamorphic rock, welded/ lithified volcanic rock
3	$> 10^{-5}$ to 10^{-3}	Sandy silt, silty sand, permeable till, clayey sand, cemented sandstone, fractured rock, shale, porous volcanic rock
4	$> 10^{-3}$	Poorly sorted sand, sand and gravel, gravel, highly fractured rock, lava tubes, poorly lithified sandstone

2.4 VERTICAL DEPTH TO GROUND WATER

This depth is measured from the ground surface, or from the deepest point of known contamination or bottom of landfill or surface impoundments to the water table. Record the value from Table GW-11 on Worksheet 6. Where ground water data quality indicate a confirmed release to ground water, record the maximum value of 8.

Table GW-11

VERTICAL DEPTH TO GROUND WATER

Depth (feet)	Value
0 - 25	8
> 25 - 50	6
> 50 - 100	4
> 100 - 200	3
> 200 - 300	2
> 300	1

3.0 TARGETS

"Assume" interconnected aquifers, unless the site documentation clearly indicates otherwise. For interconnected aquifers, use the most conservative (i.e., highest) ground water usage value and the distance to the nearest drinking water well in either aquifer. Population and area irrigated should be added for each interconnected aquifer and values assigned based on the sum of all services. For ground water not interconnected with the shallow ground water, the target values are based on usage of the uppermost ground water that may be affected by the site.

3.1 GROUND WATER USAGE

The uses or potential uses of an aquifer determine what populations may be at risk. Public water supplies (greater than two households or six users) are defined by Washington State Department of Health (DOH) Public Water Supply System Listing. Record the value for ground water usage within 2 miles from Table GW-12 on Worksheet 6.

Table GW-12

GROUND WATER USAGE

Definition	Value
Federally-designated sole source aquifer	10
Public supply (greater than 2 households); no alternate unthreatened sources available with minimal hookups	9
Private supply, no alternate unthreatened sources available	5
Public supply, but alternate sources available with minimum hookup requirements	4
Private supply, but alternate sources available with minimum hookup requirements	4
Ground water used solely for irrigation of food crops or livestock watering	3
Ground water not used, but usable	2
Ground water used solely for irrigation of non-food vegetation crops (parks, golf courses, tree farms and nurseries)	2
Ground water not usable (high dissolved solids, brackish, etc.) (This does not include ground water made unusable due to contamination - this should be scored as it was used prior to contamination)	1

3.2 DISTANCE TO NEAREST DRINKING WATER WELL

The distance should be determined utilizing available well logs and public supply information. Use distances in Table GW-13, and record value on Worksheet 6. Use distance from boundary of hazardous substances to the well, not from center of site or property boundary. If the nearest well is located within the contaminated area or is contaminated with a hazardous substance which can be attributed to the site, the value recorded on Worksheet 6 should be the maximum value (5). Wells at a facility that are not in the contaminated area should be scored based on the minimum distance between the known extent of contamination and the well. Wells that have been abandoned, and are documented as such, are not to be used in scoring the distance to the nearest well.

Table GW-13

LINEAR DISTANCE TO NEAREST DRINKING WATER WELL

Distance (feet)	Value
≤ 600	5
> 600 - 1,300	4
> 1,300 - 2,640	3
> 2,640 - 5,000	2
> 5,000 - 10,000	1
> 10,000	0

3.3 POPULATION SERVED BY DRINKING WATER WELLS WITHIN 2 MILES

Determine the population served by drinking water wells located within 2 miles of the site. For private wells, assume 3.0 residents per well. For public wells, count the permanent well users from the DOH Public Water Supply System Listing, not those for transient populations. Determine the square root of the total population served and record the value on Worksheet 6. If more than 10,000 people are served, record a value of 100 on Worksheet 6. If ground water users have been provided with an alternate supply as part of interim measure, these users are not to be included in the population served, if the alternate supply is not a ground water source within 2 miles of the site.

3.4 AREA IRRIGATED BY WELLS

Determine the area irrigated by wells located within a 2-mile radius of a site from the Washington Ecology Water Rights Information System (WRIS). The value to be recorded on Worksheet 6:

$$0.75 \quad \sqrt{\text{acreage}}$$

If more than 4,500 acres are irrigated, simply record a value of 50. Round off to nearest whole number. Note that the wells must be within 2 miles of the site; the acreage may be anywhere. The WRIS database notes the location of the wells, not the location of acreage. The total acreage irrigated by each well is listed in the database.

4.0 RELEASE

A release to the aquifer may be confirmed by one of the following:

- Direct dumping or discharge into the aquifer (i.e., down an injection or dry well)

- The presence of a waste management unit in the aquifer (i.e., bottom of landfill or surface impoundment below the top of the aquifer, or leaking containers known to have been buried below the top of the aquifer).

- Analytical evidence of a release from ground water monitoring wells at the site. For substances that may have a background concentration due to natural conditions (such as metals and other inorganic compounds), a release may be confirmed by the presence of the compound at three times the expected or measured background. If the compound is not detected in background samples, the presence of the compound at three times the detection limit may be used to confirm a release. For compounds that are not expected to be present in background samples, such as synthetic organic chemicals, the presence of the compound in samples from the site may be used to confirm a release, if the release can be attributed to onsite sources. If the compound is present in ground water at the site at levels comparable to those found in the vicinity of the site that cannot be attributed to specific sources onsite, a release should <u>not</u> be confirmed in this type of situation. A release should not be confirmed when the compounds in ground water at the site are present due to off-site sources.

(NOTE: Where ground water contamination has been identified at a site, and seeps that discharge to surface waters or discharges directly to surface waters have been identified, the site should be scored with a release to both ground water and surface water.)

If a confirmed release is determined to have occurred, record a value of 5 on Worksheet 6. Otherwise, record a value of 0.

WORKSHEET 1
SUMMARY SCORE SHEET

Site Name/Location (Street, City, County, Section/Township/Range, ICP ID Number):

Site Description (Include management areas, substances of concern, and quantities):

Special Considerations (Include limitations in site file data or data which cannot be accommodated in the model, but which are important in evaluating the risk associated with the site, or any other factor(s) over-riding a decision of no further action for the site):

ROUTE SCORES:

Surface Water/Human Health: _____ Surface Water/Environ.: _____

Air/Human Health: _____ Air/Environmental: _____

Ground Water/Human Health: _____

OVERALL RANK:

WORKSHEET 2
ROUTE DOCUMENTATION

1. SURFACE WATER ROUTE

List those substances to be considered for scoring: Source:

Explain basis for choice of substance(s) to be used in scoring.

List those management units to be considered for scoring: Source:

Explain basis for choice of unit to be used in scoring.

2. AIR ROUTE

List those substances to be considered for scoring: Source:

Explain basis for choice of substance(s) to be used in scoring

List those management units to be considered for scoring: Source:

Explain basis for choice of unit to be used in scoring.

WORKSHEET 2 (CONTINUED)
ROUTE DOCUMENTATION

3. GROUND WATER ROUTE

List those substances to be considered for scoring: Source:

Explain basis for choice of substance(s) to be used in scoring.

List those management units to be considered for scoring: Source:

Explain basis for choice of unit to be used in scoring.

WORKSHEET 3 (If Required)
SUBSTANCE CHARACTERISTICS WORKSHEET
FOR MULTIPLE UNIT/SUBSTANCE SITES
Combination 1 Combination 2 Combination 3

Unit:

1. SURFACE WATER ROUTE

Substance(s):
Human Toxicity Value:
Environ. Toxicity Value:
Containment Value:
Rationale:

Surface Water Human
Subscore: (+3)(+1)= (+3)(+1)= (+3)(+1)=
( )( ) =_ ( )( ) =_ ( )( ) =

Surface Water Environ
Subscore: (+3)(+1)= (+3)(+1)= (+3)(+1)=
( )( ) =_ ( )( ) =_ ( )( ) =

2. AIR ROUTE

Substance(s):
Human Toxicity/Mobility Value:
Environ Toxicity/ Mobility Value:
Containment Value:
Rationale:

Air Human Subscore: (+3)(+1)= (+3)(+1)= (+3)(+1)=
( )( ) =_ ( )( ) =_ ( )( ) =
Air Environ. Subscore: (+3)(+1)= (+3)(+1)= (+3)(+1)=
( )( ) =_ ( )( ) =_ ( )( ) =

3. GROUND WATER ROUTE

Substance(s):
Human Toxicity Value:
Containment Value:
Rationale:

Ground Water Subscore: (+3)(+1)= (+3)(+1)= (+3)(+1)=
( )( ) =_ ( )( ) =_ ( )( ) =

Based on their respective highest scoring toxicity/containment combinations, the following management units will be used for route scoring:

Surface Water -
Air -
Ground Water -

WORKSHEET 4
SURFACE WATER ROUTE

1.0 SUBSTANCE CHARACTERISTICS

1.1 Human Toxicity

	Drinking Water Standard (ug/l) Val.	Acute Toxicity (mg/kg-bw) Val.	Chronic Toxicity (mg/kg/day) Val.	Carcino-genicity WOE PF* Val.
1.				
2.				
3.				
4.				
5.				
6.				

*Potency Factor

Source:
Highest Value: (Max =10)

+2 Bonus Points?
Final Toxicity Value (Max.=12)

1.2 Environmental Toxicity

( ) Freshwater
( ) Marine

Substance	Acute Water Quality Criteria (ug/l)	Value	Non-human Mammalian Acute Toxicity (mg/kg)	Value	Source: _____ Value:_____ (Max =10)
1.					
2.					
3.					
4.					
5.					
6.					

1.3 Substance Quantity:_____ Source:___ **Value:** (Max.=10)
Explain basis:_____

WORKSHEET 4 (CONTINUED)
SURFACE WATER ROUTE

2.0 MIGRATION POTENTIAL

2.1 Containment — Source:___ **Value:** (Max =10)
Explain basis:

2.2 Surface Soil Permeability:_____ Source:___ **Value:** (Max =7)

2.3 Total Annual Precipitation:_____ inches Source:___ **Value:** (Max =5)

2.4 Max. 2-Yr/24-hour Precipitation:_____ inches Source:___ **Value:** (Max =5)

2.5 Flood Plain:_____ Source:___ **Value:** (Max =2)

2.6 Terrain Slope:_____ % Source:___ **Value:** (Max =5)

3.0 TARGETS

3.1 Distance to Surface Water:_____ Source:___ **Value:** (Max =10)

3.2 Population Served within 2 miles (See WARM Scoring Manual Regarding Direction): √pop.=√ = _____ Source:___ **Value:** (Max =75)

3.3 Area Irrigated within 2 miles 0.75√no. acres =
(Refer to note in 3.2.): 0.75√ =0.75( )=_____ Source:___ **Value:** (Max =30)

3.4 Distance to Nearest Fishery Resource:_____ Source:___ **Value:** (Max =12)

3.5 Distance to, and Name(s) of, Nearest Sensitive Environment(s)_____ Source:___ **Value:** (Max =12)
_____

4.0 RELEASE

Explain basis for scoring a release to surface water: Source:___ **Value:** (Max =5)

WORKSHEET 5
AIR ROUTE

1.0 SUBSTANCE CHARACTERISTICS

1.1 Introduction (WARM Scoring Manual) - Please review before scoring

1.2 Human Toxicity

Substances	Air Standard (ug/m^3) Val	Acute Toxicity (mg/m^3) Val	Chronic Toxicity (mg/kg/day) Val.	Carcino-genicity WOE PF* Val.
1.				
2.				
3.				
4.				
5.				

*Potency Factor

Source:
Highest Value: (Max =10)

+2 Bonus Points?
Final Toxicity Value: (Max =12)

1.3 Mobility (Use numbers to refer to above listed substances)

1.3.1 Gaseous Mobility

Vapor Pressure(s) (mmHg): 1= ; 2= 3= ; 4= ; 5= ; 6=

Source:
Value: (Max =4)

1.3.2 Particulate Mobility

Soil type:
Erodibility:
Climatic Factor:

Source:
Value: (Max =4)

1.4 Highest Human Health Toxicity/Mobility Matrix Value (from Table A-7) equals **Final Matrix Value:** (Max =24)

1.5 Environmental Toxicity/Mobility

Source:

Substance	Non-human Mammalian Inhal. Toxicity (mg/m^3)	Acute Value	Mobility (mmHg)	Value	(Table A-7) Matrix Value
1.					
2.					
3.					
4.					
5.					

Highest Environmental Toxicity/Mobility Matrix Value (From Table A-7) equals **Final Matrix Value:**

(Max =24)

WORKSHEET 5 (CONTINUED)
AIR ROUTE

1.6 Substance Quantity:_____ Source:____ **Value:** (Max =10)
Explain basis:_____

2.0 MIGRATION POTENTIAL

2.1 Containment:_____ Source:____ **Value:** (Max =10)
_____

3.0 TARGETS

3.1 Nearest Population:_____ Source:____ **Value:** (Max =10)

3.2 Distance to, and Name(s) of, Nearest Sensitive
Environment(s)_____ Source:____ **Value:** (Max =7)
_____

3.3 Population within 0.5 miles:√pop.=√_____=_____ Source:____ **Value:** (Max =75)

4.0 RELEASE

Explain basis for scoring a release to air:_____ Source:____ **Value:** (Max =5)
_____

WORKSHEET 6
GROUND WATER ROUTE

1.0 SUBSTANCE CHARACTERISTICS

1.1 Human Toxicity

Substance	Drinking Water Standard (ug/l) Val	Acute Toxicity (mg/kg-bw) Val	Chronic Toxicity (mg/kg/day) Val	Carcino-genicity WOE PF* Val
1				
2.				
3.				
4.				
5.				
6.				

*Potency Factor

Source:
Highest Value: (Max =10)

+2 Bonus Points?
Final Toxicity Value: (Max =12)

1.2 Mobility (Use numbers to refer to above listed substances)
Cations/Anions: 1= ; 2= ; 3= ; 4= ; 5= ; 6= . Source:____ **Value:** (Max =3)

OR
Solubility(mg/l): 1= ; 2= ; 3= ; 4= ; 5= ; 6= .

1.3 Substance Quantity:_____ Source:____ **Value:** (Max =10)
Explain basis:_____

2.0 MIGRATION POTENTIAL

2.1 Containment Source:____ **Value:** (Max =10)
Explain basis:_____

2.2 Net Precipitation:_____ inches _____ Source:____ **Value:** (Max =5)

2.3 Subsurface Hydraulic Conductivity:_____ Source:____ **Value:** (Max =4)

2.4 Vertical Depth to Ground Water:_____ feet__ Source:____ **Value:** (Max =8)

WORKSHEET 6 (CONTINUED)
GROUND WATER ROUTE

3.0 TARGETS

3.1 Ground Water Usage:_____ Source:____ **Value:** (Max =10)

3.2 Distance to Nearest Drinking Water Well:_____ ft Source:____ **Value:** (Max =5)

3.3 Population Served within 2 Miles: √pop.=√_____=_____ Source:____ **Value:** (Max =50)

3.4 Area Irrigated by (Groundwater) Wells
within 2 miles: 0.75√no.acres=_____ Source:____ **Value:** (Max =100)
0.75√_____=0.75 (_)=_____

4.0 RELEASE

Explain basis for scoring a release to ground water:_____ Source:____ **Value:** (Max =5)

SOURCES USED IN SCORING

1.

2

3.

4.

5.

6.

7.

8.

9.

10.