REMEDIAL INVESTIGATION REPORT
ANNOTATED OUTLINE
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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
BLRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminants of concern
DOE	U.S. Department of Energy
EM	Environmental Management
FFA	Federal Facility Agreement
FS	Feasibility Study
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
ORO	Oak Ridge Operations
ORR	Oak Ridge Reservation
PRG	preliminary remediation goal
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
TBC	to be considered

This annotated outline was written to be used as a guide for preparation of Remedial Investigation (RI) reports including Baseline Risk Assessment (BLRA) under the U.S. Department of Energy (DOE) Oak Ridge Operations (ORO) Environmental Management (EM) Program. This document addresses preparation of an RI report for a particular project; study area; operable unit; watershed; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) area; or release site, hereinafter referred to as the "site." Note that for study areas ("sites") having multiple discrete geographic areas, the RI report should be organized such that a given section compiles all information for a single geographic area. The area defined should be large enough that soil and groundwater extent of contamination is meaningful as well as fate and transport discussions. Site-by-site discussions are discouraged if sites are co-located. Sites are generally sources of contamination but do not represent the extent of diffuse contamination. Each section presents investigation activities, nature and extent of contamination, fate and transport, and BLRA results for that geographic area. This outline has not been approved by the Environmental Protection Agency or the Tennessee Department of Environment and Conservation and may be modified to meet their needs.

EXECUTIVE SUMMARY

An executive summary must be included in all RI reports. The executive summary begins on a separate page in the front matter of the document and should be on blue paper. The summary should briefly describe the site background, physical characteristics, nature and extent of contamination, fate and transport, and results of the BLRA.

1. INTRODUCTION

1.1 REGULATORY INITIATIVE

Briefly describe agreements, orders, regulatory guidance and permits that the document addresses. These will include the Federal Facility Agreement (FFA); Resource Conservation and Recovery Act of 1976; CERCLA; DOE Orders; and other state and federal requirements [e.g., National Environmental Policy Act (NEPA)] governing the Oak Ridge Reservation (ORR).

1.2 ORR REMEDIATION PROGRAM

Describe the overall approach for the remediation of the ORR. Briefly discuss the roles and responsibilities of DOE and its contractors.

Describe the approach being used to address the EM work at the specific facility (Oak Ridge National Laboratory, the Oak Ridge Y-12 Plant, East Tennessee Technology Park) and the overall objective of the facility's program. Indicate how this project fits into the overall approach.

1.3 PURPOSE AND SCOPE OF THE RI REPORT

Include a historical overview of characterization and evaluation activities at the site, the current regulatory status of the site, and a brief description of what will occur after the RI report is issued. If remediation decisions at this site influence work at other sites, discuss the site interactions. Discuss the

implications of the scale of ecological investigations. For example, note that off-site releases of contaminants will be considered separately in relevant larger-scale ecological studies.

State the objectives of the RI. In generic terms, the objectives of an RI report are to:

1. provide information concerning the physical characterization of the environmental setting and waste characterization for later use in the Feasibility Study (FS) report;

2. draw conclusions concerning the types and quantities of waste present at the site, the potential for migration of contamination from the site, and the potential for adverse human health and environmental effects if no action is taken at the site and exposure occurs. This goal is achieved by evaluating (a) historical and operational information about the site, (b) potential contaminants of concern (COCs), (c) potential migration pathways, (d) potential receptors, (e) exposure (dose), and (f) contaminant toxicity. The result of this evaluation is a characterization of the risks posed by the site if no action is taken (i.e., the baseline risk); and

3. identify contaminant-specific and location-specific applicable or relevant and appropriate requirement (ARAR) for the COCs as identified by the BLRA.

1.4 SITE BACKGROUND

1.4.1 Site Description

Locate the site under study in relation to major features within the surrounding area. Provide a list of relevant FFA release sites and Hazardous and Solid Waste Amendments – permitted Solid Waste Management Units that are included in the site under study. Also, identify nearby sites that are being investigated or that may be potential contaminant sources. Provide a map of the areas of concern, and include construction details such as dates, type of construction (if applicable), and materials used. Refer to architectural or engineering drawings depicting the structural nature of the unit, and include as much information as possible on the past use of the site. The level of detail will depend on the complexity and size of the site being addressed. Use any available records and the recollections of workers to determine the types and locations of potential contaminant sources. If available, include historical photographs of the site. Describe any physical features of the site (e.g., buildings).

1.4.2 Site Operational History

Describe the various types of operations that have occurred at or near the site. Include as much information as possible on the nature of these operations. Describe the products or results of each operation (i.e., potential contaminant sources) and the waste control used in the operation, such as drains, cleaning options, or burials. Summarize and discuss any direct source characterization data generated as part of normal operations.

Describe any known or suspected releases of contamination. Include the quantity, location, nature of the material, and date(s) of the release(s). Describe the reason for the release(s), such as an accident, error, or routine operations performed under different regulatory environments. Summarize and discuss any direct source characterization data generated as a result of the release(s). Any environmental media characterization data compiled as a result of the release(s) should be summarized and discussed in the appropriate section of Chap. 4.

1.4.3 Previous Investigations

List any previous investigations completed within the study area of the site.

2. SITE INVESTIGATION ACTIVITIES

This chapter should describe the field activities, tests, and analyses conducted during the RI. Include physical, chemical, radiological, or other testing in each medium, as appropriate for the investigation completed. Provide maps showing sample locations. Describe the type, number, and protocols used for each type of investigation activity, including, but not limited to, the following:

- surface features (e.g., topographic surveys),
- contaminant source investigations (e.g., waste inventories or radiological surveys),
- geological or geophysical surveys,
- soil or vadose zone investigations (e.g., borings),
- groundwater investigations (e.g., monitoring wells, sampling),
- surface water/sediment investigations, or
- ecological studies.

3. PHYSICAL CHARACTERISTICS OF THE SITE

This chapter is to describe the physical characteristics of the site on a regional and site-specific basis using all available data. Use of figures, maps, and cross-sections should be maximized. This section should not duplicate the data contained in Chap. 4.

3.1 GEOGRAPHY

Use maps to locate the site on a state, regional, and local basis. Provide a specific site plan that shows surface characteristics and structures.

3.2 DEMOGRAPHY

Present information on demography to characterize the human populations potentially exposed to contaminants released from the site. Include population size and location, sensitive groups of people, land use, transportation systems, and growth patterns. Institutional and economic information may also be needed to support NEPA assessment of community and socioeconomic impacts and impacts on environmental justice populations.

3.3 CLIMATE

Meteorological data are useful for predicting potential contaminant transport patterns (e.g., air dispersion) and are generally relevant to the ecology and land use of the area. Summarize precipitation, temperature, wind rose and maximum velocities/direction, inversion layers, and humidity.

3.4 TOPOGRAPHY, GEOLOGY, AND SOILS

Site geology affects the locations of aquifers and the release and movement of contaminants. Describe the unconsolidated overburden (thickness, areal extent, mineralogy, particle size, and other geotechnical characteristics such as standard penetration results) and the bedrock type (lithology, structure, and discontinuities). The surface soils also influence the type and rate of contaminant transport. Obtain soil characteristics (type, temperature, and engineering properties), chemistry (cation exchange capacity, solubility, leachability, etc.), and vadose zone characteristics (permeability, porosity, and chemical characteristics). Soil type also influences the characteristics of the biotic community on the site. Describe bedrock type and structure, with emphasis on transport characteristics (permeability, fracture zones, other secondary porosity solution cavities).

3.5 GROUNDWATER

Groundwater also provides a potential pathway for the transport of contaminants. Include information about aquifer boundaries and locations, direction and velocity of flow, location of discharge and recharge area, type of formation, porosity, confining layers, conductivity, and existing and potential uses.

3.6 SURFACE WATER AND SEDIMENTS

Surface water provides a pathway for the transport of contaminants. Identify ditches, streams, ponds, lakes, and erosion patterns and their flow rates and dimensions. Because the sediments in surface water may be contaminated, present existing data on sediment transport. Discuss flow characteristics, including losing/gaining reaches, base flow characteristics, and potential for overload flow to stream. Describe characteristics relevant to aquatic communities including depth, pool and riffle structure, substrate texture, etc. Discuss relevant wetland and floodplain features.

3.7 ECOLOGY

The information in this section is required as input for the ecological risk assessment. Identify the flora and fauna on the site and in off-site areas receiving site contaminants or being affected by site activities; identify critical habitats, endangered and threatened species, species listed as being “in need of management” in the state, and species in the human food chain; identify wildlife refuges, and migratory patterns; and report biomonitoring data. Discuss stressed flora and fauna if appropriate.

4. NATURE AND EXTENT OF CONTAMINATION

The purpose of this chapter is to describe the chemical and radiological nature and extent of contamination at the site.

Evaluate all available data (historical, compliance, monitoring, new etc.), for its age, quality, and representativeness of site conditions. The conclusions drawn from this evaluation (e.g., whether data quality objectives were met, whether critical samples were obtained, whether the data are at the appropriate level of quality for the necessary application) should justify the inclusion or exclusion of these data from the RI report. Most data have some use so be careful not to exclude useful information.

In each subsection, summarize and evaluate the quality of the data for their intended use. Include a table summarizing data to be excluded and the justification for exclusion. In another table, list the types of data that will be used in the BLRAs, but present the raw data (including supporting data that establish the level of quality of the environmental data) in an appendix or appendixes. When analyses are not detected, report the detection limits. Document what background data are used in each medium.

When describing the nature and extent of contamination, highlight those contaminants that are identified as COCs in subsequent chapters of the RI report as a result of contaminant migration, exceedance of an ARAR, or contribution to human health or ecological risk. In addition, describe the uncertainties associated with the data, highlighting the most probable conditions and reasonable deviations from those conditions. Note that the intent of the RI is not to fully characterize the site to eliminate all uncertainties because uncertainty is inherent in all hazardous and radioactive waste management. Indicate that the intent is instead to bound the uncertainties sufficiently (1) to allow meaningful description of the most probable site conditions and possible variations in those conditions, and (2) to develop and compare alternative remediation technologies in the FS to address the hazards to receptors posed by the site.

4.1 SOURCE DATA

Discuss any sampling and analytical data from source areas, including waste inventories, waste variability, leachate, nonaqueous phase liquids, and other source materials.

4.2 SOIL DATA

At a minimum, include the analytical results at each sampling location and the conclusions drawn from the results. Include a discussion of source materials, surface, and subsurface soil contamination.

4.3 RADIATION SURVEY DATA

Because of the unique concern about radiation at ORR sites, any existing radiation data for the site may be included in a separate data section. Describe the nature of the survey (e.g., walkover or sampling) and the types of analyses (e.g., gross alpha, beta, gamma, or isotopic analyses), and state any conclusions drawn from the analytical results for surface contamination or source characteristics. (Note that findings may also be discussed in Sects. 4.1 or 4.2.)

4.4 GROUNDWATER DATA

Discuss any groundwater analytical data that may exist. Briefly evaluate the analytical results to determine whether a contaminant plume is present and whether the contaminants are as expected or appear to have migrated from an upgradient source. Discuss any observable trends in the data. Compare groundwater data to soil data to note any similarities or discrepancies.

4.5 SURFACE WATER DATA

If any surface water data are relevant to the study of the site, then, at a minimum, describe the data at each sampling location. Discuss the analytical results and state whether the contaminants are as expected or there is evidence that they might have migrated from another source upstream. Discuss any observable

trends in the data. Compare surface water data to soil and/or groundwater data to note any similarities or discrepancies.

4.6 SEDIMENT DATA

Describe any data concerning the quality and contamination of sediments of each sampling location. It is important to distinguish surface sediments from buried sediments, suspended sediments from bed sediments, and analyses of sediment pore water from solid phase. In discussing the analytical results, state whether the contaminants are as expected or there is evidence that they might have migrated from another source upstream. Discuss any observable trends in the data.

4.7 BIOMONITORING DATA

Describe any ecological sampling or biological monitoring data that may exist for the site, the analytical results, and any conclusions drawn from these data. Discuss any observable trends in the data. Include conclusions drawn from any population surveys of the site.

4.8 AIR DATA

Include air monitoring data if available and applicable. Discuss sampling, preparation, and analytical methods. (Note that these data are typically representative of much larger areas than single sites.)

5. FATE AND TRANSPORT OF CONTAMINANTS

This section should summarize the physical and chemical characteristics of the site that are used to define the conceptual site model, including source materials, potential routes, and mechanisms for migration of contaminants through each environmental medium.

5.1 FATE OF CONTAMINANTS

Discuss the chemical properties of the contaminants that affect contaminant fate, including such properties as solubility, diffusion, biological or radioactive decay, or partitioning. Discuss fate in all relevant media.

5.2 TRANSPORT OF CONTAMINANTS

Describe the release mechanisms and migration pathways for contaminants at the site. Present results of any soil leachability modeling, natural attenuation modeling, groundwater transport modeling, or surface water integrator-point analysis for the watershed. Modeling can take many forms and may vary from project to project. Describe any transport modeling conducted to identify the fate and transport of chemicals in air, surface water, groundwater, multimedia interaction, or the food chain. This description should include, but is not limited to, the model used, the input data, the parameters, the output, and the uncertainties associated with the modeled scenario. Compare the results of such modeling with observed analytical results in affected media. Discuss the flow direction and rate of migration in each medium. The trend analysis presented above can support this discussion.

5.3 SUMMARY AND CONCLUSIONS

Summarize conclusions of the fate and transport analysis. Identify the specific COCs with regard to their potential to migrate from one medium to another within the watershed.

6. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Potential chemical- and location-specific ARARs are identified on the basis of the compilation and evaluation of existing site information. Consult available ARARs guidance such as "CERCLA Compliance with Other Laws Manual" (US EPA Draft May 1988) in determining the chemical- and location-specific ARARs and to be considereds (TBCs) for the site.

6.1 CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs/TBCs provide health or risk-based concentration limits or discharge limitations for various environmental media (i.e., surface water, groundwater, soil, air) for specific contaminants. Potential chemical-specific ARARs for water may include water quality criteria, or drinking water standards, depending on how the water is classified. EPA and Nuclear Regulatory Commission (NRC) regulations and DOE Orders related to radiation protection of the public may be ARAR/TBC.

6.2 LOCATION-SPECIFIC ARARS

Location-specific ARARs establish restrictions or permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., wetlands, floodplains, critical habitats, historic districts). Potential ARARs include DOE regulations for floodplains, wetlands, Endangered Species Act of 1973, and National Historic Preservation Act requirements. Consultation with the U.S. Fish and Wildlife Service, State Historic Preservation Officer, and other agencies is recommended at the earliest opportunity to ensure compliance with the substantive requirements of the respective laws and regulations.

7. HUMAN HEALTH BASELINE RISK ASSESSMENT

The goal of the human health evaluation process is to provide a framework for developing the risk information necessary for making decisions concerning remediation sites. Specific objectives are:

- to provide an analysis of baseline risks and help determine the need for action at sites;
- to provide a basis for determining levels of contaminants that can remain on site and still allow adequate protection of public health; and
- to provide a consistent process for evaluating and documenting public health threats.

7.1 IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

Describe the data collection, modeling, background sampling, sampling locations and media, sampling methods, quality assurance/quality control methods, and results of analyses. Include references to preceding sections of the report where more detailed information can be found. Discuss the steps used in evaluating the data. In particular, detail any optional screening procedures that were employed and the justification for them. Also discuss any uncertainty associated with the data as a whole. Summarize the contaminants of potential concern by area of the site and by media.

7.2 EXPOSURE ASSESSMENT

Characterize the Exposure Setting. Discuss the physical setting of the site with respect to climate, vegetation, soil types, groundwater hydrology, and surface water hydrology. Also discuss the location of potentially exposed populations with respect to the site (refer to Sect. 3.2), current land use, potential alternate future land uses, and subpopulations of potential concern. Include maps depicting the location of these populations.

Identify the Exposure Pathways. Discuss the (1) sources and receiving media for site contamination, (2) fate and transport of contaminants of potential concern in the release media, (3) exposure points and exposure routes, (4) completed exposure pathways, and (5) pathways to be quantified in risk assessment. Include a conceptual site model outlining the completed pathways and text justifying the inclusion or exclusion of pathways.

Quantify the Exposure. Include (1) a discussion of the derivation of the exposure concentrations for the individual contaminants of potential concern, (2) a table summarizing the exposure concentrations for each of the contaminants of potential concern, (3) a table defining the variables used to estimate chemical intakes for each of individual pathway, and (4) a table summarizing the estimated chemical intakes for the individual pathways.

Identify and evaluate uncertainties associated with each of the following areas:

- source-term definition,
- current and future land use,
- environmental sampling and analysis,
- exposure pathways evaluated,
- fate and transport modeling, and
- parameter values.

7.3 TOXICITY ASSESSMENT

Summarize applicable toxicity information [reference doses (RfDs), reference concentrations (RfCs), slope factors, etc.]. Present the information in a table.

Evaluate toxicity information for noncarcinogenic effects, including the following information:

- appropriate exposure periods for toxicity values,
- up-to-date RfDs and RfCs for all contaminants,
- 1- and 10-day health advisories for shorter-term oral exposures,
- studies consulted other than RfD or RfC,

- secondary effects,
- effects that may appear at doses higher than those required to elicit the critical effect, and
- absorption efficiency considered.

Evaluate toxicity information for carcinogenic effects, including the following information:

- exposure averaged over a lifetime,
- up-to-date slope factors for all carcinogens,
- weight-of-evidence classification of all carcinogens,
- type of cancer for Group A carcinogens, and
- concentration above which the dose-response curve is no longer linear.

Qualitatively evaluate those contaminants for which no toxicity values are available by using any available information about the contaminant. Identify uncertainties related to toxicity information by evaluating the quality of the individual studies and the completeness of the available toxicity information.

7.4 RISK CHARACTERIZATION

Characterize Current Land-Use Conditions. Include calculations for individual substance hazard quotients, shorter-term hazard quotients, hazard indices for multiple substances, the justification for combining risks across pathways, and the resultant multiple-pathway noncarcinogenic hazard index and carcinogenic risk under current land-use conditions. Present details of the calculations and interpret the results.

Characterize Future Land-Use Conditions. Include the calculations for individual substance hazard quotients, hazard indices for multiple substances, the justification for combining risks across pathways, and the resultant multiple-pathway noncarcinogenic hazard index and carcinogenic risk under future land-use conditions. Present details of the calculations and interpret the results.

Summarize uncertainties associated with each of the previous steps of the process and discuss their effect on the risk characterization. Types of uncertainties may include those associated with:

- data quality,
- definition of physical setting,
- source-term definition,
- model applicability and assumptions,
- parameter values for fate/transport and exposure calculations,
- identification of potential health effects,
- derivation of toxicity values,
- potential for synergistic or antagonistic interactions, or
- uncertainty in evaluating less-than-lifetime exposures.

Discuss and tabulate the results of the risk characterization. Identify the key site-related contaminants and key exposure pathways along with the types of health risks expected from exposure to site contaminants. Discuss the level of confidence in the quantitative information used to estimate risk. Discuss the magnitude of the carcinogenic and noncarcinogenic risk estimates, the major factors driving risk and the major factors contributing to uncertainty. Present the characteristics of the exposed population and compare the risk characterization results with site-specific health studies if available.

7.5 SUMMARY AND CONCLUSIONS

Summarize the results of the risk assessment, including contaminants of potential concern, the potential for human exposure to contaminants, the potential adverse health effects that could result from exposure to contaminants, and the overall risk to human health posed by the site.

8. ECOLOGICAL BASELINE RISK ASSESSMENT

The general objective of the ecological BLRA is to provide a basis for decisions concerning the need for remediation based on risks to nonhuman organisms. Specific objectives are to:

- provide an analysis of ecological baseline risks that will help determine the need for remediation,
- provide a basis for determining what levels of contaminants can remain on site without causing unacceptable ecological risks, and
- provide a consistent assessment process to estimate and report ecological risks at each site.

8.1 ECOLOGICAL HAZARD IDENTIFICATION

Although the hazard identification for human health risk assessment consists simply of identifying the contaminants to which humans could be exposed in toxic amounts, ecological hazard identification must identify the assessment endpoints, the sources (COCs by medium), and the scope of the environment to be assessed. If a preliminary risk assessment has been performed, it can serve as the basis for the hazard identification, and the analyses performed in that assessment may be referenced here. If the assessment includes multiple operable units, they should be discussed separately and then summarized at the end of each subsection.

Assessment Endpoints. Ecological assessment endpoints are the values to be protected. Include an entity (e.g., sunfish populations) and a degree of protection (no more than 20% reduction in biomass) in the definition of an assessment endpoint. Present a clear rationale for the selection of endpoints.

Delineate the environment that is the subject of the risk assessment. Define the spatial extent (depth of sediment, etc.), media (e.g., groundwater may be excluded), and species (e.g., transient species such as bald eagles may be excluded). As appropriate, refer to larger-scale or "downstream" assessments that will address excluded areas or species. Estimate future nontoxicological changes in the environment in the absence of remediation. These will primarily result from natural succession and recovery from physical disturbances.

Sources of exposure are concentrations of contaminants in ambient media (water, sediment, soil, and biological materials) with which organisms come into contact or with which they may come into contact through transport in the future. Include in this section:

- historical information concerning sources,
- source data collected for the risk assessment,
- data concerning background concentrations,
- descriptions of the nature of the source data,
- a description of routes of exposure for all assessment endpoints,

- a description and justification of the screening procedure,
- results of the screening (contaminants, media, and ecological endpoint), and
- a discussion of uncertainties in the screening procedure.

8.2 EXPOSURE

Much of the contaminant fate and transport modeling conducted for the human health risk assessment can be used in the ecological risk assessment to describe current and future distribution and speciation of contaminants relative to the disposal sites and ambient sinks. These methods and results can be incorporated by reference. However, the pathways and modes of exposure of nonhuman organisms are different and must be presented in this section.

Describe the physical relationship between the endpoint biota and the sources of exposure, including areas in which exposure is occurring, routes and mechanisms of transport and transformation, and estimated areas of future increase or decrease in source levels.

Describe the routes of exposure that, following screening, appear to contribute to hazards. The descriptions may differ from those in Sect. 5.3, in that conservative assumptions that are appropriate for screening should be replaced by more realistic assumptions based on site-specific information. The descriptions should include the exposure models, assumptions used to establish parameters for the models, and parameter values or distributions.

Present the results of the exposure assessments for both current and future conditions for each of the ecological endpoints and COCs. Depending on the endpoint and route of exposure, these estimates may include external exposure (e.g., water concentrations for fish, doses, and internal exposure concentrations for species with measured body burdens).

8.3 EFFECTS ASSESSMENT

Discuss the three sources of evidence concerning the effects of exposure: conventional toxicity data, media toxicity, and biological survey data.

Summarize the available toxicity data most relevant to the endpoint organisms and routes of exposure. Include exposure-response relationships, conventional test endpoints, alternate test endpoints that are more relevant, numeric summaries of multiple test results, and qualitative or quantitative extrapolation models used to relate the test endpoints to the assessment endpoints, exposure dynamics, and environmental conditions.

Toxicity tests may have been performed with contaminated and reference water, sediments, or soils, either in situ or in the laboratory. Describe the tests in detail if standard protocols were not followed. Summarize the results of the tests. Include exposure-response relationships, conventional test endpoints, alternate test endpoints that are more relevant, and qualitative or quantitative extrapolation models used to relate the test endpoints to the assessment endpoints, exposure dynamics, and environmental conditions.

Biological survey data are obtained by measuring properties of the organisms, populations, and communities exposed to the contaminated environment and reference environments. Present the results of surveys and supporting information, including the dates, locations, and methods of measurement; environmental conditions; and uncertainties, limitations, or qualifications of the data. Report any chemical analyses of media samples collected in association with the biological surveys.

8.4 RISK CHARACTERIZATION

Estimate the current effects of contamination on the ecological assessment endpoints. Estimate the effects by using the alternate lines of evidence concerning the relationships among sources, exposure, and effects and then integrating the results. Analyze reasonable alternate hypotheses about the causes of apparent effects, including point and nonpoint sources of pollution other than the waste site being assessed and differences in environmental quality other than chemical contaminants. Consider uncertainties in the calculations so that results can be expressed as probabilities. The final estimate of effects should be based on expert judgment and consideration of the weight of evidence. Present details of the calculations and logical inferences.

Estimate the effects of contaminants in the future if no remedial actions were to be taken. Typically, this portion of the assessment must rely to a large extent on model-estimated exposures and laboratory toxicity data. However, if one contaminant dominates the risks or if all contaminants will increase or decline in concentration to the same extent, media toxicity data and biological survey data can be used if they have been determined along a gradient of concentration.

Discuss both quantitative and qualitative uncertainties. Review quantitative uncertainties that were incorporated into the assessment models. Present qualitative uncertainties and estimate their relative magnitudes. Finally, discuss the implications of these uncertainties for decisions concerning remedial actions.

Highlight any ecological risks posed by particular contaminants and/or media that are greater than the risks for human health posed by the same chemicals and/or media. To the extent possible, explain why these ecological risks are greater than corresponding human health risks.

Discuss and tabulate the results of risk characterization for both current and future conditions. Highlight key endpoints, contaminants, and media, and enumerate the ecological risks that could influence the decision concerning the need for remediation. Discuss the level of confidence in the results, and identify major sources of uncertainty. Finally, compare the estimated ecological effects to the estimated ecological effects posed by other sites, effluents, and physical disturbances on the ORR.

8.5 SUMMARY AND CONCLUSIONS

Provide a concise summary of the previous sections of the ecological BLRA. Explain how the results were obtained, without repeating details about data, models, and assumptions.

9. PRELIMINARY REMEDIATION GOALS

Describe the continuing process of setting preliminary remediation goals (PRG). Present for each COC and for each medium of concern, the preliminary remedial action goals based on: (1) contaminant migration, (2) chemical-specific ARARs, (3) health-based criteria for carcinogenic effects or for systemic toxic effects, and (4) ecologically based criteria.

10. CONCLUSIONS AND RECOMMENDATIONS

Summarize the conclusions and recommendations from each of the evaluations conducted as part of the RI. This chapter should tie all other sections of the report together and should provide the justification for each of the conclusions drawn and the subsequent recommendations made. The following topics should be discussed:

- characterization of the environmental setting,
- history and current conditions at the site,
- quality of existing data,
- ARARs,
- results of the human health and ecological BLRAs, and
- preliminary remediation goals.

11. REFERENCES

Include a list of references used to develop the RI report in the format shown here. The following are general references for inclusion in an RI report.

40 *CFR* Pt. 300, National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

42 U.S.C. § 7401 et seq., Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986.

U.S. Environmental Protection Agency (EPA) 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (Interim Final), EPA/540/G89/004, Office of Emergency and Remedial Response, October.