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DOCUMENTATION FOR THE FRAMES-HWIR TECHNOLOGY SOFTWARE SYSTEM, VOLUME 15: RISK VISUALIZATION PROCESSOR AND EXIT LEVEL-II PROCESSOR

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Summary

The U.S. Environmental Protection Agency (EPA) is developing a comprehensive environmental exposure and risk analysis software system for agency-wide application. The software system will be applied to the technical assessment of exposures and risks relevant to the Hazardous Waste Identification Rule (HWIR). The software system adapted to automate this assessment is the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES), developed by the Pacific Northwest National Laboratory. The process used to develop the FRAMES-HWIR Technology Software System includes steps for requirements analysis, design, specification, and development with testing and quality assurance composing a critical portion of each step. This report documents that process for two of the key components of the system: the Risk Visualization Processor (RVP) and the second Exit Level Processor (ELP-II).

The ELP has three subcomponents. Their primary purposes are to process and reformat risk-based information generated by the Multimedia Multipathway Simulation Processor, provide a means for querying and summarizing this information graphically, and ultimately compute chemical-specific exit levels.

The RVP and ELP-II subcomponents meet the following requirements:

1) Represent a stand-alone component outside of the Monte Carlo realization and iterative loops of the FRAMES-HWIR Technology Software System complete with its own user interface.

2) Require the user to choose a header file that specifies directory paths to the Chemical Properties Processor, Risk Summary Output Files, and Protective Summary Output Files (PSOFs).

3) Provide a user interface that presents appropriate choices to view human risk/hazard results for the following: 1) chemical, 2) waste management unit (WMU) source type, 3) distance from the source, 4) method used for critical year, 5) exposure pathway (or summation of pathways), 6) receptor type, 7) cohort type, 8) risk level, and 9) hazard quotient.

4) Provide a user interface that presents appropriate choices to view ecological hazard results for the following: 1) chemical, 2) WMU source type, 3) roll-up choice combining two of five ecological categories (ring, habitat group, habitat type, receptor group and trophic level) 4) ecological hazard quotient.

5) Provide an option to generate a Protective Summary Output figure of "Probability of Protection" versus "Concentration in Waste" versus "Population Percentile," expressed as Cumulative Distribution Function (CDF) curves. The "Probability of Protection" refers to the probability of meeting the user-defined scenario (e.g., exposure pathway, cohort, risk measure, risk level, etc.). The "Concentration in Waste" (C_w) refers to the waste concentration before disposal, and the "Population Percentile" refers to the percentage of population protected.

6) Allow the user to calculate an interpolated concentration between C_w value based on the current scenario, population percentile, and probability of protection desired.

7) Provide an option to save the current "population percentile" and "probability of protection" as the defaults for the *current* "source-contaminant" combination.

8) Provide an option to save the current "population percentile" and "probability of protection" as the defaults for *all* "source-contaminant" combinations.

9) Provide an option to print hard copies of the Protective Summary Output curves.

10) Allow the user to select any combination of five risk criteria (risk level, human health, hazard quotient (HQ), ecological HQ, population percentile, and probability of protection) to a risk scenario.

11) Create a lowest target exit level human risk, human HQ , and ecolgocial HQ comparison table, and write them to the PSOF directory.

12) Create target exit level tables, for each risk scenario, and write to them to the PSOF directory.

13) Create a relative target exit level table showing the ratio between scenarios WMU, and write them to the PSOF directory.

14) Create a 50% probability of protection table for each WMU, and write them to the PSOF directory.

15) Create cohort human risk and HQ table by corhort for each WMU and waste type (i.e., combinations of WMU types), for each scenario, and write them to the PSOF directory.

16) Create receptor human risk and HQ table by receptor for each WMU and waste type, for each scenario, and write them to the PSOF directory.

17) Create an exposure human risk and HQ table by exposure pathway for each WMU and waste type, for each scenario, and write them to the PSOF directory.

18) Report processor-specific errors and warnings to the screen.

19) Provide an option from the RVP user interface to execute the ELP-II to generate exit level tables and risk/HQ tables.

20) Operate within a Windows® 95 environment (32-bit).

21) Be capable of being tested independently of the other FRAMES-HWIR Technology Software System processors.

The RVP and ELP-II have been tested to ensure it met the above requirements. The processors were tested as a unit to ensure they performed as expected, and the test cases evaluated the capability of the RVP and ELP-II to meet the requirements requested by the EPA. Both the RVP and ELP-II passed their respective tests. In addition, development of the RVP and ELP-II followed a quality assurance program designed to ensure that the processor met EPA expectations.

Acronyms and Abbreviations

CasId	Chemical Abstracts Service Registry Identification Number
CDF	Cumulative Distribution Function
C_w	waste-stream concentration
ELP	Exit Level Processor
EPA	U.S. Environmental Protection Agency
FRAMES	Framework for Risk Analysis in Multimedia Environmental Systems
GRF	Global Results Files
HQ	Hazard Quotient
HWIR	Hazardous Waste Identification Rule
Index	Site Iteration Index
LAU	Land Application Unit
LF	Landfill
MMSP	Multimedia Multipathway Simulation Processor
PDF	Protective Definition File
PNNL	Pacific Northwest National Laboratory
PSOF	Protective Summary Output File
RSOF	Risk Summary Output Files
RVP	Risk Visualization Processor
WMU	Waste Management Unit

Contents

Acknowledgments iii

Summary v

Acronyms and Abbreviations vii

1.0 Introduction 1.1

2.0 Requirements for the RVP and ELP-II 1.1
2.1 Input Requirements for the RVP and ELP-II 2.4
2.2 Scientific Requirements for the RVP and ELP II 2.9
2.3 Output Requirements for the RVP and ELP II 2.9

3.0 Design Elements for the RVP and ELP-II 3.1
3.1 Input 3.1
3.2 Implementation 3.4
3.2.1 Implementation of RVP 3.4
3.2.2 Implementation of ELP-II 3.6
3.3 Output Results 2.11
3.3.1 RVP: Probability of Protection Charts 3.12
3.3.2 ELP-II: Protective Summary Output Files 3.12

4.0 Testing Approach and Results 4.1
4.1 Summary of Requirements 4.1
4.2 Test Cases 4.4
4.2.1 RVP_01 . . . . . 4.4
4.2.2 RVP_02 . . . . . 4.7
4.2.3 RVP_03 . . . . . 4.10
4.2.4 ELP-II_04 . . . . . 4.13
4.2.5 ELP2_05 . . . . . 4.15
4.2.6 ELP2_06 . . . . . 4.17
4.2.7 ELP2_07 . . . . . 4.19
4.2.8 ELP2_8 . . . . . 4.21
4.2.9 ELP2_9 . . . . . 4.23
4.2.10 ELP2_10 . . . . . 4.25

5.0 Checklist for Quality Assurance Documentation for the Risk Visualization Processor (RVP) of the FRAMES-HWIR Technology Software System 5.1

6.0 References 6.1

Figures

Figure 1.1 Overview of the FRAMES-HWIR Technology Software System 1.2
Figure 2.1. Example Results Indicating Potential Levels with Different Degrees of Conservativeness in Risk Summary Output Files 2.8
Figure 3.1 Initial RVP/ELP-II User Interface 3.1
Figure 3.2 Additional Human Risk, Human Hazard Quotient, and Ecological Hazard Quotient Options 3.2
Figure 3.3 Selections for Table RD2E10R3C2PO and EHG2RG2 . . . . . 3.5
Figure 3.4 Save Scenario Option in the RVP/ELP-II User Interface 3.6
Figure 3.5 Interpolation of C_w Values Given Population Percentile and Probability of Protection 3.6
Figure 3.6 Protective Summary Output Figure for Human Risk 3.12
Figure 3.7 Protective Summary Output Figures for Ecological HQ 3.13
Figure 3.8 Concentration Interpolation in the RVP/ELP-II User Interface 3.13
Figure 3.9 Generate Buttons on RVP/ELP-II User Interface 3.14
Figure 4.1 Input Screen for RVP_01 Test Case 4.6
Figure 4.2 Human Risk Results for RVP_01 Test Case 4.8
Figure 4.3 Ecological HQ Results for RVP_01 Test Case 4.9
Figure 4.4 Warning Message for Chemical and WMU combination 4.9
Figure 4.5 Ecological Interpolation for Test Case RVP_3 . . . . . 4.12

Tables

Table 2.1 Four Illustrated Scenarios Implemented in HWIR for Comparative Purposes 2.7
Table 3.1 Description Table Names and Codes 3.3
Table 3.2 Lowest Target Exit Level Concentrations 3.8
Table 3.3 Target Exit Level Concentrations by Scenario 3.8
Table 3.4 Relative Target Exit Level Concentrations 3.9
Table 3.5 Target Exit Level Concentrations, Based on 50% Probability of Protection 3.9
Table 3.6 Cohort Human Risk/HQ 3.10
Table 3.7 Receptor Human Risk/HQ 3.11
Table 3.8 Exposure Human Risk/HQ 2.11
Table 4.1 Summary of the Requirements for the RVP and ELP II 4.1
Table 4.2 Matrix of Requirements to Test Case for the RVP and ELP II 4.3
Table 4.3 Bin Counts for Test Case RVP_01 . . . . . 4.5
Table 4.4 Expected Percent Sites Protected for Test Case RVP_01 . . . . . 4.6
Table 4.5 Interpolation Results for Population Percentile/ Probability of Protection Combinations . . . 4.11
Table 4.6 Scenario Input for Test Case 4.14
Table 4.7 Lowest Target Exit Level Concentration Expected Results 4.14
Table 4.8 Target Exit Level Concentration Expected Results 4.16
Table 4.9 Relative Target Exit Level Concentration Expected Results 4.18
Table 4.10 Target Exit Level Concentration Expected Results 4.20
Table 4.11 Cohort Target Risk/Hazard Level for Phenol and Landfill 4.22
Table 4.12 Receptor Target Risk/Hazard Level for Benzene and Landfill 4.25
Table 4.13 Exposure Target Risk/Hazard Level for Benzene and Landfill 4.27

1.0 Introduction

The U.S. Environmental Protection Agency (EPA) is developing a comprehensive environmental exposure and risk analysis software system for agency-wide application. The software system will be applied to the technical assessment of exposures and risks relevant to the Hazardous Waste Identification Rule (HWIR). The HWIR is designed to determine quantitative criteria for allowing a specific class of industrial waste streams to no longer require disposal as a hazardous waste (that is, to *exit* Subtitle C) and to allow disposal in Industrial Subtitle D facilities. Hazardous waste constituents with values less than these exit criteria levels would be reclassified as nonhazardous wastes under the Resource Conservation and Recovery Act.

The software system adapted to automate this assessment is the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES), developed by the Pacific Northwest National Laboratory (PNNL). The FRAMES-HWIR Technology Software System consists of a series of components within a system framework (Figure 1.1). The process used to develop the FRAMES-HWIR Technology Software System includes steps for requirements analysis, design, specification, and development with testing and quality assurance composing a critical portion of each step.

This report discusses a subcomponent of the Exit Level Processor (ELP), one of the major elements of the system. Overall, the ELP's three subcomponents process the human and ecological risk/hazard results generated by the Multimedia Multipathway Simulation Processor (MMSP) and compute chemical-specific exit levels, which are the final output of the FRAMES-HWIR Technology Software System. The ELP contains three primary subcomponents: ELP-I, Risk Visualization Processor (RVP), and ELP-II. The ELP-I reads the human-health and ecological risk/hazard results from the Global Results Files (GRF), which are generated by the MMSP, and stores these results in a series of Risk Summary Output Files (RSOFs). The information in the RSOF can be viewed graphically by the RVP. Based on a level of protectiveness and a set of risk factors chosen by an analyst, the ELP-II provides the chemical-specific waste-stream concentration (C_w) that meets that level of protectiveness via the Protective Summary Output Files (PSOF).

This report includes information on requirements of the ELP-II and RVP, as well as design elements necessary to meet those requirements. It also discusses testing plans, testing results, and the quality assurance program for the ELP-II and RVP. Information on the ELP-I can be found in *Documentation for the FRAMES-HWIR Technology Software System, Volume 7: Exit Level-I Processor*. Specifications for the ELP subcomponents are described in *Documentation for the FRAMES-HWIR Technology Software System, Volume 8: Specifications*. References cited in the text are listed in Section 6.0. The appendix provides additional details on the testing program for the ELP-II and RVP. Other components developed by PNNL are described in companion documents as listed in the reference list; the system itself is documented in a summary report, *Overview of the FRAMES-HWIR Technology Software System.*

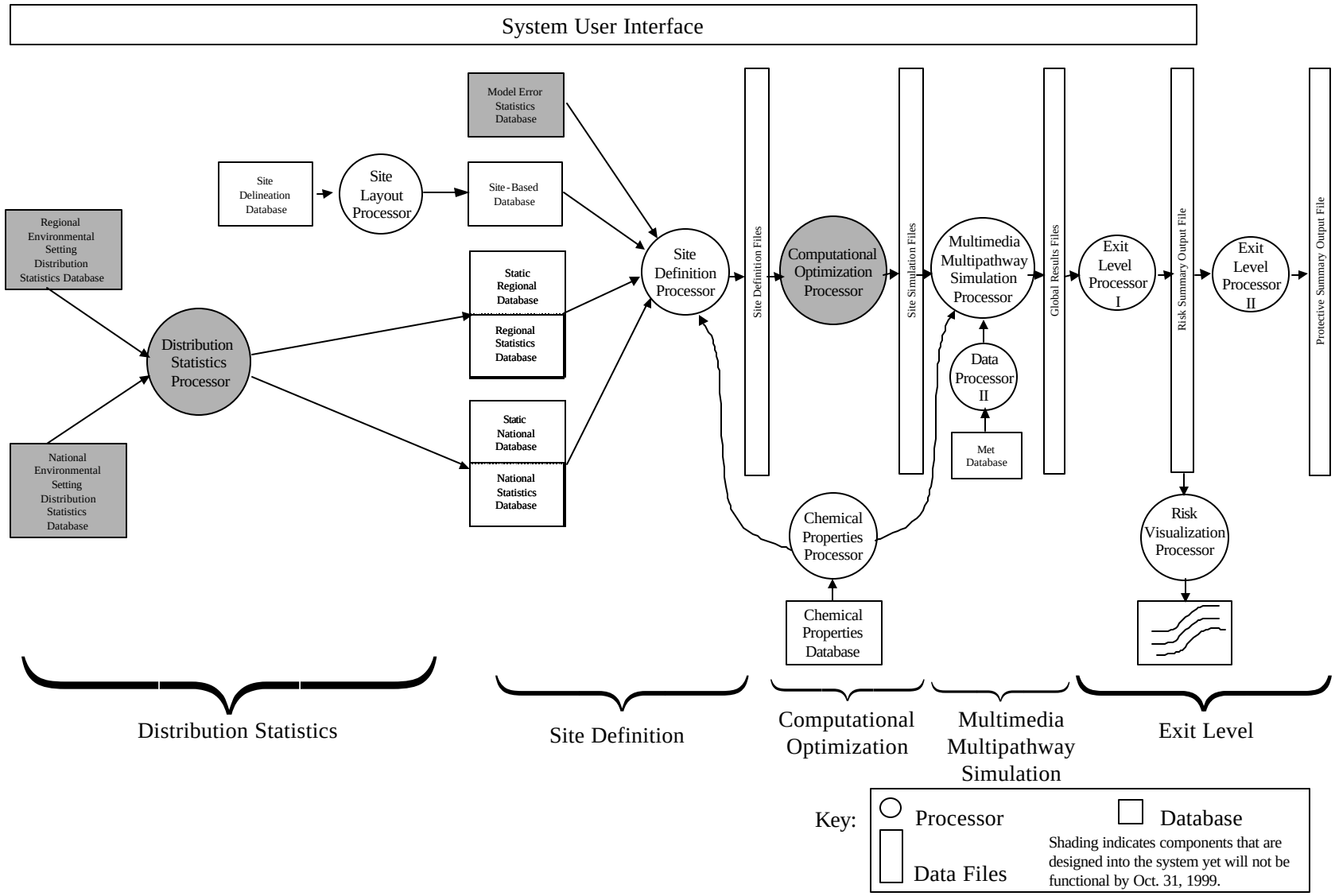


Figure 1.1 Overview of the FRAMES-HWIR Technology Software System

2.0 Requirements for the RVP and ELP-II

Requirements are characteristics and behaviors that a piece of software must possess to function adequately for its intended purpose. The primary purposes of the ELP components are to process and reformat risk-based information generated by the MMSP, provide a means for querying and summarizing this information graphically, and to ultimately compute chemical-specific exit levels. The HWIR chemical-specific (exit levels, in simplest terms, define a C_w) that, if exceeded, defines that entire waste stream as hazardous and thus requires strict Subtitle C disposal. Waste containing concentrations below the exit level may "exit" a strict Subtitle C disposal system and be disposed of in industrial Subtitle D facilities. Figure 1.1 illustrates where the three ELP components (ELP-I, RVP, and ELP-II) fit into the FRAMES-HWIR Technology Software System. The simplest possible output from the ELP is a list of chemical-specific exit levels. However, because so many factors influence the determination of an actual exit level, the ELP will output additional information that describes these factors. Also, the database of risk information used to determine exit levels will be available for others to query and summarize in different ways to arrive at other possible exit levels.

Each of the ELP's three subcomponents functions to fulfill a specific requirement. The ELP-I reads the flat-ASCII GRFs, which contain the risk/hazard results generated by the MMSP, and stores this information in RSOFs, which are Microsoft Access® database files. The RVP reads the RSOFs, so users of the system can query and summarize these data in specific ways to visually inspect the ramifications of choosing risk factors (e.g., receptor types, distance) and assuming different levels of protectiveness to arrive at possible exit levels. Once the risk factors and a level of protectiveness are chosen, the ELP-II will produce chemical-specific exit levels per Waste Management Unit (WMU) type that meet that level of protectiveness. The input, scientific, and output requirements of the RVP and ELP-II are described in the following subsections.

In summary, the RVP and ELP-II will

1) represent a stand-alone component outside of the Monte Carlo realization and iterative loops of the FRAMES-HWIR Technology Software System complete with its own user interface

2) require the user to choose a header file that specifies directory paths to the Chemical Properties Processor, Risk Summary Output Files, and Protective Summary Output Files (PSOFs)

3) provide a user interface that presents appropriate choices to view human risk/hazard results for the following: 1) chemical, 2) waste management unit (WMU) source type, 3) distance from the source, 4) method used for critical year, 5) exposure pathway (or summation of pathways), 6) receptor type, 7) cohort type, 8) risk level, and 9) hazard quotient

4) provide a user interface that presents appropriate choices to view ecological hazard results for the following: 1) chemical, 2) WMU source type, 3) roll-up choice combining two of five ecological categories (ring, habitat group, habitat type, receptor group and trophic level) 4) ecological hazard quotient

5) provide an option to generate a Protective Summary Output figure of "Probability of Protection" versus "Concentration in Waste" versus "Population Percentile," expressed as Cumulative

Distribution Function (CDF) curves. The "Probability of Protection" refers to the probability of meeting the user-defined scenario (e.g., exposure pathway, cohort, risk measure, risk level, etc.). The "Concentration in Waste" (C_w) refers to the waste concentration before disposal, and the "Population Percentile" refers to the percentage of population protected.

6) allow the user to calculate an interpolated concentration between C_w value based on the current scenario, population percentile, and probability of protection desired

7) provide an option to save the current "population percentile" and "probability of protection" as the defaults for the *current* "source-contaminant" combination.

8) provide an option to save the current "population percentile" and "probability of protection" as the defaults for *all* "source-contaminant" combination

9) provide an option to print hard copies of the Protective Summary Output curves

10) allow the user to select any combination of five risk criteria (risk level, human health, hazard quotient (HQ), ecological HQ, population percentile, and probability of protection) to a risk scenario

11) create a lowest target exit level human risk, human HQ , and ecolgocial HQ comparison table, and write them to the PSOF directory

12) create target exit level tables, for each risk scenario, and write to them to the PSOF directory

13) create a relative target exit level table showing the ratio between scenarios WMU, and write them to the PSOF directory

14) create a 50% probability of protection table for each WMU, and write them to the PSOF directory

15) create cohort human risk and HQ table by corhort for each WMU and waste type (i.e., combinations of WMU types), for each scenario, and write them to the PSOF directory

16) create receptor human risk and HQ table by receptor for each WMU and waste type, for each scenario, and write them to the PSOF directory

17) create an exposure human risk and HQ table by exposure pathway for each WMU and waste type, for each scenario, and write them to the PSOF directory

18) report processor-specific errors and warnings to the screen

19) provide an option from the RVP user interface to execute the ELP-II to generate exit level tables and risk/HQ tables

20) operate within a Windows® 95 environment (32-bit)

21) be capable of being tested independently of the other FRAMES-HWIR Technology Software System processors

The RVP allows the user to query and summarize the information stored in the RSOFs and to graphically view the results of such queries. The user is prompted for a set of scenario attributes (i.e., WMU type, chemical, distance, receptor type, cohort, etc.) and a level of protection (e.g., risk of 1.0×10^{-6} or hazard quotient of 1.0, etc.). The RVP uses this information to construct plots showing the probability of protecting any given human or ecological receptor (in the group of receptors defined by the scenario attributes) as a function of C_w. Using information obtained from the RSOFs, the probability of protecting a given receptor is determined by taking the group of receptors defined by the scenario attributes across all sites and plotting the percentage of those receptors that are protected (i.e., have a risk/hazard value equal to or below the level of protection). Because each site is simulated with multiple realizations, several probability curves are plotted, each corresponding to the chosen confidence levels (e.g., 5%, 50%, 95%). These plots are called Protective Summary Output curves.

The RVP will operate outside of the Monte Carlo realization loop and the site, chemical, source, and loops, so it will be a stand alone application not accessible from the SUI. HWIR system will loop through the ELP-I for each Monte Carlo realization. Following completion of the Monte Carlo analysis and storage of the appropriate GRF risk information in the RSOFs, the user will 1) launch the RVP, 2) examine the results of the simulations, and 3) for each WMU and chemical, construct a Protection Summary Output curve, which presents the probability of protection (by WMU types[s]) versus C_w versus the percentage of population protected for user-selected

- distance, method used for critical year, exposure pathway, receptor type, and cohort for the human risk level

- distance, method used for critical year, exposure pathway, receptor type, and cohort for the human hazard level

- combinations of distance, habitat group, habitat type, receptor group, or trophic level for ecological hazard level.

This information is then supplied to the ELP-II to generate those chemical-specific exit levels that are stored in the PSOF as an option in the RVP/ELP-II user interface.

As stated previously, the HWIR exit levels define a chemical-specific waste stream concentration that, if exceeded, defines that entire waste stream as hazardous and thus requires strict Subtitle C disposal. Waste streams with concentrations below the exit level may “exit” a Strict Subtitle C disposal system and be disposed of in industrial Subtitle D units. The task of the ELP-II is to produce these exit levels, which will apply to specific chemical and WMU combinations (e.g., benzene in Land Application Units).

Essentially, the ELP-II has all the functionality of the RVP as well as the additional function of computing exit levels. As part of the RVP interface, the ELP-II prompts the user for a WMU and chemical, along with a set of scenario attributes (e.g., receptor types, distance region from the source, cohorts, etc.) and a level of protectiveness. In addition, the ELP-II requests the percentage of the receptor population to protect along with the confidence level for each scenario. Then, the ELP-II will

compute the exit level and generate a PSOF for the confidence level chosen that will include the computed exit level along with the set of chosen scenario attributes that went into the exit level computation.

2.1 Input Requirements for the RVP and ELP-II

The ELP-I provides output in such a way that users can manipulate the results to assist in decisions regarding exit chemical-specific criteria. The RSOFs constitute the output from the ELP-I and thus serve as input for the RVP and ELP-II. The RSOF contains a summation of "site and iteration" counts per percentile of population protected by C_w and risk/hazard bin by chemical and WMU type:

- For human-health risk/hazard, the matrix is also a function of distance, critical-year method. exposure pathway, receptor type, and cohort.

- For the ecological hazard, the matrix is also a function of ring distance and habitat group, distance and habitat type, distance and receptor group, distance and trophic level, receptor group and habitat group, or trophic level and habitat group.

The "count" represents the summation of the number of times, based on site-iteration pairs, that protection criteria are met. For more information, refer to the information on the ELP-I, which can be found in *Documentation for the FRAMES-HWIR Technology Software System, Volume 7: Exit Level-I Processor*.

Human risk/hazard input information is retrieved by chemical, WMU type, C_w, distance, exposure pathway, receptor type, cohort, critical-year method, risk/hazard bin, and percentiles of population protected:

- Chemical: Although the actual number of chemicals assessed per production run varies, the ELP-1 was designed to at least address 40 chemicals, where 40 chemicals represent a subset of the total number of chemicals to be assessed, as part of HWIR. The risk/hazard information is stored in the RSOF by chemical.

- Waste Management Unit Type: Waste Pile (WP); Land Application Unit (LAU); Surface Impoundment (SI); Aerated Tank (AT); Landfill (LF).

- C_w: Five levels of the concentration in the waste (C_w), before disposal, are stored (mg/L for waste water [SI and AT], mg/kg dry weight for solids [WP and LF], and mg/kg wet weight [LAU]). These levels are chemical specific.

- Distance: "n" distances are designed into the ELP-I, but only three distances are stored for HWIR calculations: 0 to 0.5 km, 0 km to 1 km, and 0 to 2 km from the edge of the waste site area.

- Exposure Pathway: Inhalation Air, Inhalation through Showering, Summation of all Inhalation Pathways, Ingestion of Groundwater, Ingestion of Soil, Ingestion of Meat, Ingestion of Milk, Ingestion of Fish, Ingestion of Breast Milk, Ingestion of Vegetables, Summation of all Ingestion Pathways, Summation of all Inhalation and Ingestion Pathways.

- Receptor Type: The risk module analyzes 16 receptor types (eight each with and without drinking water): Beef Farmer, Dairy Farmer, Beef Farmer Fisher, Dairy Farmer Fisher, Gardener, Gardener Fisher, Resident, and Resident Fisher. Of these 16 receptor types, the risk module rolls-up the results and passes only five receptor types to the ELP-I: Beef/Dairy Farmer, Gardener, Fisher, Resident, and Summation of Receptor Types.

- Cohort: The risk module analyzes five cohorts: Infants, 1-6 years old, 7-12 years old, 13-17 years old, and 18 years old and older (adult). Risk information on the five cohorts is passed to the ELP-I, where the ELP-I rolls-up the information into four cohorts: Infants, 1-12 years old, 13 years old and older (adult), and Summation of all Cohorts.

- Critical-Year Method: The critical year is defined as the year in which a pre-specified percentage (i.e., 100% for this particular application of HWIR) of the population has the maximum total risk and/or HQ over all years (EPA 1999a). The maximum total risk for carcinogenic chemicals represents the maximum moving nine-year average risk, as defined by the mid-point of the risk-bin times population associated with the risk-bin, summed over the number of risk-bins. The same procedure is followed for HQ for noncarcinogenic chemicals, except an annual average hazard is employed. The critical year is associated with each C_w, site, iteration, and WMU type by receptor type, cohort, exposure pathway, and distance.

- Risk Bin: Risk bins include $<1 \times 10^{-8}$, (1×10^{-8} - 5×10^{-7}), (5×10^{-7} - 1×10^{-6}), (1×10^{-6} - 5×10^{-6}), (5×10^{-6} - 1×10^{-5}), (1×10^{-5} - 1×10^{-4}), and $>1 \times 10^{-4}$. Each RSOF risk bin for human health stores, by Chemical and WMU type, the number of "site and iteration" pairs that protects at least some percentile of the human population (i.e., 0%, 5%, 25%, 50%, 75%, 85%, 90%, 95%, 98%, or 99%) for each "risk-bin/C_w" pair by distance, pathway, receptor, cohort, and critical-year method.

- Hazard Bin: Hazard bins include <0.1, (0.1 - 1.0), (1.0 - 10.0), and >10.0. Each RSOF hazard bin for human health stores, by Chemical and WMU type, the number of "site and iteration" pairs that protects at least some percentile of the human population for each "hazard-bin/C_w" pair by distance, pathway, receptor, cohort, and critical-year method.

- Percentiles of Population Protected: Currently, ten population protection percentiles have been identified: 99%, 98%, 95%, 90%, 85%, 75%, 50%, 25%, 5%, and 0%. These percentiles represent the percentile of the population that at least has been protected. For 90% for example, at least 90% of the population has been protected at that C_w and risk/hazard level.

Ecological-hazard input information is retrieved by chemical, WMU type, C_w, distance, hazard bin, and percentiles of population protected, by distance and habitat group, distance and habitat type, distance and receptor group, distance and trophic level, receptor group and habitat group, or trophic level and habitat group:

- Chemical: Although the actual number of chemicals assessed per production run varies, the ELP-1 was designed to at least address 40 chemicals, where 40 chemicals represent a subset of the total

number of chemicals to be assessed, as part of HWIR. The risk/hazard information is stored in the RSOF by chemical.

- Waste Management Unit Type: Waste Pile (WP); LAU; Surface Impoundment (SI); Aerated Tank (AT); LF.

- C_w: Five levels of the concentration in the waste (C_w), prior to disposal, are stored [mg/L for waste water (SI and AT), mg/kg dry weight for solids (WP and LF), and mg/kg wet weight (LAU)]. These levels are chemical specific.

- Distance: "n" distance rings are designed into the ELP-I, but only three distances are stored for HWIR calculations: 0 to 1 km, 1 km to 2 km, and 0 to 2 km from the edge of the waste site area.

- Habitat Group: Terrestrial, aquatic, and wetland.

- Habitat Type: Grassland, Shrub/Scrub, Forest, Cropland, Residential, Stream, Pond, Lake, PFGrassland, PFShrubScrub, PFForest, and NoHabitat. PF refers to permanently flooded, a condition required to define a wetland with the potential to support aquatic life.

- Receptor Group: Reptile, bird, mammal, amphibian, soil biota, aquatic biota, sediment biota, terrestrial plant, and aquatic plant.

- Critical-Year Method: The critical year is defined as the year in which a pre-specified percentage (i.e., 100% for this particular application of HWIR) of the population has the maximum total EHQ over all years (EPA 1999b). The maximum total EHQ represents the maximum annual average EHQ, as defined by the mid-point of the hazard-bin times population associated with the hazard-bin, summed over the number of hazard-bins. The critical year is associated with each C_w, site, iteration, and WMU type by habitat group, habitat type, receptor group, trophic level, and distance.

- Trophic Level: Trophic Level 1 (T1), Trophic Level 2 (T2), Trophic Level 3 (T3), communities, and producers.

- Ecological Hazard Quotient Bin: Five ecological hazard quotient bins include <0.1, (0.1 - 1.0), (1.0 - 10), (10 - 100), and >100. Each RSOF ecological hazard quotient bin stores, by Chemical and WMU type, the number of "site and iteration" pairs that protects at least some percentile of the population for each critical-year method and "hazard-bin/C_w" pair by distance and habitat group, distance and habitat type, distance and receptor group, distance and trophic level, receptor group and habitat group, or trophic level and habitat group.

- Percentiles of Population Protected: Currently, ten population protection percentiles have been identified: 99%, 98%, 95%, 90%, 85%, 75%, 50%, 25%, 5%, and 0%. These percentiles represent the percentile of the population that at least has been protected. For 90% for example, at least 90% of the population has been protected at that C_w and hazard level.

As noted in Table 2.1, the RVP/ELP-II user interface also allows users to save up to five scenario options. In addition to the human and ecological input information discussed above, a population percentile and probability of protection values will be required. A scenario is defined by the chemical, WMU type, distance, critical-year method, and human risk/hazard and ecological hazard information. Human risk/hazard information includes risk, exposure pathway, receptor type, cohort, risk level, and hazard quotient. Ecological hazard information includes a combination of distance, habitat group or type, receptor type, trophic level, and hazard quotient. Examples of user-defined scenarios are presented in Section 3.0. Although the RVP allows the user to define the most appropriate scenario for analysis, Table 2.1 illustrates four scenarios that are evaluated as part of the HWIR assessment. These four scenarios vary risk level, human health-hazard quotient, ecological-hazard quotient, population-protection percentile, and probability of meeting all scenario criteria for protection. Differences between scenarios can be with these five parameters, as the remaining scenario parameters (e.g., exposure pathway, receptor type, etc.) did not change from scenario to scenario and, therefore, are not presented in this table.

Table 2.1 Four Illustrated Scenarios Implemented in HWIR for Comparative Purposes

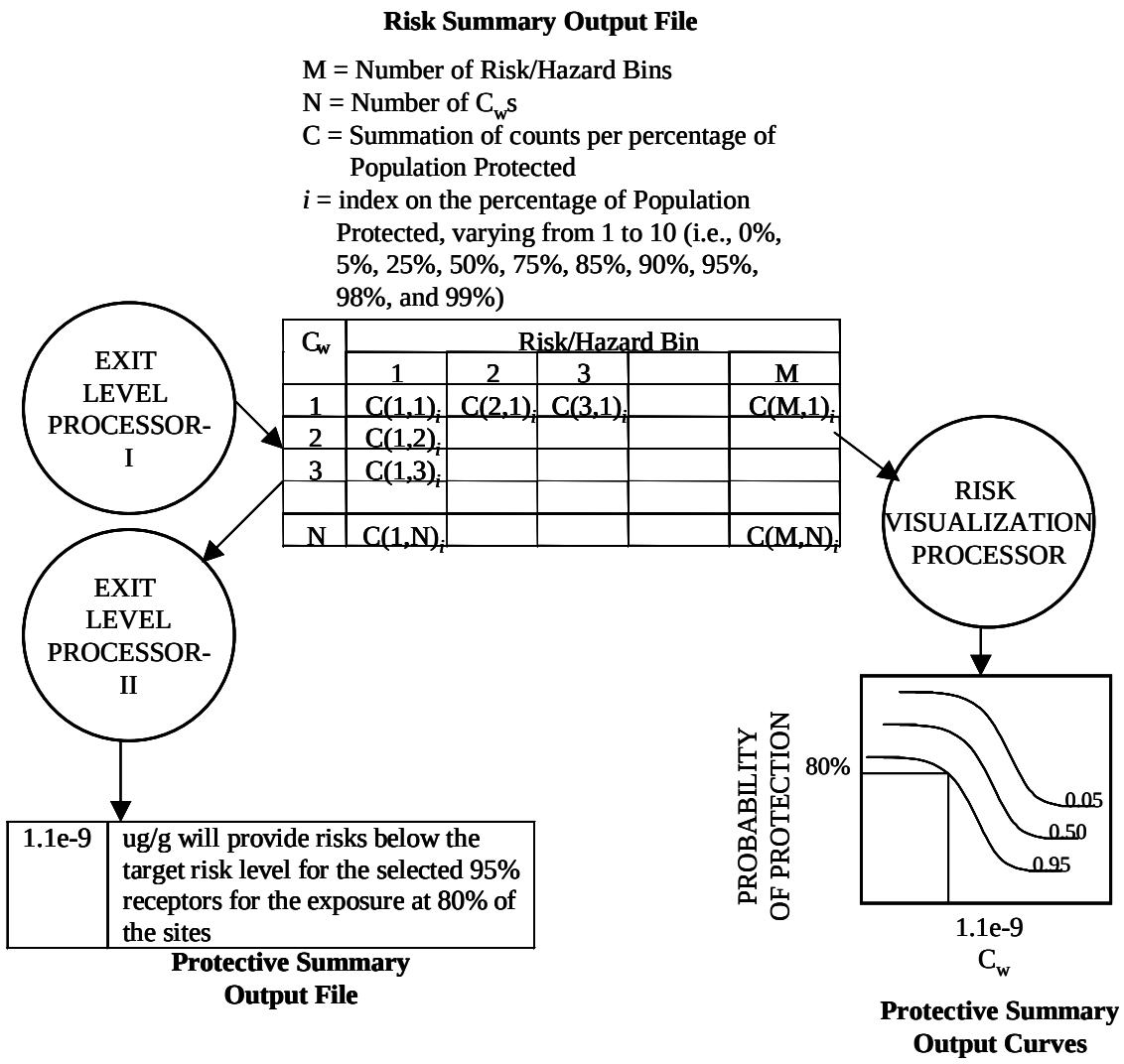
SCENARIO[(a)]	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Risk Level	10^{-6}	10^{-6}	10^{-5}	10^{-5}
Human Health-Hazard Quotient	1	1	1	10
Ecological-Hazard Quotient	1	1	1	10
Population-Protection Percentile	99	99	99	95
Probability of Protection	95	85	85	85

(a) The RVP allows a fifth scenario, although a fifth scenario was not required in HWIR. When comparing scenarios, the remaining scenario parameters (e.g., exposure pathway, receptor type, etc.) did not change from scenario to scenario and, therefore, are not presented in this table.

Figure 2.1 illustrates the relationships between the ELP-I, RVP, and ELP-II and depicts the type of information that is stored in the RSOF and the format. The RSOF matrix presented in Figure 2.1 illustrates that the RSOF file contains a summation of "site and iteration" counts per percentile of population protected by C_w and risk/hazard bin by chemical, WMU type, distance, and critical-year method. The method employed for populating the RSOF file is provided in *Documentation for the FRAMES-HWIR Technology Software System, Volume 7: Exit Level Processor-I*. $C(M,N)_i$ in Figure 2.1 represents the summation of counts per percentage of population protected. M is the number of risk/hazard bins (7 for human risk, 4 for human hazard, and 5 for ecological hazard). N is the number of C_ws (i.e., up to 5). The "i" is the index on the percentage of population protected varying from 1 to 10 (i.e., 0%, 5%, 25%, 50%, 75%, 85%, 90%, 95%, 98%, and 99% and represents a third dimension (which is not shown) to the matrix in Figure 2.1. The counts by chemical and WMU type represent the number of "site and iteration" pairs that protect at least some percentile of the population for each "risk-hazard-interval C_w" pair by

- distance and habitat group, distance and habitat type, distance and receptor group, distance and trophic level, receptor group and habitat group, or trophic level and habitat group.

Figure 2.1. Example Results Indicating Potential Levels with Different Degrees of Conservativeness in Risk Summary Output Files



2.2 Scientific Requirements for the RVP and ELP II

The mathematical equations, which define the parameters plotted by the RVP and ELP-II, are documented in the *ORD/OSW Integrated Research and Development Plan for the Hazardous Waste Identification Rule (HWIR)*. Calculations used for determining the target exit levels and target risk levels are documented in Section 3 of this document. The software design, implementation, and testing will be performed under the FRAMES-HWIR Technology Software System effort.

2.3 Output Requirements for the RVP and ELP II

The RVP retrieves data from the RSOFs, generates a plot of probability of protection as a function of C_w, and displays this plot on the screen. The Protective Summary Output figures will contain the probability of meeting all scenario criteria for protection on the y-axis and C_w (or an appropriate transformation of C_w) on the x-axis for a selected set of population-protected percentages. The RVP also interpolates a concentration between C_w values from these Protective Summary Output curves given a specific probability of protection and population percentile combination. Descriptions of the outputs produced by the RVP are described in detail in section 3.

The ELP-II retrieves data from the RSOFs, generates the PSOF based on the probability of protection as a function of C_w for both human and ecological receptors at the confidence level specified by the user, computes concentration exit levels for both human and ecological receptors, and selects the minimum of these exit levels as the final exit level. The ELP-II presents the scenario attributes, levels of protection, confidence levels, percentage of receptors protected, and the computed concentration exit levels in a PSOF.

Seven types of tables are created by the ELP-II in the PSOF directory. The following tables use the exit level scenario settings created in the RVP/ELP-II user interface (e.g., Table 2.1) to produce the desired results. Detailed descriptions of the format and contents of these tables can be found in Section 3 of this document.

- Lowest Target Exit Level tables are quantitative criteria for allowing a specific class of industrial waste streams to no longer require disposal as a hazardous waste (that is, to *exit* Subtitle C) and to allow disposal in Industrial Subtitle D facilities. Hazardous waste constituents with values less than these exit criteria levels would be reclassified as nonhazardous wastes under the Resource Conservation and Recovery Act. In these tables, the lowest exit level concentrations for human health (i.e., human risk and hazard) and ecological hazard will be evaluated and reported.

- The Target Exit Level table summarizes the results contained in the Lowest Target Exit Level tables for each chemical and WMU type by recording the lowest target exit level concentration from all categories (human health and ecological hazard) and assigning that one value to its respective scenario. Therefore, each chemical, WMU type, and scenario will be assigned one target exit level concentration (i.e., the lowest associated with that scenario). In addition, this table will note whether the lowest target exit level concentration was based on the maximum C_w used in the assessment.

- Relative Target Exit Level tables give the ratio between the first scenario's (i.e., Scenario 1 in Table 2.1) target exit level identified and the target exit level of each other scenario (i.e., Scenarios 2 through 5 in Table 2.1) for each WMU type.

- 50% Probability of Protection tables are similar to the Target Exit tables; however, the probability of protection for each scenario is set to 50%.

- Cohort Human Risk/HQ table contains the risk trigger levels found associated with the Protective Summary Output curves for each cohort category, WMU type, and waste type. In effect, target risk/hazard level (e.g., 10^{-6} for risk and 1.0 for human HQ) is determined as a function of an exit-level concentration by cohort category. The previous tables have computed the target exit level concentration as a function of the target risk/hazard level.

- Receptor Human Risk/HQ table contains the risk trigger levels found associated with the Protective Summary Output curves for each receptor category, WMU type, and waste type.. As with the Cohort Human Risk/HQ tables, the target risk/hazard level is determined as a function of an exit-level concentration by receptor category.

- Exposure Human Risk/HQ table contains the risk trigger levels found associated with the Protective Summary Output curves for each exposure category, WMU type, and waste type.. As with the Cohort Human Risk/HQ tables, the target risk/hazard level is determined as a function of an exit level concentration by exposure category.

3.0 Design Elements for the RVP and ELP-II

The RVP and ELP-II are designed to meet the requirements identified in Section 2.0. Key to meeting those requirements is the ability to create probability protection curves and determine exit level concentrations. The following subsections describe the input, implementation, and output of the RVP and ELP-II.

3.1 Input

The required input for this software is a header file, user-input entered through the user interface, and RSOF databases. Figure 3.1 depicts the initial screen when running the RVP/ELP-II user interface. The user must open a header file to direct the RVP/ELP-II to the files, directories, and DLLs that it requires. The system then evaluates the available RSOF databases and will alert the user when the necessary database for a chemical and WMU combination does not exit. If the RSOF database for the chemical and WMU combination does exist, then additional selection options will become available.

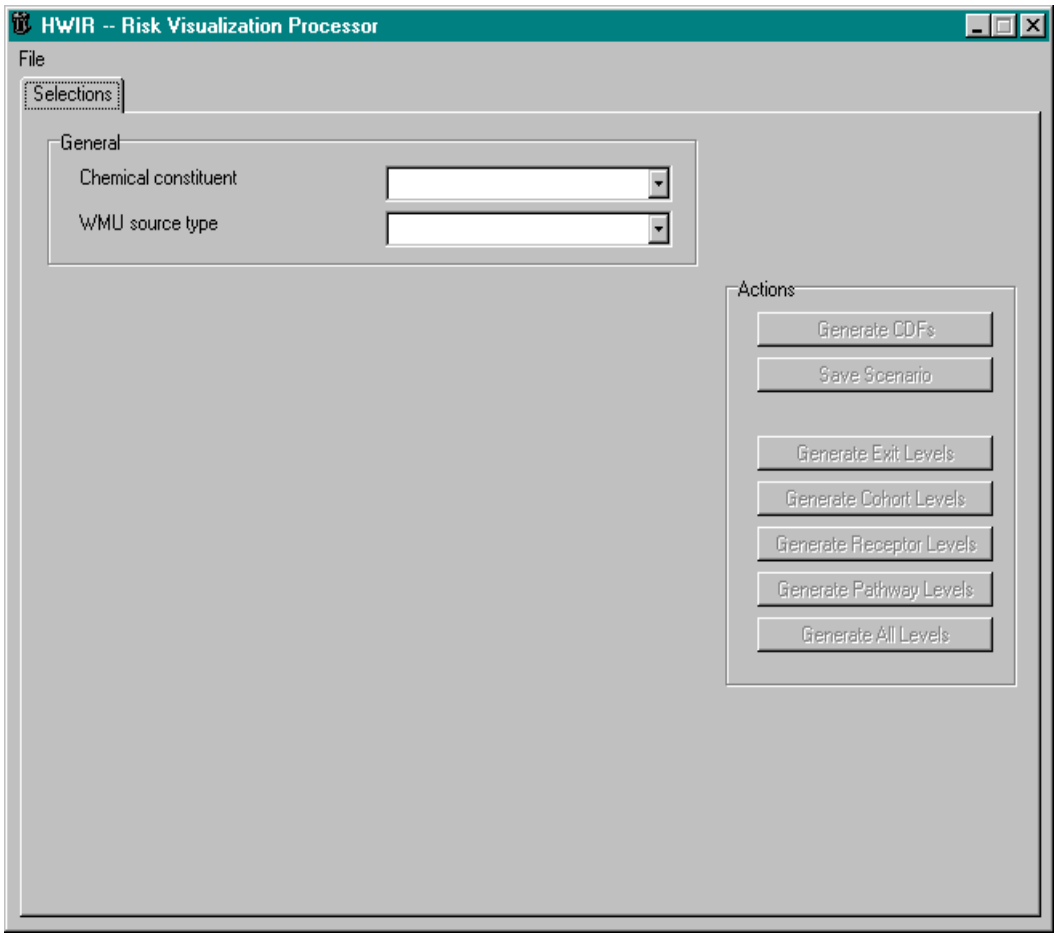


Figure 3.1 Initial RVP/ELP-II User Interface

Three potential choices in the user interface affect both human and ecological graphical or tabular results: chemical constituent, WMU source type, and population percentile(s). In addition to the five WMUs calculated for the HWIR analysis, the WMU source-type option also has the combined selection choices. These choices are AT and SI (liquid water streams), LF and WP (solids waste stream), and LF, WP, and LAU (solids/semi-solid waste stream). When calculating the cululative distribution functions (CDFs) for these three options, the CDF curve for each WMU is calculated then added.

The options specific to human risk and hazard quotient are distance of risk radius, method used for critical year, exposure pathway, receptor type, cohort type, risk level, and hazard quotient. The options for ecological hazard quotients are roll up option, radius ring distance, habitat group, receptor group, trophic level, and hazard quotient. The potential selections for each of these is determined by the description tables found in the RSOF databases described in Section 2. Figure 3.2 shows the additional human risk and hazard quotient, and ecological hazard quotient options that become available when a RSOF chemical and WMU combination exists.

The RVP/ELP-II user interface gathers the available selections for each of the options from the description files available in the RSOF databases. Description tables are used in the RSOF databases to identify the table code used to distinguish the human and ecological combinations of selections. Table 3.1 gives the RSOF database table names for the description tables and their associated table codes. The number of choices in each code and what they represent can vary from database to database. For the

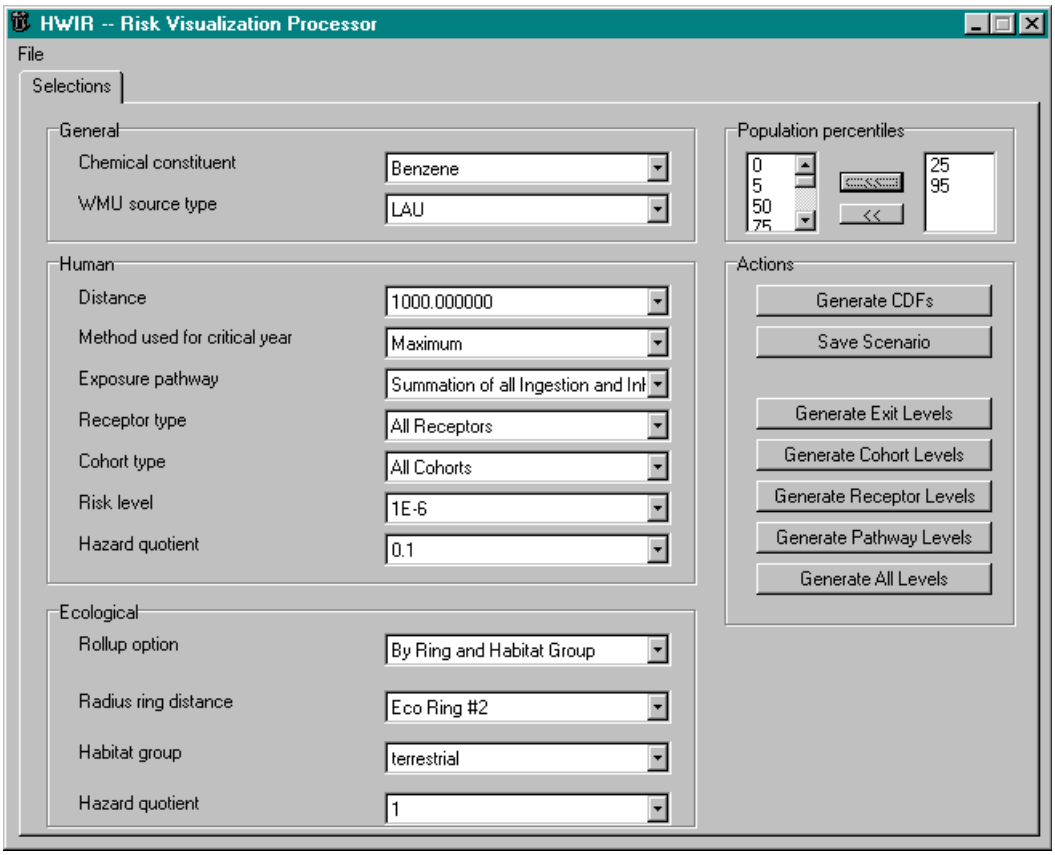


Figure 3.2 Additional Human Risk, Human Hazard Quotient, and Ecological Hazard Quotient Options

number of choices in each code and what they represent can vary from database to database. For the HWIR analysis, these codes correspond to the input requirements discussed in Section 2.

Table 3.1 Description Table Names and Codes

Receptor	Option	Description Table Name	Table Label Code
Human			
	Distance	DistDes	D0-D2
	method used for critical year	CritDes	P0
	exposure pathway	ExpDes	E0-E12
	receptor type	RecDes	R0-R4
	cohort type	CohDes	C0-C4
	risk level	BinDes	R
	hazard quotient	BinDes	H
Ecological			
	Radius ring distance	EDistDes	D0-D2
	habitat group	EHabGDes	HG0-HG2
	receptor group	ERecDes	RG0-RG8
	trophic level	EtrophicDes	TL0-TL4
	habitat type	EHabTDes	HT0-HT10
	Hazard Quotient	BinDes	E

Section 2 discusses the available selections under each of the options found in Table 3.1. Additional description tables that are not discussed in Table 3.1 include “ChemDes”, “PerDes”, “SiteIterIndex”, “RTemplate”, “HTemplate”, and “Etemplate”. “ChemDes” describes the appropriate risk output for the specific chemical (carcinogenic for ingestion, carcinogenic for inhalation, noncarcinogeic for ingestion, noncarcinogenic for inhalation, and ecological hazard). In addition, the “ChemDes” contains the C_w values for that chemical. “PerDes” describes the available population percentiles for input selection. “SiteIterIndex” describes the count for each site that is used to determine the exit level probability of protection. “Rtemplate”, “Htemplate”, and “Etemplate” are the base templates used by the ELP-I to create the data tables and are not used by the ELP-II and RVP.

Table 3.1 gave example codes that are used by the system to gather the correct bin for probability calculations. The letters used in these codes are static; however, the number of selections in each code and what those numbers represent are determined by the information stored in the RSOF databases.

These table codes are then linked together to build the table name containing the chosen combination of inputs (*RD2E10R3C2P0 or EHG2RG2*, for example). RD2E10R3C2P0 would represent the following selected options in the input screen selections.

R – Human Risk
D2 – Distance—2000
E10 – Exposure Pathway—Summation of all Ingestion
R3 – Receptor Type—Fisher
C2 – Cohort Type—13 years old and older
P0 – method used for critical year—Maximum

EH2RG2 would represent the following selected options in the input screen selections.

E – Ecological Hazard Quotient
HG2 – Habitat Group—Wetland
RG2 – Receptor Group—Mammal

Figure 3.3 demonstrates these selections for Benzene in the RVP/ELP-II user interface.

The RVP/ELP-II user interface also allows users to save up to five scenario options. These scenarios can be set by selecting the "Save Scenario" button on the "Selections" tab. A population percentile and probability of protection value will be required. Figure 3.4 demonstrates the Save Scenario screen.

3.2 Implementation

The following sections refer to how the RVP and ELP II will implement and fulfill the requirements stated in Section 2.

3.2.1 Implementation of RVP

Based on the options selected in the RVP user interface and the data found in the RSOF database, the RVP creates CDF graphs of the probability of protection. The RVP determines the appropriate charts based on the selection scenario options discussed in Section 2. With this information, the description files found in the database are used to identify the appropriate table in the chemical and WMU databases.

The description files are divided into the seven categories for human health and the six categories for ecological to match the selections found in the "Selection" tab in the RVP user interface. The Site Iteration Index is taken from the "SiteIterIndex" table for the selected percentile(s). Using the Index and the bin values found in the tables, Equation 3.1 is used to find the probability of protection for each C_w.

$$Probablity\ of\ Protection\ '\ \frac{BinValue}{Index} \tag{3.1}$$

contains the site count for the specific C_w and Bin. The RVP will then use up to five C_w values to graph the protective summary output figures. These curves will also be used to calculate exit level concentrations by interpolating between C_w values, given a target probability of protection. Figure 3.5 is an illustration, demonstrating three population percentile curves (5%, 50%, and 95%). For a target probability of protection of 80% and a population of protection curve 95%, an interpolated concentration between C_w values is returned. For this example, 1.19e-9 is the corresponding exit level concentration, which was interpolated from the user-defined C_w values. This interpolation technique is also used by the ELP-II for calculating target exit levels.

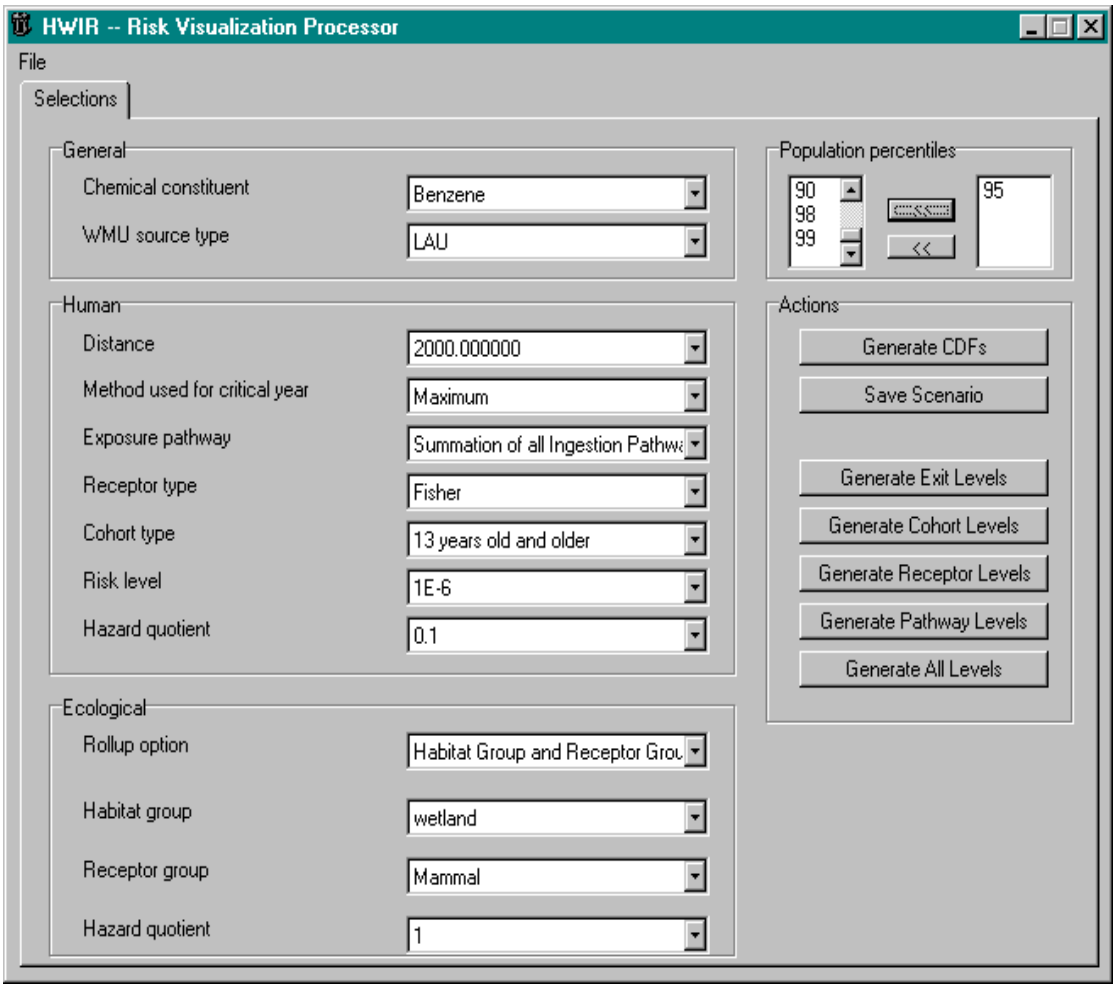


Figure 3.3 Selections for Table RD2E10R3C2PO and EHG2RG2

3.2.2 Implementation of ELP-II

The ELP-II creates up to five scenario options (e.g., Table 2.1) and seven types of tables. A scenario table is created to store the scenario and default selections made. A scenario is defined as a specified probability of protection and population percentile combination, along with the human and ecological selections options discussed in Section 2 (distance, exposure pathway, receptor type, cohort, critical-year method, and risk/hazard bin for human; distance, habitat group, habitat type, receptor group, and trophic level for ecological). Scenarios are defined through the RVP/ELP-II user interface as discussed in Section 3.1.

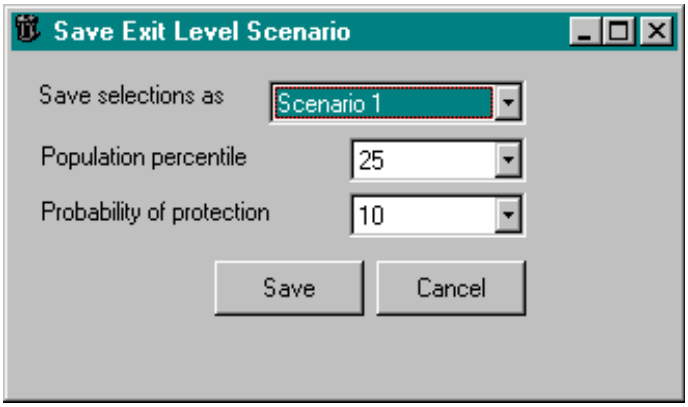


Figure 3.4 Save Scenario Option in the RVP/ELP-II User Interface

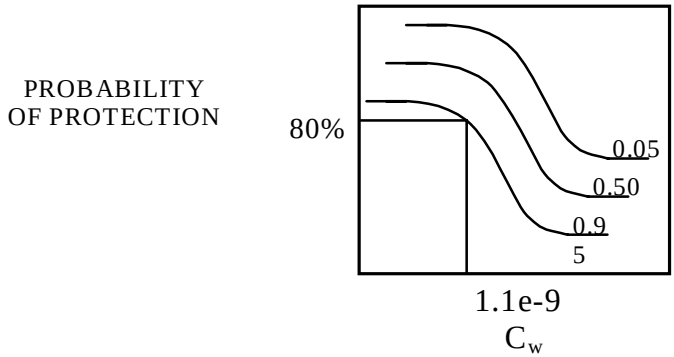


Figure 3.5 Interpolation of C_w Values Given Population Percentile and Probability of Protection

The tables created by the ELP-II use the exit-level scenario settings created in the RVP user interface to produce the desired results. As noted in Section 2.3, the seven ELP-II types of tables are

1) Lowest Target Exit Level
2) Target Exit Level
3) Relative Target Exit Level
4) 50% Probability of Protection
5) Cohort Human Risk/HQ
6) Receptor Human Risk/HQ
7) Exposure Human Risk/HQ

The ELP-II can also be run through the System User Interface (SUI). A check box is provided to activate this option. If the ELP-II is selected, these tables are produced automatically by the SUI using default scenario options, which are illustrated in Table 2.1. Each table with an illustrative example is described in the following sections.

3.2.2.1 Lowest Target Exit Level

Lowest Target Exit Level Tables are quantitative criteria for allowing a specific class of industrial waste streams to no longer require disposal as a hazardous waste (that is, to *exit* Subtitle C) and to allow disposal in Industrial Subtitle D facilities. Hazardous waste constituents with values less than these exit criteria levels would be reclassified as nonhazardous wastes under the Resource Conservation and Recovery Act. In these tables, the lowest target exit level concentrations, based on human risk, human hazard quotient and ecological hazard quotient, will be evaluated and reported. Lowest Target Exit Level tables will be created for up to five scenarios. All human risk/HQ and ecological HQ exit level concentrations will be calculated using the C_w interpolation method described in Section 3.2.1, by holding all selections constant except for the exposure pathway. The human risk and HQ exit level concentrations will be calculated for the exposure pathway "all inhalation and ingestion." If that pathway exit level concentration does not exist, then either the "all ingestion" or "all inhalation" exit level concentrations will be calculated—whichever exit level provides the lower value. In the event that only one of the pathways exist, then the existing exit level is used.

Within each table (see Table 3.2), a target exit level concentration will be assigned for Human Health (HH) by comparing the human risk (carcenogenic) exit level concentration with the human HQ (non-carcenogenic) exit level concentration and placing the lower exit level in the HH column.

The ecological exit level concentration is then calculated using the C_w interpolation method described in Section 3.2.1 assuming the largest radius ring distance (EcoRing#2) and Habitat Group options (i.e., terrestrial, aquatic, and wetland). The lowest interpolated C_w of all Habitat Group selection options is then placed in the "Eco" column. The lower of the HH and Eco exit levels is placed in the "Lowest" column. This process will be repeated for each available chemical, waste type (e.g., liquid, semi-solid, and solid, which represent combinations of WMU types), and WMU. Table 3.2 shows the type of data stored in the Lowest Target Exit Level table. There are five Lowest Target Exit Level tables, each representing a scenario (see Table 2.1). Each table contains the lowest target exit levels for each chemical for the following categories:

- Semi-Solid Waste Streams: Lowest exit level concentration between landfills, waste piles, land application units, surface impoundments, and aerated tanks for human health, ecological impact, and the lowest concentration between human health and ecological impact.

- Solid Waste Streams: Lowest exit level concentration between landfills and waste piles for human health, ecological impact, and the lowest concentration between human health and ecological impact.

- WMU Types and Waste Types: Lowest exit level concentration for each WMU and waste type (i.e., liquid, solid, semi-solid, which represent combinations of WMU types) for human health, ecological impact, and the lowest concentration between human health and ecological impact.

Table 3.2 Lowest Target Exit Level Concentrations

		Liquid			Semi-Solid			Solid			Landfill			Other WMU...		
Chemical	**CasId**	**HH**	**Eco**	**Lowest**	**HH**	**Eco**	**Lowest**	**HH**	**Eco**	**Lowest**	**HH**	**Eco**	**Lowest**	**HH**	**Eco**	**Lowest**
Benzene	71-43-2	4.00E-01	3.00E+01	4.00E-01												
Lead	7439-92-1	1.00E-05	3.00E+01	1.00E-05												

3.2.2.2 Target Exit Level Tables by Scenario

A Target Exit Level table is produced for each WMU and waste type (total of eight tables) and summarizes the results contained in the Lowest Target Exit Level tables for each chemical and WMU type by recording the lowest target exit level concentration, as recorded in the "Lowest" column in Table 3.2. Table 3.3 is an example of the type of data stored in the Target Exit Level tables. The table is continued for every chemical and all scenarios. This table also notes whether the lowest target exit level concentration was based on the maximum C_w used in the assessment. The "Max Used" column signals that the Target Exit Level given was equal to the maximum C_w (usually, C_w=5). The specification for the data in these tables can be found in *Documentation for the FRAMES-HWIR Technology Software System, Volume 8: Specifications*.

Table 3.3 Target Exit Level Concentrations by Scenario

Chemical Name	**CasId**	**Scenario 1**	**Max Used**	**Scenario 2**	**Max Used**	**Other Scenarios...**
Benzene	71-43-2	4.00E-01	"no"	1.00E+02	"no"	
Lead	7439-92-1	1.00E-05	"no"	1.00E-04	"no"	

3.2.2.3 Relative Target Exit Levels

The relative target exit level tables will be calculated by dividing the target exit level for each scenario by the target exit level for Scenario 1(see Equation 3.2). Table 3.4 shows the type of data stored in the Relative Target Exit Level concentrations table. The table is continued for every chemical and each WMU and waste type (total of eight tables).

$$Relative\ Target\ Exit\ Level\ '\ \frac{Target\ Exit\ Level\ Senario\ X}{Target\ Exit\ Level\ Senario\ 1} \tag{3.2}$$

Table 3.4 Relative Target Exit Level Concentrations

Chemical Name	CasId	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Benzene	71-43-2	1	2.00E+02	3.00E-02	3.00E+00	3.00E+00
Lead	7439-92-1	1	1.00E+01	1.00E+00	1.00E+00	1.00E+00

3.2.2.4 50% Probability of Protection

The 50% Probability of Protection is similar to the Target Exit Level concentration table by Scenario Table, except that every scenario's probability of protection has been set to 50%. Table 3.5 shows the type of data stored in the 50% Probability of Protection table. The table is continued for every chemical, all scenarios, and each WMU and waste type (total of eight tables).

Table 3.5 Target Exit Level Concentrations, Based on 50% Probability of Protection

Chemical Name	CasId	Scenario 1	Max Used	Scenario 2	Max Used	Other Scenarios...
Benzene	71-43-2	1.00E+02	"no"	1.00E+02	"no"	
Lead	7439-92-1	1.00E-04	"no"	1.00E-04	"no"	

3.2.2.5 Cohort Human Risk/HQ Tables

Cohort human risk/HQ tables are calculated in a similar manner using the target exit level method described in Section 3.2.1. In effect, target risk/hazard level (e.g., 10^{-6} for risk and 1.0 for human HQ) is determined as a function of an exit level concentration by cohort category. The previous tables have computed the target exit level concentration as a function of the target risk/hazard level. In creating the Cohort human risk table, all scenario settings are held constant while each cohort type will be evaluated for each risk and HQ level. This process yields a risk per exit level curve for each cohort. A target exit level concentration will be calculated by selecting "All Cohorts" for the desired risk level. This target exit level will then be used for interpolation on the risk per exit level curves to determine the risk trigger level. These risk trigger levels will be placed in the appropriately labeled columns. Table 3.6 shows the type of data stored in the Cohort Human Risk and HQ files. The table is continued for every chemical and all WMUs and waste types. One table is created for each scenario.

Three special situations were addressed:

- a vertical line
- the target exit level never intersects the curve
- the target exit level intersects the curve at more than one point.

Each of these cases has been specifically addressed as follows. In the event that the exit level curve is a vertical line and the target exit level is also on this vertical line, the risk trigger level selected will be the one associated with the lowest-exit level value.

In the event that the target exit level never intersects the curve, then the highest or lowest risk trigger level on the curve will be selected, depending on whether the target exit level is below or above the given curve.

In the event the target exit level intersects the curve in more than one point, the lower exit level of the two points will be used to determine the risk trigger level. The HQ risk trigger levels will be calculated in the same manner using the HQ levels. This process is repeated for each WMU, and the table will be created for each scenario.

Table 3.6 Cohort Human Risk/HQ for Landfill

Chemical Name	CasId	Landfill					
		Infants		1-12 years old		13 years old and older	
		Risk	HQ	Risk	HQ	Risk	HQ
Benzene	71-43-2	1E-04	NA	8E-07	NA	0.000005	NA
Lead	7439-92-1	1E-04	NA	0.0001	NA	0.0001	NA

3.2.2.6 Receptor Human Risk/HQ

These tables will be calculated in the same manner as the Cohort Risk/HQ tables as described in Section 3.2.2.5, except that the cohort selection will remain constant, and the risk per exit level curve will be generated for each receptor type. In effect, target risk/hazard level (e.g., 10^{-6} for risk and 1.0 for human HQ) is determined as a function of an exit level concentration by receptor category. A target exit level will be calculated by selecting “All Receptors” for the desired risk level. This target exit level concentration will then be used for interpolation on the risk per exit level curves to determine the risk trigger level. These risk trigger levels will be placed in the appropriately labeled columns.

The HQ risk trigger levels will be calculated in the same manner using the HQ levels. This process is repeated for each WMU and waste type, a table is created for each scenario. Table 3.7 shows the type of data stored in the Receptor Human Risk and HQ files. The data are continued for every chemical and all cohort options.

Table 3.7 Receptor Human Risk/HQ for Waste Pile

Chemical Name	CasId	Waste Pile							
		Beef/Dairy Farmer		Gardener		Fisher		Resident	
		Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
Benzene	71-43-2	4E-08	NA	0.000003	NA	0.000006	NA	8E-07	NA
Lead	7439-92-1	0.0001	NA	0.0001	NA	0.0001	NA	0.0001	NA

3.2.2.7 Exposure Human Risk/HQ

These tables will be calculated in the same manner as the Cohort Risk/HQ tables as described in Section 3.2.2.5, except that the cohort selection will remain constant, and the risk per exit level curve will be generated for each exposure type. As with the Cohort Human Risk/HQ tables, the target risk/hazard level is determined as a function of an exit level concentration by exposure category. A target exit level concentration will be calculated as described in Section 3.1.1 for the desired risk level. This target exit level concentration will then be used for interpolation on the risk per exit level curves to determine the risk trigger level. These risk trigger levels will be placed in the appropriately labeled columns.

The HQ risk trigger levels will be calculated in the same manner using the HQ levels. This process is repeated for each WMU, and the table will be created for each scenario. Table 3.8 shows the type of data stored in the Exposure Human Risk and HQ tables. The table is continued for all exposure pathways, all WMU, waste types, and every chemical.

Table 3.8 Exposure Human Risk/HQ

Chemical Name	CasId	Air Inhalation		Soil Ingestion		Water Ingestion		Crop Ingestion	
		Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
Benzene	71-43-2	0.000006	NA	2E-09	NA	1E-04	NA	0.00002	NA
Lead	53-70-3	1E-04	NA	0.0001	NA	1E-04	NA	0.0001	NA

3.3 Output Results

The RVP will have a visual output of three graphs that plot Percent Protection vs. C_w. The graphs will be for Human Risk Protective Summary, Human HQ Protective Summary, and Ecological Protective Summary. Users will be able to print these graphs. The ELP II will have several output files, each designed by EPA to fill a specific need. The following sections describe the format of the graphs and output files.

The RVP displays this data in the form of CDFs, correlating Probability of Protection (i.e., probability of a number of sites meeting protection criteria) versus C_w versus Probability of Protection of a Population (e.g., protect 95% of a population, as illustrated by the Protective Summary Output figure CDF in Figure 3.4).

3.3.1 RVP: Probability of Protection Charts

The RVP generates a plot of probability of protection as a function of C_w and displays this plot on the screen. The Protective Summary Output figures contain the probability of protecting a given receptor on the y-axis and C_w (or an appropriate transformation of C_w) on the x-axis for a selected set of population-protected percentages. The RVP creates a Protective Summary Output curve for human risk, human HQ, and ecological HQ, depending on the appropriateness and existence of the data for the chemical chosen. Figures 3.6 and 3.7 demonstrate two of the graphical charts produced by the RVP.

Figure 3.8 demonstrates the selection of probability of protectiveness and population percentile interpolation option found in the RVP Protective Summary Output Curves screen. Two selection windows are provided in the upper left of the screen; after both have been chosed, the interpolated concentration value will appear in the box to the right. If the value is not on the curve, an "Out of Range" message will appear the in the interpolation box.

3.3.2 ELP-II: Protective Summary Output Files

There are seven types of tables created by the ELP-II. All tables will be in comma-separated format. This format facilitates the viewing and formatting of these tables in Excel or Lotus. The above section (Section 3.2) described the type of data stored in each of the tables that will be output by the ELP-II to the PSOF directory. The format specifications for each data table can be found in *Volume 8, HWIR Specifications*. Figure 3.9 shows the "Generate" buttons on the right side of the "Selections" tab.

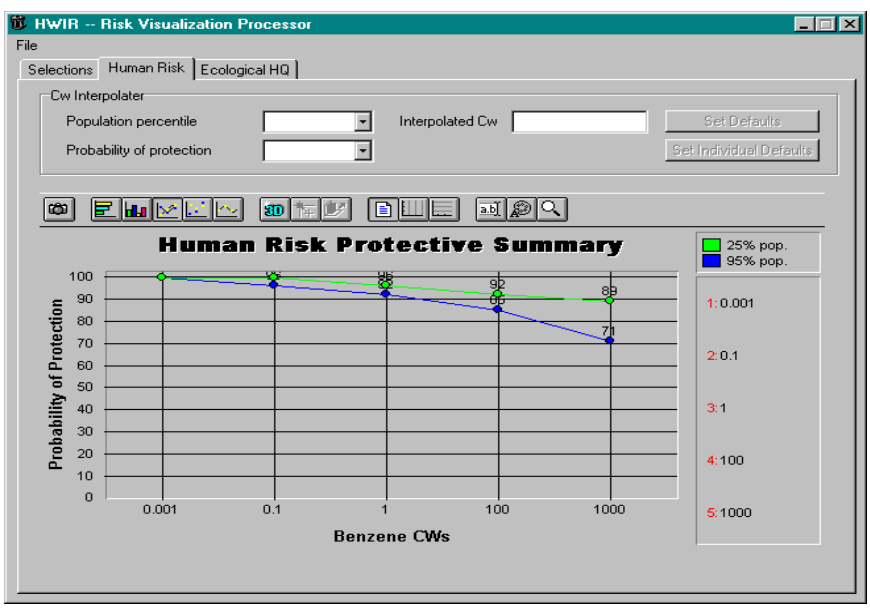


Figure 3.6 Protective Summary Output Figure for Human Risk

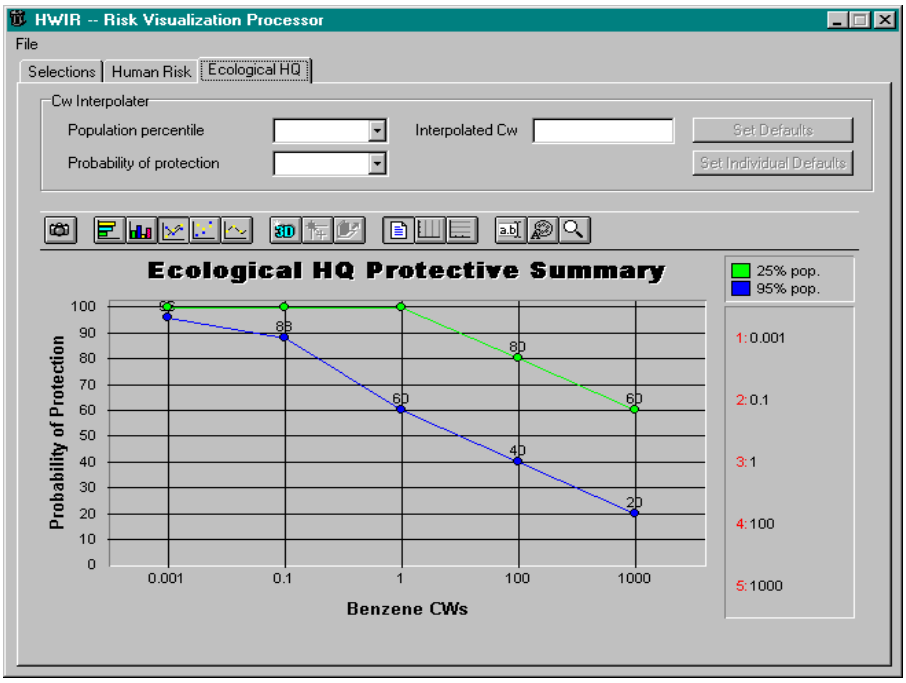


Figure 3.7 Protective Summary Output Figures for Ecological HQ

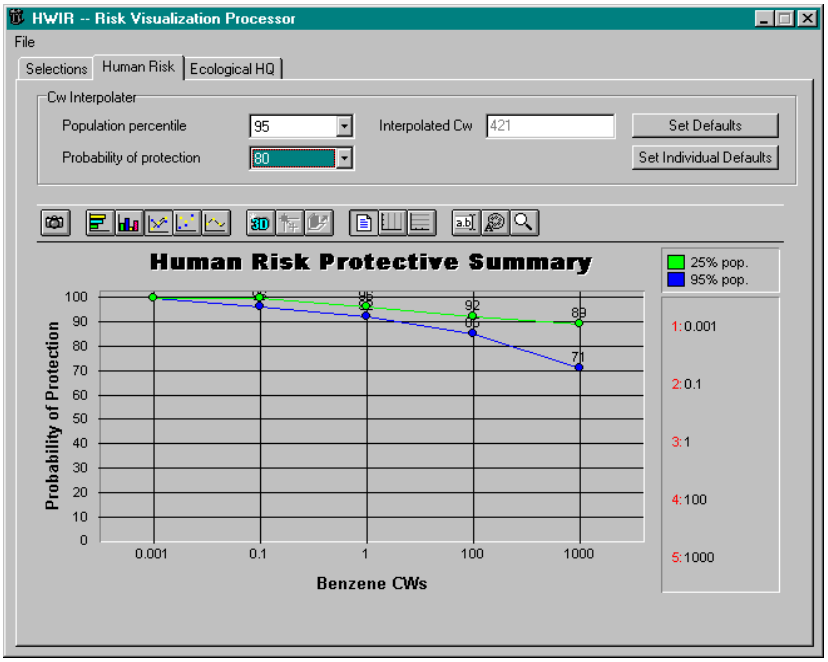


Figure 3.8 Concentration Interpolation in the RVP/ELP-II User Interface

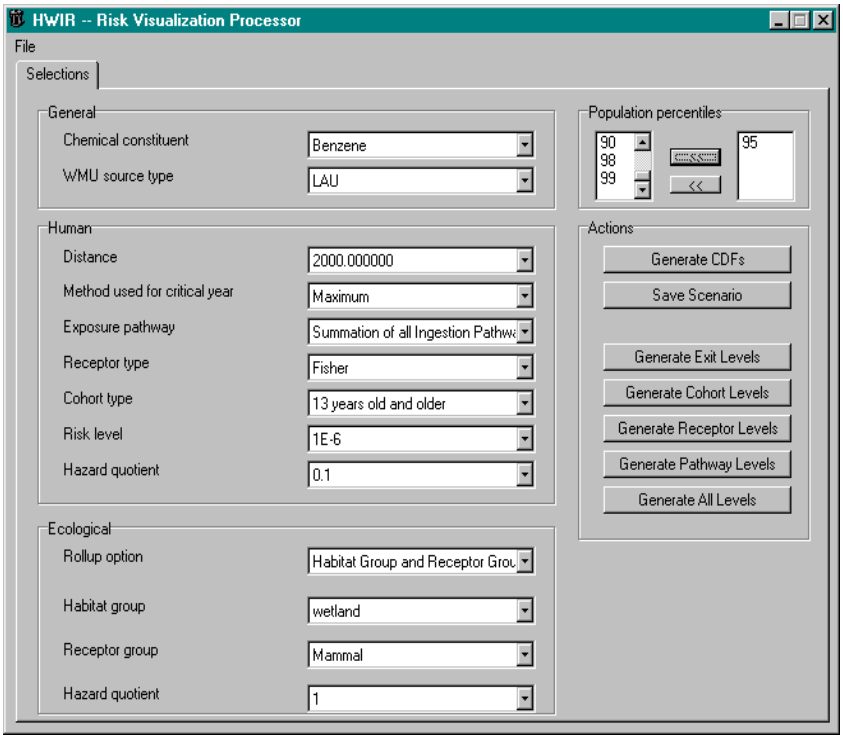


Figure 3.9 Generate Buttons on RVP/ELP-II User Interface

4.0 Testing Approach and Results

This section describes how the ELP II was tested to ensure that it met its requirements. The purpose of the ELP II is to produce exit levels of waste-stream contaminant concentrations for all WMU-contaminant combinations. The following sections summarize the requirements for the ELP II in a form suitable for testing, show how the test cases that follow relate to these requirements, describe each test case, and describe the baseline results for each test case. The test cases address the basic functionality listed in the requirements (black box testing).

This section describes how the RVP was tested to ensure that it met its requirements. The purpose of the RVP is to allow the user to query and summarize the information stored in the RSOFs and to graphically view the results of such queries. The following sections summarize the requirements for the RVP in a form suitable for testing, show how the test cases that follow relate to these requirements, describe each test case, and describe the baseline results for each test case. The test cases address the basic functionality listed in the requirements (black box testing).

4.1 Summary of Requirements

Requirements for the RVP and ELP II are described in Section 2, and the design is described in Section 3. The requirements specified (or implied) by these chapters were reworded in Table 4.1 to provide concise, fundamental requirements suitable for testing.

Table 4.1 Summary of the Requirements for the RVP and ELP II

Requirement Number	Requirement
1	Represent a stand-alone component outside of the Monte Carlo realization and iterative loops of the FRAMES-HWIR Technology Software System complete with its own user interface.
2	Require the user to choose a header file that specifies directory paths to the Chemical Properties Processor, Risk Summary Output Files, and Protective Summary Output Files.
3	Provide a user interface that presents appropriate choices to view human risk/hazard results for the following: 1) chemical, 2) WMU source type, 3) distance from the source, 4) method used for critical year, 5) exposure pathway (or summation of pathways), 6) receptor type, 7) cohort type, 8) risk level, and 9) hazard quotient.
4	Provide a user interface that presents appropriate choices to view ecological hazard results for the following: 1) chemical, 2) WMU source type, 3) roll-up choice combining two of five ecological categories (ring, habitat group, habitat type, receptor group, and trophic level) and 4) ecological hazard quotient.

Requirement Number	Requirement
5	Provide an option to generate a Protective Summary Output figure of "Probability of Protection" versus "Concentration in Waste" versus "Population Percentile," expressed as CDF curves. The "Probability of Protection" refers to the probability of meeting the user-defined scenario (e.g., exposure pathway, cohort, risk measure, risk level, etc.). The "Concentration in Waste" (C_w) refers to the waste concentration before disposal, and the "Population Percentile" refers to the percentage of population protected.
6	Allow the user to calculate an interpolated concentration between C_w value based on the current scenario, population percentile, and probability of protection desired.
7	Provide an option to save the current "population percentile" and "probability of protection" as the defaults for the *current* "source-contaminant" combination.
8	Provide an option to save the current "population percentile" and "probability of protection" as the defaults for *all* "source-contaminant" combinations.
9	Provide an option to print hard copies of the Protective Summary Output curves.
10	Allow the user to select any combination of five risk criteria (risk level, human health, HQ, ecological HQ, population percentile, and probability of protection) to a risk scenario.
11	Create a lowest target exit level human risk, human HQ, and ecolgocial HQ comparison table, and write them to the PSOF directory.
12	Create target exit level tables, for each risk scenario, and write to them to the PSOF directory.
13	Create a relative target exit level table showing the ratio between scenarios WMU, and write them to the PSOF directory
14	Create a 50% probability of protection table for each WMU, and write them to the PSOF directory.
15	Create cohort human risk and HQ table by corhort for each WMU and waste type, for each scenario, and write them to the PSOF directory.
16	Create receptor human risk and HQ table by receptor for each WMU and waste type, for each scenario, and write them to the PSOF directory.
17	Create an exposure human risk and HQ table by exposure pathway for each WMU and waste type, for each scenario, and write them to the PSOF directory.
18	Report processor-specific errors and warnings to the screen.
19	Provide an option from the RVP user interface to execute the ELP-II to generate exit level tables and risk/HQ tables.
20	Operate within a Windows® 95 environment (32-bit).
21	Be capable of being tested independently of the other FRAMES-HWIR Technology Software System processors.

Table 4.2 shows the relationship between these requirements and the test cases described in Section 4.2. While some requirements apply to all test cases, this table shows which requirements will be specifically evaluated by each case.

Table 4.2 Matrix of Requirements to Test Case for the RVP and ELP II

		Test Cases									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Requirement	**1**	X									
	2	X									
	3	X									
	4	X									
	5			X							
	6	X									
	7			X							
	8			X							
	9	X									
	10				X						
	11				X						
	12					X					
	13						X				
	14							X			
	15								X		
	16									X	
	17										X
	18		X								
	19				X	X	X	X	X	X	X
	20	X									
	21	X									

4.2 Test Cases

4.2.1 RVP_01

4.2.1.1 Description and Rationale

The RVP requires information from three locations: (a header file, the user interface, and the RSOF) to perform its primary task of graphically presenting results in the form of Protective Summary Output figures for human risk, human hazard quotient, and ecological hazard quotient. The purpose of this test is to verify that the RVP operates as expected when provided with all of its required inputs. Included in this is the capability to print copies of the figures that are created. As can be seen in Table 4.2, this test case addresses many of the RVP requirements. All test cases test requirements 1, 2, 22, and 23; however, only this test case will document that these requirements were met.

4.2.1.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database.

The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LAU
3) Population percentiles: 25 and 95

For human risk and hazard quotients:

4) Distance of risk radius: 2000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion pathways
7) Receptor type: Resident
8) Cohort type: 13 year old and older
9) Risk level: 1E-6
10) Hazard quotient: 0.1

For ecological hazard quotients:

11) Rollup option: By ring and Receptor Group
12) Radius ring distance: EcoRing#2
13) Habitat group: Mammal
14) Hazard quotient: 0.1

The RSOF database that will be used is "lau71-43-2.mdb." This database was created and edited for the purposes of testing. Table 4.3 indicates the bin counts entered into the database for this test.

Table 4.3 Bin Counts for Test Case RVP_01

	Cw1	**Cw2**	**Cw3**	**Cw4**	**Cw5**
Human risk – 25th percentile	28	28	27	26	25
Human risk – 95th percentile	28	27	26	24	20
Human hazard quotient – 25th percentile	n/a	n/a	n/a	n/a	n/a
Human hazard quotient – 95th percentile	n/a	n/a	n/a	n/a	n/a
Ecological hazard quotient – 25th percentile	25	25	25	20	15
Ecological hazard quotient – 95th percentile	24	22	15	10	5

4.2.1.3 Expected Results

The expected result for this test case will be that the RVP operates correctly as directed by user input and database entries. Specifically, two graphs should be created (human risk and ecological hazard quotient), and each graph should have two lines on it. Based on the data in the database table naming discussed in Section 3, the RSOF Database Tables used are *RD2E10R0C2P0 and ED2RG2*. The Risk Level selection of 1E-6 indicates that the site counts for human risk, found in table in Table 4.3, is located in Bin #4 in *RD2E10R0C2P0*. The Site Iteration Index for the Human Risk for this case is 28. Using this information and Equation 3.1, Table 4.4 contains the Human Risk the expected percent site protected values.

The Hazard Quotient of 0.1 indicates that the information found in Table 4.3 will be located in Bin #2 in table *ED2RG2*. The Site Iteration Index for the Ecological HQ in this case is 25. Using this information and Equation 3.1, Table 4.4 contains the Ecological HQ the expected percent site protected values. The RVP should also provide printouts of each graph when specified by the user.

4.2.1.4 Conducting the Test

Using Windows® explorer, find the directory where the program "ELP2.EXE" is located. Once in the correct directory, click on "EPL2.EXE." The user interface should appear on the screen. A screen capture of the user interface and inputs for this case is shown in Figure 4.1. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was "D:\HWIR\SSF\hdprod.ssf," and click on the "open" button.

Table 4.4 Expected Percent Sites Protected for Test Case RVP_01

	Cw1	Cw2	Cw3	Cw4	Cw5
Human risk – 25th percentile	100	100	96	92	89
Human risk – 95th percentile	100	96	92	85	71
Human hazard quotient – 25th percentile	None	None	None	None	None
Human hazard quotient – 95th percentile	None	None	None	None	None
Ecological hazard quotient – 25th percentile	100	100	100	80	60
Ecological hazard quotient – 95th percentile	96	88	60	40	20

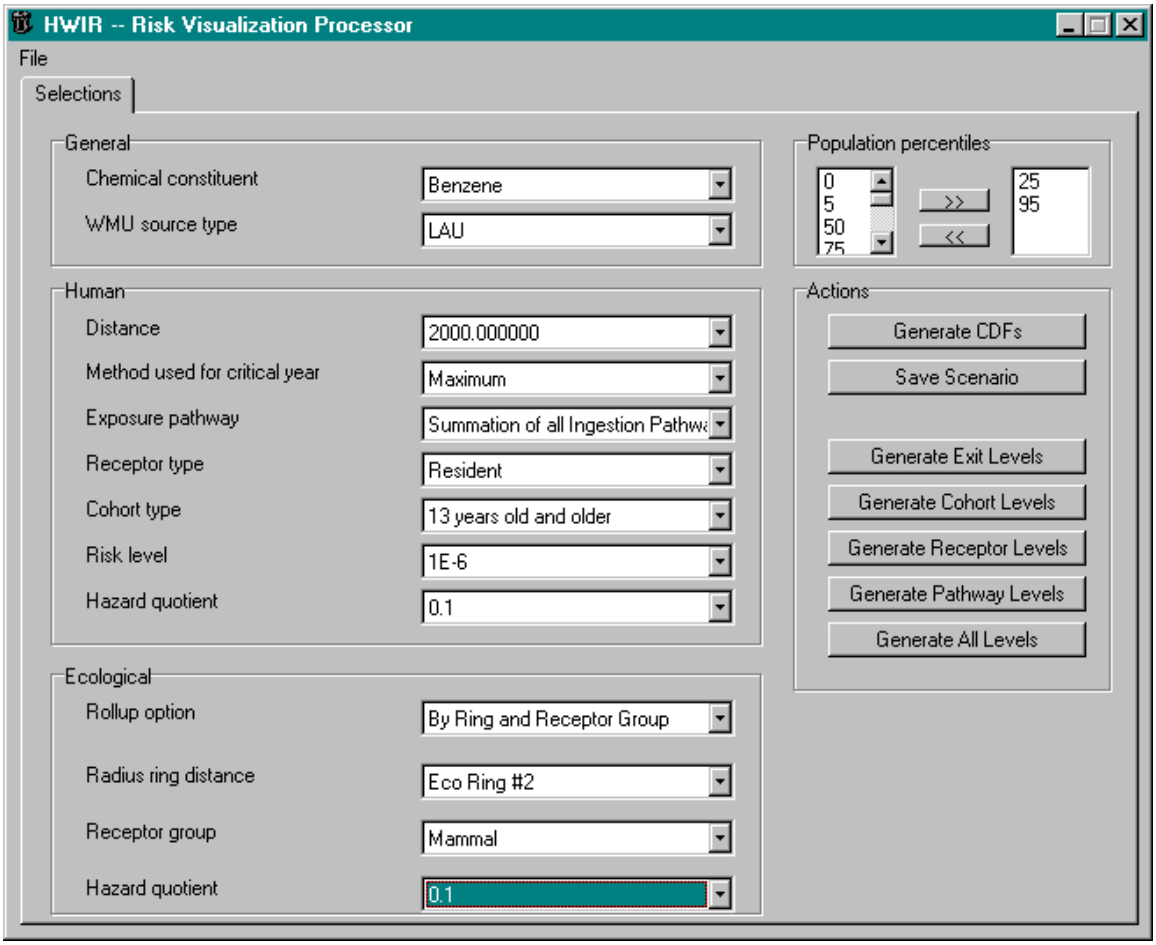


Figure 4.1 Input Screen for RVP_01 Test Case

Next enter in the user input specified in Section 4.2.1.2. Most of the inputs are simply selected from drag-down menus. The exception is the procedure for selecting "population percentiles." The "population percentiles" box is located in the upper right section of the screen. It consists of two columns. The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "25" and "95" should be selected.

When all of the inputs have been entered, click on the "Generate PDFs" button in the lower right corner to begin executing. A warning box should appear alerting the user to the fact that no summarys were available for the human-hazard quotient chart.

When the RVP is finished executing, a check can be made of the resulting graphs. Print out a copy of each figure and make a comparison of expected results calculated and the RVP output.

4.2.1.5 Baseline Testing Results

Figure 4.2 and Figure 4.3 represent the resulting CDF charts for Human Risk and Ecological HQ, respectively. As expected, the data values displayed are the same as those calculated by hand in Section 4.2.1.3. When viewing the Human Risk charts, right-click and hold to view over one of the data points, and a box will display the x and y coordinates for that point. Likewise in the Ecological HQ, double-clicking with the left mouse button will provide the same information.

4.2.2 RVP_02

4.2.2.1 Description and Rationale

The RVP should provide a warning when inappropriate input entries have been made. The purpose of this is to verify that the RVP generates a warning message when the user tries to analyze a scenario where no data exist because the scenario was never run using the HWIR SUI.

In this case, the same inputs that were entered in test case RVP_01 will be entered, except that the contaminant selected will be benzo(a)pyrene. An error message should be produced because there is no RSOF for the benzo(a)pyrene-land application unit combination.

4.2.2.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database. The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzeno(a)pyrene
2) WMU source type: LAU
3) Population percentiles: 25 and 95

4.2.2.3 Expected Results

The expected result for this test case will be that the RVP will halt execution and will produce a warning or error message indicating that there are insufficient data to perform the analysis.

4.2.2.4 Conducting the Test

Using Windows explorer, find the directory where the program“ELP2.EXE” is located. Once in the correct directory, click on“ELP2.EXE.” The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the “file” pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was “D:\HWIR\SSF\hdprod.ssf,” and click on the “open” button. Next enter in the user input specified in Section 4.2.1.2. Most of the inputs are simply selected from drag-down menus. The exception is the procedure for selecting “population percentiles.” The “population percentiles” box is located in the upper right section of the screen. It consists of two columns. The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select “population percentiles,” scroll through the list on the left, click on the percentile of interest, and then click the “>>” button, which inserts the selected percentile into the list on the right.

For this test case, “25” and “95” should be selected. Select the chemical Benzeno(a)pyrene, then WMU LAU. Execution should halt when both chemical constituent and WMU source type have been selected, and a warning message should appear. Click “ok” to close down the error message box.

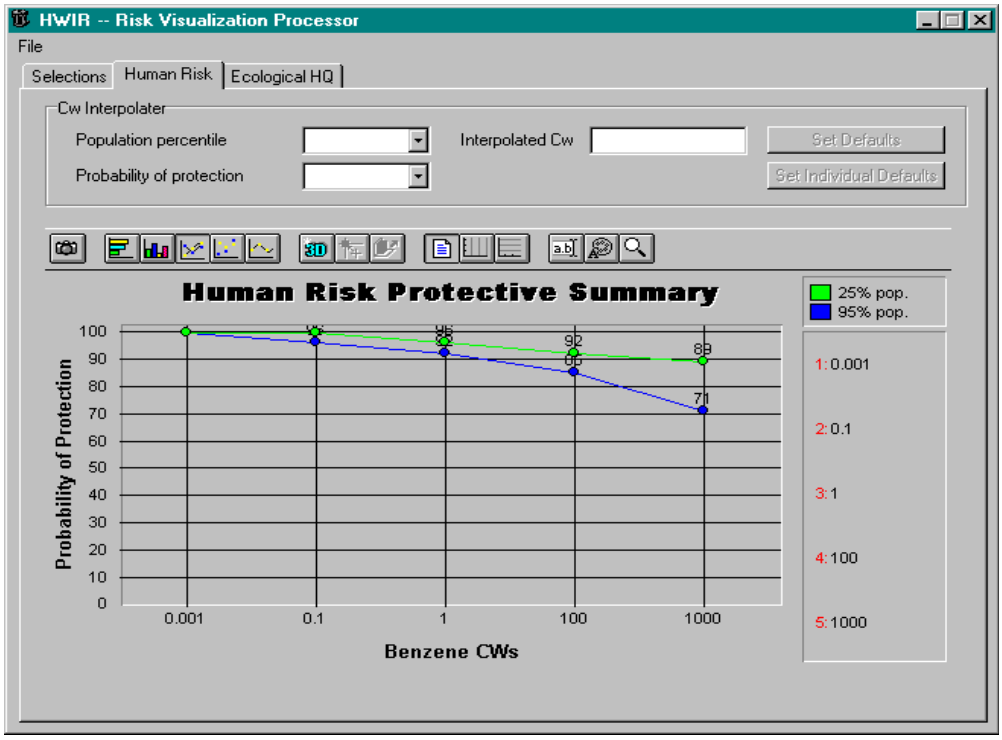


Figure 4.2 Human Risk Results for RVP_01 Test Case

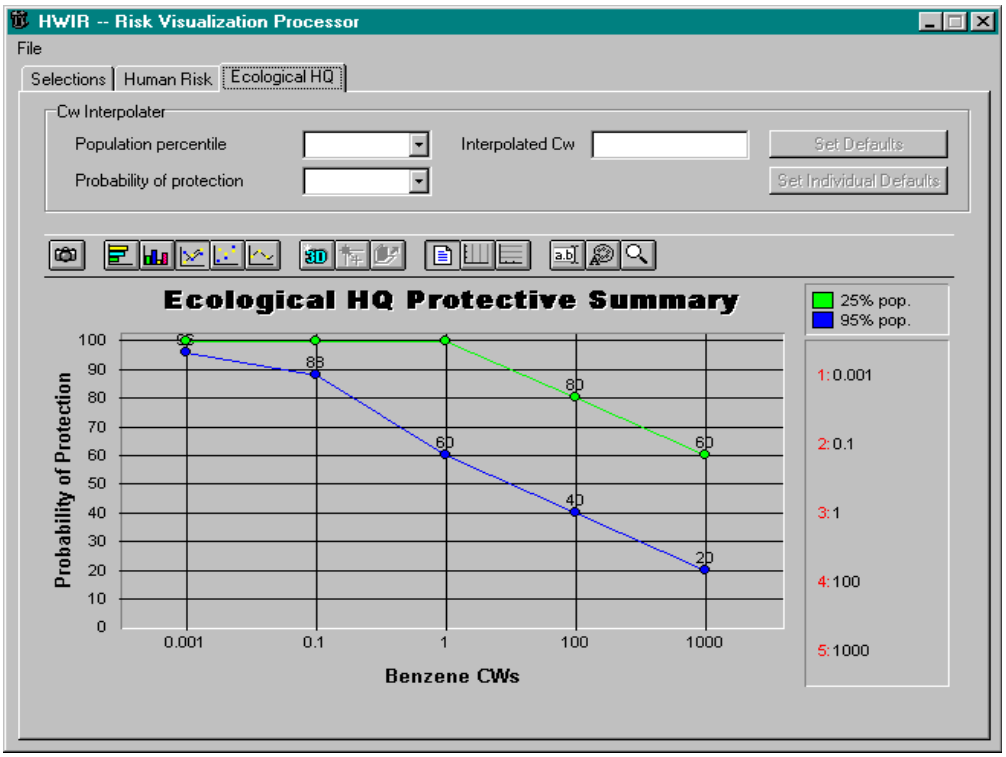


Figure 4.3 Ecological HQ Results for RVP_01 Test Case

Figure 4.4 Warning Message for Chemical and WMU combination

4.2.2.5 Baseline Testing Results

Figure 4.4 is the warning message that is correctly displayed when both chemical constituent and WMU combination do not exist in the available RSOF databases.

4.2.3 RVP_03

The RVP provides the option to calculate $_{Concentration}$s for a current scenario from its user interface. The user will be prompted for a "population percentile" and a "probability of protection," and from these data and the CDF curves, it will produce an interpolated concentration between C_w values. If the user specifies a probability of protection that does not have a corresponding point on the current CDF curve, the nearest C_w point will be returned, and a warning message should appear that states that the nearest value was reported. The purpose of this test is to verify that the RVP calculates the $_{Concentration}$ and generates a warning message as expected.

The RVP also provides some options to save the new input values. One of the options is to save the inputs as the defaults for all source-contaminant pairs, and the second option is to save the defaults for only the current source-contaminant pair. Once new defaults have been saved, the user may want to recalculate the C_ws. For this reason, the RVP user interface provides a button that saves the Exit Level Processor II information. The purpose of this test is to verify that the RVP functionalities associated with calculating C_ws operate as expected.

4.2.3.1 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database.

The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LAU
3) Population percentiles: 5, 25, and 95

For human risk and hazard quotients:

4) Distance of risk radius: 2000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion pathways
7) Receptor type: Resident
8) Cohort type: 13 year old and older
9) Risk level: 1E-6
10) Hazard quotient: 0.1

For ecological hazard quotients:

11) Rollup option: By ring and Receptor Group
12) Radius ring distance: EcoRing#2
13) Habitat group: Mammal
14) Hazard quotient: 0.1

The RSOF database that will be used is "lau71-43-2.mdb." This database was created and edited for the purposes of testing.

4.2.3.2 Expected Results

The expected result for this test case will be that the RVP correctly computes the specified $_{Concentration}$s from the two curve types. Specifically, two graphs should be created (human risk and ecological hazard quotient) with each graph having a 5, 25, and 95 population percentile curve. Based on the data in the RSOF Database, it was determined that the RVP should produce graphs with the results shown in Table 4.5. For the human risk combination, population percentile 25, and probability of protection 50, no $_{Concentration}$s meet this criteria, so the message "Out of Range" should be returned. This "Out of Range" value indicates that the interpolated $_{Concentration}$ was not located on the curve, and the curve was not a straight line. For the population percentile 5, there are several $_{Concentration}$s that meet the same probability of protection. The RVP should return the highest $_{Concentration}$ possible.

Table 4.5 Interpolation Results for Population Percentile/ Probability of Protection Combinations

Protective Summary Output Figure	Population Percentile	Probability of Protection	Interpolated Concentration
Human risk	95	80	421
Human Risk	95	90	29.3
Human Risk	25	50	Out of Range
Human Risk	5	50	1000
Ecological HQ	25	70	550

4.2.3.3 Conducting the Test

Using Windows explorer, find the directory where the program "ELP2.EXE" is located.

Once in the correct directory, click on "ELP2.EXE." The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was "D:\HWIR\RVP\hdprod.ssf," and click on the "open" button. Next enter in the user input specified in Section 4.2.3.2. Most of the inputs on the "Selections" tab are simply selected from

The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the">>" button, which inserts the selected percentile into the list on the right. For this test case, 5, 25, and 95 should be selected. When all of the inputs have been entered, click on the "Generate CDFs" button to begin executing. When the RVP is finished executing, click on the "Human Risk" tab. Use the drag-down menus to select a population percentile and a probability of protection. The interpolated $_{\text{Concentration}}$ should appear in a labeled window to the right. Repeat for the three Human Risk combinations. Then move to the "Ecological HQ" tab and repeat this process. Compare the the RVP results with the expected results in the previous section.

4.2.3.4 Baseline Testing Results

When using the edited database with the modification described in Table 4.3 (lau71-43-2.mdb) w, all interpolated values matched with Table 4.5. Figure 4.5 demonstrates the ecological interpolation done in this test case.

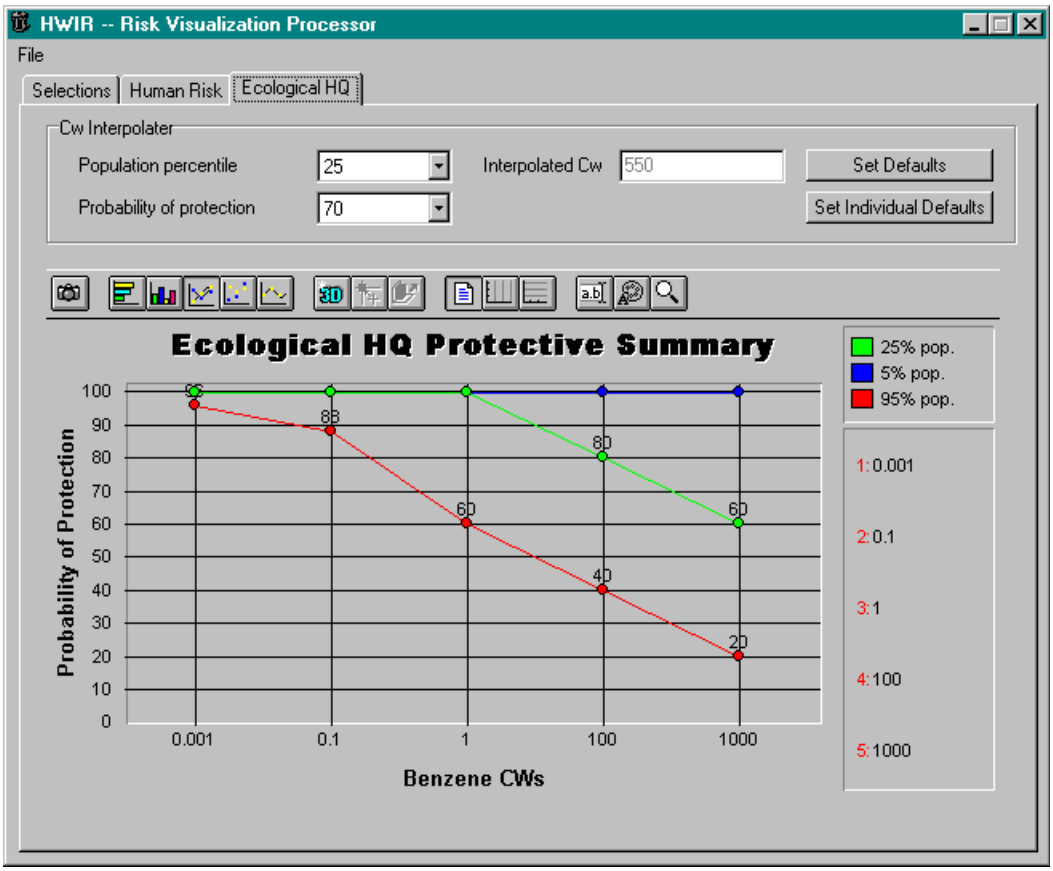


Figure 4.5 Ecological Interpolation for Test Case RVP_3

4.2.4 ELP-II_04

4.2.4.1 Description and Rationale

The ELP-II requires information from three locations (a header file, the ELP2 database, and the RSOF) to perform its task of computing lowest target exit levels and outputting them to the PSOFs. The purpose of this test is to verify that the ELP-II operates as expected when provided with all of its required inputs. RSOFs for the contaminant benzene will be used during ELP-II testing. The ELP-II will compute lowest target exit levels for the contaminant-WMU combination that has been selected. The RVP provides the option to calculate lowest target exit levels for the ELP-II tables for up to five scenarios from its user interface. The user will be prompted for a risk population percentile and probability to define each scenario. From this scenario information, the ELP-II will generate lowest target exit level tables, for each risk scenario, and write to them PSOF directory. This test case will review the correct definition of the scenarios and the correct generation of the lowest target exit level tables.

4.2.4.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database. The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LAU
3) Population percentiles: 5, 25 and 95

For human risk and hazard quotients:

4) Distance of risk radius: 2000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion and inhalation pathways
7) Receptor type: Resident
8) Cohort type: 13 year old and older
9) Risk level: 1E-6
10) Hazard quotient: 0.1

For ecological hazard quotients:

11) Rollup option: By ring and Habitat Group
12) Radius ring distance: EcoRing#2
13) Habitat group: terrestirial
14) Hazard quotient: 0.1

The RSOF database that will be used is "lau71-43-2.mdb." This database was created and edited for the purposes of testing according to the description in Section 4.2.1.2. Table 4.6 describes the scenario input for this test case.

Table 4.6 Scenario Input for Test Case

Scenario	Population Percentile	Probability of Protection
Scenario 1	25	50
Scenario 2	25	70
Scenario 3	95	80
Scenario 4	95	90
Scenario 5	5	50

4.2.4.3 Expected Results

The expected result for this test case will be that the RVP will create a scenario database containing the selection options entered above. The ELP-II will also create a comma-separated file in the PSOF directory for each scenario (Scen1.csv, Scen2.csv etc). Following the process described in Section 3.2.1 for interpolating Concentrations, and the scenario options found in Table 4.6 and Table 4.7 should be the information found in the scenario tables created in the PSOF directory.

Table 4.7 Lowest Target Exit Level Concentration Expected Results

File	Chemical Name	CasId	SemiSolid			LAU		
			HH	Eco	Lowest	HH	Eco	Lowest
Scen1.csv	Benzene	71-43-2	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
Scen2.csv	Benzene	71-43-2	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
Scen3.csv	Benzene	71-43-2	4.00E+02	5.00E+02	4.00E+02	4.00E+02	5.00E+02	4.00E+02
Scen4.csv	Benzene	71-43-2	7.00E+02	8.00E+01	8.00E+01	7.00E+02	8.00E+01	8.00E+01
Scen5.csv	Benzene	71-43-2	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
Note that Liquid, Solid, and the other four WMU entries are not listed because they are not being evaluated for this test case.								

4.2.4.4 Conducting the Test

Using Windows explorer, find the directory where the program “ELP2.EXE” is located. Once in the correct directory, click on “ELP2.EXE.” The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the “file” pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was “D:\HWIR\RVP\hdprod.ssf,” and click on the “open” button. Next enter in the user input specified in Section 4.2.4.2. Most of the inputs on the “Selections” tab are simply selected off of drag-down menus. The exception is the procedure for selecting “population percentiles.” The “population percentiles” box is located in the upper right section of the screen. It consists of two columns. The left column is the list of

possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "5", "25", and "95" should be selected. When all of the inputs have been entered, click on the "Save Scenario" button to select the specific population percentile and probability of protection for that scenario. Table 4.5 contains the population percentiles and probability of protection values for the five scenarios used in this test case. All other value selections will be held constant.

After selecting and saving all five scenarios, click on the "Generate Exit Levels" button. To confirm that the correct information was saved for the scenarios, open the file "ELP2.mdb" in the POSF directory and compare with the scenario information in Section 4.2.4.2. To confirm that the Lowest Target Exit Level Tables were generated correctly, open the "ScenX.csv" files, where X is the scenario number of interest. Compare these results with the expected results in the previous section.

4.2.4.5 Baseline Testing Results

The scenario definitions found in the ELP2.mdb database correctly match with the scenario information entered from section 4.2.4.2. Five scenario files where created. The ELP-II correctly populated these tables with the data expected in Section 4.2.4.3.

4.2.5 ELP2_05

4.2.5.1 Description and Rationale

The ELP-II requires information from three locations (a header file, the ELP2 database, and the RSOF) to perform its task of computing target exit levels and outputting them to the PSOFs. The purpose of this test is to verify that the ELP-II operates as expected when provided with all of its required inputs. RSOFs for the contaminant benzene will be used during ELP-II testing. The ELP-II will compute target exit levels for the contaminant-WMU combination that has been selected. The RVP provides the option to calculate target exit levels for the ELP-II tables for up to five scenarios from its user interface. The user will be prompted for a risk population percentile and probability to define each scenario. From this scenario information, the ELP-II will generate target exit level tables, for each WMU, and write to them PSOF directory. This test case will review the correct definition of the scenarios and the correct generation of the target exit level tables.

4.2.5.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database. The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LAU
3) Population percentiles: 5, 25 and 95

For human risk and hazard quotients:

4) Distance of risk radius: 2000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion and inhalation pathways
7) Receptor type: Resident
8) Cohort type: 13 year old and older
9) Risk level: 1E-6
10) Hazard quotient: 0.1

For ecological hazard quotients:

11) Rollup option: By ring and Habitat Group
12) Radius ring distance: EcoRing#2
13) Habitat group: terrestirial
14) Hazard quotient: 0.1

The RSOF database that will be used is "lau71-43-2.mdb." This database was created and edited for the purposes of testing according to the description in Section 4.2.1.2. Table 4.6 found in test case ELP-II_04, describes the scenario input for this test case.

4.2.5.3 Expected Results

The ELP-II will create a comma-separated file in the PSOF directory for each WMU. "LAUres.csv" will be reviewed for this test case. Following the process described in Section 3.2.1 for interpolating Concentrations and the scenario options found in Table 4.6, the results for this test case should match those from test case ELP-II_04 in the "Lowest" column under each WMU. Table 4.8 should be the information found in the "LAUres.csv" file created in the PSOF directory.

Table 4.8 Target Exit Level Concentration Expected Results

Chemical Name	CasId	Scenario 1	Max Used	Scenario 2	Max Used	Scenario 3	Max Used	Scenario 4	Max Used	Scenario 5	Max Used
Benzene	71-43-2	1.00E+3	"yes"	1.00E+3	"yes"	4.00E+2	"no"	8.00E+1	"no"	1.00E+3	"yes"

4.2.5.4 Conducting the Test

Using Windows explorer, find the directory where the program "ELP2.EXE" is located. Once in the correct directory, click on "ELP2.EXE." The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was "D:\HWIR\RVP\hdprod.ssf," and click on the "open" button. Next enter in the user input specified in Section 4.2.5.2. Most of the inputs on the "Selections" tab are simply selected off of drag-down menus. The exception is the procedure for selecting "population percentiles." The "population percentiles" box is located in the upper right section of the screen. It consists of two columns. The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been

selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "5", "25", and "95" should be selected. When all of the inputs have been entered, click on the "Save Scenario" button to select the specific population percentile and probability of protection for that scenario. Table 4.5 contains the population percentiles and probability of protection values for the five scenarios used in this test case. All other values selections will be held constant.

After selecting and saving all five scenarios, click on the "Generate Exit Levels" button. To confirm that the correct information was saved for the scenarios, open the file "ELP2.mdb" in the POSF directory and compare with the scenario information in Section 4.2.4.2. To confirm that the Target Exit Level Table were generated correctly, open the "LAUres.csv" file. Compare these results with the expected results in the previous section.

4.2.5.5 Baseline Testing Results

The scenario definitions found in the ELP2.mdb database correctly match with the scenario information entered from section 4.2.4.2. All WMU files where created. The ELP-II correctly populated the LAUres.csv file with the data expected in Section 4.2.5.3.

4.2.6 ELP2_06

4.2.6.1 Description and Rationale

The ELP-II requires information from three locations (a header file, the ELP2 database, and the RSOF) to perform its task of computing relative target exit levels and outputting them to the PSOFs. The purpose of this test is to verify that the ELP-II operates as expected when provided with all of its required inputs. RSOFs for the contaminant benzene will be used during ELP-II testing. The ELP-II will compute relative target exit levels for the contaminant-WMU combination that has been selected. The RVP provides the option to calculate relative target exit levels for the ELP-II tables for up to five scenarios from its user interface. The user will be prompted for a risk-population percentile and probability to define each scenario. From this scenario information, the ELP-II will generate relative target exit level tables, for each WMU, and write to them PSOF directory. This test case will review the correct definition of the scenarios and the correct generation of the relative target exit level tables.

4.2.6.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database. The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LAU
3) Population percentiles: 5, 25 and 95

For human risk and hazard quotients:

4) Distance of risk radius: 2000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion and inhalation pathways
7) Receptor type: Resident
8) Cohort type: 13 year old and older
9) Risk level: 1E-6
10) Hazard quotient: 0.1

For ecological hazard quotients:

11) Rollup option: By ring and Habitat Group
12) Radius ring distance: EcoRing#2
13) Habitat group: terrestirial
14) Hazard quotient: 0.1

The RSOF database that will be used is "lau71-43-2.mdb." This database was created and edited for the purposes of testing according to the description in Section 4.2.1.2. Table 4.6 found in test case ELP-II_04, describes the scenario input for this test case.

4.2.6.3 Expected Results

The ELP-II will create a comma-separated file in the PSOF directory for each WMU. "LAUres.csv" will be reviewed for this test case. Following the process described in Section 3.2.1 for interpolating Concentrations and the scenario options found in Table 4.6, the results for this test case can be calculated by using the data in Section 4.2.5.3 (Table 4.8) and using Equation 3.2. Table 4.9 should be the information found in the "LAUrel.csv" file created in the PSOF directory.

Table 4.9 Relative Target Exit Level Concentration Expected Results

Chemical Name	CasId	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Benzene	71-43-2	1	1.00E+00	4.00E-01	8.00E-02	1.00E+00

4.2.6.4 Conducting the Test

Using Windows explorer, find the directory where the program "ELP2.EXE" is located. Once in the correct directory, click on "ELP2.EXE." The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was "D:\HWIR\RVP\hdprod.ssf," and click on the "open" button. Next enter in the user input specified in Section 4.2.6.2. Most of the inputs on the "Selections" tab are simply selected off of drag-down menus. The exception is the procedure for selecting "population percentiles." The "population percentiles" box is located in the upper right section of the screen. It consists of two columns. The left column is the list of

possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "5", "25", and "95" should be selected. When all of the inputs have been entered, click on the "Save Scenario" button to select the specific population percentile and probability of protection for that scenario. Table 4.5 contains the population percentiles and probability of protection values for the five scenarios used in this test case. All other values selections will be held constant.

After selecting and saving all five scenarios, click on the "Generate Exit Levels" button. To confirm that the correct information was saved for the scenarios, open the file "ELP2.mdb" in the POSF directory and compare with the scenario information in Section 4.2.4.2. To confirm that the Relative Target Exit Level Table were generated correctly, open the "LAUrel.csv" file. Compare these results with the expected results in the previous section.

4.2.6.5 Baseline Testing Results

The scenario definitions found in the "ELP2.mdb" database correctly match with the scenario information entered from Section 4.2.4.2. All WMU files where created. The ELP-II correctly populated the "LAUrel.csv" file with the data expected in Section 4.2.6.3.

4.2.7 ELP2_07

4.2.7.1 Description and Rationale

The ELP-II requires information from three locations (a header file, the ELP2 database, and the RSOF) to perform its task of computing 50% Probability of Protection files and outputting them to the PSOFs. The purpose of this test is to verify that the ELP-II operates as expected when provided with all of its required inputs. RSOFs for the contaminant benzene will be used during ELP-II testing. The ELP-II will generate a 50% Probability of Protection table for the contaminant-WMU combination that has been selected. The RVP provides the option to calculate target exit levels for the ELP-II tables for up to five scenarios from its user interface. The user will be prompted for a risk population percentile and probability to define each scenario. However, for the 50% Probability of Protection tables, all scenario probability of protection values will be calculated assuming 50%. From this scenario information, the ELP-II will generate 50% Probability of Protection files for each WMU and write to them PSOF directory. This test case will review the correct definition of the scenarios and the correct generation of the 50% Probability of Protection files.

4.2.7.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database. The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LAU
3) Population percentiles: 5, 25 and 95

For human risk and hazard quotients:

4) Distance of risk radius: 2000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion and inhalation pathways
7) Receptor type: Resident
8) Cohort type: 13 year old and older
9) Risk level: 1E-6
10) Hazard quotient: 0.1

For ecological hazard quotients:

11) Rollup option: By ring and Habitat Group
12) Radius ring distance: EcoRing#2
13) Habitat group: terrestirial
14) Hazard quotient: 0.1

The RSOF database that will be used is "lau71-43-2.mdb." This database was created and edited for the purposes of testing according to the description in Section 4.2.1.2. Table 4.6 found in test case ELP-II_04, describes the scenario input for this test case.

4.2.7.3 Expected Results

The ELP-II will create a comma-separated file in the PSOF directory for each WMU. "LAUprob.csv" will be reviewed for this test case. Following the process described in Section 3.2.1 for interpolating Concentrations and the scenario options found in Table 4.6, Table 4.10 should be the information found in the "LAUprob.csv" file created in the PSOF directory.

Table 4.10 Target Exit Level Concentration Expected Results

Chemical Name	CasId	Scenario 1	Max Used	Scenario 2	Max Used	Scenario 3	Max Used	Scenario 4	Max Used	Scenario 5	Max Used
Benzene	71-43-2	1.00E+3	"yes"	1.00E+3	"yes"	NA	"no"	NA	"no"	1.00E+3	"yes"

4.2.7.4 Conducting the Test

Using Windows explorer, find the directory where the program "ELP2.EXE" is located. Once in the correct directory, click on "ELP2.EXE." The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was

"D:\HWIR\RVP\hdprod.ssf," and click on the "open" button. Next enter in the user input specified in Section 4.2.7.2. Most of the inputs on the "Selections" tab are simply selected from drag-down menus. The exception is the procedure for selecting "population percentiles." The "population percentiles" box is located in the upper right section of the screen. It consists of two columns. The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "5", "25" and "95", should be selected. When all of the inputs have been entered, click on the "Save Scenario" button to select the specific population percentile and probability of protection for that scenario. Table 4.5 contains the population percentiles and probability of protection values for the five scenarios used in this test case. All other values selections will be held constant.

After selecting and saving all five scenarios, click on the "Generate Exit Levels" button. To confirm that the correct information was saved for the scenarios, open the file "ELP2.mdb" in the POSF directory and compare with the scenario information in Section 4.2.4.2. To confirm that the 50% Probability of Protection tables were generated correctly, open the "LAUprob.csv" file. Compare these results with the expected results in the previous section.

4.2.7.5 Baseline Testing Results

The scenario definitions found in the ELP2.mdb database correctly match with the scenario information entered from section 4.2.4.2. All WMU files where created. The ELP-II correctly populated the "LAUprob.csv" file with the data expected in Section 4.2.7.3.

4.2.8 ELP2_8

4.2.8.1 Description and Rationale

The ELP-II requires information from three locations (a header file, the ELP2 database, and the RSOF) to perform its task of computing the cohort target risk levels and outputting them to the PSOFs. The purpose of this test is to verify that the ELP-II operates as expected when provided with all of its required inputs. RSOFs for the contaminant phenol will be used during ELP-II testing. The ELP-II will compute the cohort target risk levels for the contaminant-WMU combination that has been selected. The RVP provides the option to calculate the cohort target risk levels for the ELP-II tables for up to five scenarios from its user interface. The user will be prompted for a risk population percentile and probability to define each scenario. From this scenario information, the ELP-II will generate the cohort target risk levels tables, for each risk scenario, and write to them PSOF directory. This test case will review the correct definition of the scenarios and the correct generation of the cohort target risk levels tables.

4.2.8.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database.

The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Phenol
2) WMU source type: LF
3) Population percentiles: 85

For human risk and hazard quotients:

4) Distance of risk radius: 1000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion pathways
7) Receptor type: All receptors
8) Cohort type: 1- 12 year olds
9) Risk level: 1E-5
10) Hazard quotient: 1

For ecological hazard quotients:

11) Rollup option: By ring and Habitat Group
12) Radius ring distance: EcoRing#2
13) Habitat group: Terrestrial
14) Hazard quotient: 1

The RSOF database that will be used is "lf108-95-2.mdb."

4.2.8.3 Expected Results

The expected result for this test case will be that the RVP will create five files in the PSOF directory for each scenario. The landfill portion of "CohScn1.csv" will be evaluated for this test case. The ELP-II will calculate the human risk and HQ Concentrations for each risk and HQ category. The system will also calculate a target Concentration for "All Cohorts" using the scenario options specified. The Cohort Target Risk Level is found by interpolating this all cohort Concentration back to a risk or HQ value. For this case, phenol has only HQ values available. Following the process described in Section 3.2.1 for interpolating Concentrations and using Scenario 1 defined as 85 population percentile and 95% probability of protection, Table 4.11 should be the information found in the landfill portion of the "CohScn1.csv" file created in the PSOF directory.

Table 4.11 Cohort Target Risk/Hazard Level for Phenol and Landfill

Chemical Name	CasId	Landfill					
		Infants		1-12 years old		13 years old and older	
		Risk	HQ	Risk	HQ	Risk	HQ
Phenol	108-95-2	NA	na	NA	10	NA	0

4.2.8.4 Conducting the Test

Using Windows explorer, find the directory where the program "ELP2.EXE" is located. Once in the correct directory, click on "ELP2.EXE." The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was "D:\HWIR\RVP\hdprod.ssf," and click on the "open" button. Next enter in the user input specified in Section 4.2.7.2. Most of the inputs on the "Selections" tab are simply selected from drag-down menus. The exception is the procedure for selecting "population percentiles." The "population percentiles" box is located in the upper right section of the screen. It consists of two columns. The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "85" should be selected. When all of the inputs have been entered, click on the "Save Scenario" button to select the specific population percentile and probability of protection for that scenario. For this case, Scenario 1 will be set to population percentile of 85 and probability of protection of 95%. All other values selections will be held constant.

After selecting and saving all five scenarios, click on the "Generate Cohorts" button. To confirm that the correct information was saved for the scenario, open the file "ELP2.mdb" in the POSF directory and compare with the scenario information in Section 4.2.8.2 and 4.2.8.3. To confirm that the cohort target risk/HQ level tables were generated correctly, open the "CohScn1.csv" file. Compare these results with the expected results in the previous section.

4.2.8.5 Baseline Testing Results

The scenario definitions found in the ELP2.mdb database correctly match with the scenario information entered for Scenario 1. All cohort scenario files where created. The ELP-II correctly populated the "CohScn1..csv" file with the data expected in Section 4.2.8.3.

4.2.9 ELP2_9

4.2.9.1 Description and Rationale

The ELP-II requires information from three locations (a header file, the ELP2 database, and the RSOF) to perform its task of computing the receptor target risk levels and outputting them to the PSOFs. The purpose of this test is to verify that the ELP-II operates as expected when provided with all of its required inputs. RSOFs for the contaminant benzene will be used during ELP-II testing. The ELP-II will compute the receptor target risk levels for the contaminant-WMU combination that has been selected. The RVP provides the option to calculate the receptor target risk levels for the ELP-II tables for up to five scenarios from its user interface. The user will be prompted for a risk-population percentile and probability to define each scenario. From this scenario information, the ELP-II will generate the receptor target risk levels tables, for each risk scenario, and write to them PSOF directory. This test case will review the correct definition of the scenarios and the correct generation of the receptor target risk levels tables.

4.2.9.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database. The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LF
3) Population percentiles: 85

For human risk and hazard quotients:

4) Distance of risk radius: 1000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion and inhalation pathways
7) Receptor type: Resident
8) Cohort type: 1- 12 year olds
9) Risk level: 1E-5
10) Hazard quotient: 1

For ecological hazard quotients:

11) Rollup option: By ring and Habitat Group
12) Radius ring distance: EcoRing#2
13) Habitat group: Terrestrial
14) Hazard quotient: 1

The RSOF database that will be used is "lf71-43-2.mdb."

4.2.9.3 Expected Results

The expected result for this test case will be that the RVP will create five files in the PSOF directory for each scenario. The landfill portion of "RcpScn1.csv" will be evaluated for this test case. The ELP-II will calculate the human risk and HQ Concentrations for each risk and HQ category. The system will also calculate a target Concentration for "All Receptors" using the scenario options specified. The Receptor Target Risk Level is found by interpolating this all receptor Concentration back to a risk or HQ value. For this case, benzene has only risk values available. Following the process described in Section 3.2.1 for interpolating Concentrations and using Scenario 1 defined as 85 population percentile and 95% probability of protection, Table 4.12 should be the information found in the landfill portion of "RcpScn1.csv" file created in the PSOF directory.

Table 4.12 Receptor Target Risk/Hazard Level for Benzene and Landfill

Chemical Name	CasId	Landfill							
		Beef/Dairy Farmer		Gardener		Fisher		Resident	
		Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
Benzene	71-43-2	1E-08	NA	0.00001	NA	0.0001	NA	0.00001	NA

4.2.9.4 Conducting the Test

Using Windows explorer, find the directory where the program "ELP2.EXE" is located. Once in the correct directory, click on "ELP2.EXE." The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was "D:\HWIR\RVP\hdprod.ssf," and click on the "open" button. Next enter in the user input specified in Section 4.2.7.2. Most of the inputs on the "Selections" tab are simply selected from drag-down menus. The exception is the procedure for selecting "population percentiles." The "population percentiles" box is located in the upper right section of the screen. It consists of two columns. The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "85" should be selected. When all of the inputs have been entered, click on the "Save Scenario" button to select the specific population percentile and probability of protection for that scenario. For this case, Scenario 1 will be set to population percentile of 85 and probability of protection of 95%. All other values selections will be held constant.

After selecting and saving all five scenarios, click on the "Generate Receptors" button. To confirm that the correct information was saved for the scenario, open the file "ELP2.mdb" in the POSF directory and compare with the scenario information in Section 4.2.9.2 and 4.2.9.3. To confirm that the cohort target risk/HQ level tables were generated correctly, open the "RcpScn1.csv" file. Compare these results with the expected results in the previous section.

4.2.9.5 Baseline Testing Results

The scenario definitions found in the ELP2.mdb database correctly match with the scenario information entered for Scenario 1. All cohort scenario files where created. The ELP-II correctly populated the "RcpScn1..csv" file with the data expected in Section 4.2.9.3.

4.2.10 ELP2_10

4.2.10.1 Description and Rationale

The ELP-II requires information from three locations (a header file, the ELP2 database, and the RSOF) to perform its task of computing the exposure target risk levels and outputting them to the PSOFs. The purpose of this test is to verify that the ELP-II operates as expected when provided with all of its required inputs. RSOFs for the contaminant benzene will be used during ELP-II testing. The ELP-II will compute the exposure target risk levels for the contaminant-WMU combination that has been selected.

The RVP provides the option to calculate the exposure target risk levels for the ELP-II tables for up to five scenarios from its user interface. The user will be prompted for a risk-population percentile and probability to define each scenario. From this scenario information, the ELP-II will generate the exposure target risk levels tables, for each risk scenario, and write to them PSOF directory. This test case will review the correct definition of the scenarios and the correct generation of the exposure target risk levels tables.

4.2.10.2 Input Data

The required input for this case is a header file, user-input entered through the user interface, and an RSOF database. The header file that will be used is "hdprod.ssf." Again, the header file is used to direct the RVP to the files, directories, and .DLLs that it requires.

The user input for this case is as follows:

1) Chemical constituent: Benzene
2) WMU source type: LF
3) Population percentiles: 85

For human risk and hazard quotients:

4) Distance of risk radius: 1000 m
5) Method used for critical year: Maximum
6) Exposure pathway: Summation of all ingestion and inhalation pathways
7) Receptor type: Resident
8) Cohort type: 1- 12 year olds
9) Risk level: 1E-5
10) Hazard quotient: 1

For ecological hazard quotients:

11) Rollup option: By ring and Habitat Group
12) Radius ring distance: EcoRing#2
13) Habitat group: Terrestrial
14) Hazard quotient: 1

The RSOF database that will be used is "lf71-43-2.mdb."

4.2.10.3 Expected Results

The expected result for this test case will be that the RVP will create five files in the PSOF directory for each scenario. The landfill portion of "ExpScn1.csv" will be evaluated for this test case. The ELP-II will calculate the human risk and HQ Concentrations for each risk and HQ category. The system will also calculate a target Concentration for "All Receptors" using the scenario options specified. The Receptor Target Risk Level is found by interpolating this all receptor Concentration back to a risk or HQ value. For this case, benzene has only risk values available. Following the process described in Section 3.2.1 for interpolating Concentrations and using Scenario 1 defined as 85 population percentile and

95% probability of protection, Table 4.13 should be the information found in the landfill portion of "RcpScn1.csv" file created in the PSOF directory. For this test case air inhalation, water ingestion, crop ingestion, and beef ingestion were analyzed.

Table 4.13 Exposure Target Risk/Hazard Level for Benzene and Landfill

Chemical Name	CasId	Landfill							
		Air Inhalation		Water Ingestion		Crop Ingestion		Beef Ingestion	
		Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
Benzene	71-43-2	0.00001	NA	0	NA	0.0001	NA	1E-08	NA

4.2.10.4 Conducting the Test

Using Windows explorer, find the directory where the program "ELP2.EXE" is located. Once in the correct directory, click on "ELP2.EXE." The user interface should appear on the screen. As noted previously, the header file and user input must be entered. To specify the header file, use the "file" pull-down menu located in the upper left of the screen. Find the header file to be used, which in this case was "D:\HWIR\RVP\hdprod.ssf," and click on the "open" button. Next enter in the user input specified in Section 4.2.7.2. Most of the inputs on the "Selections" tab are simply selected from drag-down menus. The exception is the procedure for selecting "population percentiles." The "population percentiles" box is located in the upper right section of the screen. It consists of two columns. The left column is the list of possible percentiles that can be chosen, and the right column is a list of the percentiles that have been selected for the current run. To select "population percentiles," scroll through the list on the left, click on the percentile of interest, and then click the ">>" button, which inserts the selected percentile into the list on the right. For this test case, "85" should be selected. When all of the inputs have been entered, click on the "Save Scenario" button to select the specific population percentile and probability of protection for that scenario. For this case, Scenario 1 will be set to population percentile of 85 and probability of protection of 95%. All other values selections will be held constant.

After selecting and saving all five scenarios, click on the "Generate Receptors" button. To confirm that the correct information was saved for the scenario, open the file "ELP2.mdb" in the POSF directory and compare with the scenario information in Section 4.2.10.2 and 4.2.10.3. To confirm that the cohort target risk/HQ level tables were generated correctly, open the "ExpScn1.csv" file. Compare these results with the expected results in the previous section.

4.2.10.5 Baseline Testing Results

The scenario definitions found in the ELP2.mdb database correctly match with the scenario information entered for Scenario 1. All cohort scenario files where created. The ELP-II correctly populated the "ExpScn1.csv" file with the data expected in Section 4.2.9.3.

5.0 Checklist for Quality Assurance Documentation for the Risk Visualization Processor (RVP) of the FRAMES-HWIR Technology Software System

A. General Requirements Analysis

--Documented in

_____Statement of Work (stored in project file; see Gene Whelan, Gariann Gelston, or current Integration Leader)

--Contains information on (all of the following)

_____problem description

_____deliverables

_____project team

_____capabilities to be used

_____restrictions

_____difficulties envisioned

_____compatibilities with existing software/hardware

_____scope of the project

B. Specific Requirements Analysis

--Documented in

_____requirements section of documentation (PNNL-11914, Volume 15, Section 2.0)

--Contains information on (all of the following)

_____purpose of the software

_____structure of the software

_____hardware and software requirements

_____input and output requirements

_____scientific basis

_____assumptions

_____limitations

_____post-October 31 requirements

C. Design Documentation

--Documented in

_____design portion of documentation (PNNL-11914, Volume 15, Section 3.0)

_____team task plans/Project Management Plan (stored in project file; see Gene Whelan, Gariann Gelston, or current Integration Leader)

--Contains information on (all of the following)

_____code type and description

_____development team members

_____specifications

_____logic diagrams

_____“help” descriptions

_____methods to ensure consistency in components

_____mathematical formulations
_____need for pre/post-processors
_____post-October 31 design elements

D. Development Documentation
--Documented in
_____Specifications Document (PNNL-11914, Volume 8)
_____Quality Assurance Archive (see Gariann Gelston or current Integration Leader)
--Contains information on (all of the following)
_____baseline hard copy of the source code
_____diskette copy
_____name of computer language(s) used

E. Testing Documentation
--Documented in
_____test plan that meets quality assurance requirements (PNNL-11914, Volume 15, Section 4.0)
--Contains information on (all of the following)
_____description of software
_____testing scope
_____relationship between test cases and requirements
_____test activity description
_____hardware and software needed to implement plan
_____test case specifications
_____expected results

F. User's Guidance
--Documented in
_____hardcopy printout of user's guidance for system (PNNL-11914, Volume 11)
--Contains information on (all of the following)
_____description of software
_____description of use of user interface
_____mathematical formulations
_____example problems
_____explanation of modules included

G. General Quality Assurance Documentation
--Documented in
_____Quality Assurance Program Document (PNNL-11880)
_____Quality Assurance Software-Specific Checklist (PNNL-11914, Volume 15, Section 5.0)
--Contains information on (all of the following)
_____purpose of quality assurance program
_____client-specified activities
_____activities required to ensure quality in software

H. Quality Assurance Archive

--Documented in

_____hard-copy files (see Gariann Gelston or current Integration Leader)

_____back up disk files in multiple storage locations (see Gariann Gelston or current Integration Leader)

--Contains information on (all of the following)

_____all quality assurance documentation

_____client correspondence regarding software

_____modifications made to baselined software

_____disk copy back ups

_____reproducibility of code (check code for comments)

Completed by _____

Date _____

Approved by

System/Module Manager _____

Date _____

6.0 References

Documentation for the FRAMES-HWIR Technology Software System

Volume 1: Overview of the FRAMES-HWIR Technology Software System. 1998. PNNL-11914, Vol. 1, Pacific Northwest National Laboratory, Richland, Washington.

Volume 2: System User Interface Documentation. 1998. PNNL-11914, Vol. 2, Pacific Northwest National Laboratory, Richland, Washington.

Volume 3: Distribution Statistics Processor Documentation. 1998. TetraTech, Lafayette, California.

Volume 4: Site Definition Processor Documentation. 1998. PNNL-11914, Vol. 4, Pacific Northwest National Laboratory, Richland, Washington.

Volume 5: Computational Optimization Processor Documentation. 1998. TetraTech, Lafayette, California.

Volume 6: Multimedia Multipathway Simulation Processor Documentation. 1998. PNNL-11914, Vol. 6, Pacific Northwest National Laboratory, Richland, Washington.

Volume 7: Exit Level Processor Documentation. 1998. PNNL-11914, Vol. 7, Pacific Northwest National Laboratory, Richland, Washington.

Volume 8: Specifications. 1998. PNNL-11914, Vol. 8, Pacific Northwest National Laboratory, Richland, Washington.

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Volume 11: User's Guidance. 1998. PNNL-11914, Vol. 11, Pacific Northwest National Laboratory, Richland, Washington.

Volume 12: Dictionary. 1998. PNNL-11914, Vol. 12, Pacific Northwest National Laboratory, Richland, Washington.

Volume 13: Chemical Properties Processor Documentation. 1998. PNNL-11914, Vol. 13, Pacific Northwest National Laboratory, Richland, Washington.

Volume 14: Site Layout Processor Documentation. 1998. PNNL-11914, Vol. 14, Pacific Northwest National Laboratory, Richland, Washington.

Volume 15: Risk Visualization Tool Documentation. 1998. PNNL-11914, Vol. 15, Pacific Northwest National Laboratory, Richland, Washington.

Quality Assurance Program Document

Gelston, G. M., R. E. Lundgren, J. P. McDonald, and B. L. Hoopes. 1998. *An Approach to Ensuring Quality in Environmental Software*. PNNL-11880, Pacific Northwest National Laboratory, Richland, Washington.

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U.S. Environmental Protection Agency (EPA). 1997. *System Design and Development Guidance*. EPA Directive Number 2182, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1999a. *Human Risk Module: Background and Implementation for The Multimedia, Multipathway, and Multireceptor Risk Assessment (3MRA) for HWIR99*. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC (Draft).

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Marin, C., and Z. Saleem. 1997. *A Preliminary Framework for Finite-Source Multimedia, Multipathway and Multireceptor Risk Assessment (3MRA)*. Draft, October 1997, U.S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C.