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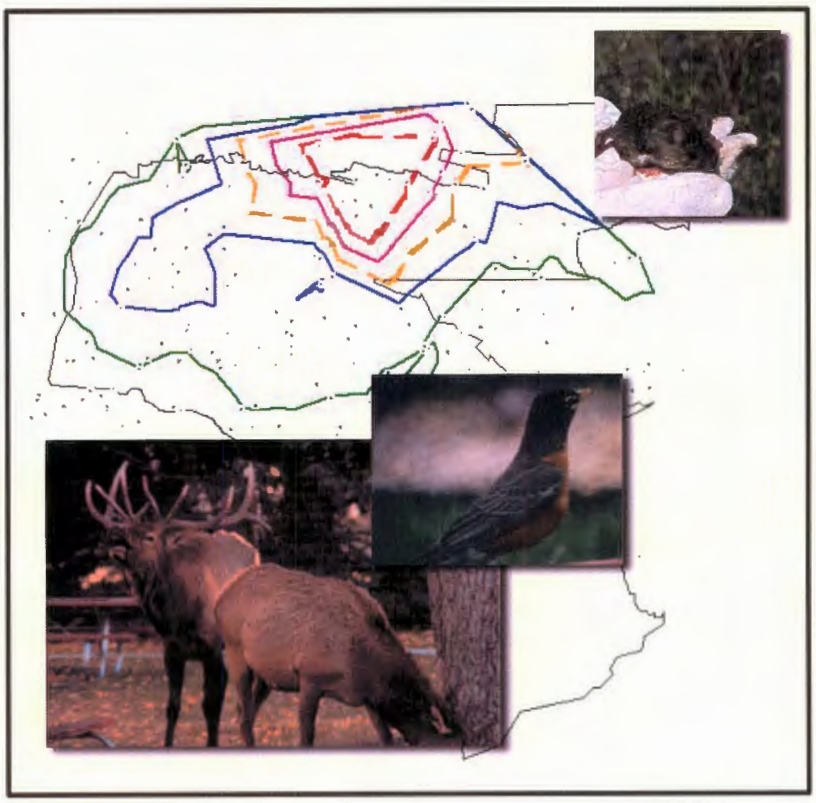
Tier 2 Ecological Risk Assessment of Los Alamos National Laboratory Institutional Issues on the Pajarito Plateau Using ECORSK.6



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Front Cover: The graphic illustrates the type of location data (hazard index contours) that can be generated from ECORSK.6 output to assess potential contaminant impacts to Rocky Mountain elk, American robin, or deer mouse within Los Alamos National Laboratory boundaries.

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ABSTRACT

The Los Alamos National Laboratory (LANL) uses multiple lines of evidence to manage biological resources that are potentially impacted by small levels of contamination occurring in environmental media in some areas of its 43 mi^2. Ecological risk assessment provides one line of evidence for making decisions on managing these resources. This information on potential impact to biota is relative, therefore is best used to help focus field studies or additional assessment on the particular contaminants, geographical areas, and/or biological endpoints needing attention. Ecological risk assessment also helps to ensure good environmental stewardship and response to concerns by the general public.

ECORSK.6 is a custom FORTRAN model that was developed as a tool specifically for conducting ecological risk assessments at LANL. ECORSK.6 integrates geographic information system data on environmental contamination and animal distribution with many other types of information, such as contaminant toxicity, so that realistic animal exposures to contaminants can be estimated and compared to no adverse effect levels or animal "safe limits." In fiscal year 2000 ECORSK.6 was used to assess potential impact from LANL-related and background concentrations of three contaminant types (radionuclides, organic chemicals, and metals) to the Rocky Mountain elk, the American robin, and the deer mouse across expansive areas of semi-desert and forested habitat ranging up to 192 km^2 (74 mi^2). The results will be used to support the development of a Biological Resources Management Plan.

Results indicate no appreciable potential impact to elk or robin and a small potential for impact to the deer mouse; however, natural and regional background sources of contamination contributed the dominant portion of total risk indicating that the safe limits used may have been overly conservative (too low). This is common in the current state of the art.

The goals of further developing the ECORSK tool as a technical programmatic capability and increasing the realism of the assessment approach have been met. Using a receptor selection process that included input from multiple agencies and interest groups, 21 species were selected as important indicators of risk on the basis of social, ecological, risk, and model criteria. The use of real animal density data for placement and distribution of animal focal points and nest sites is an important advancement because it

enables us to distribute animals on the basis of the distribution of their prey or forage. The sensitivity of results to changes in the safe limits (or toxicity reference values) and contaminant transfer coefficients demonstrates that more emphasis is needed on the development of accurate chronic toxicity benchmarks and site-specific transfer coefficients. Another important improvement to the approach was demonstration of a simple method for interpolating (predicting) contaminant levels in canyon sediment at points where we intuitively know contamination exists as based on measurements taken up-channel, but for which previous assessments at the Laboratory assumed background levels of contamination. The method was demonstrated for Los Alamos Canyon and is currently being applied to other canyons.

1.0 INTRODUCTION

In the years 1996–1999, the potential impact of chemical and radiological contaminants on threatened and endangered species in the environment surrounding the Los Alamos National Laboratory (LANL) was appraised using a custom FORTRAN model ECORSK.5. Performed as required for the Record of Decision for the construction of the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility at LANL as part of the DARHT Environmental Impact Statement, these assessments also became the ecological risk assessments of record for the the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (SWEIS; DOE 1999) and a related site-wide biological assessment.

Shortly after issuance of the SWEIS, LANL began formal planning on comprehensive biological resources management to provide policy, guide biological resources surveillance and monitoring, and ensure regulatory compliance. The development of a biological resources management plan (BRMP) was identified as necessary for the Laboratory to have continued success in the dual objectives of operating a nuclear industry in harmony with a sustained surrounding environment, including avoiding the hindrance of the land management objectives of adjacent Native American pueblos and federal land management agencies.

With trace levels of chemical (inorganic and organic) and radioactive contamination in the LANL-related environment, understanding risk to wildlife (ecological risk) that is presented by these contaminants is an important biological quality issue emphasized by many stakeholders of the Laboratory. With a region-wide spatial scope identified by the BRMP, planners identified ECORSK as a tool that could satisfy the needs of the BRMP planning and implementation process because ECORSK.5 has its strength in assessing large areas of land, thus having the same broad spatial extent as the regional context of the BRMP. The spatial extent covered by ECORSK was also envisioned to satisfy the "broad ecosystem-level component" requirement of the Natural Resource Damages Act (43 CFR 11). Thus, improvements to ECORSK.5 were made, resulting in ECORSK.6, which was used to assess the risk from environmental contaminants (chemical and radiological) to the Rocky Mountain elk, the American robin, and the deer mouse.

1.0.1 Goals, Purpose, and Objectives

The goal and purpose of the project were to conduct and document an ecological risk ("ecorisk") assessment that supports the Laboratory's mission, is endorsed by key internal and external stakeholders, and is congruent with LANL's Ecological Risk Management Approach. This goal and purpose of the project were accomplished by generating risk information that

1. Can be used to help effectively manage LANL's natural and biological resources through integration with the BRMP and in support of National Environmental Policy Act (NEPA) assessments and impact analyses;
2. Can be used to help LANL's Environmental Restoration Project to effectively manage contaminated areas, such as by identifying general areas in which to focus field surveys; and
3. Is available to natural resource trustees for their use.

The primary objective was to continue the development of ECORSK, a FORTRAN-based computer program, and its associated approach and methods as a technical capability suitable for use in the support of other programs at LANL and across the Department of Energy (DOE) Complex.

The impetus for the risk assessment described herein was not directly related to regulatory requirements, but rather was initiated as a technology capability improvement project. The products may support compliance with regulatory requirements.

1.0.2. Scope

The scope of the project can be divided into spatial extent, ecological entity or receptors, and contaminants of potential concern (COPC). The strength of the ECORSK tool is to integrate information of various types for very large geographical areas; therefore, the spatial extent identified for the project was generally the Pajarito Plateau, but with focus on an area extending 1 km beyond the maximal N, S, W, and E extents of the LANL boundary. Because of this strength, the ecological entities chosen were broad-ranging organisms (e.g., Rocky Mountain elk) and smaller-ranging organisms with multiple populations distributed across the spatial extent of LANL (e.g., American robin and deer mouse). Emphasis was also placed on organisms for which LANL's Ecology Group (RRES-ECO) has current density distribution data. All COPCs for which "safe limits" (toxicity reference values [TRVs]) existed were considered.

1.0.3 General Process Used

The Tier 2 ecological risk assessment process follows U.S. Environmental Protection Agency (USEPA) guidance on the process of characterization of exposure and characterization of effects (the Ecological Risk Assessment Guidance for Superfund [ERAGS], USEPA 1999). ERAGS is an eight-step process for two main assessment phases—screening and baseline. The "Tier 2" risk assessment presented in this report is consistent with goals and objectives of the problem formulation step of the baseline risk assessment. In problem formulation for the baseline assessment, some of the protective assumptions made during the screening phase are re-evaluated so that a more realistic assessment of the ecosystem potentially at risk can be developed. Primarily, the assumptions re-evaluated were the area occupied and the duration of occupancy of the animals assessed, which in turn affect contaminant exposure. The area occupied was based on the natural tendencies of the animals; i.e., their natural density and distribution.

1.1 Integration with LANL's Ecological Risk Management Framework (general)

In December 1999, an Ecorisk Subcommittee was established to develop an institutional Ecorisk Management Plan to integrate ecorisk assessment activities conducted throughout LANL. The plan will assist LANL in establishing an institutional approach to ecorisk management, identify roles and responsibilities to implement the Plan, improve the decision-making process for resource management, assist in identifying decision actions and end points that protect ecological resources, identify general technical ecorisk assessment approach(es), and serve as a communication tool.

Because the Ecorisk Management Plan was in development at the same time as the conduct of this assessment, integration of the Tier 2 project with the LANL ecorisk management

framework has occurred in parallel to the Subcommittee's development of charter and conceptual plan. This integration has occurred via presentations to Subcommittee members, placement of members from key organizations represented on the Subcommittee on the Tier 2 committees, and review of the Tier 2 approach against the Ecorisk Management Plan as it was developed.

1.1.1 Environmental Decision Potential

The ecological risk information produced by the ECORSK model has the potential to assist in making decisions on managing biological resources and facility sitings and operations, to make NEPA decisions, and to identify general areas in which to focus additional field studies, including those related to possible adverse ecological effects or injury to natural resources. More specifically, the ecological risk information generated by this study can also be used as a baseline to determining the effects of the Cerro Grande fire (May 2000) on ecological risk, as a baseline to determine the effects of clean-up conducted by the LANL's Environmental Restoration Project, to help researchers identify particular COPCs, and to help risk managers focus research on those areas that will lead to the greatest reductions in other areas of uncertainty in ecological risk assessment, especially as related to broad-ranging animals or animals with widespread density distribution.

1.1.2 Consideration of Factors Affecting the Value of Results for Environmental Decision Making

Ecological risk is one of many factors that should contribute to management decisions on biological resources. Political, social, economic, and scientific factors additional to ecological risk should go into LANLs environmental decision-making process. This assessment, as have most ecological risk assessments, estimated potential risk, i.e., the assessment did not determine a cause for an observed adverse effect. Empirical studies provide another line of evidence to evaluate potential adverse effects and they are theoretically closer to reality than modeling results.

1.2 Management Options to Achieve Goals

Risk management options that help to achieve goals are often linked to decision criteria. Decision criteria at lower level assessments are usually linked to "yes-no" questions, and higher level assessments attempt to answer questions of "what is the risk, where is the risk geographically, and how great is the risk?" While the assessment reported on here was more in line with answering the questions of what, where, and how great, the current state of the art of ecological risk assessment is such that results are most appropriately used to indicate relative potential for impact and to help focus field studies. Most lacking are appropriate TRVs, or "safe limits," against which estimates of COPC exposure are compared. Until TRVs give a more accurate representation of chronic COPC effects on ecosystems and the likelihood of those effects, model results are limited to helping to scope further study needs.

1.3 Scope and Complexity of the Risk Assessment

Ecological risk assessments and many other environmental program tasks at LANL must be conducted in a manner that considers the ongoing LANL technical mission and informs decision-makers on effective ways to mitigate risks. At LANL, multiple stressors, ecological

values, and political and economic factors require the ability to conduct ecorisk assessments of different complexity. This is accomplished by using the tiered and iterative approach whereby generally increasing levels of complexity with lessened uncertainty occurs at each successive level of risk assessment.

This assessment was considered a "Tier 2" assessment with commensurate complexity and uncertainty. The components of a Tier 2 assessment, and other tiers, leading to decisions and possible management actions on biological resources are shown in Figure 1-1. Tier 1 is the screening level ecological risk assessment (SLERA) and is equivalent to the first two steps of the ERAGS process. LANL's Environmental Restoration Project has developed a site-specific version of this screening phase (LANL 1999). Tiers 2 and 3 both have equivalent steps and the difference is that Tier 2 represents an intermediate level of assessment between the screening phase (Tier 1) and the baseline phase (Tier 3).

The first versions of ECORSK and the risk assessment method that employed ECORSK were simple (Gallegos and Gonzales 1999). They have progressed to more complex and realistic representations of animal exposures to COPCs. A goal in the development of ECORSK and its applications has always been to focus on spatial considerations of broad-ranging animals across the Pajarito Plateau or animals with wide distribution. In transitioning from ECORSK.5 to ECORSK.6, the version most recently applied, the primary advancement was to simulate foraging of the selected receptors such that their distribution and abundance followed empirical information. Animal abundance is assumed to track abundance of prey or other food source. Through this means, the realism of the modeled exposure was increased and the uncertainty in exposure estimation decreased. Emphasis of this project was also placed on identifying ecological values and entities (receptors) that represented a broad range of social, cultural, and ecological needs. A third emphasis was improvement of the contaminant database beyond what had been used in previous assessments that used ECORSK. In summary, the scope and complexity of the assessment in applying ECORSK.6 had emphasis placed on

- spatial dynamics/simulated foraging based on prey/forage distribution,
- integrated identification of ecological values and receptor selection, and
- expanded contaminant database (concentrations of COPCs in sediment and soil, including predicted concentrations at locations in canyons where elevated levels of COPCs are believed to occur but have not been measured).

That two of the three emphases directly affect wildlife exposure characterization should be noted. Other details of the scope and complexity of the project are described throughout the report.

1.4 Scoping/Planning Summary

The organizational structure developed for planning and scoping the ecorisk assessment consisted of an Ecorisk Management Team and a Core Team. Generally, the organization served the function of integrating the project with other LANL programs, projects, and concerns. The organization also established communication channels with internal and external stakeholders and separated project functions. The functions of the Management Team were to direct the project, guide the major technical and non-technical aspects of the project, and manage the

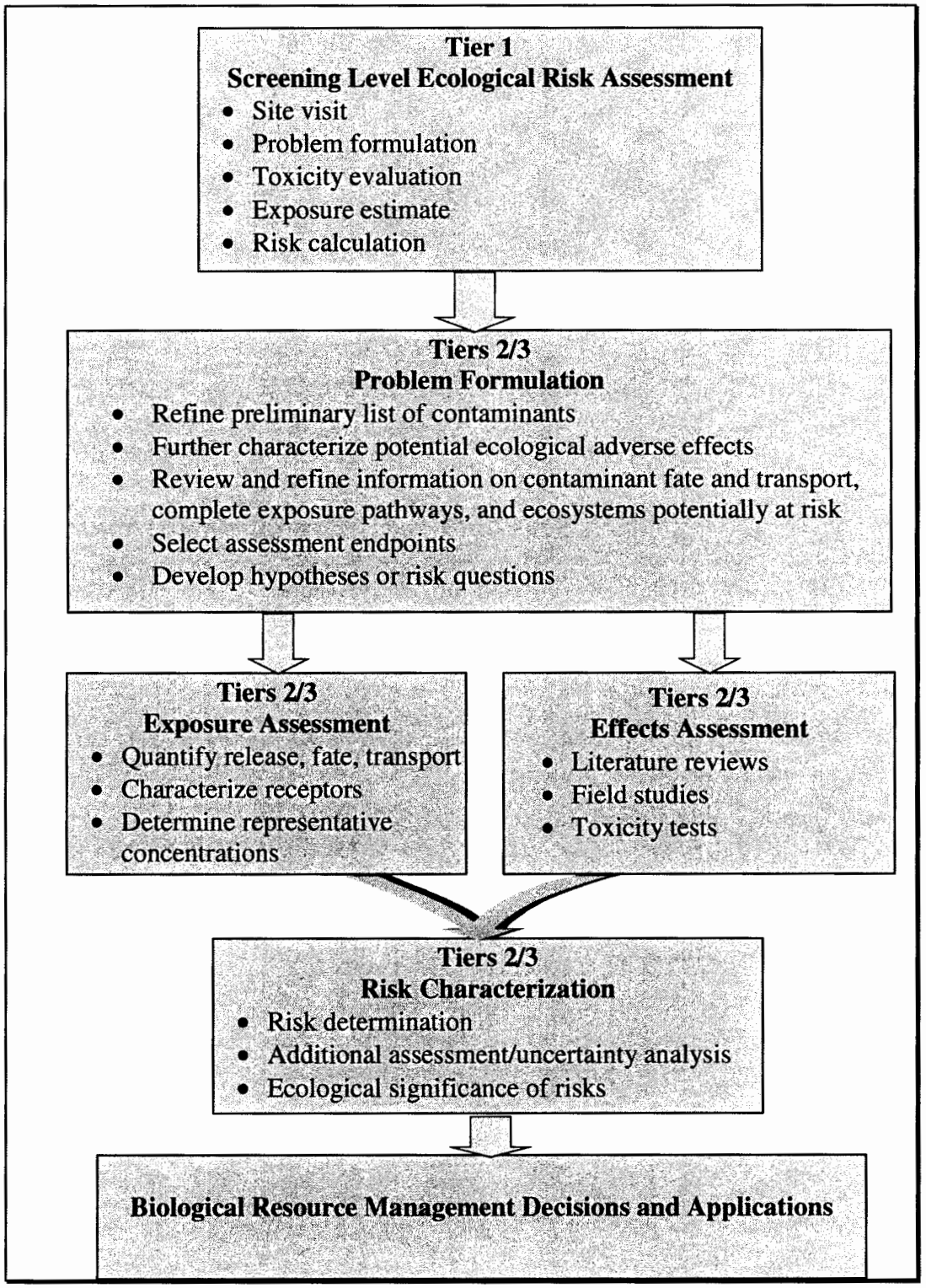

Figure 1-1. Components of an ecological risk assessment leading to decisions and possible management actions on biological resources.

project staff. The function of the Core Team was to perform the work and make the necessary communications to their respective organizations.

The ecorisk assessment project was considered a subset of the BRMP that is in development at LANL. The BRMP is one component of integrated natural resources management at LANL, which, in turn, is a subset of the LANL institutional-level Integrated Safety Management system. The BRMP is intended to manage biological resources as valuable resources in a manner that directly supports the DOE/LANL mission. One of the goals is to determine conditions and to recommend management measures that will restore, sustain, and enhance the biological quality and integrity at LANL within the regional context of the Pajarito Plateau ecosystem. With trace levels of chemical (inorganic and organic) and radioactive contamination in the LANL-related environment, understanding risk to non-human biota from COPCs is an important biological quality issue emphasized by many stakeholders. With the regional spatial scope identified above, the ecorisk assessment reported herein had a broad spatial extent similar in scope to the regional context of the BRMP and equal to the "broad ecosystem-level component" requirement of the Natural Resource Damages Act (43 CFR 11).

An existing organization, the East Jemez Resource Council (EJRC), was used as a forum for interacting with internal and external stakeholders, whereby their function was to represent their respective agency and/or expertise on ecorisk-related issues of importance to them. This generally consisted of providing feedback on general issues such as what 'environmental/ecological value(s) on the Pajarito Plateau need protection given the mission of their organization,' 'what ecological entities need protection (e.g., species, functional groups [producers], communities/populations [e.g., deer], ecosystems [e.g., piñon], valued habitats [e.g., wetlands], unique areas [e.g., cultural sites]),' and what species best represented their agencies' interests or their profession for serving as receptors in the Tier 2 ecological risk assessment.

2.0 PROBLEM FORMULATION

2.1 Selection of Assessment Endpoints—The Ecological Entity (Receptor) and Ecological Relevance

Assessment endpoints for SLERAs are any adverse effects on ecological receptors (USEPA 1997, 1998). In the case of the ECORSK model, ecological receptors include bird and mammal populations and communities, habitats, and sensitive environments. The ECORSK model helps identify potential risk of adverse effects of COPCs to these ecological receptors. The generic assessment endpoint is to sustain the structure and function of populations and communities, habitats, and sensitive environments of ecological receptors of concern.

On the issue of identifying which ecological entity(ies) represent the Pajarito Plateau, the choices were individuals, communities, populations, or ecosystems. The availability of toxicity information is a prime consideration in the selection of the ecological entity for this assessment. Because COPC "safe limits" (TRVs) are almost exclusively centered on individual organisms, the selection of entity was automatic–the individual organism was selected as the ecological entity to represent the Pajarito Plateau ecosystem. Many COPC safe limits are from toxicity studies where growth, reproduction, or mortality were the measurement endpoints. Loss in reproductive capability is a common effect of organism exposure to COPCs, therefore it is a key "sentinel" measurement endpoint; however, it is not the easiest endpoint to measure. Many TRVs are based on body growth because it is easy to measure animal weights during the toxicity study. This is an ecologically relevant effect that is linked to population dynamics because an individual organism that experiences decreased growth may also experience decreased reproductive success resulting from decreased availability of energy needed for reproduction. Toxicity studies sometimes quantify the lethal amounts of a COPC, and clearly mortality is a relevant ecological effect for evaluating ecological effects. Also, many more toxicity studies are based on sublethal effects (like biochemical changes) that are harder to relate to adverse effects on individuals or populations.

A major effort in conducting the project was spent on selecting the species of ecological receptors that would serve as the subject(s) of the ecorisk assessment. A BRMP working team of the EJRC convened in several working sessions to establish the process for selecting the ecological entity (receptors). The process established was as follows:

- Establish the general ecological/environmental values that are being protected
- Develop criteria for the selection of receptors on the basis of (1) social/cultural and ecological (SCE) factors and (2) contaminant and model strength (CMS) factors.
- Develop "straw" long list of receptors
- Engage external stakeholders
- Revise (add to) long list of receptors based on stakeholder input
- Merge SCE and CMS into "Combined Long List"
- Reduce Combined Long List to "Short List"
- Solicit final input and preferences from stakeholders on Short List of receptors
- Select receptors

A goal of this task was to place some emphasis on SCE-related criteria to support the project objective of conducting an ecorisk assessment that was relevant to the management of

biological resources. Therefore, because CMS criteria often dominate receptor selection, the approach was to initially separate the two criteria areas and have two separate subteams work in parallel to derive a list independently.

2.1.1 Social/Cultural and Ecological Criteria for Receptor Selection

The goals of the SCE subcommittee were to identify and articulate environmental or ecological values that are important to protect, including the characteristic or desired condition. The categories of values identified by the SCE subcommittee were as follows:

- Social/cultural importance
- Of or related to food webs such as provision of sustenance at key links in the food web or representative of a particular trophic level such as a top carnivore
- Important abiotic processes
- Ecological diversity
- Productivity and nutrient cycling
- Landscape integrity

2.1.2 Contaminant and Model Strength Criteria for Receptor Selection

The criteria developed by the CMS receptor selection subteam were as follows:

- Relative exposure tendency
- Relative sensitivity
- Species for which TRVs ("safe limits") exist or can be extrapolated
- Conducive to modeling strengths of ECORSK.6 such as being mobile or having known distribution and density

A very limiting factor in ecological risk assessments that currently exists worldwide is CMS criteria #3–being a species for which toxicity benchmarks (safe limits or TRVs) exist or can be extrapolated. As such, LANL's extensive ECORISK Database (LANL 1999) of toxicity benchmarks was queried to identify the test species on which TRVs are based and to tabulate the total number of TRVs in the database that directly apply to the taxonomic class, order, family, genus, and species of the 20 receptors on the CMS list for consideration in this study. The results of the query are presented in Table 2-1a. The most frequently used laboratory toxicity test species is the common laboratory rat for which there are 88 chemicals with toxicity data; 66 for the mouse, 14 for the domestic dog and mallard duck, 12 for the chicken, and 10 for the Japanese quail. There are many other test species for which there are nine or fewer chemical TRVs (Table 2-1b). The tabulation of the number of TRVs in the database that apply to the taxonomic class, order, family, genus, and species of the 20 receptors on the CMS list is presented in Table 2-1a. As an example, at the time this ecorisk assessment was performed, 91 TRVs existed in the ECORISK Database (LANL 2000a) that directly apply to the taxonomic class (aves) that the American kestrel is in. Three TRVs exist in the database that directly apply to the order (falconiformes), family (falconidae), genus (*Falco*), and species (*sparverius*) of the kestrel.

Table 2-1a. Total Number of TRVs in LANL's ECORISK Database that Directly Apply to the Taxonomic Class, Order, Family, Genus, and Species of the 20 Receptors on the CMS List Considered for Assessment Using ECORSK.6

Common Name	Class	Order	Family	Genus	Species	Relation to Test sp./No. Chemical Class	Order	Family	Genus	Species
Desert cottontail	Mammalia	Lagomorpha	Leporidae	Sylvilagus	audubonii	223	8	8	0	0
Deer mouse	Mammalia	Rodentia	Cricetidae	Peromyscus	maniculatus	223	179	3	3	0
Vagrant shrew	Mammalia	Insectivora	Soricidae	Sorex	vagrans	223	0	0	0	0
Red fox	Mammalia	Carnivora	Canidae	Vulpes	vulpes	223	16	16	0	0
Violet-green swallow	Aves	Passeriformes	Hirundinidae	Tachycineta	thalassina lepida	91	?	?	?	?
Occult little brown myotis bat	Mammalia	Chiroptera	Myotis	lucifugus	occultus	223	0	0	0	0
American kestrel	Aves	Falconiformes	Falconidae	Falco	sparverius	91	3	3	3	3
American robin	Aves	Passeriformes	Turdidae	Turdus	migratorius	91	?	?	?	?
Bat	Mammalia					223	0	0	0	0
Black bear	Mammalia		Ursidae	Ursus	americanus	223	0	0	0	0
Chorus frog						?	?	?	?	?
Deer	Mammalia		Cervidae			223	?	0	0	0
Elk	Mammalia		Cervidae	Cervus	elaphus	223	?	0	0	0
Kestrel	Aves					91	?	?	?	?
Lichens						?	?	?	?	?
Mexican spotted owl	Aves					91	?	?	?	?
Mountain lion	Mammalia		Felidae	Felis	concolor	223	?	1	0	0
Piñon						?	?	?	?	?
Water shrew	Mammalia		Soricidae	Sorex	palustris	223	0	0	0	0
Tiger salamander						?	?	?	?	?

Table 2-1b. Test Species on which Laboratory Toxicology Studies have been Performed

Common Name	Class	Order	Family	Genus	Species	Number Chemicals with Toxicity Data
Bird	Aves					2
Blackbird (Red-winged)	Aves					4
Chicken	Aves			*Gallus*		12
Chicken (White Leghorn)	Aves					2
Chukar	Aves			*Alectoris*	*chukar*	1
Cowbird (Brown-headed)	Aves					1
Dove (Mourning)	Aves					1
Dove (Ringed turtle)	Aves					2
Dove (Ringed)	Aves					3
Duck	Aves					1
Duck (American Black)	Aves			*Anas*	*rubripes*	3
Duck (Black)	Aves					3
Duck (Drake Mallard)	Aves					1
Duck (Mallard)	Aves			*Anas*	*platyrhnchos*	14
Finch (Bengalese)	Aves					1
Goose (Canada)	Aves					1
Grouse (Sharp-tailed)	Aves					2
Heron (Black-crowned night)	Aves					1
Kestrel (American)	Aves	Falconiformes	Falconidae	*Falco*	*sparverius*	3
Owl (Barn)	Aves					1
Owl (Eastern Screech)	Aves					1
Owl (Screech)	Aves					4
Partridge (Gray)	Aves					2
Pelican (Brown)	Aves					1
Pheasant	Aves					1
Pheasant (Ring-necked)	Aves					5
Quail	Aves					2
Quail (Bobwhite)	Aves					3
Quail (California)	Aves					1
Quail (Japanese)	Aves			*Coturnix*	*coturnix japonica*	10
Sparrow	Aves					1
Vulture (Black)	Aves					1
Cat	Mammalia		Felidae			1
Coyote	Mammalia		Canidae	*Canis*	*latrans*	1
Dog	Mammalia		Canidae			14
Dog (Beagle)	Mammalia		Canidae			1
Guinea Pig	Mammalia					4
Mink	Mammalia		Mustelidae			9
Monkey	Mammalia					2
Monkey (Rhesus)	Mammalia					1
Mouse	Mammalia	Rodentia				66
Mouse (CD-1)	Mammalia	Rodentia				1
Mouse (Oldfield)	Mammalia	Rodentia	Cricetidae	*Peromyscus*	*polionotus*	1
Mouse (randombred Charles River CD strain)	Mammalia	Rodentia				1
Mouse (Swiss)	Mammalia	Rodentia				1
Mouse (White-footed)	Mammalia	Rodentia	Cricetidae	*Peromyscus*	*leucopus*	2
Pig	Mammalia					1
Rabbit	Mammalia	Lagomorpha	Leporidae			8
Rat	Mammalia	Rodentia				88
Rat (Albino)	Mammalia	Rodentia				1
Rat (Carworth Farm)	Mammalia	Rodentia				1
Rat (CD)	Mammalia	Rodentia				1
Rat (Inbred BD)	Mammalia	Rodentia				1
Rat (Long-Evans)	Mammalia	Rodentia				2
Rat (RVH hooded strain)	Mammalia	Rodentia				1
Rat (Sherman)	Mammalia	Rodentia				1
Rat (Sprague-Dawley [Albino])	Mammalia	Rodentia				1
Rat (Sprague-Dawley)	Mammalia	Rodentia				3
Rat (Wistar)	Mammalia	Rodentia				1
Rodent	Mammalia	Rodentia				6
Sheep	Mammalia		Bovidae			2

Because previous work at LANL had completed a process of considering ecorisk receptors on the basis of criteria directly related to COPC factors (LANL 1999), the list of species selected in the previous effort was selected by the CMS receptor selection subteam as a starting point. To this list was added species on the basis of criteria unrelated to COPCs. These criteria were ubiquity/abundance, distribution (preference to well distributed), home range size (preference to large), ecosystem type (preference to terrestrial), and availability of site-specific distribution and density data (strong preference to species for which these data exist).

The Combined List of receptor candidates and favorable and unfavorable characteristics of each species for serving as indicator species for ecorisk assessment are shown in Table 2-2.

Table 2-2. Candidate Receptors for Tier 2 Ecorisk Assessment

Species	SCE Rating	Characteristics
American robin	3 (bird)	Preferred by stakeholders as indicator species. High exposure tendency resulting from consumption of ground invertebrates as a food source. Distribution and density known. Known to be sensitive to organochlorine pesticides, which has previously been shown to be an important COPC. High exposure due to relatively high food intake rate (relative to body weight). Wide distribution conducive to strength of ECORSK.6. Is within animal guild for which TRVs exist, i.e., birds.
American kestrel	3 (bird)	Top carnivore, therefore addresses issue of potential biomagnification. Omnivorous diet (insects, animal flesh, plants). Ubiquitous in LA County, but quantified distribution and density (needed for the new feature of ECORSK.6) unknown. Surrogate for peregrine falcon and Mexican spotted owl, both of which were modeled in late-1990s. Density and distribution better known for falcon and owl, which will be re-modeled, therefore, kestrel not selected.
Black bear	16	Top carnivore, therefore addresses issue of potential biomagnification. Few taxonomically relevant TRVs for this species. Distribution and density unknown on the Pajarito Plateau. Omnivorous diet and large home range.
Mule deer	9	Species is similar to elk in home range, but smaller, and diet, but more browsing of shrubs. Sample availability for field studies for model validation. Elk was preferred among stakeholders to represent mammalian herbivores. Distribution and density partially known on the Pajarito Plateau.
Deer mouse	6 (piñon mouse)	Omnivore. High score on CMS criteria and preference indicated by external stakeholders as indicator species. High exposure tendency resulting from consumption of invertebrates as a food source. Distribution and density known. High exposure tendency resulting from relatively high food intake rate (relative to body weight). Wide distribution conducive to strength of ECORSK.6. Is within animal guild for which TRVs exist, i.e., mammals.
Desert cottontail	Not scored	Species is similar to elk in its diet, but the cottontail home range is much smaller. Known to be generally ubiquitous and abundant, but distribution and density on Pajarito Plateau not quantified. Some exposure and toxicity data available, but elk was preferred mammalian herbivore among stakeholders.
Chorus frog	7	Likely sensitive to certain COPCs, therefore good indicator. Lack of TRVs for amphibians, which are required for ECORSK.6. Populations are cyclic, therefore not present in adult stages some years and are largely confined to isolated wetlands.
Rocky Mountain elk	20	Very good distribution and density data. Large home range well suited to strengths of ECORSK.6. High social and economic value. Sample availability for field studies for model validation. Second highest score.
Grey fox	3	Top carnivore, therefore addresses issue of potential biomagnification. Diet is primarily carnivorous, therefore moderately high exposure, but distribution and density unknown on the Pajarito Plateau.

Table 2-2 (con't.)

Species	SCE Rating	Characteristics
Lichen	12	Good indicator species of COPC impacts but not suited to spatial modeling or COPC exposure modeling used in ECORSK.6.
Mexican spotted owl	12	Top carnivore, therefore addresses issue of potential biomagnification. Very high social importance. Relative exposure tendency high as a top predator. Population, habitat, and diet well known. Was subject of assessment with ECORSK.5 in 1997 and will be re-modeled in the future.
Mountain lion	21	Relative exposure tendency high as a strictly carnivorous top predator. Top carnivore, therefore addresses issue of potential biomagnification. Highest rating on SCE criteria, however low abundance/ubiquity, benchmark rating relatively low, and range thought too broad to associate risk with LANL contaminants.
Myotis bat	7 (bat)	Aerial insectivore with some information on its abundance on the Pajarito Plateau. Model validation studies with guano possible.
Piñon pine	10	Not suited to spatial modeling or COPC exposure modeling used in ECORSK.6 for animals.
Pocket gopher	5	Good indicator of high exposure to external penetrating radiation, but distribution and densities unknown. Sensitivity largely unknown. Subterranean, therefore difficult to study.
Tiger salamander	8	Likely sensitive to certain COPCs, therefore good indicator. Lack of TRVs for amphibians and reptiles, which are required for ECORSK.6. Also, amphibian populations are cyclic and are largely confined to isolated wetlands.
Western bluebird	3 (bird)	Aerial insectivore with some information on its abundance on the Pajarito Plateau. Migratory species some individuals of which are year-round residents. Peregrine falcon more sensitive to certain COPCs.
Vagrant shrew	10 (water shrew)	Ground invertivore with small home range and small amount of information on its abundance on the Pajarito Plateau. Exposure tendency resulting from consumption of invertebrates as a food source higher than deer mouse because shrew experiences high soil intake resulting from "grubbing" for soil invertebrates, while deer mouse largely consumes surface-dwelling invertebrates and some plant material.
Violet-green swallow	3 (bird)	Aerial insectivore with small amount of information on its abundance on the Pajarito Plateau. Migratory species that is only a part-year resident. Moderate interest by the public. High exposure tendency resulting from relatively high food intake rate (relative to body weight). Peregrine falcon more sensitive to certain COPCs.
Other amphibians and reptiles		Known to be very sensitive to certain COPCs, therefore good indicator. Lack of TRVs for amphibians and reptiles, which are required for ECORSK.6. Also, amphibian populations are cyclic and are largely confined to isolated wetlands.

2.1.3 Selection

An important goal of the project was to add a dimension of exposure determination that is based on animal distribution. Simulating distribution based on real data had been previously identified as an improvement to the model that would make ECORSK.6 model results more realistic. Among other factors, animals distribute themselves based on the location of their food source (forage or prey). Stratification and density of animals across the Pajarito Plateau have been monitored by LANL's RRES-ECO for a few organisms. The importance of the goal related to this factor and the limited number of animals for which information exists limited the range of

species from the Combined List that could be selected for assessment. Fortunately, some of the species for which this information exists ranked relatively high in preference to serve as an indicator species as expressed by the stakeholders. Three species for which this combination existed were Rocky Mountain elk, American robin, and deer mouse, and these are the species that were chosen for the assessment. Other species that should be assessed are the Mexican spotted owl and the American bald eagle. They are top carnivores, therefore have the potential to bioaccumulate COPCs to greater amounts than can the three species assessed thus far. Roughly three years have passed since these two species were assessed (Gallegos et al. 1997a, Gonzales et al. 1998a), and the COPC database has been enlarged through additional sampling and analysis of environmental media. The bald eagle is largely piscivorous, eating fish from the Rio Grande and Cochiti Lake. In 1998 when the eagle was assessed, the input of organic COPCs was largely based on the results of monitoring sediment in the Rio Grande by the Water Quality and Hydrology Group. For the three years examined, organics were not detected in sediment, but since then dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethane (DDE), Aroclors, and polychlorinated biphenyl (PCB) congeners have been detected in fish (Gonzales et al. 1999; Fresquez and Gonzales 2000) and in other media including the great horned owl (Gonzales et al. 2001a). The Mexican spotted owl represents a food chain with more potential than the bald eagle for COPC bioaccumulation and/or biomagnification. ECORSK.4 was executed on the Mexican spotted owl in 1997 (Gallegos et al. 1997a) and ECORSK.5 was executed on the bald eagle in 1998 (Gonzales et al. 1998a). Plans are currently under way to execute ECORSK.6 on the Mexican spotted owl with the expanded contaminant database (Gonzales et al. 2001b).

2.1.4 Defining Assessment Endpoints

Assessment endpoints for SLERAs are any adverse effects on ecological receptors, including populations and communities, habitats, and sensitive environments (USEPA 1997, 1998). In the case of the Tier 2 ecorisk assessment, the ecological receptors include bird and mammal species. These species have populations across the Parjarito Plateau that represent various ecological communities, habitats, and sensitive environments. The assessment endpoint is to identify potential adverse effects from COPCs on these ecological receptors that in turn provide information on potential adverse effects on the structure and function of populations and communities, habitats, and sensitive environments.

2.2 Conceptual Models

The conceptual model describes the COPC sources, dominant transport pathways and exposure routes, and potential receptors. The potential receptors have previously been defined as terrestrial animals that occupy two functional groups (herbivore and omnivore) within the terrestrial food web. Aquatic species and terrestrial plants/invertebrates were not considered because ECORSK.6 was developed to model terrestrial animals. The conceptual model developed for the Tier 2 ecorisk assessment is based on the screening-level ecorisk conceptual model (LANL 1999). The spatial scale of the Tier 2 ecorisk assessment is the entire Laboratory surrounded by a 1-km-wide buffer area[1], and the conceptual model was developed to apply to a wide variety of potential ecological exposures within this approximately 30,000-ha area. Exposures from incidental soil ingestion and food consumption are quantified by ECORSK.6,

[1] This area is termed the Ecological Exposure Unit (EEU).

while other pathways and media were evaluated in a qualitative manner only. This approach is consistent with guidance from the USEPA that suggests that direct ingestion pathways are most important for assessments of terrestrial animals (USEPA 1997), and with the methodology for developing ecological soil screening levels (Eco-SSL) (USEPA 2000).

2.2.1 Risk Hypotheses

Risk hypotheses (questions) are used to determine if adverse effects on terrestrial receptors are occurring based on exposure to COPCs in soil or sediment. For this Tier 2 ecorisk assessment, the risk questions are developed to provide measures of effects on individuals or populations. The risk questions are also intended to inform managers and technical experts of data gaps or uncertainties in the risk estimates. These questions supplement previous Tier 2 ecorisk assessments of threatened and endangered (T&E) species (Gonzales et al. 1997, Gonzales et al. 1998a, and Gonzales et al. 1998b), which focussed on determining potential for impacts to individuals of T&E species.

The following risk questions were developed for these Tier 2 assessments:

Are chemical concentrations in soil sufficient to lead to individual or population-level[2] adverse ecological effects through the incidental soil ingestion pathway for terrestrial receptors in two functional groups (herbivore and omnivore)?

Are chemical concentrations in soil sufficient to lead to individual or population-level adverse ecological effects through the food ingestion pathway for terrestrial receptors in two functional groups (herbivore and omnivore)?

What are the dominant COPCs to animals based on the incidental soil ingestion pathway?

What spatial areas of the Laboratory or the surrounding buffer area contribute the largest proportion of the estimated risk to animal receptors?

Which exposure pathway, incidental soil ingestion or food ingestion, contributes the larger amount to estimated risk to animal receptors?

What is the importance of background or estimated soil/sediment concentrations on the estimated risk to animal receptors?

2.2.2 Conceptual Model Diagrams

Conceptual model diagrams depict a graphic relationship between the contaminated media, exposure pathways, and ecological receptors. Only surface soil is considered in this Tier 2 ecorisk assessment because the ECORSK.6 model does not assess exposure to surface water or subsurface material. For the purposes of this Tier 2 ecorisk assessment, media classified as "sediment" is considered to have the same exposure pathways as surface soil for terrestrial receptors, which is an appropriate designation for most Pajarito Plateau canyon-bottom settings with ephemeral water. Canyon sediments in settings with perennial or intermittent surface water should be evaluated for impacts on aquatic receptors and pathways. Figure 2-1 shows the transport mechanisms and exposure pathways expected to be complete from surface soil. Surface

[2] USEPA guidance is to consider adverse population level effects for all species but T&E species (USEPA 1999). Thus, it is desirable to determine possible adverse effects of contaminants to animal populations or ecological communities, but toxicity information exists for individual animals. Possible use of ECORSK.6 model results for population-level ecorisk assessments will be considered in Section 5 of this report.

soil is assumed to represent the primary exposure medium of concern to terrestrial receptors. Complete exposure pathways include food web transport, incidental soil ingestion, dermal contact, external gamma radiation, respiration of vapors, and inhalation of dust. Plant uptake is a complete pathway but modeling exposure to plants is outside of the capabilities of ECORSK.6 and will not be considered further. Dermal contact and inhalation/respiration pathways have not typically been assessed quantitatively in ecorisk assessments, based on guidance that suggests that the ingestion route is most important to terrestrial animals (USEPA 1997). Soil exposure pathway analysis has shown that inhalation and dermal pathways contribute a small fraction of the dose obtained orally (USEPA 2000). The contribution from dermal exposure was shown to vary with COPC type, with semivolatile organic chemicals (SVOCs) or high explosives contributing the largest amount and inorganic chemicals contributing the least to total dose (USEPA 2000). Airborne exposures are expected for volatile organic chemicals (VOCs), especially in subsurface locations that are not considered as part of this assessment. For animals considered in this study, only deer mice may spend enough time in subsurface burrows to warrant a qualitative assessment of this pathway.

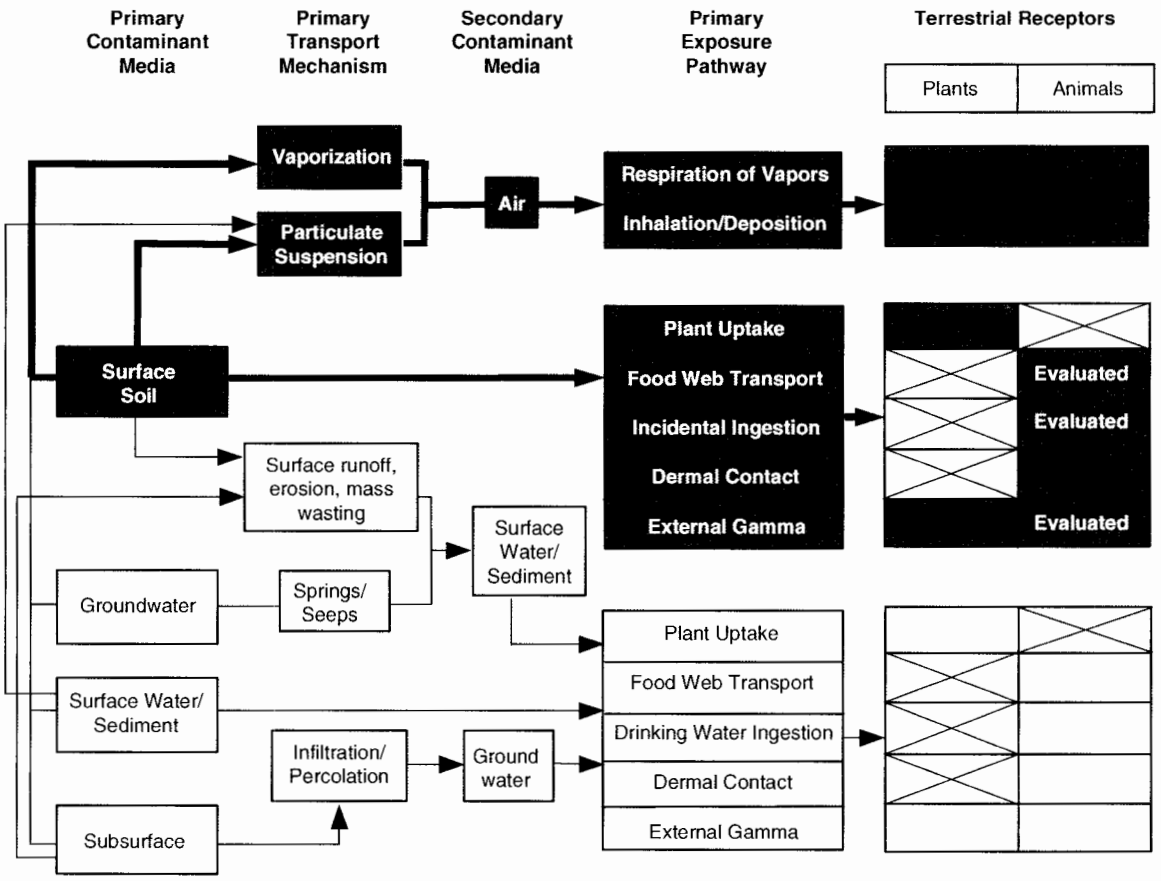

Figure 2-1. Ecological conceptual model for soil pathways. (Taken from LANL 1999). Complete pathways are gray; evaluated pathways are included in the ECORSK.6 calculations.

2.2.3 Uncertainty in Conceptual Model

The conceptual model is based on current COPC concentrations in surface soils and sediments. For meaningful estimates of adverse effects based on ECORSK.6 calculations, there is an inherent assumption that concentrations are at equilibrium at all locations or are decreasing in a steady state fashion. Thus, the conceptual model does not account for new releases into the environment or changes to the historical transport pathways. Thus, one source of uncertainty in the conceptual model is the potential future transport of COPCs from source areas to locations downgradient with potentially different receptors or receptor use factors. For example, contamination on a hill slope may erode and be transported downstream into a wetlands or aquatic environment. In general, releases from operating facilities date back to before 1980 and thus decades have elapsed to permit surface water transport. Thus, one may expect decreasing concentrations of COPCs in active channel settings over time, which has been documented in reports on sediments in Los Alamos, Pueblo, and DP Canyons (Katzman et al. 1999, Reneau et al. 1998a, b, c).

However, these observations of COPC concentrations pre-date the Cerro Grande fire (May 2000), which has impacted much of LANL and upgradient areas in the Jemez Mountains. Preliminary data suggest that background concentrations of radionuclides, inorganics, and organic chemicals have changed as a result of this fire. The effects of the fire should be evaluated in at least a qualitative manner with regard to COPC distribution, animal occupancy patterns, and COPC migration potential.

Other uncertainties in the conceptual model relate to the completeness and validity of information in the COPC database, TRVs, and species distribution patterns. Some of these uncertainties with more supporting information can be quantified (e.g., species distribution) and others with limited information (e.g., a COPC with a single TRV) will be evaluated in a qualitative manner.

Lastly, the exposure pathways modeled by ECORSK.6 do not include dermal absorption or inhalation, and also do not address any exposure related to contaminated surface water or any effects of COPCs on aquatic receptors, terrestrial plants, or invertebrates. Strictly aquatic species are outside the scope of this Tier 2 ecological risk assessment, but potential for exposure through these other pathways and to other terrestrial receptors will be considered in a qualitative manner.

2.3 Analysis Plan

2.3.1 Selecting Measures

2.3.1.1 Measures of Effect

The generic assessment endpoint is addressed with measured effects that are related to population sustainability such as reproductive success, normal development, and general health and survivorship of individual organisms. Adverse effects on reproduction are related to decreased population sustainability, as are adverse effects on development of offspring, general health effects (e.g., weight loss can decrease the availability of energy for reproduction), and survival of breeding adults. Thus, these measured effects on individual organisms can be used to gauge effects to higher levels of biological organization. Furthermore, the majority of available toxicity data is for effects on individual organisms, which limits the ability to assess adverse

effects to higher levels of biological organization by any means other than relevant effects on individual organisms.

2.3.1.2 Measures of Exposure/Receptor Characteristics

2.3.1.2.1 Density Distributions/Presence Ratios

2.3.1.2.1.1 Rocky Mountain Elk

During 1996-1997, 12 elk were captured from five different locations at the Laboratory and fitted with a Telonics model ST14 GPS (Global Positioning System) collar. These collars were programmed to acquire a GPS position every 23 hours and uplink to Argos satellites every three days for data retrieval. Data were received from Argos, Inc., via e-mail and were stored on a personal computer for post-processing. Data and attributes (Date, Julian Day, Greenwich Mean Time, and Collar-ID) were imported to a geographic information system (GIS) using ARC/INFO software. Greater than 1800 locations were obtained. Locational error of positions was estimated to be 106 m (Bennett et al. 1997). These data points became the basis of the data analysis to build a GIS-based habitat suitability index for elk.

We used land cover type, slope, and aspect as physical habitat variables and fences, roads, and buildings/structures as human land use variables to create the habitat suitability index. Chi-square analysis was used to examine site-specific elk locations to land cover types. In addition, elk use or avoidance of human land use features were determined by comparing literature information to observed data.

Scales for natural resource variables were derived from the contribution of a variable class to the calculated Chi-square for that variable. Variable classes that were used more than expected (greater than a random distribution) were scaled with a high value (maximum value of 100). Variable classes that were not used were given a value of zero. Human land use variables were scaled based on literature information and from observed data. These scalings were applied to each GIS layer representing each variable. After all the scalings were applied, all of the GIS layers were added together to form one composite layer.

The composite GIS layer was analyzed for clustering of values. From this analysis, six different habitat suitability classes were determined. These classes were designated no use, very low use, low use, moderate use, high use, and very high use. Overlay analysis was performed looking at the distribution of elk GPS positions to the habitat suitability map of six categories. Not all classes were found to be statistically different at the alpha = 0.05 level. Therefore, we combined classes that were not significant and the resulting GIS habitat suitability index layer was comprised of three categories (low, moderate, and high). The habitat suitability index was then used as a basis to code the elk EEU.

2.3.1.2.1.2 American Robin

Songbird surveys conducted in the summers of 1998 and 1999 were analyzed for the presence of American robin and grouped by cover type. Table 2-3 shows that robins were found in four cover types visited. A presence ratio was calculated based on the number of robins detected in each cover type divided by how often each cover type was visited.

Since the EEU includes more than these four cover types, a presence ratio was calculated for the other four cover types (water, juniper woodlands, aspen/deciduous vegetation, and

developed areas). Since American robins are most prevalent in turf areas, such as parks and around homes, we estimated that developed areas, which contain both turf and asphalt, would have a presence ratio of 0.5.

Table 2-3. Presence Ratios for American Robin

Land Cover From Map	Detects	Visits	Presence Ratio (Detects/Visits)
Piñon-Juniper	5	66	0.08
Ponderosa Pine	13	53	0.25
Mixed Conifer	2	6	0.33
Grassland	1	4	0.25

2.3.1.2.1.3 Deer Mouse

Density for deer mouse was calculated by land cover and topography (mesa top or canyon bottom). To develop the deer mouse EEU spatial layer, we first intersected (using ARC/INFO INTERSECT command) the land cover layer with the canyon-mesa top layer to produce a composite layer with land cover attributes and canyon and mesa top attributes. We coded this new layer with the relative importance values derived from the average density information.

Deer mouse population density estimates were calculated for each habitat type identified at LANL and whether it was within a canyon or on a mesa top. Density estimates were calculated in one of two ways, depending on the trapping design used at each sampling location.

We used a trapping web design (Buckland et al. 1993) consisting of 12 lines radiating from the center similar to the spokes of a wheel with 12 traps in each line and an additional four traps in the center of the web for a total of 148 traps (Parmenter et al. 1998) in sampling locations large enough to support this size of trapping design. The first four traps from the center in each line were spaced 5 m apart, thereafter the spacing was 10 m. Sherman live traps were baited in late afternoon with a molasses-coated horse feed and a dry mixture of peanut butter. Trapping took place between four and six consecutive nights, until no new captures were recorded within the inner five rings of the web. Traps were checked in early morning then closed during the day to avoid diurnal captures. All incidental kills were submitted to the University of New Mexico Museum of Southwestern Biology where species identification was confirmed. Population density (# animals/ha) was estimated using Program Distance (half-normal with cosine adjustment model; Buckland et al. 1993; Laake et al. 1994). For the purpose of density estimation, we eliminated the outer ring captures to minimize the effect of animals drawn into the web during the course of the trapping session.

In smaller sampling areas, grids were used. Grid designs consisting of up to 100 snap traps are placed approximately 10 m apart in 10 by 10, 5 by 10, or any combination thereof to fit the area being sampled. Snap trapping takes place over three to four nights (until at least 15 animals are captured at each site). Direct removal models are used to analyze data for density information in sampling where animals were captured and euthanized or ear-tagged and released. Primarily, rodent densities were estimated using regression equations (Seber 1982) applied to each grid where daily total number of captures were plotted against the cumulative daily captures. Confidence intervals were calculated at 90% using the general method (Seber 1982). Once calculated, the density estimates were pooled by habitat type and topography by which relative importance values were obtained.

2.3.1.2.2 Integration with Land Cover, Modeling, and Digital Coding

2.3.1.2.2.1 Development of the Site EEU

The site EEU was mapped using a GIS and GIS software ARC/INFO and Arcview. These software products were developed by Environmental Systems Research Institute, Inc. (ESRI 1989). The spatial extent of the site EEU was 1 km beyond the DOE boundary. A grid was developed that would encompass this spatial extent of the EEU needed for the modeling activity. In ARC/INFO, a grid was created using the command GENERATE with the fishnet and labels option. The grid cell size was set to 100 ft by 100 ft.

ECORSK.6 requires that each row and column of the site EEU grid be designated by a label. In addition, the coordinates of the center of each cell were needed. To accomplish this a *BASIC* program was developed as shown in Appendix Table A-1. These attributes were then added to the grid spatial data set.

2.3.1.2.2.2 Development of the Elk EEU

For the elk EEU, the habitat suitability index GIS layer was used and the values were coded to represent the relative suitability of each land cover class. The habitat suitability index covered only the portions of the EEU that were represented by the home ranges calculated from the elk GPS positional data (Biggs et al. 1999, 1997). Where variable data were available, we expanded the suitability index to cover the entire site EEU. The habitat suitability index layer was intersected (using ARC/INFO INTERSECT command) with the site EEU layer to create the elk EEU layer. The resulting layer was comprised of the site EEU attributes (row, column, x-coordinate, and y-coordinate) as well as the elk habitat suitability index values. This new elk EEU layer had numerous small polygons with suitability values within each 100-ft by 100-ft grid cell. To reduce these values down to one value for each grid cell, the ARC/INFO command DISSOLVE was used with the maximum value option. Using the maximum value yields the maximum predicted elk use for a grid cell. This resulted in a new elk EEU layer that had only one value for each grid cell based on the maximum value found within the 100-ft by 100-ft grid cell. Table 2-4 lists the values assigned to the elk EEU layer.

Table 2-4. Geocoding of the Elk EEU

Value	Description of the value
0.9999	Within the EEU, but there were no data to model elk use
0	Grid cell outside the elk EEU
1	Inside the EEU but outside the elk home range data. Modeled low elk use.
10	Inside the EEU but outside the elk home range data. Modeled moderate elk use.
20	Inside the EEU but outside the elk home range data. Modeled high elk use.
1000	Inside the EEU and within the elk home range data. Modeled low elk use.
10000	Inside the EEU and within the home range data. Modeled moderate elk use.
20000	Inside the EEU and within the home range data. Modeled high elk use.

Areas assigned a 20 were 20 times more suitable to elk than cells assigned a one and were also two times more suitable than areas assigned a 10. The coding was increased for areas within the home range data set. This coding was performed as a measure to keep track of which areas were within the 1996-1997 elk study area and which ones were estimated based on land cover

class. Areas assigned a 1000 were still 20 times less suitable for elk than areas assigned a 20000. These are relative importance values for elk habitat use.

The elk EEU layer was used to generate data tables needed for ECORSK.6 and to produce maps. The ECORSK.6 model also requires the home range of the elk, which was calculated as 755 ha or approximately 8130 grid cells. ECORSK.6 calculates home range based on body weight following allometric relationships developed by Peters (1993).

2.3.1.2.2.3 Development of the American Robin EEU

After calculating the presence ratio for robin by land cover type, we coded the land cover layer to correspond to the presence ratio. Coded land cover values are listed in Table 2-5. These are relative importance values for habitat use by the robin.

Table 2-5. Coded Land Cover Values

Land Cover Class	Presence Ratio (Detects/Visits)	Coded Value within the Land Cover Class
Water	0.0	0.0
Piñon-Juniper	0.08	0.08
Juniper Woodlands	0.08	0.08
Ponderosa Pine	0.25	0.25
Mixed Conifer	0.33	0.33
Aspen/Deciduous Vegetation	0.3	0.3
Grassland	0.25	0.25
Developed Areas	0.5	0.5

The new land cover layer coded with the presence ratio of robins was intersected (using ARC/INFO INTERSECT command) with the site EEU layer. The resulting layer was comprised of the site EEU attributes (row, column, x-coordinate, and y-coordinate) as well as the robin presence ratios from the coded land cover layer. This new robin EEU layer had numerous small polygons with presence ratios values within each 100-ft by 100-ft grid cell. To reduce these values down to one value for each grid cell, the ARC/INFO command DISSOLVE was used with the maximum value option. This resulted in a new robin EEU layer that had only one value for each grid cell based on the maximum value found within the 100-ft by 100-ft grid cell, and would overestimate robin use of a grid cell with multiple cover types.

The robin EEU layer was used to generate data tables needed for ECORSK.6 and to produce maps. The ECORSK.6 model also requires the home range of the robin, which was calculated as 12.6 ha (0.1259 km^2) or approximately 136 grid cells. ECORSK.6 calculates home range based on body weight following allometric relationships developed by Peters (1993).

2.3.1.2.2.4 Development of the Deer Mouse EEU

Density for deer mouse was calculated by land cover and topography (mesa top or canyon bottom). To develop the deer mouse EEU spatial layer, we first intersected (using ARC/INFO INTERSECT command) the land cover layer with the canyon-mesa top layer to produce a composite layer with land cover attributes and canyon and mesa top attributes. We coded this new layer with the relative importance values derived from the average density information. These values are listed in Table 2-6.

Table 2-6. Relative Importance Values of Deer Mouse Based on Land Cover Type and Topography

Land Type[1]	Average Density	Assigned Values
Wetlands/Riparian/Water	3.4	100
Piñon-Juniper–Mesas	4.0	120
Piñon-Juniper–Canyon	6.0	180
Bare Ground Areas	4.0	120
Deciduous/Aspen/Oak	6.0	180
Ponderosa Pine Canyons	6.0	180
Ponderosa Pine Mesa	42.0	1240
Grasslands	9.0	260
Juniper Woodlands	9.0	260
Mixed Conifer	11.0	320
Disturbed Areas	16.0	470

[1]If canyons or mesas are not specified then there was no difference found.

The new land cover/topography layer coded with the importance values of deer mouse was intersected (using ARC/INFO INTERSECT command) with the site EEU layer. The resulting layer was comprised of the site EEU attributes (row, column, x-coordinate, and y-coordinate) as well as the deer mouse importance values from the coded land cover/topography layer. This new deer mouse EEU layer had numerous small polygons with importance values within each 100-ft by 100-ft grid cell. To reduce these values down to one value for each grid cell, the ARC/INFO command DISSOLVE was used with the maximum value option. This resulted in a new deer mouse EEU layer that had only one value for each grid cell based on the maximum value found within the 100-ft by 100-ft grid cell and would overestimate deer mouse use of a grid cell with multiple cover types.

The deer mouse EEU layer was used to generate data tables needed for ECORSK.6 and to produce maps. The ECORSK.6 model also requires the home range of the deer mouse, which was calculated as 0.064 ha or approximately 0.7 grid cells. ECORSK.6 calculates home range based on body weight following allometric relationships developed by Peters (1993). Because the home range for the deer mouse is less than one grid in areal extent and data are only resolved to grid cell scale, the modeled exposure for the deer mouse will be based on COPCs within a single grid cell. Because higher or lower concentrations could exist in the approximately 70% of the cell equal to the mouse home range, exposure to the deer mouse could be over- or under-estimated.

2.3.2 Comprehensive Integrated Contaminant Database

2.3.2.1 SWEIS Database

The base data set that we used was the raw soil and sediment data used to compile contaminant data tables in Appendix C of the SWEIS (DOE 1999). The raw data set was constructed from databases maintained as part of LANL's Environmental Surveillance Program and Environmental Restoration Project. Sediment data consisted of environmental surveillance and compliance program data from the years 1991 through 1996, found in the LANL Environmental Surveillance Reports (e.g., *Environmental Surveillance at Los Alamos During 1995*). Soils data consisted of Environmental Restoration Project data queried in 1998 from

LANL's Facility for Information Management, Analysis, and Display (FIMAD). These data were queried using the following criteria and then underwent an assessment of quality:

Original Query Criteria:

- included soil and sediment data
- included all soil horizons of depth 0 - 6"
- query by sample_ID (identification)
- suite (inorganic, organic, rad)
- excluded samples collected via toxicity characteristic leaching procedure (TCLP) and x-ray flourescence (XRF)
- excluded Radvan and Chemvan data
- marked as nondetect ("ND") if value was <3 × sigma (three standard deviations).

To the base set of data described above was added measured canyons data and interpolated data for Los Alamos Canyon, both described below.

2.3.2.2 Canyons Database

The canyons COPC database was obtained from information published in four reports on sediments in the Los Alamos and Pueblo Canyons watershed and consists of the results of sampling in canyons (Katzman et al. 1999, Reneau et al. 1998a). These reports describe the results of phased, geomorphic investigations of post-1943 sediment deposits in sections of canyon bottom sediments called "reaches." The reaches were located based on information on COPC sources, available historic sediment data, and the conceptual model of COPC redistribution. These investigations used geomorphic surveys, radiation field screening measurements, and analytical laboratory data to refine the conceptual model and provide information on the nature and extent of COPCs in canyon-bottom sediment deposits. The canyons database consisted of 777 samples, which included samples collected from 13 reaches. Concentrations of COPCs in canyons are from Appendix D of the reach reports. These data were assessed in a formal quantitative data review process that included baseline data validation, focussed data validation, and statistical analyses. The result of this process was to eliminate suspect values based on laboratory validation reports and review of laboratory data packages. The detection limit was used for samples where an analyte was not detected. In some cases, radionuclide sample results were not censored at the detection limit and the canyons database included those uncensored radionuclide results. For grid cells that were not sampled, estimated interpolated values were used as described in Section 2.3.2.3. A total of 84 analytes were included in the database.

2.3.2.3. Interpolation of Analyte Values in Los Alamos Canyon

We interpolated analyte concentrations in Los Alamos Canyon surface sediments to investigate how spatial trends in COPC distributions affect risk indices. Concentrations of analytes were interpolated (predicted) from points at which they were measured to points along a canyon reach at which they were not measured but known to exist based on logic. Our interpolation data set was collected by the Environmental Restoration Project and was discussed in Section 2.3.2.2. These data were collected with detailed geomorphic unit descriptions to enable precise characterization of COPC distributions. Our analysis required predicted analyte concentrations in areas where detailed geomorphic unit information was not available, so other information was used to reduce uncertainty of the interpolated values.

Preliminary examination of analyte concentrations in canyon sediments indicated that spatial trends may exist in the data. For a single source and down-gradient attenuation of a marker substance in canyon sediments, a useful interpolation model is $\log(concentration) = \alpha + \beta \cdot \log(x)$, where x is distance from the source and α and β are estimated from site-specific data. For Los Alamos Canyon we substituted distance (meters) from the Rio Grande along the Los Alamos Canyon active channel. The trends appeared to be increasing in certain cases where sources apparently increase loading of analytes along the canyon reach. In other cases, the trend was for decreasing concentrations. One factor affecting analyte concentrations is the input of sediments from an adjacent sub-watershed, such as when DP Canyon empties into Los Alamos Canyon. To account for the effect of DP Canyon sediments on downstream concentrations of Los Alamos Canyon sediments, a piece-wise interpolation model was used:

$$\log(concentration) = \begin{cases} \alpha 1_i + \beta 1_i \cdot \log(meters), \text{ if upstream of DP Canyon, and} \\ \alpha 2_i + \beta 2_i \cdot \log(meters), \text{ if downstream of DP Canyon.} \end{cases}$$

This interpolation model allows mean values and trends to be different above and below the confluence of DP and Los Alamos Canyons. When β values are close to 1.0, there is no trend with respect to distance along the stream channel.

Sediment texture is another factor affecting concentrations of analytes. Auxiliary texture information in the Environmental Restoration Project canyons data set was used to help predict analyte concentrations as an additive effect on $\alpha 1_i$ and $\alpha 2_i$, because coarse channel sediments tended to have lower concentrations than finer floodplain sediments. We assumed that 10% of the cell was composed of coarse sediments and 90% was fine sediments, and a weighted mean was calculated from the interpolated channel and floodplain sediments. The weighted mean was then back-transformed to populate the concentration grid used in the analysis.

2.3.2.4 Integration

The three data sets (SWEIS database, canyons database, and interpolations database) were integrated into one database forming species-specific input files that are named using the naming convention example of 'eeuelk.dat.' Collectively, this ecological risk assessment database is very comprehensive. The file 'eeuelk.dat,' for example, consists of approximately 48,000 records. Each species-specific file serves as 'eeuinp.dat' input files to ECORSK.6 as discussed in the sections below.

2.3.3 ECORSK.6

Version 6 of the ecorisk software (ECORSK.6) is the FORTRAN 90 version of ECORSK.5 that has been documented elsewhere (Gallegos and Gonzales 1999). With sufficient RAM memory it can be run in the WINDOWS 95/98 environment using the current version of the RNDBOS software supplied by the FTN90 Salford Compiler. Under development is the Salford FTN95 version, which can be executed in the WINDOWS 95/95/NT environment without any additional software requirements.

2.3.3.1 Operations Summary

The operation of ECORSK.6 is identical to the operation of ECORSK.5 with one exception. The previous version was executed exclusively with avian species nest sites that were randomly or non-randomly selected from established habitats for these species (Gonzales et al. 1998a, b, and c; 1997; and Gallegos et al. 1997a and b). The habitat was assumed to be uniform in quality throughout its range. A modification of this strategy now incorporated into ECORSK.6 is the establishment of habitats for all types of species on the basis of graded foraging evaluation. A weighting scheme in the latter version (ECORSK.6) uses this information to determine the fraction of nest sites/focal points that originate from each habitat grade for determination of a cumulative hazard index (HI). The mathematical representation for this strategy will be discussed in another section of this report (3.3.3).

A summary of the operations of ECORSK.6 is shown in Figure 2-2. ECORSK.6 integrates several different kinds of GIS information, the integrated contaminant database, and animal toxicological information.

2.3.3.2 ECORSK.5 to ECORSK.6 Input File Database Development

Input file development for both ECORSK.5 (Gallegos and Gonzales 1999) and ECORSK.6 is identical. The files consist of MAPCDE.DAT, EEUINP.DAT, and INRSK.DAT, which have been described previously for various applications as well as in the documentation of the program. However, input into MAPCDE.DAT now includes habitat quality information for use in the weighting scheme discussed in the previous section.

EEUINP.DAT is the largest input file. For each grid cell in the EEU, it contains a count of the number of "hits" on which each COPC concentration is based, the mean COPC concentration for a grid cell for a particular COPC, background values, the grid cell "x" and "y" coordinates, TRVs, a TRV adjustment factor, an occupancy factor, the area of the grid cell, bioconcentration factors (BCFs), the row and column ID, and the analyte. An example of EEUINP.DAT is provided as Appendix Table A-2, which is discussed in Section 4.1.3. For the basic definition of and differences between bioaccumulation, biomagnification, and bioconcentration, please see the discussion in Section 3.3.4.

2.3.4 Scenario/Parameter Selection, Variation, and Sensitivity Analyses

Previous ecorisk assessments on T&E species have determined that TRVs and BCFs have the greatest impact on risk indices. With TRVs, it is the number of COPCs for which TRVs exist as well as the particular TRV value chosen or derived for each COPC that can impact modeled HIs or hazard quotients (HQs). Secondly, the number of COPCs for which BCFs exist or are chosen as well as the particular bioaccumulation value chosen or derived for each COPC can substantially impact HIs. In this study, three parameters were varied for purposes of determining the effect on HIs. The parameters varied were the number and level (value) of TRVs, BCF values, and the number of nest sites (robin and deer mouse) or focal points (elk).

For the TRV sensitivity analysis, the use of critical study (CS) TRVs (defined in Section 2.3.4.1.1) was compared to the use of geometric mean (GMM) TRVs, both of which are described below. In the course of making this comparison, the opportunity arose to also quantify the effects of the number of TRVs used; i.e., there were 141 possible CS TRVs compared to 238

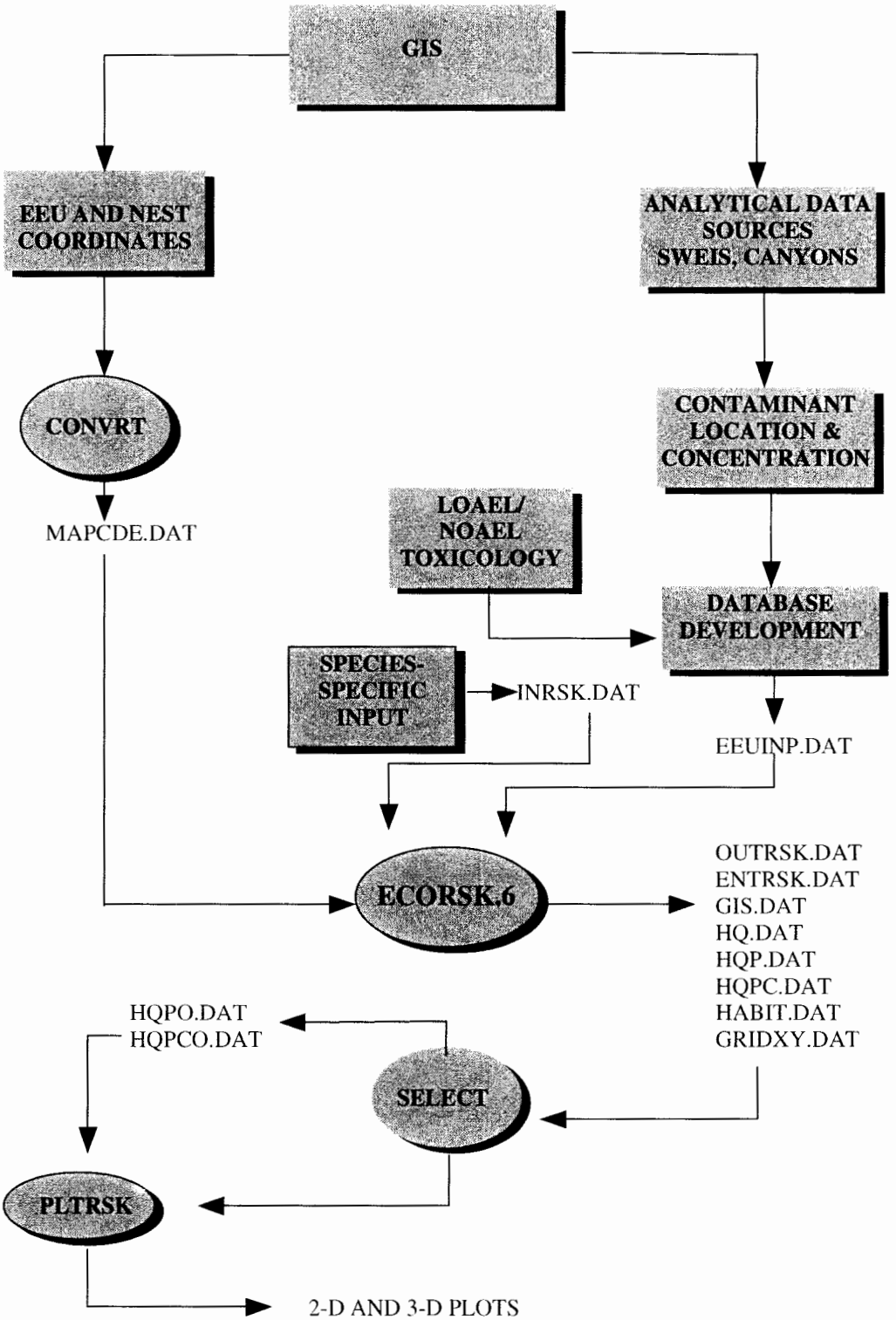

Figure 2-2. Schematic of strategy for integrating FORTRAN code with GIS and analytical data.

possible GMM TRVs for the deer mouse and elk. For the BCF sensitivity analysis, the use of "conservative" (relatively high) BCFs was contrasted to the use of "realistic" or site-specific BCFs. Section 3.3.4 describes the method used to derive BCFs and lists the two different sets of BCFs used. Lastly, three different numbers of nest sites (robin, deer mouse) or focal areas (elk) were contrasted: 100, 200, and 500.

The previous version of ECORSK, ECORSK.5, had the ability to weight simulated foraging on the basis of distance from nest sites or other focal points of an animal's home range, scale the dimensions (height and width) of an animal's home range, and to angle the orientation of an animals home range (see Gallegos and Gonzales 1999 for the documentation of ECORSK.5). To further improve the realism of the risk assessment approach, ECORSK.6 was coded to enable weighting the simulated foraging process as based on the distribution of prey or forage of modeled receptors. In our application, receptor distribution across the EEU and density by land cover type was assumed to correlate with prey or forage distribution. As discussed in Section 2.3.3, this constitutes the greatest change from ECORSK.5 to ECORSK.6.

Previous ecorisk assessments have been limited largely by the availability of COPC data that are both spatially comprehensive and representative of ecological exposure. Much sampling of Laboratory soil and sediment have been biased to locations where COPCs are expected. In canyon bottoms, where water-related dispersion of COPCs has occurred, the primary need has been to evaluate historical transport, estimate current risks to human health and the environment, and determine the potential for future COPC transport. The approach to sampling sediments in canyons has been to characterize COPC concentrations in representative reaches based on an initial conceptual model. The conceptual model for these canyons investigations is updated based on sampling and analysis results. These canyons investigations are ongoing and this report only uses published data from the Los Alamos Canyon. As data for other canyons have become available, we have added measured and interpolated values to the data base for future executions of ECORSK.

2.3.4.1 Toxicity Reference Value (TRV) Selection

The following sections describe the selection process for both nonradionuclide and radionuclide TRVs for avian and mammalian ecological screening receptors evaluated with the ECORSK model. In the following sections, a TRV is a dose rate (mg/kg/d) for nonradionuclides or concentration in an exposure medium for radionuclides (e.g., pCi/g soil). A TRV is a threshold above which adverse effects on the exposed organism could occur.

2.3.4.1.1 Nonradionuclide TRV Selection

This section describes the selection processes for two types of TRVs for nonradionuclide chemicals for ECORSK ecological receptors (elk, deer mouse, and robin): the CS TRV and the GMM TRV. In the case of the ECORSK model, both types of TRVs are equivalent to a chronic no-observed adverse effects level (NOAEL) for an ecologically relevant effect (reproduction/development, growth, or survival). The selection process for a CS TRV involves a detailed evaluation of the available primary toxicity literature (Section 2.3.4.1.1.1, Primary Toxicity Data) to be able to select the most appropriate CS toxicity value (e.g., NOAEL, lowest observed adverse effects level [LOAEL]) to base the TRV on. The Laboratory Environmental Restoration Ecorisk team developed this literature review process (LANL 1999; 2000a and b). If the primary literature has not been reviewed, toxicity data from secondary sources are evaluated

with a set of criteria (Section 2.3.4.1.1.1, Secondary Toxicity Data) that also allows the selection of the most appropriate CS toxicity value on which to base the TRV.

The selection process for each GMM TRV involves selecting an appropriate set of TRVs from primary and secondary data sources to calculate a GMM of those values. Selecting an appropriate set of TRVs involves coding toxicity values available from each data source. The coding limits the data set to ecologically relevant toxicity values that are appropriate for deriving a GMM TRV.

This section also includes a table of uncertainty factors (UFs) applied to both CS and GMM TRVs that are used to extrapolate less appropriate data to a chronic NOAEL. Finally, this section concludes with a description of a confidence rating that is to be developed for both CS and GMM TRVs that will be based on the type of data used for each TRV.

2.3.4.1.1.1 Critical Study (CS) TRV Derivation

A CS TRV is selected based on an evaluation of the toxicity study from which the primary toxicity value is derived followed by the selection of the most appropriate effect/effect level to be used to derive the TRV for a particular chemical/organism class (i.e., bird or mammal) combination. The CS TRV value is selected based on professional judgement supported by primary and secondary toxicity data.

Primary Toxicity Data

Information from the primary reference was retrieved and evaluated with the following criteria:

Study Design and Documentation

- Control is used.
- Multiple exposure groups are used.
- Test organism name, source/origin, sex, and age/lifestage information are all reported.
- All test organism exposure parameters (i.e., body weight and ingestion rate or body weight normalized ingestion rate) are reported.
- Exposure concentration is measured on a dry weight basis. If concentrations are not reported as so, nominal and/or wet weight concentrations are accepted, but noted as so.
- Statistical test and confidence level are reported.

Test Organism

Taxonomic relationship to ecological screening receptor must be at least at the class level. Information is available on why the particular test species was chosen.

Exposure Conditions

- Test environment is controlled.
- Test exposure medium is at least similar if not equivalent to the exposure medium of concern (e.g., both food).
- Multiple chemical interactions are absent.
- Test exposure route is at least similar to if not equivalent to the exposure route of concern (e.g., both oral).

- Exposure duration is chronic or during a critical lifestage. Other exposure durations (e.g., subchronic, acute, single dose) are accepted, but noted as so.
- Exposure frequency is frequent or continuous. Other frequencies are accepted, but noted as so (e.g., single dose).

Measurements and Results

The effect measured is ecologically relevant (e.g., a reproductive/developmental, growth, or survival effect vs a biochemical effect such as cholesterol in blood). Other effects are noted, but not considered further in TRV development unless data are very limited.

The effect measured is for entire exposure period. Other effect measurement periods are accepted, but noted as so.

Effect level reported (e.g., NOAEL, LOAEL, lethal dose [LD] 50, etc.).

Secondary Toxicity Data

When the primary reference was not evaluated, toxicity data from secondary sources are evaluated as to how well the following criteria are met:

The test species is in the same taxonomic class as the screening receptor.

The focus measurement is an ecologically relevant effect (reproduction, development, growth, or survival). Other effects are accepted if data are limited.

The effect level (endpoint) is a NOAEL. Other effect levels are accepted, but noted as so.

The exposure duration is chronic or during a critical lifestage. Other exposure durations are accepted, but noted as so.

The exposure route is oral. Injection exposures are considered if data are limited. Inhalation and dermal exposures are never accepted.

If the primary toxicity value selected to derive the CS TRV is not a chronic or chronic-critical lifestage NOAEL, appropriate UFs (see Table 2-7) are applied to the value to extrapolate to a chronic NOAEL. Appendix B contains a complete list of bird and mammal CS TRVs used in the ECORSK.6 model assessments.

2.3.4.1.1.2 Geometric Mean (GMM) TRV Derivation

The purpose of deriving the GMM TRV was to provide a more realistic TRV than the CS TRV because it incorporates multiple TRVs for ecologically relevant effects. (See Appendix B for a complete listing of bird and mammal GMM TRVs.) A similar statistical approach is being used by USEPA to develop the Eco-SSLs (USEPA 2000).

A GMM TRV is derived using the same toxicity data set used for the CS TRV selection. However, the GMM TRV is based upon the GMM of two or more ecologically relevant TRVs for each chemical (or any study that can yield a NOAEL value with application of appropriate UF values). GMM TRVs are derived as follows. As described in Appendix C, the toxicity data are coded for age of test organism, exposure medium (Table C-2), route and duration of exposure (Tables C-3 and C-5), and for effect category and level (Tables C-4 and C-6). The coding identifies ecologically relevant, toxicity values and their exposure duration and associated effect level(s). To remain in the GMM TRV data set, the values must meet these minimum criteria:

- The test species is in the same taxonomic class as the screening receptor.
- The focus measurement is an ecologically relevant effect (reproduction, development, growth, or survival). Data are excluded if the focus measurement is not reported.
- The exposure route is oral. Data are excluded if the exposure route is not reported.
- Exposure duration is reported. Data are otherwise excluded.
- The primary toxicity value is unique and originates from the most preferred secondary data source. (In other words, a single toxicity value is selected from a set of toxicity values that are obtained from the same primary reference for equivalent effects, but were derived by different authors. When this cannot be discerned, the value was left in the data set.). Preferred secondary data sources follow the hierarchy of LANL Environmental Restoration > Oak Ridge National Laboratory > Sandia National Laboratories > USEPA R4 > Other. Data are excluded if the primary or secondary references cannot be identified.
- The effect level is reported. If more than one effect level is reported for a specific effect, the NOAEL of the primary reference is used, followed by the LOAEL, then any other effect level. Records in which effect levels were not reported were omitted from the data set.
- Finally, if an ecologically relevant toxicity value is not a chronic or chronic critical lifestage NOAEL (it is a subchronic NOAEL, chronic LOAEL, or some other combination), appropriate UFs are applied to the value to extrapolate it to a chronic NOAEL. UFs were applied according to the UF assignment scheme in Table 2-7.

Table 2-7. Uncertainty Factors (UFs)*

Exposure Duration	Effect Level	UF
Acute	LOAEL	100
Acute	NOAEL	100
Acute	Other	100
Chronic	LOAEL	10
Chronic	NOAEL	1
Chronic	Other	100
Chronic- Critical Lifestage	LOAEL	10
Chronic- Critical Lifestage	NOAEL	1
Subchronic	LOAEL	100
Subchronic	NOAEL	10
Subchronic	Other	100

*Based on Dourson and Stara (1983), McNamara (1976), McCollister (1963) cited in USEPA (1997) and choosing a maximum limit of 100 for a UF.

For many chemicals, there is only a single study, and thus only a single no-effect level can be estimated. If there are two or more Primary Toxicity Values (PTVs) for a chemical, then the GMM of these values was calculated. The GMM is used as a simple estimate of the central tendency of the observed PTVs. The GMM is always less than the arithmetic mean, and thus represents a lower estimate of the no-effect dose. Because the no-effect dose or TRV is in the denominator of the HQ calculation, lower estimates of the TRV will potentially overestimate the HQ. Thus, use of the GMM is a defensible, lower bound estimate of the central tendency of a skewed distribution. The GMMs of the PTVs were calculated by using the simple estimator of

the sample GMM[3] (Gilbert 1987, p. 172). This simple estimator of the GMM is known to be negatively biased, and sample GMM is thus less than an unbiased estimator (Gilbert 1987, p. 172). Thus, using the simple estimate of the GMM will also potentially overestimate the HQ.

The statistical approach to developing the no-effect dose level for avian receptors is compared with the CS TRV in Figures 2-3 and 2-4 and the data are summarized in Tables 2-8 and 2-9. In the majority of cases, the GMM TRV is less than the avian CS TRV, which suggests that the GMM predicts that lessor amount of a chemical represents a potentially toxic dose compared to the CS value. [Note that the CS TRVs for these comparisons are from the ECORISK database, September 2000 version, LANL 1998–2000.] For toxicity values of inorganic chemicals (with more than one study) to avian receptors, only the barium GMM TRV is greater than the CS TRV, and the other 12 inorganic chemicals have CS TRVs greater than the GMM TRVs (see Table 2-8 and Figure 2-3). For toxicity values of organic chemicals to avian receptors the 17 chemicals with more than one PTV are split about equally between cases where the GMM is less the CS TRV (7 chemicals) and where the GMM is larger than the CS TRV (8 chemicals) (see Table 2-9 and Figure 2-4). All of the avian CS TRVs are included in the range of values used to calculate the GMM, although toxicity data were added to calculate GMMs for 29 additional organic chemicals beyond those included in the ECORISK database.

The statistical approach to developing the no-effect dose level for mammalian receptors is compared with the CS TRV in Figures 2-5 through 2-7 and the data are summarized in Tables 2-10 and 2-11. In the majority of cases, the GMM TRV is greater than the mammalian CS TRV, which suggests that the GMM predicts that greater amount of a chemical represents a potentially toxic dose compared to the CS value. [Note that the CS TRVs for these comparisons are from the ECORISK Database, September 2000 version, LANL 1998–2000.] For toxicity values of inorganic chemicals to mammalian receptors with more than a single study, 10 GMM PTVs are greater than the CS TRV and 14 inorganic chemicals have CS TRVs greater than the GMM TRVs (see Table 2-10 and Figure 2-5). For toxicity values of organic chemicals to mammalian receptors, roughly three times as many chemicals (31 greater versus 12 less than the CS TRV) have GMMs that are greater than the CS value (see Table 2-11 and Figures 2-6, 2-7). Some of the mammalian CS values were excluded from the calculation of GMM values, typically because effects were classified as "other" or the measurement endpoint was not recorded. Thus, the range of PTVs does not overlap the CS TRV for nine chemicals (see Figures 2-5 to 2-7). There were also 103 chemicals (one inorganic and 102 organics) that were added to the ECORISK database to calculate GMM TRVs.

Figures 2-3 through 2-7 are useful to visualize the amount of variability in the no-effect levels across chemicals. The range of no-effect doses (minimum to maximum) vary from less than an order of magnitude to seven orders of magnitude, and variability of one to two orders of magnitude is common. This variability is not surprising given that no-effect levels are difficult to ascertain and are more subject to specifics of the study design (like the number of treatments and the concentrations of treatments). A better approach would be to develop a dose-response curve for the receptor-chemical combination, but, unfortunately, such data do not exist for most chemicals.

[3] The simple estimate of the sample GMM is calculated by exponentiating the average of the natural logarithms.

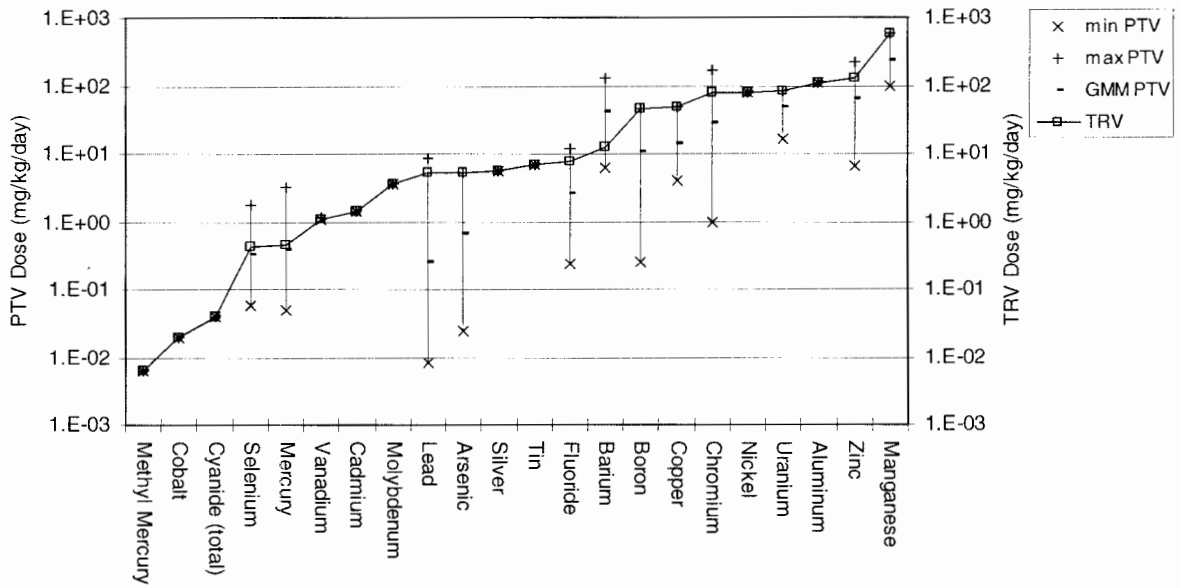

Figure 2-3. Plots of avian PTV statistics (minimum, GMM, maximum) and TRVs for inorganic chemicals. [Note that chemicals are ordered from lowest to highest TRV.]

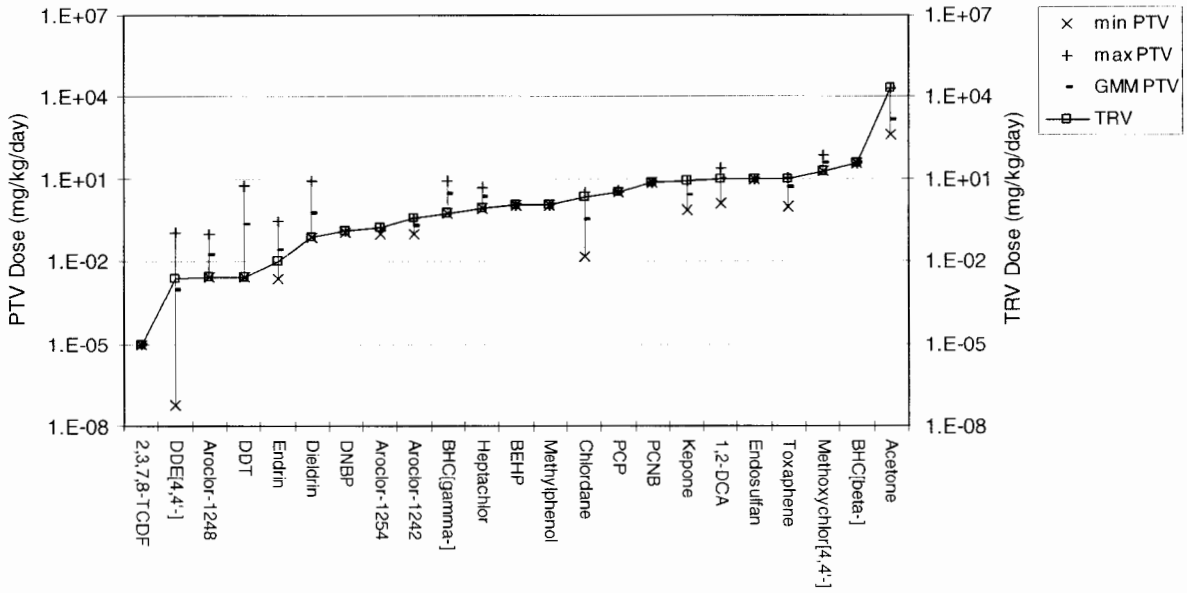

Figure 2-4. Plots of avian PTV statistics (minimum, GMM, maximum) and TRVs for organic chemicals. [Note that chemicals are ordered from lowest to highest TRV.]

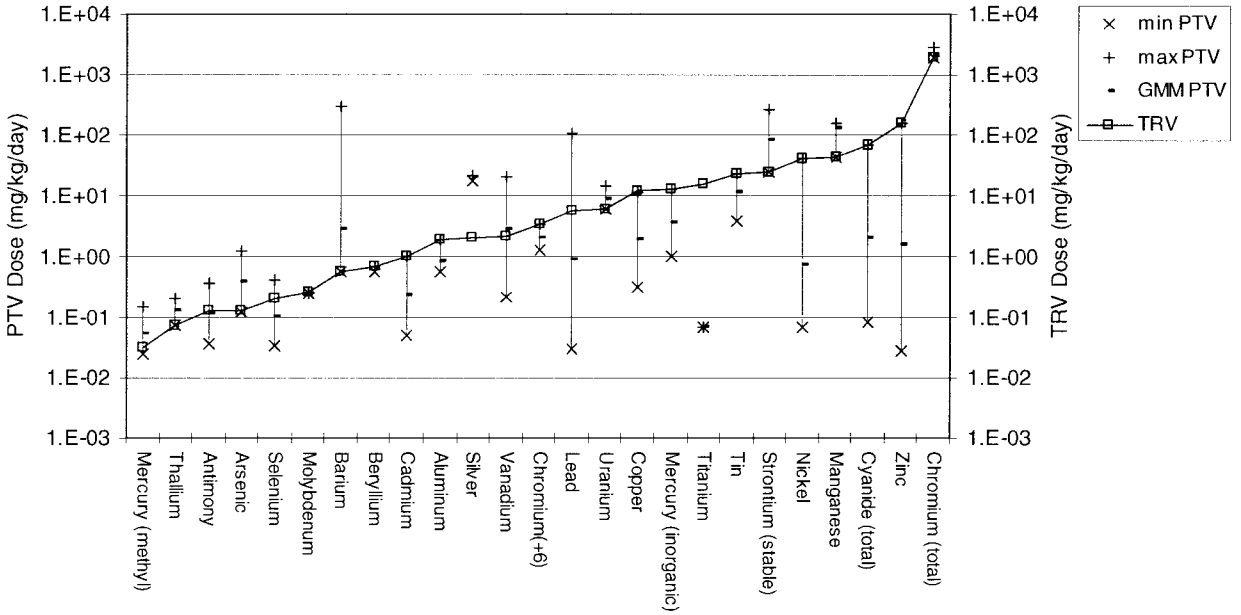

Figure 2-5. Plots of mammalian PTV statistics (minimum, GMM, maximum) and TRVs for inorganic chemicals. [Note that chemicals are ordered from lowest to highest TRV.]

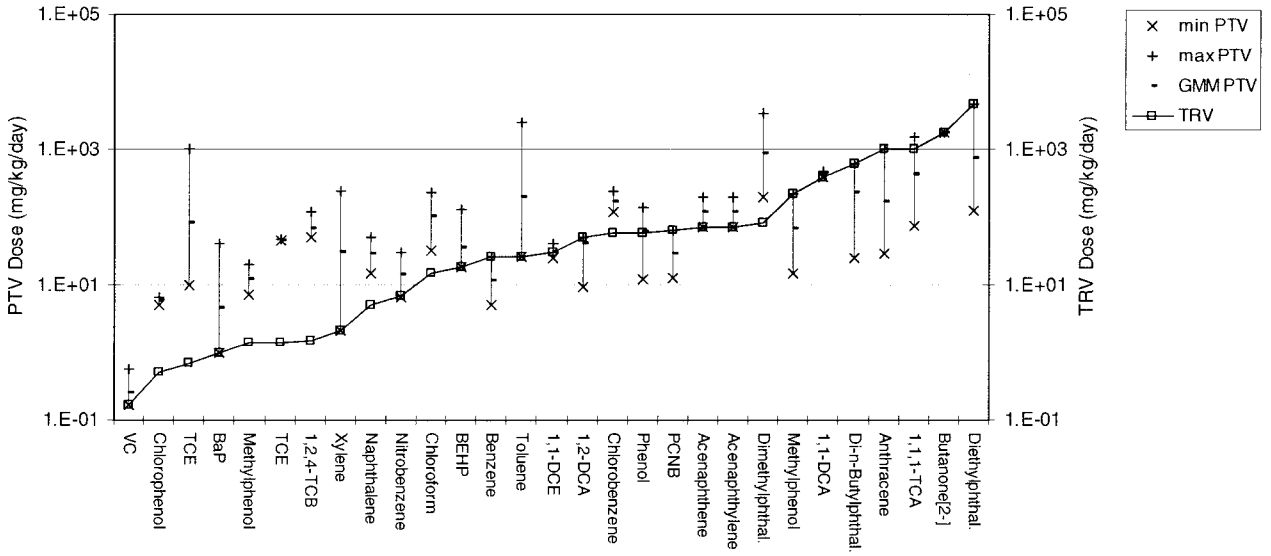

Figure 2-6. Plots of mammalian PTV statistics (minimum, GMM, maximum) and TRVs for organic chemicals (SVOCs and VOCs). [Note that chemicals are ordered from lowest to highest TRV.]

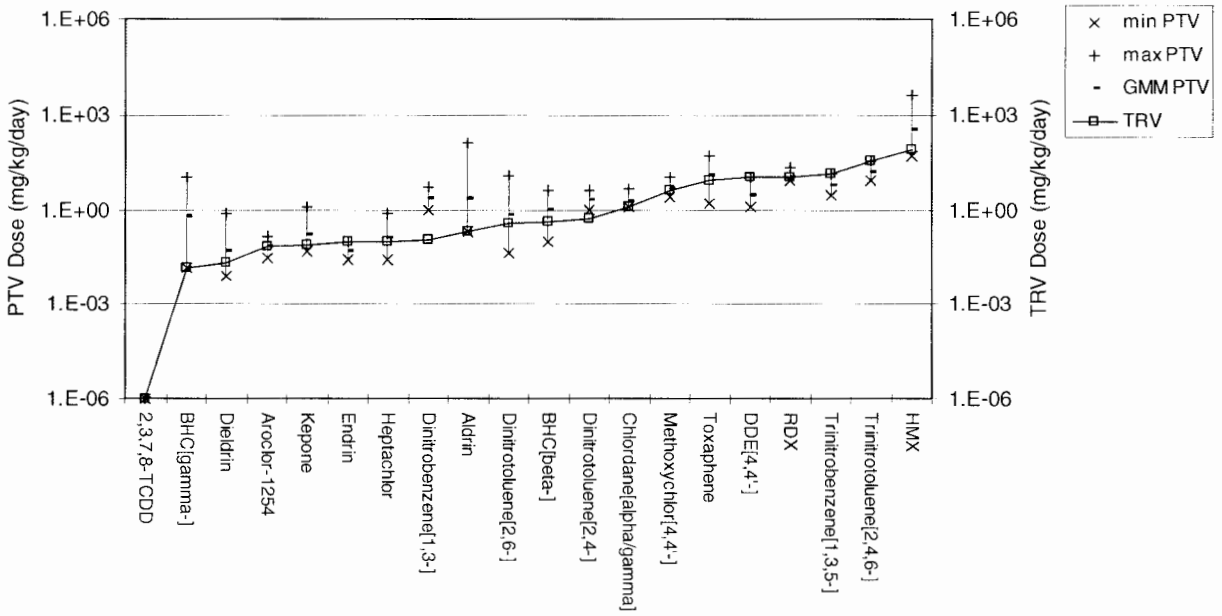

Figure 2-7. Plots of avian PTV statistics (minimum, GMM, maximum) and TRVs for organic chemicals (dioxins/furans, pesticides, PCBs, and high explosives). [Note that chemicals are ordered from lowest to highest TRV.]

Table 2-8. Summary of Avian PTV Statistics for Inorganic Chemicals

Analyte Name	PTV with UF Adjustment				TRV	GMM PTV/TRV
	Count	Minimum	Maximum	GMM PTV		
Aluminum	1	109.7	109.7	n/a	110	n/a
Arsenic	3	0.025	5.14	0.68	5.1	0.1
Barium	3	6.23	125.9	39.8	12.6	3.2
Boron	4	0.25	46	10.6	46.3	0.2
Cadmium	1	1.45	1.45	n/a	1.45	n/a
Chromium	7	1	165	28.7	77	0.4
Cobalt	1	0.02	0.02	n/a	0.02	n/a
Copper	2	4.05	47	13.8	47	0.3
Cyanide (total)	1	0.04	0.04	n/a	0.04	n/a
Fluoride	11	0.24	12	2.6	7.8	0.3
Lead	9	0.0083	8.3	0.25	5.1	0.05
Manganese	2	97.7	575	237	575	0.4
Mercury	4	0.05	3.2	0.38	0.45	0.9
Methyl Mercury	1	0.0064	0.0064	n/a	0.0064	n/a
Molybdenum	1	3.5	3.5	n/a	3.5	n/a
Nickel	1	77.4	77.4	n/a	77.4	n/a
Selenium	6	0.057	1.8	0.33	0.44	0.7
Silver	2	5.44	5.44	5.44	5.44	1.0
Tin	1	6.8	6.8	n/a	6.8	n/a
Uranium	3	16	83	47.9	83	0.6
Vanadium	3	1.1	1.14	1.11	1.1	1.0
Zinc	13	6.6	214.4	63.9	129	0.5

n/a = not applicable.

Table 2-9. Summary of Avian PTV Statistics for Organic Chemicals

Analyte Name	PTV with UF Adjustment				TRV	GMM PTV/TRV
	Count	Minimum	Maximum	GMM PTV		
Acrolein	2	0.033	0.0911	0.055	n/a	n/a
Aramite	1	5.31	5.31	n/a	n/a	n/a
D[2,4-]	3	4.72	10.01	6.8	n/a	n/a
DDD[4,4'-]	3	4.45	48.14	16.7	n/a	n/a
Diallate	2	2.9	5	3.8	n/a	n/a
Dibromo-3-chloropropane[1,2-]	2	0.668	1.56	1.02	n/a	n/a
Dibromoethane[1,2-]	1	32	32	n/a	n/a	n/a
Dichloroethane[1,2-]	4	1.33	26.5	9.5	9.3	1.0
Dimethoate	3	0.2	0.42	0.31	n/a	n/a
Dinoseb	3	0.264	0.305	0.28	n/a	n/a
Disulfoton	3	0.00211	0.333	0.036	n/a	n/a
Endosulfan I	2	0.596	1.355	0.90	n/a	n/a
Endosulfan II	2	0.596	1.355	0.90	n/a	n/a
Ethyl Parathion	3	0.00125	1.06	0.030	n/a	n/a
Famphur	3	0.00572	0.068	0.019	n/a	n/a
Hexachlorobenzene	1	2	2	n/a	n/a	n/a
Hexachlorobutadiene	1	3.187	3.187	n/a	n/a	n/a
Hexachlorophene	2	5.75	14.5	9.1	n/a	n/a
Hexanone[2-]	1	200	200	n/a	n/a	n/a
Isodrin	3	0.0659	0.292	0.15	n/a	n/a
Methyl Parathion	3	0.46	6.82	1.5	n/a	n/a
Methyl-2-pentanone[4-]	1	1	1	n/a	n/a	n/a
Nitroaniline[2-]	3	7.5	10	8.3	n/a	n/a
Nitroaniline[3-]	1	5.62	5.62	n/a	n/a	n/a
Phorate	2	0.1403	0.2125	0.17	n/a	n/a
Polychlorinated Dibenzofurans	1	1E-05	1E-05	n/a	n/a	n/a
T[2,4,5-]	1	10	10	n/a	n/a	n/a
Tetrachlorodibenzofuran[2,3,7,8-]	1	1E-05	1E-05	n/a	1E-05	n/a
Thionazine	3	0.025	0.24	0.07	n/a	n/a
Aroclor-1242	2	0.1	0.41	0.20	0.41	0.5
Aroclor-1248	2	0.00272	0.1	0.016	0.00272	6.1
Aroclor-1254	2	0.1	0.18	0.13	0.18	0.7
Polychlorinated Biphenyls	3	0.122	12.34	0.57	n/a	n/a
Aldrin	3	0.0659	0.292	0.15	n/a	n/a
BHC[beta-]	1	38.3	38.3	n/a	38.3	n/a
BHC[gamma-]	5	0.56	8.82	3.0	0.56	5.3
Chlordane[alpha/gamma]	4	0.015	3.31	0.32	2.1	0.2
DDE[4,4'-]	3	5.37E-08	0.115	0.00087	0.00224	0.4
DDT	3	0.0028	5.68	0.23	0.0028	83.4
Dieldrin	4	0.077	8.84	0.54	0.077	7.0
Endosulfan	1	10	10	n/a	10	n/a
Endrin	5	0.0025	0.3	0.027	0.01	2.7
Heptachlor	3	0.92	4.8	2.1	0.92	2.3
Kepone	2	0.7968	8.499	2.6	8.499	0.3
Methoxychlor[4,4'-]	2	20.01	72	38.0	20	1.9
Toxaphene	3	1	10.6	4.7	10	0.5
Bis(2-ethylhexyl)phthalate	1	1.1	1.1	n/a	1.1	n/a
Chloro-3-methylphenol[4-]	1	1.13	1.13	n/a	1.13	n/a
Di-n-Butyl Phthalate	2	0.11	0.14	0.1	0.14	0.9
Pentachloronitrobenzene	1	7.07	7.07	n/a	7.1	n/a
Pentachlorophenol	2	3.29	3.8	3.5	3.29	1.1
Acetone	3	400	19900	1471	19900	0.1

n/a = not applicable.

Table 2-10. Summary of Mammalian PTV Statistics for Inorganic Chemicals

Analyte Name	PTV with UF Adjustment				TRV	GMM PTV/TRV
	Count	Minimum	Maximum	GMM PTV		
Aluminum	3	0.55	1.93	0.84	1.93	0.4
Antimony	5	0.035	0.35	0.11	0.13	0.9
Arsenic	2	0.125	1.25	0.40	0.13	3.0
Barium	9	0.55	300	2.70	0.55	4.9
Beryllium	3	0.55	0.66	0.58	0.66	0.9
Boron	1	28	28	n/a	28	n/a
Cadmium	4	0.05	1	0.24	1	0.2
Chromium (total)	6	1924	2737	2062	1900	1.1
Chromium(+6)	2	1.31	3.28	2.07	3.3	0.6
Copper	2	0.32	11.7	1.93	12	0.2
Cyanide (total)	4	0.08	68.7	2.05	69	0.0
Fluoride	1	27	27	n/a	26.6	n/a
Lead	12	0.029	106.2	0.89	5.8	0.2
Lithium	1	9.4	9.4	n/a	9.4	n/a
Manganese	6	44	158	128	44	2.9
Mercury (inorganic)	2	1	13.2	3.63	13	0.3
Mercury (methyl)	4	0.024	0.15	0.053	0.032	1.7
Molybdenum	2	0.25	0.25	0.25	0.26	1.0
Nickel	5	0.066	40	0.74	40	0.0
Niobium	1	0.155	0.155	n/a	0.16	n/a
Nitrate (expressed as NO3)	1	507	507	n/a	500	n/a
Selenium	6	0.034	0.42	0.10	0.2	0.5
Silver	2	18.12	22.22	20.1	2	10.0
Strontium (stable)	2	24.6	263	80.4	25	3.2
Sulfide (total)	1	3.1	3.1	n/a	n/a	n/a
Thallium	3	0.071	0.2	0.13	0.071	1.8
Tin	4	3.75	23.4	11.4	23	0.5
Titanium	2	0.066	0.066	0.066	15.8	0.0
Uranium	7	6.1	15	8.97	6.1	1.5
Vanadium	22	0.21	20	2.86	2.1	1.4
Zinc	5	0.0275	160	1.54	160	0.01
Zirconium	1	1.74	1.74	n/a	1.7	n/a

n/a = not applicable.

Table 2-11. Summary of Mammalian PTV Statistics for Organic Chemicals

Analyte Name	PTV with UF Adjustment				TRV	GMM PTV/TRV
	Count	Minimum	Maximum	GMM PTV		
Tetrachlorodibenzodioxin[2,3,7,8-]	2	1E-6	1E-6	1E-6	1E-6	1.0
Pentachlorodibenzofuran[1,2,3,7,8-]	1	0.0016	0.0016	n/a	n/a	n/a
Pentachlorodibenzofuran[2,3,4,7,8-]	1	0.0016	0.0016	n/a	n/a	n/a
Trinitrotoluene[2,4,6-]	3	7.95	34.7	15.1	34.7	0.4
Trinitrobenzene[1,3,5-]	2	2.68	13.44	6.00	13.44	0.4
Nitroglycerine	1	96.4	96.4	n/a	96.4	n/a
RDX	5	8	20	10.5	10	1.1
Dinitrotoluene[2,6-]	2	0.04	11	0.66	0.36	1.8
Dinitrotoluene[2,4-]	2	1	3.9	1.97	0.54	3.7
HMX	8	50	4000	342	75	4.6
Dinitrobenzene[1,3-]	2	1	4.8	2.19	0.113	19.4
Diethyl Phthalate	2	125	4583	757	4600	0.2
Methylphenol[2-]	3	15	219.2	69.0	220	0.3
Dichloroethane[1,2-]	12	9.5	49.7	40.8	49.7	0.8
Ethanol	1	31.9	31.9	n/a	32	n/a
Carbon Tetrachloride	1	16	16	n/a	16	n/a
Di-n-hexylphthalate	1	55	55	n/a	55	n/a
Dioxane[1,4-]	1	0.5	0.5	n/a	0.5	n/a
Ethyl Acetate	1	900	900	n/a	900	n/a
Formaldehyde	1	9.4	9.4	n/a	9.4	n/a
Hexachlorodibenzofuran[1,2,3,6,7,8-]	1	0.0016	0.0016	n/a	0.0016	n/a
Pentachlorodibenzofuran[1,2,3,4,8-]	1	0.48	0.48	n/a	0.48	n/a
Vinyl Chloride	3	0.17	0.56	0.25	0.17	1.5
Methanol	1	500	500	n/a	50	10.0
Acetonitrile	2	27.5	27.5	27.5	n/a	n/a
Acetophenone	2	9	423	61.7	n/a	n/a
Acrolein	1	0.097	0.097	n/a	n/a	n/a
Acrylonitrile	2	0.1	14	1.18	n/a	n/a
Aniline	2	0.22	100	4.69	n/a	n/a
Aramite	1	10	10	n/a	n/a	n/a
Benzyl Alcohol	3	20	400	84.3	n/a	n/a
Bis(2-chloroethoxy)methane	1	0.65	0.65	n/a	n/a	n/a
Bis(2-chloroethyl)ether	2	2.5	25	7.91	n/a	n/a
Bromodichloromethane	1	13	13	n/a	n/a	n/a
Bromoform	2	80	200	126	n/a	n/a
Bromomethane	2	1.4	3.57	2.24	n/a	n/a
Carbon Disulfide	3	2.5	30200	104	n/a	n/a
Chloro-1,3-butadiene[2-]	1	0.005	0.005	n/a	n/a	n/a
Chloro-1-propene[3-]	1	500	500	n/a	n/a	n/a
Chlorobenzilate	3	2	30	9.09	n/a	n/a
D[2,4-]	2	15	25	19.4	n/a	n/a
Diallate	2	5	9.8	7	n/a	n/a
Diaminobenzene[1,4-]	2	1	2.5	1.58	n/a	n/a
Dibromo-3-chloropropane[1,2-]	2	12.5	25	17.7	n/a	n/a
Dibromoethane[1,2-]	2	2	2	2	n/a	n/a
Dibromomethane	1	300	300	n/a	n/a	n/a
Dichlorobenzene[1,2-]	1	120	120	n/a	n/a	n/a
Dichlorobenzene[1,3-]	1	120	120	n/a	n/a	n/a
Dichlorodifluoromethane	3	80	179	129	n/a	n/a
Dichlorophenol[2,4-]	3	440	1300	754	n/a	n/a
Dichlorophenol[2,6-]	2	21.2	21.98	21.6	n/a	n/a
Dichloropropane[1,2-]	3	0.0125	100	2.5	n/a	n/a
Dimethoate	1	2.4	2.4	n/a	n/a	n/a
Dimethylphenethylamine[alpha,alpha-]	1	1.51	1.51	n/a	n/a	n/a
Dinitro-2-methylphenol[4,6-]	2	0.21	0.26	0.23	n/a	n/a

n/a = not applicable.

Table 2-11. (con't.)

Analyte Name	PTV with UF Adjustment				TRV	GMM PTV/TRV
	Count	Minimum	Maximum	GMM PTV		
Dinitrophenol[2,4-]	3	0.2	0.8	0.36	n/a	n/a
Dinoseb	2	0.1	0.1	0.1	n/a	n/a
Diphenylamine	1	2.5	2.5	n/a	n/a	n/a
Disulfoton	2	0.02	0.05	0.032	n/a	n/a
Endosulfan I	2	0.6	0.9	0.73	n/a	n/a
Endosulfan II	2	0.6	0.9	0.73	n/a	n/a
Endosulfan Sulfate	1	0.18	0.18	n/a	n/a	n/a
Endrin Aldehyde	3	0.013	0.3	0.047	n/a	n/a
Ethyl Methacrylate	3	36300	150000	75283	n/a	n/a
Ethyl Parathion	2	0.01	0.02	0.014	n/a	n/a
Ethylbenzene	1	47.28	47.28	n/a	n/a	n/a
Famphur	3	0.125	0.48	0.25	n/a	n/a
Heptachlor Epoxide	2	0.125	0.25	0.18	n/a	n/a
Hexachlorobenzene	2	1	2	1.41	n/a	n/a
Hexachlorobutadiene	1	0.39	0.39	n/a	n/a	n/a
Hexachlorocyclopentadiene	3	1.9	38	6.50	n/a	n/a
Hexachloroethane	2	1	100	10	n/a	n/a
Hexachlorophene	2	0.5	1	0.71	n/a	n/a
Iodomethane	1	1500	1500	n/a	n/a	n/a
Isodrin	2	0.125	0.45	0.24	n/a	n/a
Isophorone	1	250	250	n/a	n/a	n/a
Isosafrole	3	13	50	25.3	n/a	n/a
Methacrylonitrile	3	0.15	1.75	0.35	n/a	n/a
Methyl Methacrylate	2	60000	80000	69282	n/a	n/a
Methyl Methanesulfonate	1	2.25	2.25	n/a	n/a	n/a
Methyl Parathion	2	0.13	0.3	0.20	n/a	n/a
Methyl-1-propanol[2-]	1	316	316	n/a	n/a	n/a
Methyl-5-nitroaniline[2-]	1	5.74	5.74	n/a	n/a	n/a
Methylaniline[2-]	3	1.5	130	11.8	n/a	n/a
Methylphenol[3-]	2	50	100	70.7	n/a	n/a
Methylphenol[4-]	3	175	450	328	n/a	n/a
Methylpyridine[2-]	2	6.74	9	7.79	n/a	n/a
Nitroaniline[2-]	1	35.6	35.6	n/a	n/a	n/a
Nitroaniline[3-]	3	3.08	5.35	4.20	n/a	n/a
Nitroaniline[4-]	1	120	120	n/a	n/a	n/a
Nitrophenol[2-]	3	3.34	28.3	10.7	n/a	n/a
Nitrophenol[4-]	2	25	40	31.6	n/a	n/a
Nitrosodiethylamine[N-]	1	200	200	n/a	n/a	n/a
Nitrosodimethylamine(N-)	3	0.002	0.5	0.022	n/a	n/a
Nitrosodi-n-propylamine[N-]	1	0.51	0.51	n/a	n/a	n/a
Nitrosomorpholine[N-]	1	0.371	0.371	n/a	n/a	n/a
Nitrosopyrrolidine[N-]	2	0.135	0.816	0.33	n/a	n/a
Oxybis(1-chloropropane)[2,2'-]	1	2.4	2.4	n/a	n/a	n/a
Pentachlorobenzene	2	9.4	12.5	10.8	n/a	n/a
Pentachloroethane	2	53.6	178.5	97.8	n/a	n/a
Phenacetin	2	16.5	60	31.5	n/a	n/a
Phorate	2	0.000625	0.075	0.0068	n/a	n/a
Polychlorinated Dibenzofurans	2	0.0001584	0.01	0.0013	n/a	n/a
Polychlorinated dibenzo-p-dioxins	1	0.000001	0.000001	n/a	n/a	n/a
Pronamide	1	202.5	202.5	n/a	n/a	n/a
Propionitrile	3	4	40	14.7	n/a	n/a
Pyridine	1	25	25	n/a	n/a	n/a
Safrole	2	7.5	19.5	12.1	n/a	n/a
Sulfotepp	1	3	3	n/a	n/a	n/a
T[2,4,5-]	1	21.5	21.5	n/a	n/a	n/a

n/a = not applicable.

Table 2-11. (con't.)

Analyte Name	PTV with UF Adjustment				TRV	GMM PTV/TRV
	Count	Minimum	Maximum	GMM PTV		
Tetrachlorobenzene[1,2,4,5-]	1	5	5	n/a	n/a	n/a
Tetrachloroethane[1,1,1,2-]	2	30	250	86.6	n/a	n/a
Tetrachlorophenol[2,3,4,6-]	3	1.4	100	11.2	n/a	n/a
Thionazine	3	0.12	0.625	0.21	n/a	n/a
TP[2,4,5-]	1	2.6	2.6	n/a	n/a	n/a
Trichloroethane[1,1,2-]	1	19.5	19.5	n/a	n/a	n/a
Trichlorofluoromethane	4	34.9	48.8	41.3	n/a	n/a
Trichloropropane[1,2,3-]	3	2	8	3.63	n/a	n/a
Triethylphosphorothioate[o,o,o-]	1	7.5	7.5	n/a	n/a	n/a
Vinyl Acetate	1	35	35	n/a	n/a	n/a
Anthracene	2	28	1000	167	1000	0.2
Dibenzo(a,h)anthracene	1	1.43	1.43	n/a	1.43	n/a
Acenaphthene	2	70	200	118	70	1.7
Acenaphthylene	2	70	200	118	70	1.7
Benzo(a)pyrene	4	1	40	4.68	1	4.7
Naphthalene	3	15	50	28.2	5	5.6
Methylnaphthalene[2-]	1	16.3	16.3	n/a	2.5	6.5
Aroclor-1254	2	0.0304	0.14	0.065	0.068	1.0
Aroclor-1016	1	1.37	1.37	n/a	1.4	n/a
Aroclor-1242	1	0.069	0.069	n/a	0.069	n/a
Aroclor-1248	1	0.01	0.01	n/a	0.01	n/a
Polychlorinated Biphenyls	3	0.2	1	0.37	n/a	n/a
DDE[4,4'-]	3	1.21	10	2.86	10	0.3
Endrin	3	0.025	0.092	0.049	0.092	0.5
Endosulfan	1	1.5	1.5	n/a	1.5	n/a
Methoxychlor[4,4'-]	4	2.5	10	4.34	4	1.1
Heptachlor	3	0.025	0.75	0.12	0.1	1.2
Chlordane[alpha/gamma]	4	1.175	4.6	1.74	1.175	1.5
Toxaphene (Technical Grade)	4	1.5	49	12.1	8	1.5
Kepone	4	0.05	1.25	0.16	0.08	2.0
Dieldrin	3	0.008	0.75	0.049	0.02	2.5
BHC[beta-]	3	0.1	4	1	0.4	2.5
Aldrin	3	0.2	125	2.24	0.2	11.2
BHC[gamma-]	5	0.014	10	0.62	0.014	44.1
DDT and metabolites	4	0.075	1	0.33	n/a	n/a
Di-n-Butyl Phthalate	5	25	600	234	600	0.4
Pentachloronitrobenzene	2	12.5	65	28.5	65	0.4
Pentachlorophenol	1	0.24	0.24	n/a	0.24	n/a
Phenol	3	12	140	61.3	60	1.0
Nitrobenzene	2	6.4	30	13.9	7	2.0
Bis(2-ethylhexyl)phthalate	3	18.3	130	35.9	18	2.0
Chlorobenzene	2	120	250	173	60	2.9
Chloro-3-methylphenol[4-]	2	7.1	20	11.9	1.4	8.5
Dimethyl Phthalate	3	200	3500	888	83	10.7
Chlorophenol[2-]	2	5	6.7	5.79	0.5	11.6
Di-n-octylphthalate	1	6500	6500	n/a	79.4	81.9
Trichlorophenol[2,4,5-]	1	100	100	n/a	n/a	n/a
Trichlorophenol[2,4,6-]	2	1000	1325	1151	n/a	n/a
Tetrachloroethane[1,1,2,2-]	1	0.32	0.32	n/a	14	0.02
Trichloroethane[1,1,1-]	4	75	1500	422	1000	0.4
Benzene	2	5	26.36	11.5	26	0.4
Dichloroethene[1,1-]	4	25	40	29.4	30	1.0
Butanone[2-]	2	1771	1771	1771	1800	1.0
Dichlorobenzene[1,4-]	1	250	250	n/a	250	n/a
Dichloroethene[cis/trans-1,2-]	1	452	452	n/a	452	n/a

n/a = not applicable.

Table 2-11. (con't.)

Analyte Name	PTV with UF Adjustment				TRV	GMM PTV/TRV
	Count	Minimum	Maximum	GMM PTV		
Tetrachlorobenzene[1,2,4,5-]	1	5	5	n/a	n/a	n/a
Dichloroethane[1,1-]	3	382	475	442	382	1.2
Chloroform	3	31.1	237	103	15	6.9
Toluene	3	26	2500	201	26	7.7
Xylene (Total)	3	2.1	250	29.7	2.1	14.2
Tetrachloroethene	2	45.4	47.2	46.3	1.4	33.1
Trichlorobenzene[1,2,4-]	3	50	120	69.5	1.48	47.0
Trichloroethene	6	10	1000	82.4	0.7	117.7
Methylene Chloride	1	18000	18000	n/a	5.9	3050.8

n/a = not applicable.

2.3.4.1.2 Radionuclide TRV Selection

This section describes the process for selecting a radionuclide TRV. There is only one type of radionuclide TRV and it can most closely be described as a CS TRV. The radionuclide TRV is based on the International Atomic Energy Commission's (IAEA's) dose limit of 0.1 rad/day, which is deemed protective of ecological receptors for all radionuclides (IAEA 1992). However, the ECORSK model uses a media specific (pCi/g soil) ecological screening level (ESL) input that is specific to each screening receptor, which defines this safe exposure level. The ESLs are calculated with the LANL Environmental Restoration SLERA methodology for deriving ESLs for soil for radionuclides (LANL 1999).

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3.0 ANALYSIS PHASE

3.1 Evaluation of Data Quality

3.1.1 Contaminant Data Quality

Two sources of COPC data were used for this Tier 2 ecorisk assessment: (1) the final raw data used for the 1999 LANL SWEIS and published data for Los Alamos and Pueblo Canyons (Katzman et al. 1999, Reneau et al. 1998a). The raw SWEIS data were originally queried in 1998 from LANL's FIMAD database and the FIMAD database was also used to generate the summary data tables in the 1999 SWEIS (DOE 1999). These data were queried using the following criteria and then underwent a qualitative assessment of quality:

Original Query Criteria:

- included soil and sediment data
- included all soil horizons of depth 0 to 6"
- query by sample_ID (identification)
- suite (inorganic, organic, rad)
- excluded samples collected via TCLP and XRF
- excluded Radvan and Chemvan data
- marked as nondetect (ND) if value was <3 × sigma (three standard deviations).

As published data, the canyons data underwent formal validation through data quality assessment. Interpolated canyons data (described in Section 2), which consist of values extrapolated from measured values between canyon reaches, generally have the same basis of quality as the canyons data.

3.1.2 Toxicity Reference Values

The methods for selecting and deriving TRVs were discussed in Section 2.3.4.1. The PTV and other statistics, as well as the TRVs actually used, are also presented. CS TRVs are listed in Appendix B.

3.2 Uncertainty

Many sources and types of uncertainty exist in ecorisk assessments. All ecorisk assessments have a great deal of uncertainty associated with the parameters and decisions that go into the assessment. Being that the parameters are variable, there are choices associated with these parameters and there is uncertainty associated with the resultant values chosen.

Currently in ecological risk assessment, the uncertainty associated with TRVs and BCFs probably has the greatest effect on the outcome of the assessment. Other possible sources of uncertainty that are not necessarily exclusive of each other include

- extrapolation within and between species,
- extrapolation of acute dose derived NOAELs to chronic responses,
- LOAEL to NOAEL conversions,
- extrapolation of sensitive-test-species data to nonsensitive or "normal" life stages,
- extrapolation of less-than-life-span toxicological data to life span, and
- time to achievement of contaminant steady-state in laboratory tests on which NOAELs are based, and laboratory to field extrapolation (Calabrese and Baldwin 1993).

As with all ecological risk assessments currently being conducted, there was uncertainty associated with this risk assessment. Uncertainty associated with the general conceptual model of exposure, consequence, and risk is discussed in Section 2. Table 3-1 lists the technical issues that were variables in this study as well as how they were resolved, i.e., decisions and choices that were made.

There is uncertainty associated with all of these factors. Because TRVs can have such a substantial effect on risk results and conclusions, Section 2 addresses how TRVs were chosen or derived for this study, the uncertainty associated with TRVs, and how UFs were used to account for the uncertainty associated with extrapolations in exposure duration. The UFs actually used are presented in Section 2. The use of UFs causes an overestimate in HIs and, therefore, makes risk assessments where UFs are employed protective.

As mentioned, many of the factors listed in Table 3-1 have the potential to increase or decrease (under- or overestimate) toxicological values. UFs could be applied to account for many types of uncertainty and attempts to calculate UFs based on extrapolations of TRVs have been made by some researchers, however, the bases vary from one researcher to another. For example, Sample et al. (1995) assumed that "smaller animals have higher metabolic rates and are usually more resistant to toxic chemicals because of more rapid rates of detoxification and that metabolism is proportional to body weight." Conversely, in a study of risk to vertebrates from pesticides, Tiebout and Brugger (1995) predicted that small-bodied insectivores faced the highest exposure. Also, several instances exist of interdependence of uncertainty, therefore the assumption that these factors are independent in the application of UFs would likely lead to over-conservatism (Calabrese and Baldwin 1993). For example, uncertainty associated with extrapolations of duration of exposure and exposure level might be related or body weight/size-related factors could be related. For these reasons, the authors believe that the collective amount of uncertainty originating from different sources is great enough and/or variable enough such that making adjustments for all or many such uncertainty would make the results unusable because of large total margins of introduced error. Thus, the use of UFs to accurately account for all uncertainty is neither possible nor desirable. Some of this uncertainty is more appropriately reduced or eliminated in the next level (Tier 3) of risk assessment.

Table 3-1. Resolution of Technical Issues and Parameters as Used in ECORSK.6

Technical Issue	Resolution
Ecosystem type	Terrestrial (Rocky Mountain elk, American robin, deer mouse) and/or Terrestrial/Aquatic-dependent (eagle).
Spatial scope	EEU 1-km-beyond-LANL. Home range species dependent.
Ecological entity (endpoint)	Individuals for broad-ranging organisms (elk). Individual extrapolated to populations for narrow-ranging organisms (deer mouse, robin).
Assessment endpoint by COPC class	Mortality, growth, reproduction in general. Growth is an ecologically relevant effect linked to population health because an individual organism that experiences significantly decreased body weight may also experience decreased reproductive success because of decreased availability of energy needed for reproduction.
Prey distribution scheme	Assumed equivalent to and modeled as receptor density distribution. Weighting of focal points was 1, 10, and 20 for low, moderate, and high elk habitat use, respectively; 1 to 12.4 for deer mouse; and 1, 3.125, 4.125, and 6.250 for low, low/moderate, moderate, and high robin habitat use, respectively.
COPC interaction	Assumed linear and additive. Broken down into rad, inorganic, organic.
Rad dose model	Internal dose: Equilibrium model w/decay and elimination factors. External dose: Alpha/beta eliminated on basis of insignificant contribution. Gamma: Size of organism maximized, 180° exposure based on water immersion.
COPC data quality	SWEIS: Published data. Qualitative assessment of data quality. Original Query Criteria: - included soil and sediment data - included all soil horizons of depth 0 to 6" - sample_Ids - suite (inorganic, organic, rad) - excluded samples collected via TCLP and XRF - excluded Radvan and Chemvan data - marked as nondetect if value was <3 × sigma Canyons: Published data. Formal validation through data quality assessment. Interpolations: Same as 'Canyons.'
TRV selection scheme (level of conservatism)	CS TRVs (often minimums) used to 8/22/00. Criteria used included taxonomic class, ecological relevance of effect, endpoint type (effect level), exposure duration, and exposure route. UF assignment scheme attached. Critical TRVs will be replaced w/GMM TRVs because minimums are overly conservative for Tier 2 assessments. Using full background value assignment scheme, HIs for many constituents would indicate that species that we know are abundant should be experiencing "very probable impacts."
Bioaccumulation factor (BAF) and Biomagnification factor (BMF)	BAFs/BMFs used/calculated for 20 analytes Method: Values for 5 COPCs (aldrin, DDT, DDE, dieldrin, endrin) are directly out of Calabrese and Baldwin (1993) for terrestrial systems. Other 15 are based on ratio of aquatic to terrestrial for the above-mentioned five. Values used and more detailed discussion of this issue are provided in this chapter.
Pathways	Quantitative: food consumption and soil ingestion. Qualitative: inhalation (air and dust), water ingestion, and dermal.
Percentage of diet as soil	Species-specific. elk = 2.0, deer mouse = 2.0, robin = 10.0.
Background value source	Used single value. Sources: Fresquez et al. (1996) and Soil Horizon A values from report by Longmire et al. (1996). Regional background values used for DDE and DDT (Gonzales and Podolsky 2002).

3.3 Characterization of Exposure

3.3.1 COPC Sources

Contaminant releases are typically associated with historical LANL practices, in particular, activities associated with World War II (Manhattan Project era) through the 1960s, when environmental regulations on the handling and disposal of hazardous and radioactive materials were enacted (LANL 1998). COPCs are chemicals that are detected at a site that have the potential to adversely impact human and/or ecological receptors (LANL 1998). COPC sources can be related to the operational activities in various LANL technical areas (TAs). TAs can be broadly classified into firing sites (e.g., TA-8, TA-9), high explosive production sites (e.g., TA-16), industrial sites (e.g., TA-3), Material Disposal Areas (MDAs) (e.g., TA-54), and radiochemical experimental sites (e.g., TA-21). Some TAs contain multiple types of activities (e.g., TA-21 has several MDAs in addition to radiochemical laboratories), and there are also historic activities in the Los Alamos town site. Categories of COPCs include radionuclides (actinides and fission products), inorganic chemicals (heavy metals including lead, mercury, and barium from firing sites), high explosive residues and breakdown products, PCBs, pesticides, and SVOCs (polynuclear aromatic hydrocarbons [PAHs]). COPCs likely to be of concern for ecological receptors include inorganic chemicals and pesticides. A summary of COPC data can be found in Appendix D, Tables D-1, D-2, and D-3.

3.3.2 Current COPC Spatial Distribution

Most LANL and community developments are confined to mesa tops, and the surrounding land is largely undeveloped. Areas used for building sites, experimental areas, waste disposal locations, roads, and utility rights-of-way account for only a small part of the total land area; most land provides buffer areas for security and safety and is held in reserve for future use (LANL 1999). Thus, initial COPC sources are primarily located on mesa tops, and some of these sources were outfalls that directly discharged into canyons. Investigations of canyon-bottom sediments have been useful for describing the current distribution of COPCs and in identifying the major sources for these COPCs. For the Los Alamos/Pueblo Canyon watershed, which has been the subject of four reports describing patterns of sediment contamination (Katzman et al. 1999, Reneau et al. 1998a, b, c), the major sources of COPCs were two outfalls (at TA-21 and former TA-45) that discharged radiochemical liquid releases. These reports also identified pesticides and PAHs coming from nonpoint sources in the Los Alamos town site. In other watersheds, outfalls would also be expected to be the dominant sources for COPCs in surface soil and sediment, although firing sites would have broad surficial levels of COPCs from aerosol deposition. Thus, there are two categories of COPC distribution that correspond to releases from outfalls with well-defined surface water transport pathways into canyon-bottom sediments and broad spatial distribution of COPCs from either nonpoint sources or firing sites. Another process that may lead to broad spatial distribution of COPCs is aerial application, which is a suspected source for some of the pesticide residues detected on LANL property (Gonzales et al. 1998a, b, c).

3.3.3 Mathematical Representation of Exposure

Mathematical representation of exposure analysis has been presented elsewhere in great detail for the ECORSK.5 software (Gallegos and Gonzales 1999; Gonzales et al. 1998a, b, and c; Gonzales et al. 1997; and Gallegos et al. 1997a and b). The current software, ECORSK.6, is

identical with one exception: a weighting scheme has been incorporated into the code to determine the number of nest sites/focal points from each graded habitat type that is based on food utilization potential. The latter is used in conjunction with a random selection of nest site/focal points in the total habitat. The following relationship was used to obtain the nest sites/focal points per land cover class:

$$S_i = N*G_i/\sum_{j=1}^{n} G_j ,$$

where

S_i = number of nest sites/focal points selected from the ith habitat food utilization factor…ex.. 1.5, 3.6, 4.5…G_n,
N = total number of nest sites/focal points randomly generated in the run,
G_i = value of the ith habitat food utilization factor, and
n = total number of habitat food utilization factors employed (10 maximum).

Thus, the sum of all S_is is equal to the total number of nest sites/focal points generated randomly without replacement. Note that the weighting scheme for land covers does not change within the home range of a given nest site/focal point, but foraging within the home range can be weighted on the basis of distance from nest site/focal point as described by Gallegos and Gonzales (1999).

3.3.4 Bioaccumulation and Biomagnification

Bioaccumulation is the process by which contaminants build up over time in an individual organism that is exposed through ingestion of food or soil (animals) or absorption from soil (plants). In essence, organisms act as strainers when contaminants that are lipophilic are stored in tissue rather than being metabolized or excreted. With each passage of some amount of contaminant into an organism some portion is retained such that over the organisms life span an increase in tissue concentration occurs. Biomagnification also involves the passage of contaminants into organisms over time, with some being retained, but this process relies on the hierarchy of organisms in a food chain and the fact that animals consume many times their weight in food over their life span. With concentrations increasing up the food chain, top carnivores experience the highest exposure. Bioaccumulation is said to have occurred when the ratio of contaminant concentration in soil to contaminant concentration in organism exceeds one. Biomagnification is said to have occurred when the ratio of contaminant concentration in one trophic level to contaminant concentration in a higher trophic level exceeds one. BMFs are typically larger then BAFs. Bioconcentration is a more generic term used to refer to both bioaccumulation and biomagnification and the term bioconcentration factors (BCFs) will be used to refer to both BAFs and BMFs.

"Bioconcentration" as used in this report accounts for the processes of bioaccumulation and biomagnification. BCF values were used for the 25 COPCs shown in Table 3-2. Bioconcentration was not evaluated for other COPCs. The BCF represents the concentration ratio between soil and food (e.g., the ratio of plant concentration to soil concentration for a herbivore) as well as food chain transfer (e.g., the ratio of concentration in earthworms to concentration in omnivores). Accumulation of contaminants that occurs through deliberate and

incidental soil ingestion is captured by the fraction of soil in the diet parameter (Beyer et al. 1994).

Calabrese and Baldwin (1993) published individual trophic level transfer coefficients (TCs) for five pesticides in terrestrial systems. For these pesticides (aldrin, DDE, DDT, dieldrin, and endrin), BCF values were calculated from calibrated BAFs presented in Table 6.3 of Calabrese and Baldwin (1993). The BCFs were calibrated for conditions specific to the Rocky Mountain Arsenal. The elk BCF values used in ECORSK.6 assumed an herbivore diet, thus were the soil-plant BAF values. The BCF values for the deer mouse and robin (assuming an omnivore diet) were represented by the larger of the soil-plant-insect and soil-worm BAF values. For the additional 20 COPCs, TCs used by the Environmental Restoration Project in risk screening were used (LANL 1999). The total of 25 BCFs (listed in Table 3-2) were used to compute the HIs that are presented in Section 4.

Next to TRVs, the choices and decisions on TCs, including the use of inherent or special BCFs, has the largest influence on HI results. A sensitivity analysis conducted as part of a risk assessment (Gonzales et al. 1997) conducted on the American peregrine falcon at LANL showed wide variation in HI results based on whether BMFs were used or not. Subsequently, in 1999, a field study was conducted at LANL to estimate site-specific TCs of organochlorines, metals, and PCB mixtures (Gonzales and Podolsky 2002). Of particular interest were PCBs and organochlorine pesticides. These analytes and a suite of metals were studied in soil, arthropods, earthworms, and avian prey. Contaminant transfer factors measured in this study were compared to modeled transfer factors used in ecological risk screening at LANL, and HIs generated from real data collected in this study were compared to modeled HIs. Table 3-3 compares the invertebrate BCFs used in ECORSK.6 for the baseline modeling scenario of robin with the measured invertebrate BCFs as calculated for the food chain study for four key organic analytes. The model BCFs were very close to the measured BCFs and the measured BCFs are in good agreement with the calibrated BCFs reported by Calabrese and Baldwin (1993). In three of the four cases the "model" BCFs are greater than the measured BCFs. This is preferable because, since there are many uncertainties with models, they should be somewhat "conservative," protective, or err on the side of overestimating potential adverse effects. Note that TCs ranging to an order of magnitude higher are available in the literature and can be used in cases where biomagnification is expected.

In comparing TCs of five pesticides–aldrin, dieldrin, DDT, DDE, and endrin–from different sources, we found good agreement between the BCFs used in ECORSK.6, those used for screening at LANL (LANL 1999), and those calculated from the site-specific measurements. The upper range of measured TCs exceeded those used in the baseline ECORSK.6 scenario. To address this, we varied the BCFs by using higher (uncalibrated) BCFs from Calabrese and Baldwin for the five pesticides and adjusting the screening level BCF values by the same ratio.

3.4 Characterization of Ecological Effects

As this ecorisk is focussing on the results of a computer model (ECORSK.6), there are only the results from some previous investigations to measure responses of elk, deer mouse, and robin to chemical stressors. These previous field studies will be briefly summarized in Section 4. Determining causality of adverse effects is not the objective of this Tier 2 ecorisk assessment. Because COPC "safe limits" (TRVs) are almost exclusively centered on individual organisms, the individual organism was selected as the ecological entity to represent the Pajarito Plateau

Table 3-2. BCFs Used in ECORSK.6 for Baseline (calibrated) and Conservative (uncalibrated) Modeling Scenarios

	ELK	ROBIN		DEER MOUSE	
COPC	Calibrated BCF	Calibrated BCF	Uncalibrated BCF	Calibrated BCF	Uncalibrated BCF
Aldrin	0.375	4	9.9	4	9.9
DDE	0.81	2.835	26.1	2.835	26.1
DDT	2.56	4.608	82.4	4.608	82.4
Dieldrin	0.375	0.4	9.9	0.4	9.9
Endrin	0.056	5.9	29	5.9	29
Anthracene	0.091	2.149	25.46	2.149	25.46
Aroclor-1016	0.163	2.043	24.20	2.043	24.20
Aroclor-1242	0.163	2.043	24.20	2.043	24.20
Aroclor-1248	0.022	2.425	28.73	2.425	28.73
Aroclor-1254	0.012	2.551	30.22	2.551	30.22
Aroclor-1260	0.011	2.572	30.47	2.572	30.47
Aroclors - max TC	0.163	2.572	30.47	2.572	30.47
Arsenic	0.04	1	11.85	1	11.85
Benzo(a)pyrene	0.011	2.572	30.47	2.572	30.47
BHC[gamma-] (Lindane)	0.270	1.955	23.16	1.955	23.16
Cadmium	0.55	0.6	7.11	0.6	7.11
Chlordane[alpha- or gamma-]	0.009	2.635	31.21	2.635	31.21
Dichlorobenzene[1,4-]	0.409	1.887	22.35	1.887	22.35
Lead	0.09	0.04	0.47	0.04	0.47
Mercury (inorganic)	1	1	11.85	1	11.85
Mercury (methyl)	1	1	11.85	1	11.85
Nickel	0.2	0.38	4.50	0.38	4.50
Phenanthrene	0.091	2.149	25.46	2.149	25.46
Pyrene	0.043	2.292	27.15	2.292	27.15
Thallium	0.004	1	11.85	1	11.85
Zinc	1.5	0.3	3.55	0.3	3.55

Table 3-3. A Comparison of Measured and Modeled Invertebrate BCFs

Analyte	Measured BCFs [1]	BCFs Used in ECORSK.6 Baseline Scenario[2]	BCFs Used in ECORSK.6 Conservative Scenario[3]
4,4-DDT	1.01	4.61	82.4
4,4-DDE	1.15	2.84	26.1
Aroclor 1254*	3.42	2.55	30.2
Aroclor 1260	1.89	2.57	30.5

[1]Calculated from concentrations measured in soils and arthropods collected from three study sites within LANL. Values are a mean based on n = 3 at each site. Ten subsamples were composited to comprise each sample.
[2]Computed from calibrated BAFs in Calabrese and Baldwin (1993) as discussed in Section 3.3.4.
[3]Computed from uncalibrated BAFs in Calabrese and Baldwin (1993) as discussed in Section 3.3.4.

ecosystem. Many COPC safe limits are from toxicity studies where growth, reproduction, or mortality were the measurement endpoints. Loss in reproductive capability is a common effect of organism exposure to COPCs; therefore, it is a key "sentinel" measurement endpoint. However, it is not the easiest endpoint to measure. Many TRVs are based on body growth because it is easy to measure animal weights during the toxicity study. This is an ecologically

relevant effect that is linked to population dynamics because an individual organism that experiences decreased growth may also experience decreased reproductive success resulting from decreased availability of energy needed for reproduction. Toxicity studies sometimes quantify the lethal amounts of a COPC, and clearly mortality is a relevant ecological effect for evaluating ecological effects. Toxicity studies that are based on sublethal effects (like biochemical changes) are harder to relate to adverse effects on individuals or populations.

As previously discussed, the HI as calculated in ECORSK.6 provides an indication of possible adverse ecological effects under the assumption of additivity of response over all COPCS and all spatial units (grid cells), and ECORSK.6 also generates partial HQs such that any grouping of COPCs and spatial units can be achieved. For a point of comparison HIs/HQs will also be calculated for background concentrations representative of the Pajarito Plateau. The background HQ/HI represents a reference to which "LANL added" HIs/HQs can be compared.

4.0 RISK CHARACTERIZATION

4.1 Risk Estimation

4.1.1 Field Studies

From 1996 to 1999 a series of Tier 2 ecorisk assessments on T&E species established that organic chemicals dominated HIs compared to radionuclides and inorganic chemicals. This resulted in the design of a series of field studies aimed at validating the risk assessments and resolving related gaps in data, knowledge, or other information. The gap analysis leading to these field studies is summarized in an internal report (Gonzales 2000). The reader is referred to the reports by reference for information resulting from the field studies.

4.1.2 The USEPA Hazard Quotient Method and Risk Evaluation Criteria

Fundamental to the Tier 2 ecorisk assessment is the concept of the HQ. The HQ is a ratio between exposure and an effect level, which can be used as a potential indicator of effects. The HI is a sum of HQ values for COPCs with common toxicological effects. The following equations are simplified versions of how the HQ and HI are calculated, and are based on USEPA (1997):

$$HQ_{ij} = \frac{exposure_{ij}}{effect_{ij}} \qquad (4\text{-}1) \qquad\qquad HI_i = \sum_{j=1}^{n} HQ_{ij} \qquad (4\text{-}2)$$

where

HQ_{ij} is hazard quotient for receptor i to COPC j (unitless),
$exposure_{ij}$ is exposure to COPC j for receptor i (units are mg of COPC per kg body weight per day or mg/kg/day),
$effect_{ij}$ is effect level for exposure to COPC j for receptor i (mg/kg/day), and
HI_i is hazard index for receptor i to n COPCs (unitless).

The LANL Environmental Restoration Project uses a HQ value of 0.3 to identify contaminants of potential ecological concern (COPEC) (LANL 1999). This project is responsible for evaluating potential releases sites (PRS) under the Resource Conservation and Recovery Act Corrective Action Program and formally identifying COPECs.

In this study, COPCs with receptor average HQ values greater than 0.3 will be listed and discussed with the primary objective of providing information to be used in the development of the BRMP.

The context for evaluating the HI values is presented in Table 4-1, which is based on Menzie et al. (1993) and USEPA (1986). Effects are not likely unless the HI is greater than 10, and this level is based on the assumption that LOAELs are roughly ten times greater than NOAELs that form the basis of the HI calculations. Impacts would be expected at HI>100 because the LD50 value is typically assumed to be 100 times greater than the NOAEL.

Table 4-1. Relative HI Evaluation Criteria for Interpreting Results of the USEPA Hazard Quotient Method (Menzie et al. 1993; USEPA 1986)

Hazard Index Range	Conclusion
<1.0	No appreciable impact
1.0 to 10.0	Small potential for impacts
10 to 100	Substantial potential for impacts
>100	Ecological impacts very probable

4.1.3 Hazard Index/Quotient Results

Appendix E, Tables E-1–E-3 show the detailed HI and HQ results for each species. Table 4-2 shows HI results for the "baseline" modeling scenario. The baseline scenario included 200 focal points (elk) or nest sites (robin and deer mouse), the use of GMM TRVs, and realistic ("nonconservative") BCFs. All scenarios use the integrated contaminant database, which consists of approximately 48,000 records of mesa top and canyons COPC concentrations. For this scenario, mean HIs were 0.64 for Rocky Mountain elk, 0.80 for American robin, and 7.6 for deer mouse. A summary of COPC input data was presented in Appendix D, Tables D-1, D-2, and D-3. The "Sample Value" and "Background" fields remain constant regardless of receptor or modeling scenario. Other fields, such as TRV or BCF, often change with a change in receptor or modeling scenario.

Table 4-3 summarizes the HI results into ranges that correspond to the HI categories presented in Table 4-2 and has frequencies of HIs for 200 nest sites or focal points of the modeled receptors. If the HI = 0, then this means that no COPC data were available for the cells in the animals' home range surrounding that particular nest site or focal point. HI = 0 can also be interpreted as the animal receiving no LANL-specific COPC dose or receives a dose equal to background or ambient levels of constituents. About 10% of the elk focal points, 75% of the robin nest sites, and 90% of the deer mouse nest sites have HI = 0. It is important to recall that a cell may have no data because validated or interpolated data were not available at the time that the ECORSK model was executed. Thus, these percentages of nest sites with HI = 0 somewhat overestimate the proportion of animals that encounter no LANL-derived COPC sources within their home range. The results for background concentrations of COPCs detected in the animal foraging areas are also provided in Table 4-3. The frequency of HI values in the groups identified in Table 4-3 are similar for the total and background HI values. Table 4-4 summarizes the data presented in Table 4-3 in terms of the impact categories ("Conclusion") presented in Table 4-1. Table 4-4 shows that 80% of the elk focal points and robin nest sites and >90% of the deer mouse nest sites are in the "no impact" category. The percentages are similar for the background concentration column, which suggests that much of the estimated risk to these animals is related to background concentrations and not LANL contaminant releases. This is supported by the fact that some of the COPCs that dominated the contribution to HIs have been detected upwind and upslope of LANL (e.g., DDE, Gonzales and Podolsky 2002) and by the fact that the toxicities of other dominant COPCs (e.g., Al) have been overestimated as the result of TRVs being unrealistically low; e.g., below natural background levels of Al.

Table 4-2. Mean HIs (200 focal points/nest sites) as Relatively Affected by Parameter Adjustment. Values are mean of 200 focal points (elk) and 200 nest sites (robin and deer mouse).

Rocky Mountain Elk

Risk Source	Baseline H1[1]	Maximum	Minus Interpolated Contaminant Data
Total[2]	0.64	3.1	-21%
Background[3]	0.58	3.0	
Unadj – Bckg	0.06	0.1	
Dominant COPCs	Al (0.53), Pb (0.02)		

American Robin

Risk Source	Baseline HI[1]	Maximum	Conservative BCFs[4]	Minus Interpolated Contaminant Data
Total	0.81	19.9	2.7 (+333%)	-58%
Background	0.63	16.6		
Unadj – Bckg	0.17	3.3		
Dominant COPCs	Co (0.34), Pb (0.13), DDE (0.07), Aroclor-1260 (0.02)		DDE (0.6), Pb (0.54), As (0.43), Co (0.34), Aroclor-1248 (0.11), Aroclor-1260 (0.11)	

Deer Mouse

Risk Source	Baseline H1[3]	Maximum	Conservative BCFs[4]
Total	7.6	463	24.9(+328%)
Background	6.4	463	
Unadj – Bckg	1.2	0	
Dominant COPCs	Al (5.8), Aroclor-1248 (0.37), Aroclor-1260 (0.36), Zn (0.31), As (0.28)		Al (5.8), Aroclor-1248 (4.3), Aroclor-1260 (4.2), Zn (3.4), As (3.3), Ni (0.9), Aroclor-1254 (0.8), Aroclor-1242 (0.5), Pb (0.5), Cd (0.3)

[1]Baseline refers to the modeled scenario in which the complete set of COPC values (SWEIS, canyons, and Los Alamos Canyon interpolation data) is used, TRVs are GMM, and 200 nest sites are randomly selected within weighted distribution among habitat use categories.

[2]Total Risk – Quantified relative risk index associated with sampling within LANL boundaries.

[3]Background Risk – Quantified relative risk associated with "natural" and "regional" concentrations of COPCs. A background value was entered only for sampled grid cells yielding detections of analytes in the background set.

[4]BCF includes BAF and BMF for the food consumption pathway.

Table 4-3. Frequency of HI Values for 200 Nest Sites or Focal Points of the Modeled Receptors

HI Category	Elk		Robin		Deer Mouse	
	Total	Background	Total	Background	Total	Background
= 0	22	22	148	150	185	186
>0 and <1	140	150	23	26	1	0
>= 1 and <10	38	28	25	22	4	4
>= 10 and <100	0	0	4	2	5	7
>= 100	0	0	0	0	5	3
Total	200	200	200	200	200	200

Table 4-4. Categorization of HI Values into Effect Categories (based on Table 4-3) for Modeled Receptors

Impact Category	Elk		Robin		Deer Mouse	
	Total	Background	Total	Background	Total	Background
None	81%	86%	85%	88%	93%	93%
Small potential	19	14	13	11	2	2
Substantial potential	0	0	2	1	2.5	3.5
Probable	0	0	0	0	2.5	1.5

4.1.3.1 Rocky Mountain Elk

4.1.3.1.1 Mean HI

The mean total HI for the baseline modeling scenario for elk was 0.64 with the background contribution accounting for about 0.58, or 94%, of the total (Table 4-2).

4.1.3.1.2 HI by Focal Point

Elk habitat was divided into two areas: one in which collared elk movements have been studied using GIS telemetry (Bennett et al. 1997) and areas, mostly north and south of LANL, in which collared animals have not migrated. As discussed previously, based on real elk distribution data, three land cover habitat use categories were identified for the elk: low, moderate, and high. The distribution data were then used to program ECORSK.6 to weight the distribution of "elk focal areas," which serve as risk "sinks" for calculation of HIs. Within each habitat use area, focal point location was randomly generated by ECORSK.6. The distribution of the 200 focal areas was approximately 7 in the low use areas, 64 in the moderate use areas, and 128 in the high use areas. Appendix Table E-1 shows the distribution of HIs across the 200 focal areas. The maximum HI for any one focal area was 3.1 at x,y = 269,451 and 279,458. Figure 4-1 shows the elk HI contours for 200 focal sites, and these contours show an area of high HI that decreases to low values. Thus, 200 focal points were an adequate number to develop a meaningful elk HI contour map. These contours show that the northern and western parts of the

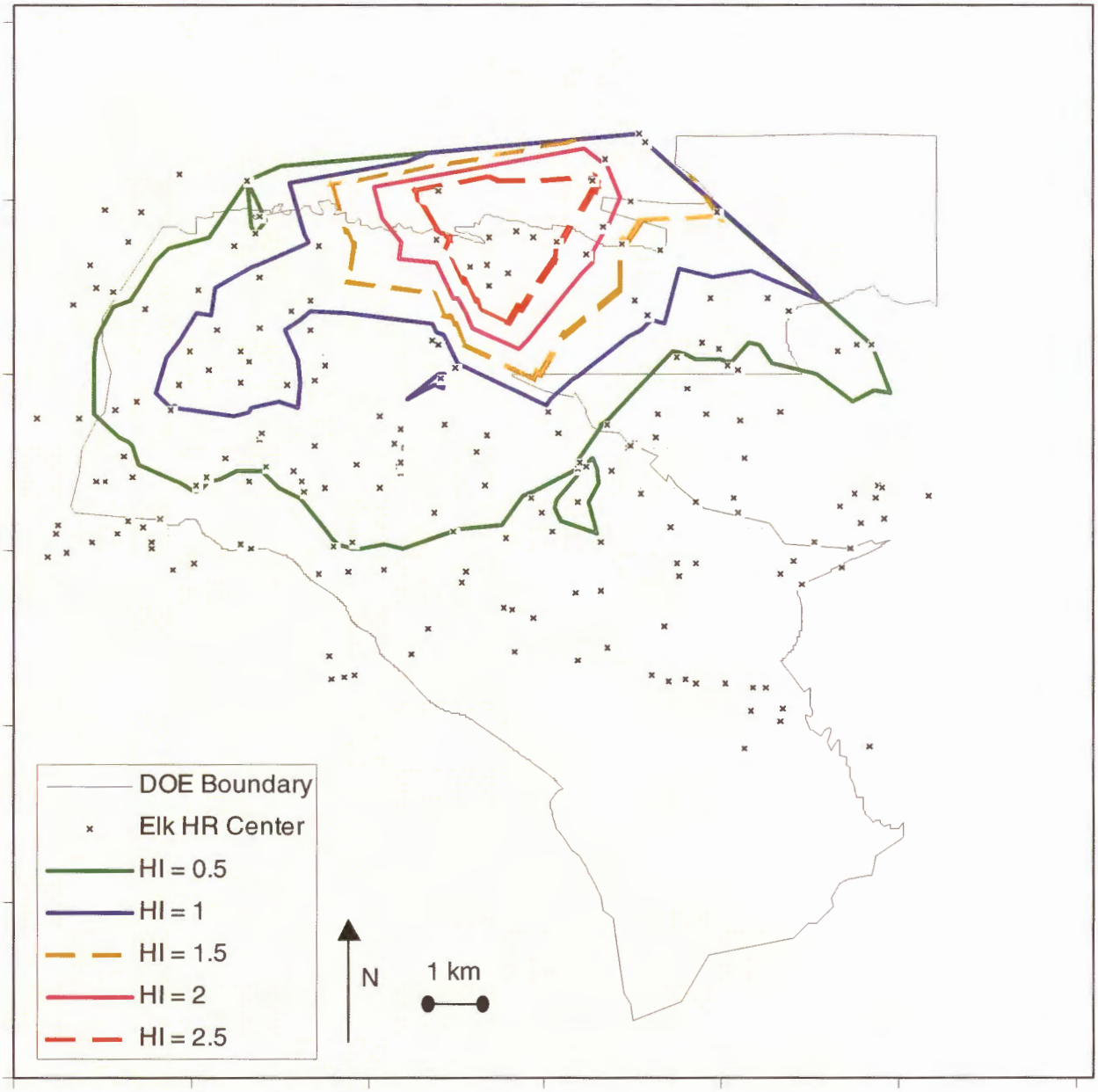

Figure 4-1. Contour plot of elk HI values for 200 focal points.

elk HI contour plot at LANL are the areas with HI values greater than 1. The area with HI greater than 1 includes parts of the Los Alamos/Pueblo Canyon, Sandia Canyon, Two-mile Canyon, Three-mile Canyon, and Cañon de Valle watersheds. It is worth noting that the northern boundary of the elk HI contours for HI>2 are not bounded by focal points with HI<2 but instead are limited by the focal points selected in the simulation. However, these contour lines (HI>2) are not expected to change greatly if elk home ranges were forced to occur north of the northern LANL boundary because the HI values would be low due to the lack of PRSs north of Bayo Canyon.

4.1.3.1.3 HQ by COPC

Appendix Table E-1b shows the mean HQ for each COPC averaged across the 200 focal areas. There are 158 COPCs included in this list, and the number of COPCs reflects two factors—the number of mammalian TRVs available and the home range of the elk. The large home range of the elk ensures that most or all of COPCs in the contaminant database with mammalian TRVs are encountered. The dominant COPCs, contributing the largest proportion of the mean HI, were Al (HQ = 0.53) and Pb (HQ = 0.02). Al has a high HQ because the TRV for elk is very low, probably unrealistically low in that when the TRV is converted to an equivalent amount in soil, the soil-equivalent TRV is about an order of magnitude lower than natural background levels of Al. While using a GMM TRV sometimes reduces this overestimate of Al toxicity associated with choosing a single TRV, it does not eliminate it. As with most metals, the assumed toxicity of Al is tied to its chemical form, and, for the purposes of developing a TRV, the most bioavailable form of Al is assumed (aluminum chloride). It is extremely unlikely that Al exists in this form in the neutral pH soils found on LANL property.

4.1.3.2 American Robin

4.1.3.2.1 Mean HI

The mean total HI for the baseline modeling scenario for robin was 0.81 with the background contribution accounting for about 0.63, or 79%, of the total (Table 4-2).

4.1.3.2.2. HI by Nest Site

As discussed previously, based on real density data, four land cover habitat use categories were identified for the robin: low, low/moderate, moderate, and high. The proportion of total nest placement in the four different habitat use areas was weighted based on the density data. Within each habitat use area, nest location was randomly generated by ECORSK.6. The distribution of the 200 nests was 14 in the low use area, 44 in the low/moderate, 57 in the moderate, and 87 in the high use area. Appendix Table E-2a shows the distribution of HIs across 200 nest sites. The maximum HI for any one nest site was 19.9 at x,y = 282,480. Figure 4-2 shows the robin HI contours for 200 nest sites. Based on these selected nest sites, only three areas had HI>10 (Los Alamos Canyon, Pajarito Canyon, and Chaquehui Canyon). Ten areas had HI values greater than 1, and these areas were mostly located in the northern half of LANL. However, the density of nest sites does not appear adequate to depict HI contours for the robin at the spatial scale of LANL. However, 200 nest sites are adequate to understand the frequency of HI values expected over LANL and provide estimates of the average HI values for robins.

4.1.3.2.3 HQ by COPC

Appendix Table E-2b shows the HQ for each COPC averaged over the 200 nest sites. There are 115 COPCs included in this list, and the number of COPCs reflects two factors—the number of avian TRVs available and the home range of the robin. The moderate home range of the robin ensures that the majority of COPCs in the contaminant database with avian TRVs are encountered. The dominant COPCs, contributing the largest mean HQ, were Co (HQ = 0.34), Pb (HQ = 0.13), DDE (0.07), and Aroclor-1260 (0.02). The average HQ exceeded 0.3 for a single COPC, Co, but the background HQ for Co (0.32) contributed 94% of the unadjusted or total HQ.

Robin HI Contour Plot

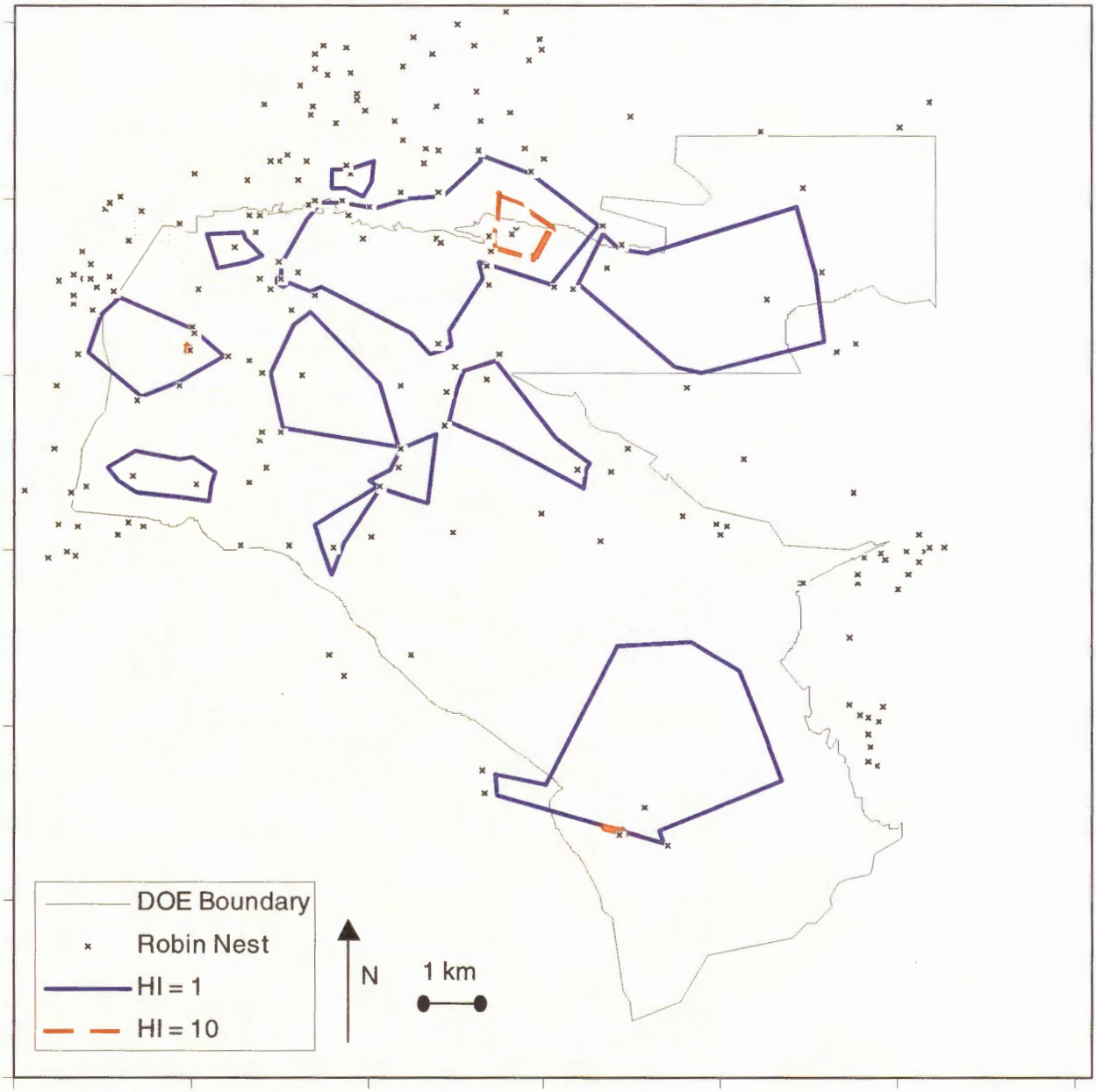

Figure 4-2. Contour plot of robin HI values for 200 nest sites.

4.1.3.3 Deer Mouse

4.1.3.3.1 Mean HI

The mean total HI for the baseline modeling scenario for deer mouse was 7.6 with the background contribution accounting for about 6.4, or 84%, of the mean total HI (Table 4-2). Recall that the home range of the deer mouse is roughly 70% of a grid cell in area. The deer mouse HI is believed to be higher than that for robin partly because of the availability of

substantially more TRVs for mammals (238) than for birds (107). The HI may also be larger for the deer mouse because the home area assumed for the deer mouse (0.064 ha) is smaller than the robin home range (12.6 ha) and thus high concentrations in a cell are not averaged with low values that may be found in adjoining cells.

4.1.3.3.2 HI by Nest Site

As discussed previously, based on real density data, seven land cover habitat use categories were identified for the deer mouse. The proportion of total nest placement in the seven different habitat use areas was weighted based on the density data. Within each habitat use area, nest location was randomly generated by ECORSK.6. The distribution of the 200 nests in the seven use categories was previously presented. Appendix Table E-3a shows the distribution of HIs across 200 nest sites. The maximum HI for any one nest site was 463 at x,y = 294,478. Figure 4-3 shows the deer mouse HI contours for 200 focal points. Based on these selected focal points, only two areas had HI>100 (Los Alamos Canyon and Chaquehui Canyon). Nine areas had HI>1 and these areas were mostly located in the northern and western parts of LANL. However, the density of nest sites does not appear adequate to depict HI contours for the deer mouse at the LANL spatial scale. However, 200 focal points are adequate to understand the frequency of HI values expected over LANL and provide estimates of the average HI values for deer mice.

4.1.3.3.3 HQ by COPC

Appendix Table E-3b shows the HQ for each COPC averaged over 200 nest sites. There are 76 COPCs included in this list, and the number of COPCs reflects two factors—the number of mammalian TRVs available and the home range of the deer mouse. [Note: The number of COPCs encountered in the simulated foraging by each species will change based on the size of their home ranges. The number of COPCs is greatest for the elk because their large home range results in a much larger area of coverage by the cumulative number (200) of foraging simulations.] The small home range of the deer mouse explains why only about half of the elk COPCs were encountered for the deer mouse. The dominant COPCs, contributing the largest proportion of the mean HI, were Al (HQ = 5.8), Aroclor-1248 (HQ = 0.37), Aroclor-1260 (HQ = 0.36), Zn (HQ = 0.31), and As (HQ = 0.28). Aluminum is not a concern because the TRV converted to an equivalent amount in soil is artificially low and is based on a chemical form of Al unlikely to exist in LANL soils. Zinc was another metal with an average HQ greater than 0.3, and the background HQ for Zn (0.16) was similar to the "Lab-added" HQ value. Thus, there is little evidence for an incremental risk due to metals exposure to the deer mouse. Two PCBs, Aroclor-1248 and Aroclor-1260, also had average HQ values greater than 0.3. Although a value of '0' was entered for background concentrations of Aroclor mixtures, detections have been made in birds collected upwind and upslope of LANL (Gonzales and Podolsky 2002); therefore, an unknown proportion of the HQ for these compounds is the result of sources outside the Laboratory. PCBs are pervasive worldwide resulting from atmospheric transport (Stoker and Seager 1976).

Deer Mouse HI Contour Plot

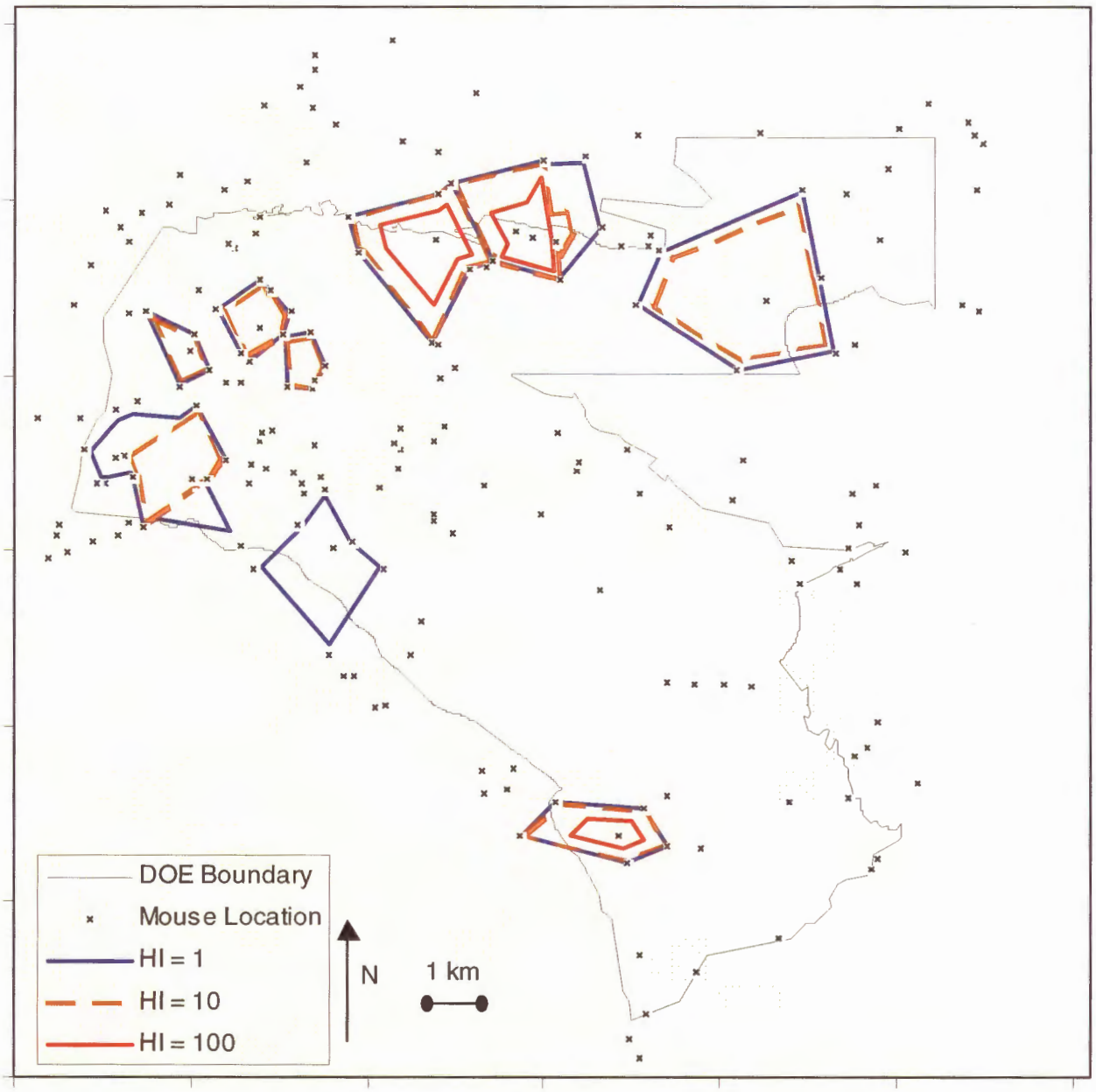

Figure 4-3. Contour plot of deer mouse HI values for 200 nest sites.

As discussed in Section 2 (conceptual model), inhalation of vapors or dust is a potential exposure pathway that is not evaluated by ECORSK.6. These pathways are potentially more important for the deer mouse, which spends a considerable amount of time in its nest. However, detections of VOCs are relatively few and the HQ values for these chemicals are low based on the ingestion pathways. Thus, it is not expected that modifying ECORSK.6 to include vapor inhalation pathways would change the conclusions on the significant COPCs. Likewise, the dust inhalation pathway is not expected to alter the conclusions.

4.1.3.4 Sensitivity Analyses

In Section 2 we introduced the scenarios and parameters that were selected for sensitivity analysis and how they were varied.

4.1.3.4.1 Number of Nest Sites/Focal Points

For organisms with a small home range such as the robin and deer mouse, HIs over an expansive area can be affected by the number of nest sites that are chosen because the level of utilization of that area could vary. Increasing from 100 to 200 nest sites decreased the average robin HI by 8% and increased the average deer mouse HI by 94% (results for 100 focal points are not shown). Increasing to 500 nest sites further decreased the robin HI, but only by 4%, and decreased the deer mouse HI by 82% (results for 500 focal points are not shown). Although the robin and deer mouse have relatively similar home ranges, the direction of change in HI is not expected to be the same because of differences in TRVs and other factors. Although the change in mean HI resulting from using 500 nest sites may be small in some cases, the baseline HI contour plots for the robin and the deer mouse could be improved by plotting the values resulting from the use of 500 nest sites.

4.1.3.4.2 Toxicity Reference Values

TRVs can greatly influence HIs and, thus, can have a large impact on conclusions of potential risk. The TRV is the denominator of the HI equation; therefore, the absence of a TRV for an analyte eliminates it from the HI calculation and, other than listing those analytes lacking a TRV, the analyte is treated as though it does not exist. Varying the TRV parameter by switching from CS TRVs to GMM TRVs had two effects: it increased the number of TRVs available and, depending on animal class (mammal or bird), it either increased or decreased the mean change in TRV value. For the deer mouse, the number of available TRVs increased from 141 to 238. An increase in the number of TRVs would increase the overall HI that sums HQs for all COPCs. In converting from CS TRVs to GMM TRVs, an increase in the TRV on average would tend to lower HIs since the TRV is in the denominator. For the deer mouse the net effect of converting to GMM TRVs and experiencing an increase in the number of analytes for which a TRV was available was an increase in the HI of about 220% (data not shown), thus the increase in the number of TRVs used more than counteracted any decrease caused by larger TRVs.

4.1.3.4.3 Bioaccumulation and Bioconcentration

Increase in Mean HI Associated with Increases in BCFs. BCF derivation was discussed in Section 3.3.4. Some of the uncertainty associated with the use of relatively realistic BCFs was examined by varying the BCFs, i.e., by using higher (uncalibrated) BCFs from Calabrese and Baldwin for aldrin, dieldrin, DDT, DDE, and endrin and adjusting the LANL screening BCFs by a similar ratio. These higher BCFs were listed in Table 3-2. As an example of the magnitude of increase in BCFs, note that the increased BCFs for Aroclor-1260 of 30.5 compares to the BCFs high of 4.3 measured by Gonzales and Podolsky (2002). The results of using the larger BCFs for the robin and the deer mouse are shown in Table 4-2. For the robin, the HI averaged for 200 nest sites increased from 0.8 to 2.7, a 238% increase, and the HI for deer mouse increased from 7.6 to 24.9, a 228% increase.

Robin HQs × COPCs With Conservative BAFs. DDE dominated the mean COPC contribution (HQ = 0.6) to the HI for the robin when the more conservative BAFs were used. Although DDT has dominated contribution to carnivore birds in previous assessments (Gonzales 1998), use of a GMM TRV increased the TRV for DDT by two orders of magnitude; whereas, the GMM TRV for DDE (0.00087 mg/kg-d) is lower than the CS TRV of 0.0022. The highest DDE concentrations in soil or sediment were associated with the following PRSs: 00-030(n), 53-002(a) and (c), 03-002(c), c-00-021, 09-013, 46-006(a), 46-004(c2), 09-013, and 73-001(a). DDE (HQ = 0.6) was followed by Pb (0.54), As (0.43), and Co (0.34).

Deer Mouse HQs × COPCs With Conservative BAFs. For the deer mouse, the same ranking of COPCs (Al>Aroclor-1248>Aroclor-1260>Zn>As>Ni>Aroclor-1254>Aroclor-1242>Pb>Cd) generally occurred when the higher BAFs were used in comparison to when the lower BAFs were used. With the higher BAFs several COPCs had individual HQs high enough (>0.3) to warrant further assessment. Excluding Al from concern, Aroclors again dominated the contribution to the HI, but Zn and As followed closely.

4.1.3.5 Uncertainty Analyses

In addition to the sensitivity analyses, uncertainties in model results related to exposure pathways, contaminated media, and biota distribution are evaluated in a qualitative manner. The pathways and exposure media evaluated in ECORSK.6 are related to ingestion of soil or sediment by terrestrial animals (external gamma radiation is also evaluated for radionuclides). Other potentially complete exposure pathways from soil include inhalation (of dust or vapors) and dermal contact. The possible importance of the inhalation pathways was considered for the deer mouse (the animal among the three modeled with the greatest chance for inhalation exposures because of its fossorial habits), and the conclusion was that including the inhalation pathway would not likely change the results significantly. Dermal contact would increase animal exposure, especially for SVOCs. Because some semivolatiles were among the COPCs with the largest average HQ values, the importance of these chemicals may be slightly underestimated by the ECORSK.6 model. However, ecological pathway analysis done in support of Eco-SSL development indicated that the dermal pathway contributed up to 11% of the ingestion pathway (across a suite of analytes including semivolatile organics). Thus, adding the dermal pathway would increase the HQ for some chemicals, but it is not expected to dramatically increase the HQ value for any chemical.

ECORSK.6 assesses potential adverse ecological effects from soil or sediment only, and does not consider contaminants in water or air. Possible exposures through the air pathway have already been considered through the inhalation pathway. Both ingestion and dermal contact are possible exposure pathways to water. Of these two pathways, ingestion is considered the more important pathway for the same reasons that ingestion of soil is expected to dominate over dermal contact. Certainly, the potential for adverse ecological effects is understated by ignoring the water pathway. However, the proportion of total risk from the water pathway is believed to be small because the concentrations of COPCs in water are typically much less than concentrations of COPCs in soil and sediment. It is also clear that potential adverse ecological effects on aquatic communities are closely tied to COPCs in water (or aquatic sediments). Modeling ecorisk for aquatic organisms is currently beyond the scope of ECORSK.6 model.

The results of the ECORSK.6 are tied to the estimated animal use of various land cover classes. There is uncertainty in determining land cover classes from remote sensing information

and uncertainty in the estimated use patterns. It is not known if these uncertainties led to overestimates or underestimates of ecorisk. However, using the maximum quality factors for a grid cell may lead to overestimating animal exposure and, therefore, overestimating ecorisk. Furthermore, any error that may be associated with land cover/animal distribution is likely to be small and is well outweighed by the benefit of adding this aspect of realism to the modeling. As evidenced by the Cerro Grande fire (May 2000), land cover classes change over time, which also suggests that animal use of grid cells will change. The current results of ECORSK.6 serve as a baseline to future land cover changes related to the Cerro Grande fire or other disturbances.

4.1.4 Summary

The summary of the risk characterization is presented as responses to the risk hypotheses (questions) posed in Section 2.

Are chemical concentrations in soil sufficient to lead to individual or population-level adverse ecological effects through the incidental soil ingestion pathway for terrestrial receptors in two functional groups (herbivore and omnivore)?

Yes. Individual effects are possible for the robin and the deer mouse. However, individual effects are unlikely for the elk.

Are chemical concentrations in soil sufficient to lead to individual or population-level adverse ecological effects through the food ingestion pathway for terrestrial receptors in two functional groups (herbivore and omnivore)?

Yes. Using the conservative BCFs increased the HI values for the robin and the deer mouse.

What are the dominant COPCs to animals based on the incidental soil ingestion pathway?

The COPCs that had average HQ values greater than 0.3 included Al, Co, Zn, Aroclor-1248, and Aroclor-1260. Radionuclides did not contribute a significant amount to the average HI values.

What spatial areas of the Laboratory or the surrounding buffer area contribute the largest proportion of the estimated risk to animal receptors?

The areas of the EEU with the largest HI values depended on the receptor (see Figures 4-1, 4-2, and 4-3), but the areas tended to be on the northern or western parts of LANL.

Which exposure pathway, incidental soil ingestion or food ingestion, contributes the larger amount to estimated risk to animal receptors?

Based on the conservative BCF values, food ingestion was a larger contributor to HI than soil ingestion for the omnivorous species (robin and deer mouse).

What is the importance of background or estimated soil/sediment concentrations on the estimated risk to animal receptors?

Background plays an important role in the calculated HI values for many metals, including Al, Co, and Zn that were significant, but not dominant, contributors to the average receptor HI.

5.0 CONCLUSIONS

5.1 Significance of Results

The goal of further developing the ECORSK tool as a technical programmatic capability has been met. The use of real animal density data for placement of animal focal points and nest sites is an important advancement because it enables us to distribute animals on the basis of the distribution of their prey or forage when it can be assumed that receptor density is a direct function of prey or forage distribution. The sensitivity of results, however, as a function of changes in TRVs and BCFs demonstrates that more emphasis is needed on the development of more accurate chronic toxicity benchmarks (TRVs) and more accurate TCs. This is true both internationally and on a site-specific basis. A second line of evidence to this effect is that HIs substantially greater than 1.0 were generated; however, the majority of risk contribution was from background sources. This is an indication that the TRVs used may have been overly protective.

The HI results are relative and their greatest use is to identify COPCs, contaminated areas, and/or organisms that need further study through laboratory or field studies or additional modeling. The Aroclors consistently ranked high in relative contribution to HIs. Since Aroclors do not exist naturally their contribution to relative risk is entirely from anthropogenic sources. Combining these two facts, and the review of field studies, PCBs should be considered COPCs requiring further investigation. Other COPCs that should be considered for further investigation are the organochlorine DDE, PCBs, and the metals Pb, As, Co, and Cd.

5.2 Application to Biological Resources Management Plan

HIs for Rocky Mountain elk were generally low. In the few cases when a HI of 1.0 was exceeded, Al dominated the contribution. The contribution by Al is somewhat artificial because both GMM and CS TRVs are extremely low in comparison to naturally-occurring levels of Al, and are based on a chemical form of Al unlikely to occur in Pajarito Plateau soils. Thus, based on the results on Rocky Mountain elk, we predict that they are not experiencing adverse ecological effects from COPCs. For radionuclides specifically, this was supported by a field validation study previously conducted (Ferenbaugh et al. 2002). On these bases, we do not see the need to consider special management of elk for their protection from hazardous or radiological materials.

There is still too much uncertainty associated with risk parameters for biological resource managers to pursue special management techniques on the basis of HIs greater than 1.0 for the American robin and the deer mouse.

5.3 Application to Environmental Restoration

The results of these analyses can be directly applied to LANL Environmental Restoration risk assessments, and additional executions of the ECORSK.6 model would also be useful for watershed surface aggregate assessments. One of the important findings is that wide-ranging mammalian herbivores are not impacted from LANL chemical releases. In addition, over the scale of the EEU, only a small percentage of the animals in robin or deer mouse populations is potentially impacted by COPCs.

To determine general spatial trends in HI values over the Laboratory, the HI contour maps generated from ECORSK model runs can be evaluated (see Figures 4-1 to 4-3 in Section 4). In general, the larger HI values were from receptors located in the northern watersheds (Los Alamos, Sandia, and Mortandad Canyons). Generally, predicted elk use in those areas is relatively low compared to the southern portion of the Laboratory. For robin and deer mouse, more isolated occurrences of elevated HI values (>10) were noted in other TAs (e.g., TA-16).

For direct application to Environmental Restoration assessments, additional runs of the ECORSK model can be created to address questions at spatial scales relevant for PRSs and watersheds. In particular, ECORSK model runs at the watershed scale are appealing, and this information could be used in surface watershed aggregate reports to evaluate HI values for LANL screening level wildlife receptors (robin, kestrel, desert cottontail, deer mouse, shrew, and gray fox). This information could be used to evaluate possible impacts to populations of these receptors.

The results of the T&E feeding studies also show that uptake to predators could be of concern. Additional modeling to address possible impacts to individuals of T&E raptor species would also support Environmental Restoration assessments. As more data are validated and available for ECORSK simulations, then assessments to populations and individuals of animal receptors would benefit future Environmental Restoration Project screening and baseline ecological risk assessments.

5.4 Data Gaps

Several data gaps existed in this modeling study. The contaminant database used for HI calculations was extensive in comparison to previous efforts in three ways: (1) in cases where only one or a few measured values of contaminants exist for a grid cell, a contaminant value was assumed for the entire 10,000-ft^2 grid cell; this results in the assignment of a contaminant value to areas within a grid cell that might otherwise be assumed to contain no elevated levels of contaminants; (2) grid cells in Los Alamos Canyon where sampling and analysis have not been completed were still assigned contaminant values by interpolating from measured contaminant values in "neighbor" grid cells; (3) 48,000 records of contaminant data were used in the analyses. As contaminant data for other canyons has become available from the Environmental Restoration Project, contaminant data from measurements and interpolations to grid cells where sampling has not been conducted has made the contaminant data base more comprehensive. Secondly, gaps existed in the availability and applicability of chronic TRVs. As the ECORSK.6 model is currently structured, COPCs in water cannot be assessed. If Tier 2 ecorisk assessments for aquatic communities are desired, then additional enhancements to ECORSK are needed in addition to adding water COPC concentrations to the contaminant database. Lastly, site-specific TCs for the risk dominant COPCs are needed. While other, less significant, data gaps existed, resolution of the major data gaps will bring commensurate levels of improvement to risk assessments at LANL.

5.5 Recommendations

5.5.1 Research

Sensitivity analyses showed that varying TRVs and TCs had a large effect on HIs. Therefore, we recommend that LANL engage in the development of site-specific contaminant TCs and in the international development of chronic toxicity benchmarks for particular application to terrestrial systems. LANL should continue to conduct field studies on PCBs and organochlorines. Risk managers and researchers should investigate the particular areas and COPECs that generated high HIs/HQs for potential validation studies.

The development of confidence ratings for both CS and GMM TRVs would enable LANL to conduct assessments knowing that HIs are relatively optimal with regard to the TRVs that have been selected. The confidence rating could be based on the type of data used to derive each TRV with the highest confidence going to those values based on "primary literature" that has been reviewed. For example, TRVs associated with toxicity studies that do not have control groups, multiple dose levels, or explicit information about the type exposure conditions would have a lower confidence rating than one in which these same circumstances are satisfied. Also, the confidence rating will reflect the number of values available for a particular chemical/ecological screening receptor class combination.

There are also opportunities to evaluate how a major forest fire (the Cerro Grande fire) impacts potential ecorisk to terrestrial animals. Since ECORSK.6 was applied before the fire, this can be accomplished by integrating post-fire sampling and analysis and post-fire animal distributions into the ECORSK.6 model. Biota monitoring can help validate contaminant transport and species abundance changes. Biota monitoring can be coordinated with monitoring of other media (primarily sediment and water) to gain an integrated perspective on the potential magnitude and duration of fire impacts on terrestrial animals.

5.5.2 Iterations

We recommend that after conducting additional interpolations of measured contaminant values to nonsampled points in all of the prominent canyons that traverse LANL (Pueblo, Mortandad, Cañon de Valle, etc.) the Tier 2 assessment described in this report be applied to a top-level carnivore such as the Mexican spotted owl or the bald eagle. Higher levels of contaminant biomagnification by top-level carnivores would likely result in higher HIs.

5.5.3 Population Risk

USEPA has issued guidance for risk managers to base cleanup decisions (except for T&E species) on population risks (USEPA 1999). Methods to evaluate population risks are being developed. An example is the procedure developed based on 1997 State of Oregon amendments to the hazardous waste site cleanup law (Hope and Peterson 2000). The ECORSK model is structured in a similar way to the Hope and Peterson (2000) procedure, and the main differences lie in the spatial scale of this execution of the

ECORSK model and the selection of NOAELs for TRVs for ECORSK. A trivial difference is that the Hope and Peterson procedure is based on an approximate analytical solution and ECORSK is a simulation model. In the case of the results for elk from ECORSK, the predicted distribution of HI values can be easily thought to represent a coherent biological population of elk. For the robin and the deer mouse ECORSK simulations, there are many populations of these animals represented across the simulated landscape. Thus, additional executions of the ECORSK model could be created over spatial scales more representative of robin and deer mouse populations. A starting point for the scale of population assessments would be a watershed, which would also integrate with the spatial scale at which the Environmental Restoration Project is conducting investigations and reporting its assessments.

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APPENDIX A

Table A-1. The *BASIC* Program Created to Generate Site EEU Attribute Values for Row, Column, X-coordinate, and Y-coordinate

Table A-2. Example of eeuinp.dat for the Rocky Mountain Elk used in ECORSK.6

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Table A-1. The *BASIC* Program Created to Generate Site EEU Attribute Values for Row, Column, X-coordinate, and Y-coordinate

```
REM GRID Program
countr = 0
OPEN "d:\ecorisk\site_eeu.dat" FOR INPUT AS #1
OPEN "d:\ecorisk\siteeu.out" FOR OUTPUT AS #2
   INPUT #1, x, y
   LET yo = y
   DO
       LET countr = countr + 1
       LET rowo = countr
       LET countc = 0
       LET xo = x
       DO WHILE (countc) <= 554
            LET countc = countc + 1
            LET colo = countc
            WRITE #2, rowo, colo, xo, yo
            LET xo = xo + 100
            LOOP
       LET yo = yo + 100
    LOOP WHILE countr <= 608
```

Table A-2. Example of eeuinp.dat for the Rocky Mountain Elk used in ECORSK.6

Count	Sample Value	Soil Bckg	XCenter	YCenter	TRV	TRV Adj	Occ	Area	BCF	Row-Column	ANALYTE
8	3800	26600	1639888	1736571	0.84	1	1	0.000929	0	100-358	Aluminum
8	77.4	263	1639888	1736571	2.7	1	1	0.000929	0	100-358	Barium
8	0.144	0.43	1639888	1736571	7500	1	1	0.000929	0	100-358	Cesium-137
8	27.5	30.7	1639888	1736571	1.93	1	1	0.000929	0	100-358	Copper
8	8.7	28.4	1639888	1736571	0.89	1	1	0.000929	0.09	100-358	Lead
8	167	1000	1639888	1736571	128	1	1	0.000929	0	100-358	Manganese
8	407.12	1.87	1639888	1736571	8.97	1	1	0.000929	0	100-358	Uranium
8	21.8	47.1	1639888	1736571	1.54	1	1	0.000929	1.5	100-358	Zinc
7	0.44	0	1645788	1736571	1.37	1	1	0.000929	0.163	100-417	Aroclor-1016
7	0.88	0	1645788	1736571	0.37	1	1	0.000929	0.163	100-417	Aroclor-1221
7	0.44	0	1645788	1736571	0.37	1	1	0.000929	0.163	100-417	Aroclor-1232
7	0.44	0	1645788	1736571	0.069	1	1	0.000929	0.163	100-417	Aroclor-1242
7	0.44	0	1645788	1736571	0.01	1	1	0.000929	0.022	100-417	Aroclor-1248
7	0.44	0	1645788	1736571	0.065	1	1	0.000929	0.012	100-417	Aroclor-1254
7	1.645	0	1645788	1736571	0.04	1	1	0.000929	0.011	100-417	Aroclor-1260
11	5510	26600	1645888	1736571	0.84	1	1	0.000929	0	100-418	Aluminum
11	2.5	6.99	1645888	1736571	0.4	1	1	0.000929	0.04	100-418	Arsenic
11	114.38	263	1645888	1736571	2.7	1	1	0.000929	0	100-418	Barium
11	1	1.41	1645888	1736571	0.58	1	1	0.000929	0	100-418	Beryllium
11	0.79733	0.43	1645888	1736571	7500	1	1	0.000929	0	100-418	Cesium-137
11	3.3	0	1645888	1736571	2.07	1	1	0.000929	0	100-418	Cyanide (total)
11	16.1	28.4	1645888	1736571	0.89	1	1	0.000929	0.09	100-418	Lead
11	205	1000	1645888	1736571	128	1	1	0.000929	0	100-418	Manganese
11	2.1782	7.15	1645888	1736571	18000	1	1	0.000929	0	100-418	Radium-226
11	0.66	1.87	1645888	1736571	8.97	1	1	0.000929	0	100-418	Uranium
11	46.94	47.1	1645888	1736571	1.54	1	1	0.000929	1.5	100-418	Zinc
8	5560	26600	1645988	1736571	0.84	1	1	0.000929	0	100-419	Aluminum
8	93.85	263	1645988	1736571	2.7	1	1	0.000929	0	100-419	Barium
8	0.5365	0.43	1645988	1736571	7500	1	1	0.000929	0	100-419	Cesium-137
8	12.6	30.7	1645988	1736571	1.93	1	1	0.000929	0	100-419	Copper
8	20.45	28.4	1645988	1736571	0.89	1	1	0.000929	0.09	100-419	Lead
8	217	1000	1645988	1736571	128	1	1	0.000929	0	100-419	Manganese
8	3.5	1.87	1645988	1736571	8.97	1	1	0.000929	0	100-419	Uranium
8	34.35	47.1	1645988	1736571	1.54	1	1	0.000929	1.5	100-419	Zinc
11	10993.3	26600	1646188	1736571	0.84	1	1	0.000929	0	100-421	Aluminum
11	125.667	263	1646188	1736571	2.7	1	1	0.000929	0	100-421	Barium
11	1.15	1.41	1646188	1736571	0.58	1	1	0.000929	0	100-421	Beryllium
11	0.25967	0.43	1646188	1736571	7500	1	1	0.000929	0	100-421	Cesium-137
11	6.66667	30.7	1646188	1736571	1.93	1	1	0.000929	0	100-421	Copper
11	8.96667	28.4	1646188	1736571	0.89	1	1	0.000929	0.09	100-421	Lead
11	201.333	1000	1646188	1736571	128	1	1	0.000929	0	100-421	Manganese
11	0.12	0.09	1646188	1736571	3.63	1	1	0.000929	1	100-421	Mercury
11	0.69333	1.87	1646188	1736571	8.97	1	1	0.000929	0	100-421	Uranium
11	11.9	42.8	1646188	1736571	2.86	1	1	0.000929	0	100-421	Vanadium
11	28.7	47.1	1646188	1736571	1.54	1	1	0.000929	1.5	100-421	Zinc

APPENDIX B

B-1. CS TRVs for Nonradionuclides for Deer Mouse and Elk

B-2. CS TRVs for Nonradionuclides for Robin

B-3a. GMM TRVs for Nonradionuclides for Deer Mouse and Elk

B-3b. GMM TRVs for Nonradionuclides for Robin

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B-1 CS TRVs - Nonradionuclides

Elk and Deer Mouse

The CS TRVs (mg/kg/d) for nonradionuclide chemicals for the deer mouse and elk ECORSK models are from the LANL Environmental Restoration Project Ecorisk Database (September or April 2000; Table B-1). The dates vary because the initial input files were created with April 2000 data. Note that although Lithium, Molybdenum, Aldrin, Diethyl Phthalate, Methyl-2-pentanone[4-], and Methylphenol[2-] are from the Ecorisk Database, they are not retrievable from the database interface because they are not LANL Environmental Restoration Project priority chemicals. The database manager must retrieve the information for these non-priority chemicals manually from underlying tables of the database. Nonradionuclide TRVs are not species-specific, but rather class-specific (i.e., the same mammal data is used for the deer mouse and elk).

Table B-1. CS TRVs for Nonradionuclides for Deer Mouse and Elk

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
INORG	Aluminum	AL	1.93	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Antimony	SB	0.125	Secondary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Arsenic	AS	0.126	Secondary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Barium	BA	0.55	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Beryllium	BE	0.66	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Boron	B	28	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Cadmium	CD	1	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Chromium (total)	CR	1924	Primary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Chromium(+6)	CR(+6)	3.28	Secondary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Cobalt	CO	0.2	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Copper	CU	11.7	Secondary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Cyanide (total)	CN(-1)	68.7	Secondary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Fluoride	F(-1)	26.6	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Lead	PB	5.8	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Lithium	LI	9.4	Secondary	Ecorisk Db (Apr. 2000), non-priority chemical
INORG	Manganese	MN	44	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Mercury	HG	13.2	Secondary	Ecorisk Db (Apr. 2000), priority chemical

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
INORG	Mercury (methyl)	HGM	0.032	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Molybdenum	MO	0.26	Secondary	Ecorisk Db (Apr. 2000), non-priority chemical
INORG	Nickel	NI	40	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Selenium	SE	0.2	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Silver	AG	2	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Strontium	SR	24.6	Primary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Thallium	TL	0.07	Primary	Ecorisk Db (Apr. 2000), priority chemical
INORG	Titanium	TI	15.8	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Uranium	U	6.1	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Uranium (total)	U(total)	6.1	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Vanadium	V	2.1	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Zinc	ZN	160	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Acenaphthene	83-32-9	70	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Acenaphthylene	208-96-8	70	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Acetone	67-64-1	10	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aldrin	309-00-2	0.2	Secondary	Ecorisk Db (Apr. 2000), non-priority chemical
ORG	Amino-2,6-dinitrotoluene[4-]	19406-51-0	1.93	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Amino-4,6-dinitrotoluene[2-]	35572-78-2	2.81	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Anthracene	120-12-7	100	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aroclor-1016	12674-11-2	1.37	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Aroclor-1242	53469-21-9	0.069	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aroclor-1248	12672-29-6	0.01	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aroclor-1254	11097-69-1	0.068	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aroclor-1260	11096-82-5	0.04	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Benzene	71-43-2	26.4	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Benzo(a)anthracene	56-55-3	1.7	Secondary	Ecorisk Db (Sept. 2000), priority chemical

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
ORG	Benzo(a)pyrene	50-32-8	1	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Benzo(b)fluoranthene	205-99-2	4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Benzo(g,h,i)perylene	191-24-2	7.2	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Benzo(k)fluoranthene	207-08-9	7.2	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Benzoic acid	65-85-0	4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	BHC[beta-]	319-85-7	0.4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	BHC[gamma-]	58-89-9	0.014	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Bis(2-ethylhexyl)phthalate	117-81-7	18.3	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Butanone[2-]	78-93-3	1771	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Butyl benzyl phthalate	85-68-7	159	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chlordane[alpha-]	5103-71-9	1.175	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chlordane[gamma-]	5103-74-2	1.175	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chloro-3-methylphenol[4-]	59-50-7	1.37	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Chlorobenzene	108-90-7	60	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chloroform	67-66-3	15	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chlorophenol[2-]	95-57-8	0.5	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chrysene	218-01-9	1.7	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	DDE[4,4'-]	72-55-9	10	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	DDT[4,4'-]	50-29-3	0.8	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Di-n-Butyl Phthalate	84-74-2	600	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Di-n-octylphthalate	117-84-0	79.4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dibenzo(a,h)anthracene	53-70-3	1.33	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dichlorobenzene[1,4-]	106-46-7	250	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dichloroethane[1,1-]	75-34-3	382	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dichloroethane[1,2-]	107-06-2	49.7	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dichloroethylene[1,1-]	75-35-4	30	Secondary	Ecorisk Db (Sept. 2000), priority chemical

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
ORG	Dichloroethylene[1,2-]	540-59-0	45.2	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Dieldrin	60-57-1	0.02	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Diethyl Phthalate	84-66-2	4583	Secondary	Ecorisk Db (Apr. 2000), non-priority chemical
ORG	Dimethylphthalate	131-11-3	83	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dinitrobenzene[1,3-]	99-65-0	0.113	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dinitrotoluene[2,4-]	121-14-2	0.54	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dinitrotoluene[2,6-]	606-20-2	0.36	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Endosulfan	115-29-7	0.15	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Endrin	72-20-8	0.092	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Fluoranthene	206-44-0	12.5	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Fluorene	86-73-7	12.5	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Heptachlor	76-44-8	0.1	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	HMX	2691-41-0	75	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Indeno(1,2,3-cd)pyrene	193-39-5	7.2	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Kepone	143-50-0	0.08	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Methoxychlor[4,4'-]	72-43-5	4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Methyl-2-pentanone[4-]	108-10-1	25	Secondary	Ecorisk Db (Apr. 2000), non-priority chemical
ORG	Methylene Chloride	75-09-2	5.85	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Methylnaphthalene[2-]	91-57-6	2.45	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Methylphenol[2-]	95-48-7	219.2	Secondary	Ecorisk Db (Apr. 2000), non-priority chemical
ORG	Naphthalene	91-20-3	5	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Nitrobenzene	98-95-3	6.95	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Nitroglycerine	55-63-0	96.4	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Nitrotoluene[2-]	88-72-2	1.79	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Nitrotoluene[3-]	99-08-1	2.16	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Nitrotoluene[4-]	99-99-0	3.94	Secondary	Ecorisk Db (Apr. 2000), priority chemical

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
ORG	Pentachloronitrobenzene	82-68-8	65	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Pentachlorophenol	87-86-5	0.24	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	PETN	78-11-5	5868	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Phenanthrene	85-01-8	51.4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Phenol	108-95-2	60	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Pyrene	129-00-0	7.5	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	RDX	121-82-4	10	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Tetrachlorodibenzodioxin [2,3,7,8-]	1746-01-6	0.000001	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Tetrachloroethane[1,1,2,2-]	79-34-5	14.1	Secondary	Ecorisk Db (Apr. 2000), priority chemical
ORG	Tetrachloroethene	127-18-4	1.4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Tetryl	479-45-8	1.3	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Toluene	108-88-3	26	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Toxaphene (Technical Grade)	8001-35-2	8	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Trichlorobenzene[1,2,4-]	120-82-1	1.48	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Trichloroethane[1,1,1-]	71-55-6	1000	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Trichloroethene	79-01-6	0.7	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Trinitrobenzene[1,3,5-]	99-35-4	13.44	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Trinitrotoluene[2,4,6-]	118-96-7	34.7	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Xylene (Total)	1330-20-7	2.1	Secondary	Ecorisk Db (Sept. 2000), priority chemical

* INORG = inorganic chemical and ORG = organic chemical

Robin

If available, the CS TRVs (Table B-2) for the robin are from the LANL Environmental Restoration Project ECORISK Database (September 2000). Otherwise, they were taken from the LANL RRES-ECO T&E (Willow Flycatcher) Database. Exceptions to this rule: the values for Molybdenum and Thallium were taken from the T&E Database even though values were available in the Ecorisk Database because these values were not accessible at the time the first input file was created for the robin. Note also, Chlorophenol [2-] is from the Ecorisk Database (September 2000), yet it is not retrievable from the database interface because it is not a LANL Environmental Restoration Project priority chemical. The database

manager must retrieve the information for this non-priority chemical manually from underlying tables of the database. Also, the value for silver and many of those taken from the T&E Database were rounded to fewer digits than were in the original data sources due to data transfer issues (copying and pasting of formatted values instead of raw data).

Table B-2. CS TRVs for Nonradionuclides for Robin

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
INORG	Aluminum	AL	110	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Antimony	SB	0.04	Secondary	T&E (Willow Flycatcher) Database
INORG	Arsenic	AS	5.1	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Barium	BA	12.6	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Beryllium	BE	0.54	Secondary	T&E (Willow Flycatcher) Database
INORG	Boron	B	46.3	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Cadmium	CD	1.45	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Calcium	CA	24	Secondary	T&E (Willow Flycatcher) Database
INORG	Chromium (total)	CR	77	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Chromium(+6)	CR(+6)	3.8	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Cobalt	CO	0.2	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Copper	CU	47	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Cyanide (total)	CN(-1)	0.4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Lead	PB	5.1	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Lithium	LI	480	Secondary	T&E (Willow Flycatcher) Database
INORG	Magnesium	MG	1000	Secondary	T&E (Willow Flycatcher) Database
INORG	Manganese	MN	575	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Mercury	HG	0.45	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Molybdenum	MO	0.28	Secondary	T&E (Willow Flycatcher) Database
INORG	Nickel	NI	77.4	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Selenium	SE	0.44	Secondary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Silver	AG	5.4	Primary	Ecorisk Db (Sept. 2000), priority chemical

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
INORG	Sodium	NA	124	Secondary	T&E (Willow Flycatcher) Database
INORG	Thallium	TL	1.2	Secondary	T&E (Willow Flycatcher) Database
INORG	Uranium	U	8.3	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Vanadium	V	1.1	Primary	Ecorisk Db (Sept. 2000), priority chemical
INORG	Zinc	ZN	129	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Acenaphthene	83-32-9	175	Secondary	T&E (Willow Flycatcher) Database
ORG	Acetone	67-64-1	199	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aldrin	309-00-2	0.02	Secondary	T&E (Willow Flycatcher) Database
ORG	Anthracene	120-12-7	1000	Secondary	T&E (Willow Flycatcher) Database
ORG	Aroclor-1016	12674-11-2	0.48	Secondary	T&E (Willow Flycatcher) Database
ORG	Aroclor-1221	11104-28-2	0.48	Secondary	T&E (Willow Flycatcher) Database
ORG	Aroclor-1232	11141-16-5	0.48	Secondary	T&E (Willow Flycatcher) Database
ORG	Aroclor-1242	53469-21-9	0.41	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aroclor-1248	12672-29-6	0.00272	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aroclor-1254	11097-69-1	0.18	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Aroclor-1260	11096-82-5	0.047	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Azobenzene	103-33-3	26.36	Secondary	T&E (Willow Flycatcher) Database
ORG	Benzene	71-43-2	0.56	Secondary	T&E (Willow Flycatcher) Database
ORG	Benzoic acid	65-85-0	4.46	Secondary	T&E (Willow Flycatcher) Database
ORG	BHC[beta-]	319-85-7	38.3	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	BHC[gamma-]	58-89-9	0.56	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Bis(2-ethylhexyl)phthalate	117-81-7	1.1	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Bromodichloromethane	75-27-4	17.9	Secondary	T&E (Willow Flycatcher) Database
ORG	Butyl benzyl phthalate	85-68-7	159	Secondary	T&E (Willow Flycatcher) Database
ORG	Carbon Disulfide	75-15-0	11	Secondary	T&E (Willow Flycatcher) Database
ORG	Chlordane[alpha-]	5103-71-9	2.1	Secondary	Ecorisk Db (Sept. 2000), priority chemical

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
ORG	Chlordane[gamma-]	5103-74-2	2.1	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chloro-3-methylphenol[4-]	59-50-7	11.3	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Chlorobenzene	108-90-7	19	Secondary	T&E (Willow Flycatcher) Database
ORG	Chlorophenol[2-]	95-57-8	11.3	Secondary	T&E (Willow Flycatcher) Database
ORG	D[2,4-]	94-75-7	0.8	Secondary	T&E (Willow Flycatcher) Database
ORG	DDD[4,4'-]	72-54-8	0.24	Secondary	T&E (Willow Flycatcher) Database
ORG	DDE[4,4'-]	72-55-9	0.00224	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	DDT[4,4'-]	50-29-3	0.0028	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Di-n-Butyl Phthalate	84-74-2	0.14	Primary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Di-n-octylphthalate	117-84-0	175	Secondary	T&E (Willow Flycatcher) Database
ORG	Dichlorobenzene[1,2-]	95-50-1	85.7	Secondary	T&E (Willow Flycatcher) Database
ORG	Dichlorodifluoromethane	75-71-8	15	Secondary	T&E (Willow Flycatcher) Database
ORG	Dichlorophenol[2,4-]	120-83-2	0.3	Secondary	T&E (Willow Flycatcher) Database
ORG	Dieldrin	60-57-1	0.077	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Diethyl Phthalate	84-66-2	4583	Secondary	T&E (Willow Flycatcher) Database
ORG	Dimethylphenol[2,4-]	105-67-9	50	Secondary	T&E (Willow Flycatcher) Database
ORG	Dimethylphthalate	131-11-3	1000	Secondary	T&E (Willow Flycatcher) Database
ORG	Dinitrobenzene[1,3-]	99-65-0	0.000422	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Dinitrophenol[2,4-]	51-28-5	2	Secondary	T&E (Willow Flycatcher) Database
ORG	Dinitrotoluene[2,4-]	121-14-2	0.2	Secondary	T&E (Willow Flycatcher) Database
ORG	Dinoseb	88-85-7	1	Secondary	T&E (Willow Flycatcher) Database
ORG	Diphenylamine	122-39-4	2.5	Secondary	T&E (Willow Flycatcher) Database
ORG	Endosulfan I	959-98-8	0.15	Secondary	T&E (Willow Flycatcher) Database
ORG	Endosulfan II	33213-65-9	0.15	Secondary	T&E (Willow Flycatcher) Database
ORG	Endosulfan Sulfate	1031-07-8	10	Secondary	T&E (Willow Flycatcher) Database
ORG	Endrin	72-20-8	0.01	Secondary	Ecorisk Db (Sept. 2000), priority chemical

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
ORG	Endrin Aldehyde	7421-93-4	0.3	Secondary	T&E (Willow Flycatcher) Database
ORG	Fluoranthene	206-44-0	125	Secondary	T&E (Willow Flycatcher) Database
ORG	Fluorene	86-73-7	125	Secondary	T&E (Willow Flycatcher) Database
ORG	Heptachlor	76-44-8	9.2	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Heptachlor Epoxide	1024-57-3	0.01	Secondary	T&E (Willow Flycatcher) Database
ORG	Hexachlorobenzene	118-74-1	0.08	Secondary	T&E (Willow Flycatcher) Database
ORG	Hexachlorocyclopentadiene	77-47-4	7	Secondary	T&E (Willow Flycatcher) Database
ORG	Hexachloroethane	67-72-1	1	Secondary	T&E (Willow Flycatcher) Database
ORG	HMX	2691-41-0	50	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Isophorone	78-59-1	150	Secondary	T&E (Willow Flycatcher) Database
ORG	Methoxychlor[4,4'-]	72-43-5	20	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Methylene Chloride	75-09-2	5.85	Secondary	T&E (Willow Flycatcher) Database
ORG	Methylphenol[2-]	95-48-7	50	Secondary	T&E (Willow Flycatcher) Database
ORG	Methylphenol[4-]	106-44-5	5	Secondary	T&E (Willow Flycatcher) Database
ORG	Naphthalene	91-20-3	0.139	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Nitrobenzene	98-95-3	4.6	Secondary	T&E (Willow Flycatcher) Database
ORG	Nitrotoluene[3-]	99-08-1	2.16	Secondary	T&E (Willow Flycatcher) Database
ORG	Pentachlorophenol	87-86-5	32.9	Secondary	Ecorisk Db (Sept. 2000), priority chemical
ORG	Phenol	108-95-2	60	Secondary	T&E (Willow Flycatcher) Database
ORG	Polychlorinated Biphenyls	1336-36-3	0.41	Secondary	T&E (Willow Flycatcher) Database
ORG	Pyrene	129-00-0	75	Secondary	T&E (Willow Flycatcher) Database
ORG	RDX	121-82-4	0.3	Secondary	T&E (Willow Flycatcher) Database
ORG	Tetrachloroethene	127-18-4	14	Secondary	T&E (Willow Flycatcher) Database
ORG	Toluene	108-88-3	25.98	Secondary	T&E (Willow Flycatcher) Database
ORG	Trichloro-1,2,2-trifluoroethane[1,1,2-]	76-13-1	273	Secondary	T&E (Willow Flycatcher) Database
ORG	Trichlorobenzene[1,2,4-]	120-82-1	14.8	Secondary	T&E (Willow Flycatcher) Database

Group*	Name	Code	TRV (mg/kg/d)	Data Type	Data Source
ORG	Trichloroethane[1,1,1-]	71-55-6	1000	Secondary	T&E (Willow Flycatcher) Database
ORG	Trichlorofluoromethane	75-69-4	349	Secondary	T&E (Willow Flycatcher) Database
ORG	Trichlorophenol[2,4,5-]	95-95-4	100	Secondary	T&E (Willow Flycatcher) Database
ORG	Trinitrobenzene[1,3,5-]	99-35-4	0.51	Secondary	T&E (Willow Flycatcher) Database
ORG	Trinitrotoluene[2,4,6-]	118-96-7	0.5	Secondary	T&E (Willow Flycatcher) Database
ORG	Xylene (Total)	1330-20-7	0.777	Secondary	Ecorisk Db (Sept. 2000), priority chemical

* INORG = inorganic chemical and ORG = organic chemical

B-2 GMM TRVs - Nonradionuclides

GMM-TRVs (Table B-3a and b) are based upon toxicity data taken from primary and secondary data sources found in the ECORISK Database (September 2000).

Table B-3a. GMM TRVs for Nonradionuclides for Deer Mouse and Elk

Group	Name	Code	TRV (mg/kg/d)	Count*
INORG	Aluminum	AL	0.84	3
INORG	Antimony	SB	0.11	5
INORG	Arsenic	AS	0.40	2
INORG	Barium	BA	2.70	9
INORG	Beryllium	BE	0.58	3
INORG	Boron	B	28	1
INORG	Cadmium	CD	0.24	4
INORG	Chromium (total)	CR	2062	6
INORG	Chromium(+6)	CR(+6)	2.07	2
INORG	Copper	CU	1.93	2
INORG	Cyanide (total)	CN(-1)	2.05	4
INORG	Fluoride	F(-1)	27	1
INORG	Lead	PB	0.89	12
INORG	Lithium	LI	9.4	1
INORG	Manganese	MN	128	6
INORG	Mercury (inorganic)	HG	3.63	2
INORG	Mercury (methyl)	HGM	0.053	4
INORG	Molybdenum	MO	0.25	2
INORG	Nickel	NI	0.74	5
INORG	Niobium	NB	0.155	1
INORG	Nitrate (expressed as NO3)	NO3(-1)	507	1
INORG	Selenium	SE	0.10	6
INORG	Silver	AG	20.1	2
INORG	Strontium (stable)	SR	80.4	2
INORG	Sulfide (total)	S(-2)	3.1	1
INORG	Thallium	TL	0.13	3
INORG	Tin	SN	11.4	4
INORG	Titanium	TI	0.066	2
INORG	Uranium	U	8.97	7
INORG	Vanadium	V	2.86	22
INORG	Zinc	ZN	1.54	5
INORG	Zirconium	ZR	1.74	1
ORG	Acenaphthene	83-32-9	118	2
ORG	Acenaphthylene	208-96-8	118	2
ORG	Acetonitrile	75-05-8	27.5	2
ORG	Acetophenone	98-86-2	61.7	2
ORG	Acrolein	107-02-8	0.097	1
ORG	Acrylonitrile	107-13-1	1.18	2
ORG	Aldrin	309-00-2	2.24	3
ORG	Aniline	62-53-3	4.69	2

Group	Name	Code	TRV (mg/kg/d)	Count*
ORG	Anthracene	120-12-7	167	2
ORG	Aramite	140-57-8	10	1
ORG	Aroclor-1016	12674-11-2	1.37	1
ORG	Aroclor-1242	53469-21-9	0.069	1
ORG	Aroclor-1248	12672-29-6	0.01	1
ORG	Aroclor-1254	11097-69-1	0.065	2
ORG	Benzene	71-43-2	11.5	2
ORG	Benzo(a)pyrene	50-32-8	4.68	4
ORG	Benzyl Alcohol	100-51-6	84.3	3
ORG	BHC[beta-]	319-85-7	1	3
ORG	BHC[gamma-]	58-89-9	0.62	5
ORG	Bis(2-chloroethoxy)methane	111-91-1	0.65	1
ORG	Bis(2-chloroethyl)ether	111-44-4	7.91	2
ORG	Bis(2-ethylhexyl)phthalate	117-81-7	35.9	3
ORG	Bromodichloromethane	75-27-4	13	1
ORG	Bromoform	75-25-2	126	2
ORG	Bromomethane	74-83-9	2.24	2
ORG	Butanone[2-]	78-93-3	1771	2
ORG	Carbon Disulfide	75-15-0	104	3
ORG	Carbon Tetrachloride	56-23-5	16	1
ORG	Chlordane[alpha/gamma]	57-74-9	1.74	4
ORG	Chloro-1,3-butadiene[2-]	126-99-8	0.005	1
ORG	Chloro-1-propene[3-]	107-05-1	500	1
ORG	Chloro-3-methylphenol[4-]	59-50-7	11.9	2
ORG	Chlorobenzene	108-90-7	173	2
ORG	Chlorobenzilate	510-15-6	9.09	3
ORG	Chloroform	67-66-3	103	3
ORG	Chlorophenol[2-]	95-57-8	5.79	2
ORG	D[2,4-]	94-75-7	19.4	2
ORG	DDE[4,4'-]	72-55-9	2.86	3
ORG	DDT and metabolites	DDT/METAB	0.33	4
ORG	Diallate	2303-16-4	7	2
ORG	Diaminobenzene[1,4-]	106-50-3	1.58	2
ORG	Dibenzo(a,h)anthracene	53-70-3	1.43	1
ORG	Dibromo-3-chloropropane[1,2-]	96-12-8	17.7	2
ORG	Dibromoethane[1,2-]	106-93-4	2	2
ORG	Dibromomethane	74-95-3	300	1
ORG	Dichlorobenzene[1,2-]	95-50-1	120	1
ORG	Dichlorobenzene[1,3-]	541-73-1	120	1
ORG	Dichlorobenzene[1,4-]	106-46-7	250	1
ORG	Dichlorodifluoromethane	75-71-8	129	3
ORG	Dichloroethane[1,1-]	75-34-3	442	3
ORG	Dichloroethane[1,2-]	107-06-2	40.8	12
ORG	Dichloroethene[1,1-]	75-35-4	29.4	4
ORG	Dichloroethene[cis/trans-1,2-]	540-59-0	452	1
ORG	Dichlorophenol[2,4-]	120-83-2	754	3
ORG	Dichlorophenol[2,6-]	87-65-0	21.6	2

Group	Name	Code	TRV (mg/kg/d)	Count*
ORG	Dichloropropane[1,2-]	78-87-5	2.5	3
ORG	Dieldrin	60-57-1	0.049	3
ORG	Diethyl Phthalate	84-66-2	757	2
ORG	Dimethoate	60-51-5	2.4	1
ORG	Dimethyl Phthalate	131-11-3	888	3
ORG	Dimethylphenethylamine[alpha,alpha-]	122-09-8	1.51	1
ORG	Di-n-Butyl Phthalate	84-74-2	234	5
ORG	Di-n-hexylphthalate	84-75-3	55	1
ORG	Dinitro-2-methylphenol[4,6-]	534-52-1	0.23	2
ORG	Dinitrobenzene[1,3-]	99-65-0	2.19	2
ORG	Dinitrophenol[2,4-]	51-28-5	0.36	3
ORG	Dinitrotoluene[2,4-]	121-14-2	1.97	2
ORG	Dinitrotoluene[2,6-]	606-20-2	0.66	2
ORG	Di-n-octylphthalate	117-84-0	6500	1
ORG	Dinoseb	88-85-7	0.1	2
ORG	Dioxane[1,4-]	123-91-1	0.5	1
ORG	Diphenylamine	122-39-4	2.5	1
ORG	Disulfoton	298-04-4	0.032	2
ORG	Endosulfan	115-29-7	1.5	1
ORG	Endosulfan I	959-98-8	0.73	2
ORG	Endosulfan II	33213-65-9	0.73	2
ORG	Endosulfan Sulfate	1031-07-8	0.18	1
ORG	Endrin	72-20-8	0.049	3
ORG	Endrin Aldehyde	7421-93-4	0.047	3
ORG	Ethanol	64-17-5	31.9	1
ORG	Ethyl Acetate	141-78-6	900	1
ORG	Ethyl Methacrylate	97-63-2	75283	3
ORG	Ethyl Parathion	56-38-2	0.014	2
ORG	Ethylbenzene	100-41-4	47.3	1
ORG	Famphur	52-85-7	0.25	3
ORG	Formaldehyde	50-00-0	9.4	1
ORG	Heptachlor	76-44-8	0.12	3
ORG	Heptachlor Epoxide	1024-57-3	0.18	2
ORG	Hexachlorobenzene	118-74-1	1.41	2
ORG	Hexachlorobutadiene	87-68-3	0.39	1
ORG	Hexachlorocyclopentadiene	77-47-4	6.50	3
ORG	Hexachlorodibenzofuran[1,2,3,6,7,8-]	57117-44-9	0.0016	1
ORG	Hexachloroethane	67-72-1	10	2
ORG	Hexachlorophene	70-30-4	0.71	2
ORG	HMX	2691-41-0	342	8
ORG	Iodomethane	74-88-4	1500	1
ORG	Isodrin	465-73-6	0.24	2
ORG	Isophorone	78-59-1	250	1
ORG	Isosafrole	120-58-1	25.3	3
ORG	Kepone	143-50-0	0.16	4
ORG	Methacrylonitrile	126-98-7	0.35	3
ORG	Methanol	67-56-1	500	1

Group	Name	Code	TRV (mg/kg/d)	Count*
ORG	Methoxychlor[4,4'-]	72-43-5	4.34	4
ORG	Methyl Methacrylate	80-62-6	69282	2
ORG	Methyl Methanesulfonate	66-27-3	2.25	1
ORG	Methyl Parathion	298-00-0	0.20	2
ORG	Methyl-1-propanol[2-]	78-83-1	316	1
ORG	Methyl-5-nitroaniline[2-]	99-55-8	5.74	1
ORG	Methylaniline[2-]	95-53-4	11.8	3
ORG	Methylene Chloride	75-09-2	18000	1
ORG	Methylnaphthalene[2-]	91-57-6	16.3	1
ORG	Methylphenol[2-]	95-48-7	69.0	3
ORG	Methylphenol[3-]	108-39-4	70.7	2
ORG	Methylphenol[4-]	106-44-5	328	3
ORG	Methylpyridine[2-]	109-06-8	7.79	2
ORG	Naphthalene	91-20-3	28.2	3
ORG	Nitroaniline[2-]	88-74-4	35.6	1
ORG	Nitroaniline[3-]	99-09-2	4.2	3
ORG	Nitroaniline[4-]	100-01-6	120	1
ORG	Nitrobenzene	98-95-3	13.9	2
ORG	Nitroglycerine	55-63-0	96.4	1
ORG	Nitrophenol[2-]	88-75-5	10.7	3
ORG	Nitrophenol[4-]	100-02-7	31.6	2
ORG	Nitrosodiethylamine[N-]	55-18-5	200	1
ORG	Nitrosodimethylamine(N-)	62-75-9	0.022	3
ORG	Nitrosodi-n-propylamine[N-]	621-64-7	0.51	1
ORG	Nitrosomorpholine[N-]	59-89-2	0.371	1
ORG	Nitrosopyrrolidine[N-]	930-55-2	0.33	2
ORG	Oxybis(1-chloropropane)[2,2'-]	108-60-1	2.4	1
ORG	Pentachlorobenzene	608-93-5	10.8	2
ORG	Pentachlorodibenzofuran[1,2,3,4,8-]	67517-48-0	0.48	1
ORG	Pentachlorodibenzofuran[1,2,3,7,8-]	57117-41-6	0.0016	1
ORG	Pentachlorodibenzofuran[2,3,4,7,8-]	57117-31-4	0.0016	1
ORG	Pentachloroethane	76-01-7	97.8	2
ORG	Pentachloronitrobenzene	82-68-8	28.5	2
ORG	Pentachlorophenol	87-86-5	0.24	1
ORG	Phenacetin	62-44-2	31.5	2
ORG	Phenol	108-95-2	61.3	3
ORG	Phorate	298-02-2	0.0068	2
ORG	Polychlorinated Biphenyls	1336-36-3	0.37	3
ORG	Polychlorinated Dibenzofurans	136677-10-6	0.0013	2
ORG	Polychlorinated dibenzo-p-dioxins	PDD	0.1E-05	1
ORG	Pronamide	23950-58-5	203	1
ORG	Propionitrile	107-12-0	14.7	3
ORG	Pyridine	110-86-1	25	1
ORG	RDX	121-82-4	10.5	5
ORG	Safrole	94-59-7	12.1	2
ORG	Sulfotepp	3689-24-5	3	1
ORG	T[2,4,5-]	93-76-5	21.5	1

Group	Name	Code	TRV (mg/kg/d)	Count*
ORG	Tetrachlorobenzene[1,2,4,5-]	95-94-3	5	1
ORG	Tetrachlorodibenzodioxin[2,3,7,8-]	1746-01-6	0.1E-05	2
ORG	Tetrachloroethane[1,1,1,2-]	630-20-6	86.6	2
ORG	Tetrachloroethane[1,1,2,2-]	79-34-5	0.32	1
ORG	Tetrachloroethene	127-18-4	46.3	2
ORG	Tetrachlorophenol[2,3,4,6-]	58-90-2	11.2	3
ORG	Thionazine	297-97-2	0.21	3
ORG	Toluene	108-88-3	201	3
ORG	Toxaphene (Technical Grade)	8001-35-2	12.1	4
ORG	TP[2,4,5-]	93-72-1	2.6	1
ORG	Trichlorobenzene[1,2,4-]	120-82-1	69.5	3
ORG	Trichloroethane[1,1,1-]	71-55-6	422	4
ORG	Trichloroethane[1,1,2-]	79-00-5	19.5	1
ORG	Trichloroethene	79-01-6	82.4	6
ORG	Trichlorofluoromethane	75-69-4	41.3	4
ORG	Trichlorophenol[2,4,5-]	95-95-4	100	1
ORG	Trichlorophenol[2,4,6-]	88-06-2	1151	2
ORG	Trichloropropane[1,2,3-]	96-18-4	3.63	3
ORG	Triethylphosphorothioate[o,o,o-]	126-68-1	7.5	1
ORG	Trinitrobenzene[1,3,5-]	99-35-4	6.00	2
ORG	Trinitrotoluene[2,4,6-]	118-96-7	15.1	3
ORG	Vinyl Acetate	108-05-4	35	1
ORG	Vinyl Chloride	75-01-4	0.25	3
ORG	Xylene (Total)	1330-20-7	29.7	3

* The value in Count represents the number of TRVs used in the GMM calculation.

Table B-3b. GMM TRVs for Nonradionuclides for Robin

Group	Name	Code	TRV (mg/kg/d)	Count*
INORG	Aluminum	AL	110	1
INORG	Arsenic	AS	0.68	3
INORG	Barium	BA	39.8	3
INORG	Boron	B	10.6	4
INORG	Cadmium	CD	1.45	1
INORG	Chromium (total)	CR	28.7	7
INORG	Cobalt	CO	0.02	1
INORG	Copper	CU	13.8	2
INORG	Cyanide (total)	CN(-1)	0.04	1
INORG	Fluoride	F(-1)	2.6	11
INORG	Lead	PB	0.25	9
INORG	Manganese	MN	237	2
INORG	Mercury	HG	0.38	4
INORG	Methyl Mercury	HGM	0.0064	1
INORG	Molybdenum	MO	3.5	1
INORG	Nickel	NI	77.4	1
INORG	Selenium	SE	0.33	6

Group	Name	Code	TRV (mg/kg/d)	Count*
INORG	Silver	AG	5.44	2
INORG	Tin	SN	6.8	1
INORG	Uranium	U	47.9	3
INORG	Vanadium	V	1.11	3
INORG	Zinc	ZN	63.9	13
ORG	Acrolein	107-02-8	0.055	2
ORG	Acetone	67-64-1	1471	3
ORG	Aldrin	309-00-2	0.15	3
ORG	Aramite	140-57-8	5.31	1
ORG	Aroclor-1242	53469-21-9	0.20	2
ORG	Aroclor-1248	12672-29-6	0.016	2
ORG	Aroclor-1254	11097-69-1	0.13	2
ORG	BHC[beta-]	319-85-7	38.3	1
ORG	BHC[gamma-]	58-89-9	3.0	5
ORG	Bis(2-ethylhexyl)phthalate	117-81-7	1.1	1
ORG	Chlordane[alpha/gamma]	57-74-9	0.32	4
ORG	Chloro-3-methylphenol[4-]	59-50-7	1.13	1
ORG	D[2,4-]	94-75-7	6.8	3
ORG	DDD[4,4'-]	72-54-8	16.7	3
ORG	DDE[4,4'-]	72-55-9	0.00087	3
ORG	DDT	50-29-3	0.23	3
ORG	Diallate	2303-16-4	3.8	2
ORG	Dibromo-3-chloropropane[1,2-]	96-12-8	1.02	2
ORG	Dibromoethane[1,2-]	106-93-4	32.0	1
ORG	Dichloroethane[1,2-]	107-06-2	9.5	4
ORG	Dieldrin	60-57-1	0.54	4
ORG	Dimethoate	60-51-5	0.31	3
ORG	Di-n-Butyl Phthalate	84-74-2	0.1	2
ORG	Dinoseb	88-85-7	0.28	3
ORG	Disulfoton	298-04-4	0.036	3
ORG	Endosulfan	115-29-7	10	1
ORG	Endosulfan I	959-98-8	0.90	2
ORG	Endosulfan II	33213-65-9	0.90	2
ORG	Endrin	72-20-8	0.027	5
ORG	Ethyl Parathion	56-38-2	0.030	3
ORG	Famphur	52-85-7	0.019	3
ORG	Heptachlor	76-44-8	2.1	3
ORG	Hexachlorobenzene	118-74-1	2.0	1
ORG	Hexachlorobutadiene	87-68-3	3.2	1
ORG	Hexachlorophene	70-30-4	9.1	2
ORG	Hexanone[2-]	591-78-6	200	1
ORG	Isodrin	465-73-6	0.15	3
ORG	Kepone	143-50-0	2.6	2
ORG	Methoxychlor[4,4'-]	72-43-5	38.0	2
ORG	Methyl Parathion	298-00-0	1.5	3
ORG	Methyl-2-pentanone[4-]	108-10-1	1	1
ORG	Nitroaniline[2-]	88-74-4	8.3	3

Group	Name	Code	TRV (mg/kg/d)	Count*
ORG	Nitroaniline[3-]	99-09-2	5.6	1
ORG	Pentachloronitrobenzene	82-68-8	7.1	1
ORG	Pentachlorophenol	87-86-5	3.5	2
ORG	Phorate	298-02-2	0.17	2
ORG	Polychlorinated Biphenyls	1336-36-3	0.57	3
ORG	Polychlorinated Dibenzofurans	136677-10-6	1.E-05	1
ORG	T[2,4,5-]	93-76-5	10	1
ORG	Tetrachlorodibenzofuran[2,3,7,8-]	51207-31-9	1.E-05	1
ORG	Thionazine	297-97-2	0.07	3
ORG	Toxaphene	8001-35-2	4.7	3

* Each value in count represents the number of TRVs used in the GMM calculation. If the value is equal to 1, the GMM TRV is equal to a CS TRV.

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APPENDIX C

Primary Toxicity Data Coding

Primary Toxicity Data Coding

Bird-specific age category coding issues

Age was coded according to the age of the test organism at the time of exposure as shown in Table C-1. In experiments in which birds were associated with breeding stage or sexual maturity, birds were classified as Adult. Precocial birds (those that are rather well-developed upon hatching and can follow parents around, feed themselves, etc.; e.g., ducks, chickens, quail) are classified as hatchlings until they reach a point where they appear adult-like. Between this stage and sexual maturation, they are classified as juveniles. Altricial (born naked, blind, helpless) birds are classified as hatchlings until they are able to leave the nest and fly on their own. Between this stage and sexual maturation, they are classified as juveniles. Most songbirds cannot breed the same year they are born; therefore, the general rule applied was songbirds after hatchling age and under 1-year-old were considered juveniles.

Table C-1. Age Category*

Age Category ID	Age Category	Notes
A	Adult	A bird or mammal that has reached sexual maturity.
E	Egg	
E-J	Egg to Juvenile	
EM	Embryo	
F	Fetus	
H	Hatchling	Altricial birds (robins, sparrows) - from hatching to when they leave the nest & fly on their own. Precocial birds (chickens, quail) - from hatching to resembling adult birds.
H-J	Hatchling to Juvenile	
J	Juvenile	A bird that has left the nest, but is not of breeding age.
J-L	Juvenile to Lifespan (death)	
L	Lifespan	
NB	Newborn	
NB-J	Newborn to Juvenile	
NR	Not reported	

*Based on Ehrlich et al. (1988) and Varghese (2000).

Exposure medium and route coding. Exposure medium and exposure route were coded as shown in Tables C-2 and C-3.

Table C-2. Exposure Medium

Exposure Medium ID	Exposure Medium
A	Air
AQS	Aqueous Solution
CO	Corn Oil
DW	Drinking Water
F	Food
NR	Not Reported
OTHER	Other

Table C-3. Exposure Route

Exposure Route ID	Exposure Route
INH	Inhalation
INJ_IP	Injection (intraperitoneal)
INJ_IV	Injection (intravenous)
NR	Not reported
O	Oral
OC	Oral (capsule)
OD	Oral (diet)
OG	Oral (gavage)
OI	Oral (intubation)
OW	Oral (water)

Bird-specific effect (focus measurement) category coding issues

Bird-specific effect (focus measurement) category was coded as shown in Table C-4. For hatchlings to juveniles: If the effect was related to mortality (survival, lethality), growth (body weight gain, loss, or change, feed conversion or consumption, backbone development, crown-rump length), or physical and neurological abnormalities (leg paralysis, tremors), in such a way that significant effects on development and/or reproduction can be expected, it was coded as R/D.

Table C-4. Effect Category

Effect Category ID	Effect Category
G	Growth (Adult)
MULTI-G,O	Multiple effects (growth and other)
MULTI-G,R/D	Multiple effects (growth and reproductive/ developmental)
MULTI-G,R/D,O	Multiple effects (growth, reproductive/ developmental, and other)
MULTI-G,S	Multiple effects (growth and survival)
MULTI-G,S,O	Multiple effects (growth, survival, and other)
MULTI-O	Multiple effects (other)
MULTI-R/D,O	Multiple effects (reproductive/ developmental and other)
MULTI-R/D,S	Multiple effects (reproductive/ developmental and survival)
MULTI-R/D,S,O	Multiple effects (reproductive/ developmental, survival and other)
MULTI-S,O	Multiple effects (survival and other)
NR	Not reported
O	Other effects (cancer, organ toxicity, biochemical)
R/D	Reproductive or developmental
S	Survival (Adult)

Exposure duration category and effect level
Exposure durations were categorized and coded as shown in Table C-5 and effect levels were coded as shown in Table C-6.

Table C-5. Exposure Duration Category

Exposure Duration Category ID	Exposure Duration Category	Exposure Duration Category Definition
A	Acute	<14 days
C	Chronic	>90 days
C-CL	Chronic- critical lifestage	During a critical lifestage (reproduction/ development, growth or survival.)
NR	Not reported	NA
SC	Subchronic	15 to 90 days
SD	Single Dose	Considered acute

Table C-6. Effect Level

Effect Level ID	Effect Level
L	LOAEL or LOEL
N	NOAEL or NOEL
NL	NOAEL and LOAEL or NOEL and LOEL
OTH	Other effect level (LD50, LC50)

Deer Mouse and Elk

Table C-7 and C-8 show the CS TRV and source for radionuclides for the deer mouse and Rocky Mountain elk, respectively. The TRVs for radionuclides (pCi/g soil) for the elk and deer mouse ECORSK models are from spreadsheets (July 2000) that calculate media-specific screening levels for each screening receptor based on LANL Environmental Restoration Project SLERA methodology (LANL 1999). Although the elk is not a LANL Environmental Restoration Project screening receptor, the basic exposure model used for other LANL Environmental Restoration Project screening receptors was used to generate the values used in the ECORSK model for the elk with a few modifications for elk-specific information (e.g., body weight normalized intake rates and soil ingestion fraction of diet). The deer mouse is a LANL Environmental Restoration Project screening receptor and the values used in the ECORSK model are from a spreadsheet used to generate data for the Ecorisk Database. However, the version of this spreadsheet (July 2000) is an intermediate between the April and September versions and does not necessarily correspond to the values in either database version. The TRV data for the elk for Americium-241 (gamma spec) is based on Americium-241, Cesium-137 is based on Cesium-137/Barium-137, Plutonium-239 is based on Plutonium-239/240, and Strontium-90 is based on Strontium-90/Yttrium-90. However, the TRV data set for the deer mouse was missing values in early ECORSK model runs for these chemicals, but they are included in the final model runs for completeness.

Table C-7. Deer Mouse

Name	Code	TRV (pCi/kg soil)	Data Type	Data Source
Americium-241	AM-241	8500	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Americium-241 (gamma spec)	AM-241 (gamma spec)	8500	Secondary	Ecorisk Db Spreadsheet (Jul. 2000), missing from all but final deer mouse ECORSK model run
Cesium-134	CS-134	890	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Cesium-137	CS-137	1300	Secondary	Ecorisk Db Spreadsheet (Jul. 2000), missing from all but final deer mouse ECORSK model run
Cobalt-60	CO-60	960	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Europium-152	EU-152	1700	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Lead-210	PB-210	17000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Neptunium-237	NP-237	510	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Plutonium-238	PU-238	4600	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Plutonium-239	PU-239	4900	Secondary	Ecorisk Db Spreadsheet (Jul. 2000), missing from all but final deer mouse ECORSK model run
Plutonium-239, 240	PU-239/240	4900	Secondary	Ecorisk Db Spreadsheet (Jul. 2000), missing from all but final deer mouse ECORSK model run
Radium-226	RA-226	510	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Radium-228	RA-228	940000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Sodium-22	NA-22	1100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Strontium-90	SR-90	750	Secondary	Ecorisk Db Spreadsheet (Jul. 2000), missing from all but final deer mouse ECORSK model run
Thorium-228	TH-228	5500	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-229	TH-229	4200	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-230	TH-230	5300	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-232	TH-232	6200	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Tritium	H-3	1000000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-234	U-234	4200	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-235	U-235	3600	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-238	U-238	4800	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)

Table C-8. Elk

Name	Code	TRV (pCi/g soil)	Data Type	Data Source
Americium-241	AM-241	430000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Americium-241 (gamma spec)	AM-241 (gamma spec)	430000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Cesium-134	CS-134	3100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Cesium-137	CS-137	7500	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Cobalt-60	CO-60	1900	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Europium-152	EU-152	4400	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Lead-210	PB-210	1000000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Neptunium-237	NP-237	56000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Plutonium-238	PU-238	740000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)

Name	Code	TRV (pCi/g soil)	Data Type	Data Source
Plutonium-239	PU-239	780000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Plutonium-239, 240	PU-239/240	780000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Radium-226	RA-226	18000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Radium-228	RA-228	36000000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Ruthenium-106	RU-106	7200	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Sodium-22	NA-22	2300	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Strontium-90	SR-90	3100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-228	TH-228	660000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-229	TH-229	89000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-230	TH-230	720000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-232	TH-232	850000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Tritium	H-3	5000000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-234	U-234	590000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-235	U-235	41000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-238	U-238	670000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)

Robin

Table C-9 shows the CS TRV and source for radionuclides for the robin. The TRVs for radionuclide chemicals (pCi/g soil) for the robin ECORSK model are also from a spreadsheet (July 2000) that calculates media-specific screening levels for this screening receptor based on LANL Environmental Restoration Project SLERA methodology (LANL 1999). The robin is a LANL Environmental Restoration Project screening receptor and the values used in the ECORSK model are from a spreadsheet used to generate data for the Ecorisk Database. However, the version of the spreadsheet used here is an intermediate between the April and September 2000 versions and does not necessarily correspond to either database version. Also, the TRV data set for the robin was missing values in early ECORSK model runs for the following chemicals; Americium-241 (gamma spec), Cesium-137, Plutonium-239, Plutonium-239/240 and Strontium-90. These chemicals are in the final model run, and Americium-241 (gamma spec) is based on Americium-241, Cesium-137 is based on Cesium-137/Barium-137, Plutonium-239 is based on Plutonium-239/240, and Strontium-90 is based on Strontium-90/Yttrium-90.

Table C-9. Robin

Name	Code	TRV (pCi/g soil)	Data Type	Data Source
Americium-241	AM-241	1800	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Americium-241 (gamma spec)	AM-241 (gamma spec)	1800	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Cesium-134	CS-134	490	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Cesium-137	CS-137	550	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Cobalt-60	CO-60	1500	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Europium-152	EU-152	1200	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Lead-210	PB-210	3700	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Neptunium-237	NP-237	100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Plutonium-238	PU-238	890	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)

Name	Code	TRV (pCi/g soil)	Data Type	Data Source
Plutonium-239	PU-239	940	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Plutonium-239, 240	PU-239/240	940	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Radium-226	RA-226	100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Radium-228	RA-228	200000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Sodium-22	NA-22	2000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Strontium-90	SR-90	430	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-228	TH-228	1100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-229	TH-229	960	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-230	TH-230	1000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Thorium-232	TH-232	1200	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Tritium	H-3	1500000	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-234	U-234	1100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-235	U-235	1100	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)
Uranium-238	U-238	1200	Secondary	Ecorisk Db Spreadsheet (Jul. 2000)

APPENDIX D

Table D-1. Summary of COPC Information for the Rocky Mountain Elk

Table D-2. Summary of COPC Information for the American Robin

Table D-3. Summary of COPC information for the Deer Mouse

Table D-1. Summary of COPC Information for the Rocky Mountain Elk

Analyte	Count	Minimum	Maximum	Units
Acenaphthene	96	0.033	40.5	mg/kg
Acenaphthylene	17	0.036	2.55	mg/kg
Acetone	73	0.002	2.2	mg/kg
Aldrin	500	0.00154	0.0489	mg/kg
Aluminum	1887	8.9	68468	mg/kg
Americium-241	801	0.005	301	pCi/g
Americium-241 (gamma spec)	510	0.0446	18.4	pCi/g
Amino-4,6-dinitrotoluene[2-]	17	0.107	41.4	mg/kg
Aniline	9	0.21	1.9	mg/kg
Anthracene	123	0.037	59.3	mg/kg
Antimony	750	0.03	181	mg/kg
Aroclor-1016	6	0.179	2.17	mg/kg
Aroclor-1221	4	0.35	4.35	mg/kg
Aroclor-1232	4	0.18	2.165	mg/kg
Aroclor-1242	10	0.18	1042	mg/kg
Aroclor-1248	8	0.054	2.82	mg/kg
Aroclor-1254	561	0.035	21.3	mg/kg
Aroclor-1260	572	0.02	65.5	mg/kg
Arsenic	1741	0.24	260.6	mg/kg
Barium	2244	8.6	38000	mg/kg
Benzene	2	0.01	3	mg/kg
Benzo(a)anthracene	205	0.026	160	mg/kg
Benzo(a)pyrene	194	0.03	130	mg/kg
Benzo(b)fluoranthene	247	0.035	200	mg/kg
Benzo(g,h,i)perylene	141	0.038	120.94	mg/kg
Benzo(k)fluoranthene	150	0.027	77	mg/kg
Benzoic acid	68	0.035	3.90	mg/kg
Benzyl Alcohol	7	0.067	3.8	mg/kg
Beryllium	1544	0.07	147	mg/kg
BHC[beta-]	3	0.0023	0.0026	mg/kg
BHC[gamma-]	2	0.0041	0.031	mg/kg
Bis(2-chloroethoxy)methane	5	0.34	1.9	mg/kg
Bis(2-chloroethyl)ether	5	0.34	1.9	mg/kg
Bis(2-ethylhexyl)phthalate	227	0.034	83.5	mg/kg
Boron	1	6.4	6.4	mg/kg
Bromodichloromethane	1	0.004	0.004	mg/kg
Butanone[2-]	16	0.003	0.275	mg/kg
Butyl benzyl phthalate	27	0.056	30	mg/kg
Cadmium	990	0.026	1540	mg/kg
Carbon Disulfide	5	0.004	0.0109	mg/kg
Cesium-134	500	0.0077	3.37	pCi/g
Cesium-137	1151	0.032	658	pCi/g
Chlordane[alpha-]	507	0.00159	0.131	mg/kg

Chlordane[gamma-]	505	0.0015	0.18	mg/kg
Chloro-3-methylphenol[4-]	7	0.67	5.31	mg/kg
Chlorobenzene	1	2.5	2.5	mg/kg
Chlorophenol[2-]	8	0.34	67	mg/kg
Chromium (total)	521	0.88	18.3	mg/kg
Chromium(+6)	3	0.98	5.9	mg/kg
Chrysene	234	0.03	190	mg/kg
Cobalt	1317	0.33	255	mg/kg
Cobalt-60	515	-0.028	27.7	pCi/g
Copper	1821	0.83	38802	mg/kg
Cyanide (total)	44	0.05	66.8	mg/kg
D[2,4-]	2	1.89	2.32	mg/kg
DDE[4,4'-]	521	0.0014	0.607	mg/kg
DDT[4,4'-]	527	0.0034	0.66	mg/kg
Dibenzo(a,h)anthracene	79	0.033	35.5	mg/kg
Dibenzofuran	62	0.043	19.1	mg/kg
Dichlorobenzene[1,2-]	8	0.0016	60.8	mg/kg
Dichlorobenzene[1,3-]	8	0.0015	1.9	mg/kg
Dichlorobenzene[1,4-]	10	0.0016	1.9	mg/kg
Dichlorodifluoromethane	4	0.001	0.038	mg/kg
Dichloroethylene[1,1-]	1	2.9	2.9	mg/kg
Dichlorophenol[2,4-]	5	0.34	1.9	mg/kg
Dieldrin	17	0.0007	0.048	mg/kg
Diethyl Phthalate	18	0.041	90	mg/kg
Dimethylphthalate	7	0.06	1.9	mg/kg
Di-n-Butyl Phthalate	114	0.035	92	mg/kg
Dinitro-2-methylphenol[4,6-]	5	1.6	9.5	mg/kg
Dinitrobenzene[1,3-]	3	0.072	1.04	mg/kg
Dinitrophenol[2,4-]	5	1.6	9.5	mg/kg
Dinitrotoluene[2,4-]	30	0.046	47.5	mg/kg
Dinitrotoluene[2,6-]	16	0.053	1.9	mg/kg
Di-n-octylphthalate	17	0.037	4.5	mg/kg
Dinoseb	1	0.692	0.692	mg/kg
Diphenylamine	1	1.1	1.1	mg/kg
Endosulfan I	7	0.0061	0.232	mg/kg
Endosulfan II	14	0.0021	0.024	mg/kg
Endosulfan Sulfate	4	0.0019	0.018	mg/kg
Endrin	7	0.0025	0.605	mg/kg
Endrin Aldehyde	8	0.0031	0.18	mg/kg
Europium-152	530	0.031	0.713	pCi/g
Fluoranthene	295	0.034	320	mg/kg
Fluorene	82	0.04	36.9	mg/kg
Heptachlor	2	0.0061	0.028	mg/kg
Heptachlor Epoxide	7	0.0015	0.11	mg/kg
Hexachlorobenzene	7	0.176	1.9	mg/kg
Hexachlorobutadiene	5	0.34	1.9	mg/kg
Hexachlorocyclopentadiene	5	0.34	1.9	mg/kg
Hexachloroethane	5	0.34	1.9	mg/kg

HMX	52	0.18	55050	mg/kg
Indeno(1,2,3-cd)pyrene	150	0.039	80	mg/kg
Isophorone	5	0.34	1.9	mg/kg
Lead	2271	1.5	66223	mg/kg
Lead-210	58	0.87	57.4	pCi/g
Lithium	227	2.44	51.7	mg/kg
Manganese	1965	65.1	1488	mg/kg
Mercury	986	0.0061	259	mg/kg
Methoxychlor[4,4'-]	7	0.027	70.5	mg/kg
Methyl-2-pentanone[4-]	5	0.003	0.06	mg/kg
Methylene Chloride	56	0.0027	0.13	mg/kg
Methylnaphthalene[2-]	41	0.035	9.3	mg/kg
Methylphenol[2-]	8	0.068	1.9	mg/kg
Methylphenol[3-]	1	0.35	0.35	mg/kg
Methylphenol[4-]	21	0.038	1.9	mg/kg
Molybdenum	27	1.7	21	mg/kg
Naphthalene	73	0.002	26.6	mg/kg
Neptunium-237	21	0.422	1.49	pCi/g
Nickel	1491	0.91	1200	mg/kg
Nitroaniline[2-]	5	1.6	9.5	mg/kg
Nitroaniline[3-]	5	1.6	9.5	mg/kg
Nitroaniline[4-]	6	0.67	3.8	mg/kg
Nitrobenzene	13	0.098	7.06	mg/kg
Nitrophenol[2-]	5	0.34	1.9	mg/kg
Nitrophenol[4-]	6	1.6	9.5	mg/kg
Nitrosodimethylamine(N-)	6	0.34	330	mg/kg
Nitrosodi-n-propylamine[N-]	6	0.34	1.9	mg/kg
Nitrotoluene[2-]	4	0.16	1.76	mg/kg
Nitrotoluene[3-]	7	0.16	2.68	mg/kg
Nitrotoluene[4-]	3	0.469	4.33	mg/kg
Oxybis(1-chloropropane)[2,2'-]	4	0.34	0.35	mg/kg
Pentachlorophenol	8	0.23	9.5	mg/kg
Phenanthrene	247	0.04	178	mg/kg
Phenol	16	0.043	82.5	mg/kg
Plutonium-238	980	0.0004	353	pCi/g
Plutonium-239	891	0.002	832	pCi/g
Plutonium-239, 240	495	0.53	2.17	pCi/g
Polychlorinated Biphenyls	63	0.02	1042	mg/kg
Pyrene	302	0.0345	280	mg/kg
Pyridine	1	1.6	1.6	mg/kg
Radium-226	264	0.599	304	pCi/g
Radium-228	2	1.364	1.954	pCi/g
RDX	31	0.191	29600	mg/kg
Ruthenium-106	498	0.010	9.25	pCi/g
Selenium	723	0.070	361	mg/kg
Silver	727	0.11	410	mg/kg
Sodium-22	502	0.0021	0.38	pCi/g
Strontium	364	3.8	187	mg/kg

Strontium-90	643	0.00041	525	pCi/g
Tetrachloroethene	18	0.001	0.08	mg/kg
Tetryl	16	0.091	9.5	mg/kg
Thallium	729	0.02	121	mg/kg
Thorium-228	198	0.052	12.8	pCi/g
Thorium-229	1	0.29	0.29	pCi/g
Thorium-230	268	0.056	9.69	pCi/g
Thorium-232	235	0.053	15.2	pCi/g
Toluene	56	0.0013	0.88	mg/kg
Trichlorobenzene[1,2,4-]	8	0.14	1.9	mg/kg
Trichloroethane[1,1,1-]	13	0.002	21	mg/kg
Trichloroethene	20	0.0012	2.4	mg/kg
Trichlorofluoromethane	23	0.001	0.019	mg/kg
Trichlorophenol[2,4,5-]	5	0.35	9.5	mg/kg
Trichlorophenol[2,4,6-]	6	0.34	9.3	mg/kg
Trinitrobenzene[1,3,5-]	4	0.17	3.09	mg/kg
Trinitrotoluene[2,4,6-]	17	0.1275	4570	mg/kg
Tritium	580	0.003	227067	pCi/g
Uranium	1108	0.157	34540	mg/kg
Uranium (total)	4	3.255	5.9	mg/kg
Uranium-234	1049	0.154	7242	pCi/g
Uranium-235	778	0.0021	693	pCi/g
Uranium-238	1032	0.088	1687	pCi/g
Vanadium	1775	0.85	239	mg/kg
Xylene (Total)	7	0.0023	0.102	mg/kg
Zinc	2128	7.35	4979	mg/kg

Table D-2. Summary of COPC Information for the American Robin

Analyte	Count	Minimum	Maximum	Units
Acenaphthene	96	0.033	40.5	mg/kg
Acetone	73	0.002	2.2	mg/kg
Aldrin	500	0.0015	0.049	mg/kg
Aluminum	1887	8.9	68468	mg/kg
Americium-241	801	0.005	301	pCi/g
Anthracene	123	0.037	59.3	mg/kg
Antimony	750	0.03	181	mg/kg
Aroclor-1016	6	0.18	2.17	mg/kg
Aroclor-1221	4	0.35	4.35	mg/kg
Aroclor-1232	4	0.18	2.17	mg/kg
Aroclor-1242	10	0.18	1042	mg/kg
Aroclor-1248	8	0.054	2.82	mg/kg
Aroclor-1254	561	0.035	21.3	mg/kg
Aroclor-1260	572	0.02	65.5	mg/kg
Arsenic	1741	0.24	261	mg/kg
Azobenzene	6	0.43	11.1	mg/kg
Barium	2244	8.6	38000	mg/kg
Benzene	2	0.01	3	mg/kg
Benzoic acid	68	0.035	3.90	mg/kg
Beryllium	1544	0.07	147	mg/kg
BHC[beta-]	3	0.0023	0.0026	mg/kg
BHC[gamma-]	2	0.0041	0.0308	mg/kg
Bis(2-ethylhexyl)phthalate	227	0.034	83.5	mg/kg
Boron	1	6.4	6.4	mg/kg
Bromodichloromethane	1	0.004	0.004	mg/kg
Butyl benzyl phthalate	27	0.056	30	mg/kg
Cadmium	990	0.026	1540	mg/kg
Calcium	1416	2.12	58100	mg/kg
Carbon Disulfide	5	0.004	0.011	mg/kg
Cesium-134	500	0.0077	3.37	pCi/g
Chlordane[alpha-]	507	0.0016	0.13	mg/kg
Chlordane[gamma-]	505	0.0015	0.18	mg/kg
Chloro-3-methylphenol[4-]	7	0.67	5.31	mg/kg
Chlorobenzene	1	2.5	2.5	mg/kg
Chlorophenol[2-]	8	0.34	67	mg/kg
Chromium (total)	521	0.88	18.3	mg/kg
Chromium(+6)	3	0.98	5.9	mg/kg
Cobalt	1317	0.33	255	mg/kg
Cobalt-60	515	-0.028	27.7	pCi/g
Copper	1821	0.83	38802	mg/kg
Cyanide (total)	44	0.05	66.8	mg/kg
D[2,4-]	2	1.89	2.32	mg/kg
DDD[4,4'-]	6	0.0045	0.132	mg/kg

DDE[4,4'-]	521	0.0014	0.607	mg/kg
DDT[4,4'-]	527	0.0034	0.66	mg/kg
Dichlorobenzene[1,2-]	8	0.0016	60.8	mg/kg
Dichlorodifluoromethane	4	0.001	0.038	mg/kg
Dichlorophenol[2,4-]	5	0.34	1.9	mg/kg
Dieldrin	17	0.0007	0.048	mg/kg
Diethyl Phthalate	18	0.041	90	mg/kg
Dimethylphenol[2,4-]	7	0.13	1.9	mg/kg
Dimethylphthalate	7	0.06	1.9	mg/kg
Di-n-Butyl Phthalate	114	0.035	92	mg/kg
Dinitrobenzene[1,3-]	3	0.072	1.04	mg/kg
Dinitrophenol[2,4-]	5	1.6	9.5	mg/kg
Dinitrotoluene[2,4-]	30	0.046	47.5	mg/kg
Di-n-octylphthalate	17	0.037	4.5	mg/kg
Dinoseb	1	0.692	0.692	mg/kg
Diphenylamine	1	1.1	1.1	mg/kg
Endosulfan I	7	0.0061	0.23	mg/kg
Endosulfan II	14	0.0021	0.024	mg/kg
Endosulfan Sulfate	4	0.0019	0.018	mg/kg
Endrin	7	0.0025	0.60	mg/kg
Endrin Aldehyde	8	0.0031	0.18	mg/kg
Europium-152	530	0.031	0.71	pCi/g
Fluoranthene	295	0.034	320	mg/kg
Fluorene	82	0.04	36.9	mg/kg
Heptachlor	2	0.0061	0.028	mg/kg
Heptachlor Epoxide	7	0.0015	0.11	mg/kg
Hexachlorobenzene	7	0.18	1.9	mg/kg
Hexachlorocyclopentadiene	5	0.34	1.9	mg/kg
Hexachloroethane	5	0.34	1.9	mg/kg
HMX	52	0.18	55050	mg/kg
Isophorone	5	0.34	1.9	mg/kg
Lead	2271	1.5	66223	mg/kg
Lead-210	58	0.87	57.4	pCi/g
Lithium	227	2.44	51.7	mg/kg
Magnesium	1300	1.08	7530	mg/kg
Manganese	1965	65.1	1488	mg/kg
Mercury	986	0.0061	259	mg/kg
Methoxychlor[4,4'-]	7	0.027	70.5	mg/kg
Methylene Chloride	56	0.0027	0.13	mg/kg
Methylphenol[2-]	8	0.068	1.9	mg/kg
Methylphenol[4-]	21	0.038	1.9	mg/kg
Molybdenum	27	1.7	21	mg/kg
Naphthalene	73	0.002	26.6	mg/kg
Neptunium-237	21	0.422	1.49	pCi/g
Nickel	1491	0.91	1200	mg/kg
Nitrobenzene	13	0.098	7.06	mg/kg
Nitrotoluene[3-]	7	0.16	2.678	mg/kg
Pentachlorophenol	8	0.23	9.5	mg/kg

Phenol	16	0.043	82.5	mg/kg
Plutonium-238	980	0.0004	353	pCi/g
Plutonium-239, 240	495	0.53	2.17	pCi/g
Polychlorinated Biphenyls	63	0.02	1042	mg/kg
Pyrene	302	0.035	280	mg/kg
Radium-226	264	0.60	304	pCi/g
Radium-228	2	1.36	1.95	pCi/g
RDX	31	0.19	29600	mg/kg
Selenium	723	0.070	361	mg/kg
Silver	727	0.11	410	mg/kg
Sodium	765	0.83	30888	mg/kg
Sodium-22	502	0.0021	0.38	pCi/g
Tetrachloroethene	18	0.001	0.08	mg/kg
Thallium	729	0.02	121.3	mg/kg
Thorium-228	198	0.052	12.8	pCi/g
Thorium-229	1	0.29	0.29	pCi/g
Thorium-230	268	0.056	9.69	pCi/g
Thorium-232	235	0.053	15.2	pCi/g
Toluene	56	0.0013	0.88	mg/kg
Trichloro-1,2,2-trifluoroethane[1,1,2-]	5	0.006	3	mg/kg
Trichlorobenzene[1,2,4-]	8	0.14	1.9	mg/kg
Trichloroethane[1,1,1-]	13	0.002	21	mg/kg
Trichlorofluoromethane	23	0.001	0.019	mg/kg
Trichlorophenol[2,4,5-]	5	0.35	9.5	mg/kg
Trinitrobenzene[1,3,5-]	4	0.17	3.09	mg/kg
Trinitrotoluene[2,4,6-]	17	0.13	4570	mg/kg
Tritium	580	0.003	227067	pCi/g
Uranium	1108	0.157	34540	mg/kg
Uranium-234	1049	0.154	7242	pCi/g
Uranium-235	778	0.0021	693	pCi/g
Uranium-238	1032	0.088	1687	pCi/g
Vanadium	1775	0.85	239	mg/kg
Xylene (Total)	7	0.0023	0.102	mg/kg
Zinc	2128	7.35	4979	mg/kg

Table D-3. Summary of COPC Information for the Deer Mouse

Analyte	Count	Minimum	Maximum
Acenaphthene	96	0.033	40.5
Acenaphthylene	17	0.036	2.55
Acetone	73	0.002	2.2
Aldrin	500	0.001543	0.0489
Aluminum	1887	8.9	68468
Americium-241	801	0.005	301.155
Americium-241 (gamma spec)	510	0.044594	18.4
Amino-4,6-dinitrotoluene[2-]	17	0.107	41.4
Aniline	9	0.21	1.9
Anthracene	123	0.037	59.3
Antimony	750	0.03	181
Aroclor-1016	6	0.178933	2.165
Aroclor-1221	4	0.35	4.35
Aroclor-1232	4	0.18	2.165
Aroclor-1242	10	0.18	1042
Aroclor-1248	8	0.0535	2.819867
Aroclor-1254	561	0.035438	21.3
Aroclor-1260	572	0.02	65.48822
Arsenic	1741	0.24	260.6
Barium	2244	8.6	38000
Benzene	2	0.01	3
Benzo(a)anthracene	205	0.026	160
Benzo(a)pyrene	194	0.03	130
Benzo(b)fluoranthene	247	0.035	200
Benzo(g,h,i)perylene	141	0.038	120.94
Benzo(k)fluoranthene	150	0.027	77
Benzoic acid	68	0.035	3.903333
Benzyl Alcohol	7	0.067	3.8
Beryllium	1544	0.07	146.7
BHC[beta-]	3	0.0023	0.0026
BHC[gamma-]	2	0.0041	0.0308
Bis(2-chloroethoxy)methane	5	0.34	1.9
Bis(2-chloroethyl)ether	5	0.34	1.9
Bis(2-ethylhexyl)phthalate	227	0.034	83.5
Boron	1	6.4	6.4
Bromodichloromethane	1	0.004	0.004
Butanone[2-]	16	0.003	0.275
Butyl benzyl phthalate	27	0.056	30
Cadmium	990	0.0264	1540
Carbon Disulfide	5	0.004	0.0109
Cesium-134	500	0.007669	3.37
Cesium-137	1151	0.032	657.822
Chlordane[alpha-]	507	0.001589	0.1305
Chlordane[gamma-]	505	0.0015	0.18
Chloro-3-methylphenol[4-]	7	0.67	5.31

Chlorobenzene	1	2.5	2.5
Chlorophenol[2-]	8	0.34	67
Chromium (total)	521	0.88	18.3
Chromium(+6)	3	0.98	5.9
Chrysene	234	0.03	190
Cobalt	1317	0.33	255.34
Cobalt-60	515	-0.028	27.7
Copper	1821	0.83	38801.6
Cyanide (total)	44	0.05	66.795
D[2,4-]	2	1.89	2.32
DDE[4,4'-]	521	0.0014	0.607
DDT[4,4'-]	527	0.003379	0.6585
Dibenzo(a,h)anthracene	79	0.033	35.5
Dibenzofuran	62	0.043	19.1
Dichlorobenzene[1,2-]	8	0.00155	60.77
Dichlorobenzene[1,3-]	8	0.00151	1.9
Dichlorobenzene[1,4-]	10	0.00156	1.9
Dichlorodifluoromethane	4	0.001	0.038
Dichloroethylene[1,1-]	1	2.9	2.9
Dichlorophenol[2,4-]	5	0.34	1.9
Dieldrin	17	0.0007	0.048
Diethyl Phthalate	18	0.041	90
Dimethylphthalate	7	0.06	1.9
Di-n-Butyl Phthalate	114	0.035	92
Dinitro-2-methylphenol[4,6-]	5	1.6	9.5
Dinitrobenzene[1,3-]	3	0.072	1.0385
Dinitrophenol[2,4-]	5	1.6	9.5
Dinitrotoluene[2,4-]	30	0.046	47.546
Dinitrotoluene[2,6-]	16	0.053	1.9
Di-n-octylphthalate	17	0.037	4.5
Dinoseb	1	0.692	0.692
Diphenylamine	1	1.1	1.1
Endosulfan I	7	0.0061	0.232
Endosulfan II	14	0.00205	0.024
Endosulfan Sulfate	4	0.00188	0.018
Endrin	7	0.0025	0.6045
Endrin Aldehyde	8	0.00314	0.18
Europium-152	530	0.03087	0.713
Fluoranthene	295	0.034	320
Fluorene	82	0.04	36.9
Heptachlor	2	0.0061	0.0284
Heptachlor Epoxide	7	0.00148	0.11
Hexachlorobenzene	7	0.1755	1.9
Hexachlorobutadiene	5	0.34	1.9
Hexachlorocyclopentadiene	5	0.34	1.9
Hexachloroethane	5	0.34	1.9
HMX	52	0.179	55050
Indeno(1,2,3-cd)pyrene	150	0.039	80

Isophorone	5	0.34	1.9
Lead	2271	1.5	66223
Lead-210	58	0.87	57.35
Lithium	227	2.44	51.66667
Manganese	1965	65.1	1487.5
Mercury	986	0.00611	258.8573
Methoxychlor[4,4'-]	7	0.027	70.5206
Methyl-2-pentanone[4-]	5	0.003	0.06
Methylene Chloride	56	0.002735	0.13
Methylnaphthalene[2-]	41	0.035	9.3
Methylphenol[2-]	8	0.068	1.9
Methylphenol[3-]	1	0.35	0.35
Methylphenol[4-]	21	0.038	1.9
Molybdenum	27	1.7	21
Naphthalene	73	0.002	26.6
Neptunium-237	21	0.422	1.49
Nickel	1491	0.91	1200
Nitroaniline[2-]	5	1.6	9.5
Nitroaniline[3-]	5	1.6	9.5
Nitroaniline[4-]	6	0.67	3.8
Nitrobenzene	13	0.098	7.06
Nitrophenol[2-]	5	0.34	1.9
Nitrophenol[4-]	6	1.6	9.5
Nitrosodimethylamine(N-)	6	0.34	330
Nitrosodi-n-propylamine[N-]	6	0.34	1.9
Nitrotoluene[2-]	4	0.16	1.755
Nitrotoluene[3-]	7	0.16	2.678
Nitrotoluene[4-]	3	0.469	4.325
Oxybis(1-chloropropane)[2,2'-]	4	0.34	0.35
Pentachlorophenol	8	0.23	9.5
Phenanthrene	247	0.04	177.9
Phenol	16	0.043	82.5
Plutonium-238	980	0.0004	353.1499
Plutonium-239	891	0.002	832.2161
Plutonium-239, 240	495	0.527473	2.166147
Polychlorinated Biphenyls	63	0.02	1042
Pyrene	302	0.0345	280
Pyridine	1	1.6	1.6
Radium-226	264	0.599	304
Radium-228	2	1.364	1.954
RDX	31	0.191	29600
Selenium	723	0.0696	361
Silver	727	0.1139	410
Sodium-22	502	0.002132	0.38
Strontium	364	3.8	186.5
Strontium-90	643	0.000415	525
Tetrachloroethene	18	0.001	0.08
Tetryl	16	0.091	9.5

Thallium	729	0.02	121.3
Thorium-228	198	0.05205	12.79273
Thorium-229	1	0.2875	0.2875
Thorium-230	268	0.0555	9.688
Thorium-232	235	0.0529	15.19455
Toluene	56	0.00129	0.882
Trichlorobenzene[1,2,4-]	8	0.14	1.9
Trichloroethane[1,1,1-]	13	0.002	21
Trichloroethene	20	0.00117	2.4
Trichlorofluoromethane	23	0.001	0.019
Trichlorophenol[2,4,5-]	5	0.35	9.5
Trichlorophenol[2,4,6-]	6	0.34	9.3
Trinitrobenzene[1,3,5-]	4	0.17	3.092667
Trinitrotoluene[2,4,6-]	17	0.1275	4570
Tritium	580	0.003	227066.7
Uranium	1108	0.157	34540
Uranium (total)	4	3.255	5.9
Uranium-234	1049	0.154212	7241.591
Uranium-235	778	0.002053	692.9953
Uranium-238	1032	0.088	1687.3
Vanadium	1775	0.845	238.8533
Xylene (Total)	7	0.00228	0.102
Zinc	2128	7.35	4979.233

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APPENDIX E

ECORSK.6 Results for Baseline Modeling Scenario for Elk, Robin, and Deer Mouse

Table E-1a. Mean HIs for 200 Elk Focal Areas

Nest x-coordinate	Nest y-coordinate	HI	Observation No.
298	321	0.48	1
465	413	0.79	2
51	494	0.27	3
244	371	0.87	4
67	342	0.39	5
475	332	0	6
218	344	0.82	7
333	484	2.06	8
426	443	0.75	9
138	490	0.43	10
248	310	0.49	11
413	352	0.06	12
445	281	0	13
344	474	1.47	14
371	313	0.17	15
407	329	0.13	16
30	299	0.26	17
217	347	0.82	18
266	337	0.66	19
473	301	0	20
132	339	0.46	21
347	358	0.34	22
225	241	0.18	23
72	493	0.12	24
410	403	0.35	25
138	363	0.64	26
104	448	0.93	27
483	188	0	28
99	414	1.12	29
132	408	1.35	30
250	404	0.91	31
136	481	0.50	32
267	462	3.02	33
269	451	3.12	34
258	461	2.92	35
140	367	0.64	36
103	337	0.53	37
376	285	0.17	38
353	537	1.71	39
476	417	0.76	40
487	330	0	41
492	317	0	42

Table E-1a. (Con't.)

Nest x-coordinate	Nest y-coordinate	HI	Observation No.
355	332	0.34	43
240	504	2.78	44
308	367	0.84	45
186	228	0.16	46
180	302	0.48	47
318	276	0.35	48
319	327	0.53	49
277	267	0.27	50
485	417	0.74	51
352	440	1.19	52
386	224	0.02	53
268	478	2.79	54
327	510	2.62	55
370	225	0.09	56
375	410	0.38	57
418	222	0.01	58
25	314	0.28	59
479	315	0	60
124	473	0.64	61
284	482	2.84	62
207	336	0.90	63
64	476	0.22	64
441	294	0	65
93	394	1.21	66
138	455	1.19	67
386	292	0.15	68
358	434	1.09	69
142	347	0.51	70
178	240	0.19	71
236	419	0.72	72
69	385	0.81	73
380	226	0.03	74
349	498	1.76	75
433	379	0	76
156	436	1.17	77
209	289	0.33	78
413	187	0.05	79
381	392	0.01	80
392	377	0	81
338	345	0.48	82
319	237	0.23	83
488	337	0	84
128	303	0.07	85
34	440	0.32	86
128	396	1.37	87
332	305	0.49	88
73	313	0.25	89
59	309	0.23	90
452	304	0	91

Table E-1a. (Con't.)

Nest x-coordinate	Nest y-coordinate	HI	Observation No.
65	316	0.28	92
19	296	0.27	93
402	224	0.01	94
218	358	0.82	95
37	375	0.36	96
438	436	0.70	97
319	346	0.49	98
278	307	0.46	99
351	361	0.30	100
167	442	1.12	101
43	463	0.34	102
192	229	0.16	103
267	365	1.00	104
239	477	2.39	105
363	364	0.11	106
323	468	2.14	107
335	371	0.46	108
152	23	1.05	109
131	511	0.50	110
56	447	0.36	111
157	345	0.62	112
294	261	0.25	113
128	413	1.41	114
253	282	0.27	115
175	405	0.71	116
517	331	0	117
283	242	0.27	118
351	442	1.22	119
357	532	1.82	120
189	288	0.32	121
332	277	0.34	122
109	341	0.52	123
404	405	0.41	124
134	301	0.12	125
46	450	0.35	126
307	476	2.51	127
335	245	0.25	128
62	354	0.38	129
90	289	0.11	130
175	335	0.59	131
237	321	0.79	132
365	471	1.10	133
207	376	0.97	134
320	350	0.47	135
119	352	0.54	136
193	349	0.75	137
349	360	0.31	138
241	398	1.04	139
433	287	0	140

Table E-1a. (Con't.)

Nest x-coordinate	Nest y-coordinate	HI	Observation No.
360	229	0.14	141
397	492	1.53	142
162	339	0.52	143
179	226	0.16	144
172	287	0.25	145
169	360	0.68	146
44	305	0.25	147
110	403	1.19	148
24	309	0.30	149
102	292	0.10	150
164	333	0.54	151
93	514	0.15	152
240	417	0.69	153
154	394	1.19	154
215	361	0.81	155
425	222	0	156
394	444	0.84	157
399	415	0.72	158
292	330	0.46	159
218	350	0.81	160
191	305	0.55	161
364	377	0.11	162
294	478	2.75	163
282	266	0.26	164
169	397	0.78	165
417	209	0	166
82	317	0.26	167
468	290	0	168
411	374	0	169
302	379	0.91	170
467	325	0	171
389	418	0.79	172
77	304	0.22	173
172	473	1.13	174
138	427	1.23	175
334	522	1.99	176
115	426	1.04	177
167	425	0.79	178
375	293	0.17	179
74	437	0.64	180
57	380	0.68	181
410	321	0.12	182
218	369	0.75	183
434	210	0	184
433	203	0	185
261	356	1.00	186
51	339	0.33	187
304	310	0.48	188
255	288	0.23	189

Table E-1a. (Con't.)

Nest x-coordinate	Nest y-coordinate	HI	Observation No.
324	347	0.51	190
88	380	0.97	191
279	458	3.07	192
13	375	0.23	194
77	301	0.20	195
491	336	0	196
47	339	0.29	197
234	255	0.25	198
368	257	0.02	199
385	327	0.13	200

Table E-1b. Mean HQ by COPC for Elk Baseline Modeling Scenario

Mean HQ	Standard Dev.	Number Observations	Analyte	Observation Number
5.3E-01	5.9E-01	2.0000000E+02	Aluminum	1
1.6E-02	2.9E-02	2.0000000E+02	Lead	2
1.4E-04	1.7E-04	2.0000000E+02	Manganese	3
1.2E-04	2.1E-04	2.0000000E+02	Mercury	4
5.8E-09	2.4E-08	2.0000000E+02	Plutonium-238	5
2.0E-08	6.3E-08	2.0000000E+02	Plutonium-239	6
4.0E-05	8.8E-05	2.0000000E+02	Uranium	7
7.9E-02	9.0E-02	2.0000000E+02	Zinc	8
5.3E-06	1.4E-05	2.0000000E+02	Cesium-137	9
8.6E-07	1.5E-06	2.0000000E+02	Radium-226	10
8.7E-09	1.6E-08	2.0000000E+02	Sodium-22	11
1.2E-10	2.4E-10	2.0000000E+02	Europium-152	12
2.6E-04	3.1E-04	2.0000000E+02	Vanadium	13
3.1E-03	3.6E-03	2.0000000E+02	Barium	14
1.2E-03	1.6E-03	2.0000000E+02	Copper	15
7.2E-13	1.0E-12	2.0000000E+02	Methylene Chloride	16
3.2E-12	5.8E-12	2.0000000E+02	Lead-210	17
9.3E-05	2.7E-04	2.0000000E+02	RDX	18
1.9E-07	4.6E-07	2.0000000E+02	Uranium-235	19
5.8E-05	1.0E-04	2.0000000E+02	Thallium	20
4.0E-05	5.1E-05	2.0000000E+02	Beryllium	21
3.3E-03	3.5E-03	2.0000000E+02	Nickel	22
7.8E-11	2.2E-10	2.0000000E+02	Toluene	23
3.4E-10	1.0E-09	2.0000000E+02	Trichloroethene	24
1.3E-10	3.4E-10	2.0000000E+02	Xylene (Total)	25
2.1E-03	2.2E-03	2.0000000E+02	Cadmium	26
6.1E-11	1.7E-10	2.0000000E+02	Methyl-2-pentanone[4-]	27
8.8E-04	9.7E-04	2.0000000E+02	Arsenic	28
1.9E-03	2.5E-03	2.0000000E+02	Cobalt	29
1.0E-08	1.6E-08	2.0000000E+02	Acetone	30
3.3E-09	5.2E-09	2.0000000E+02	Thorium-228	31
1.2E-08	2.5E-08	2.0000000E+02	Di-n-Butyl Phthalate	32
1.5E-07	3.5E-07	2.0000000E+02	Uranium-234	33
6.9E-08	1.4E-07	2.0000000E+02	Uranium-238	34

Table E-1b. (Con't.)

Mean HQ	Standard Dev.	Number Observations	Analyte	Observation Number
2.5E-07	3.8E-07	2.0000000E+02	Bis(2-ethylhexyl)phthalate	35
3.0E-09	3.9E-09	2.0000000E+02	Thorium-230	36
5.0E-09	8.2E-09	2.0000000E+02	Thorium-232	37
1.9E-08	3.0E-08	2.0000000E+02	Acenaphthene	38
1.5E-07	2.1E-07	2.0000000E+02	Anthracene	39
6.9E-06	9.9E-06	2.0000000E+02	Benzo(a)anthracene	40
2.7E-06	3.9E-06	2.0000000E+02	Benzo(a)pyrene	41
3.1E-06	4.5E-06	2.0000000E+02	Benzo(b)fluoranthene	42
7.2E-07	9.7E-07	2.0000000E+02	Benzo(g,h,i)perylene	43
8.9E-07	1.3E-06	2.0000000E+02	Benzo(k)fluoranthene	44
8.3E-06	1.2E-05	2.0000000E+02	Chrysene	45
3.9E-07	9.2E-07	2.0000000E+02	Cyanide (total)	46
8.8E-07	1.5E-06	2.0000000E+02	Dibenzo(a,h)anthrace	47
7.8E-04	1.3E-03	2.0000000E+02	Dibenzofuran	48
1.9E-06	2.7E-06	2.0000000E+02	Fluoranthene	49
1.6E-07	2.6E-07	2.0000000E+02	Fluorene	50
8.0E-07	1.1E-06	2.0000000E+02	Indeno(1,2,3-cd)pyrene	51
1.6E-06	2.1E-06	2.0000000E+02	Phenanthrene	52
8.6E-06	1.2E-05	2.0000000E+02	Pyrene	53
1.6E-06	2.2E-06	2.0000000E+02	Silver	54
2.1E-04	2.5E-04	2.0000000E+02	Antimony	55
4.6E-08	6.7E-08	2.0000000E+02	Naphthalene	56
1.2E-11	2.2E-11	2.0000000E+02	Di-n-octylphthalate	57
4.1E-09	9.4E-09	2.0000000E+02	Butyl benzyl phthalate	58
7.2E-07	2.0E-06	2.0000000E+02	Dinitrotoluene[2,4-]	59
9.7E-08	1.7E-07	2.0000000E+02	Dinitrotoluene[2,6-]	60
1.5E-08	4.3E-08	2.0000000E+02	Nitrobenzene	61
5.3E-08	1.1E-07	2.0000000E+02	Aldrin	62
4.1E-12	9.9E-12	2.0000000E+02	Americium-241 (gamma spec)	63
2.7E-08	8.2E-08	2.0000000E+02	Americium-241	64
2.1E-05	3.3E-05	2.0000000E+02	Aroclor-1254	65
3.5E-05	7.1E-05	2.0000000E+02	Aroclor-1260	66
4.0E-08	9.3E-08	2.0000000E+02	Cesium-134	67
9.0E-09	1.8E-08	2.0000000E+02	Chlordane[alpha-]	68
8.4E-09	1.8E-08	2.0000000E+02	Chlordane[gamma-]	69
3.2E-08	7.0E-08	2.0000000E+02	Chromium (total)	70
9.1E-08	3.0E-07	2.0000000E+02	Cobalt-60	71
1.5E-06	3.2E-06	2.0000000E+02	DDE[4,4'-]	72
1.4E-04	3.0E-04	2.0000000E+02	DDT[4,4'-]	73
4.9E-12	1.1E-11	2.0000000E+02	Plutonium-239, 240	74
3.4E-08	8.1E-08	2.0000000E+02	Ruthenium-106	75
1.2E-04	2.3E-04	2.0000000E+02	Selenium	76
4.9E-06	1.3E-05	2.0000000E+02	Strontium-90	77
4.4E-09	1.5E-08	2.0000000E+02	Tritium	78
1.3E-05	3.8E-05	2.0000000E+02	HMX	79
3.3E-09	1.2E-08	2.0000000E+02	Nitrotoluene[3-]	80
2.9E-07	6.4E-07	2.0000000E+02	Tetryl	81
9.3E-06	2.7E-05	2.0000000E+02	Trinitrotoluene[2,4,6-]	82
6.7E-06	1.5E-05	2.0000000E+02	Polychlorinated Biphenyls	83

Table E-1b. (Con't.)

Mean HQ	Standard Dev.	Number Observations	Analyte	Observation Number
1.3E-12	3.1E-12	2.0000000E+02	Radium-228	84
4.0E-11	1.5E-10	2.0000000E+02	Trichloroethane[1,1,1-]	85
5.9E-07	1.4E-06	2.0000000E+02	Dieldrin	86
1.2E-09	2.7E-09	2.0000000E+02	Endosulfan II	87
1.1E-06	3.0E-06	2.0000000E+02	Endrin	88
7.4E-10	2.4E-09	2.0000000E+02	Heptachlor Epoxide	89
1.7E-08	5.3E-08	2.0000000E+02	Methoxychlor[4,4'-]	90
2.6E-10	1.9E-09	2.0000000E+02	Endosulfan Sulfate	91
5.1E-09	1.6E-08	2.0000000E+02	Endrin Aldehyde	92
1.3E-09	3.5E-09	2.0000000E+02	Heptachlor	93
2.1E-08	3.7E-08	2.0000000E+02	Methylnaphthalene[2-	94
3.1E-11	6.7E-11	2.0000000E+02	Trichlorofluoromethane	95
3.1E-10	6.8E-10	2.0000000E+02	Acenaphthylene	96
2.3E-10	4.3E-10	2.0000000E+02	Methylphenol[4-]	97
1.9E-08	8.4E-08	2.0000000E+02	Phenol	98
2.6E-09	6.9E-09	2.0000000E+02	BHC[gamma-]	99
4.4E-06	1.4E-05	2.0000000E+02	Lithium	100
6.1E-09	2.2E-08	2.0000000E+02	Aniline	101
8.4E-08	1.6E-07	2.0000000E+02	Benzoic acid	102
7.6E-10	2.4E-09	2.0000000E+02	Benzyl Alcohol	103
3.0E-08	8.9E-08	2.0000000E+02	Bis(2-chloroethoxy)m	104
2.5E-09	7.3E-09	2.0000000E+02	Bis(2-chloroethyl)et	105
1.2E-08	2.5E-08	2.0000000E+02	Chloro-3-methylphenol	106
1.1E-07	5.8E-07	2.0000000E+02	Chlorophenol[2-]	107
9.5E-09	3.6E-08	2.0000000E+02	Dichlorobenzene[1,2-]	108
2.3E-10	5.3E-10	2.0000000E+02	Dichlorobenzene[1,3-	109
4.7E-09	1.1E-08	2.0000000E+02	Dichlorobenzene[1,4-	110
2.6E-11	7.7E-11	2.0000000E+02	Dichlorophenol[2,4-]	111
1.2E-09	4.3E-09	2.0000000E+02	Diethyl Phthalate	112
2.2E-11	6.5E-11	2.0000000E+02	Dimethylphthalate	113
4.1E-07	1.2E-06	2.0000000E+02	Dinitro-2-methylphenol	114
2.6E-07	7.7E-07	2.0000000E+02	Dinitrophenol[2,4-]	115
1.8E-08	4.2E-08	2.0000000E+02	Hexachlorobenzene	116
5.1E-08	1.5E-07	2.0000000E+02	Hexachlorobutadiene	117
3.0E-09	8.9E-09	2.0000000E+02	Hexachlorocyclopentadiene	118
2.0E-09	5.8E-09	2.0000000E+02	Hexachloroethane	119
7.9E-11	2.3E-10	2.0000000E+02	Isophorone	120
1.0E-09	2.1E-09	2.0000000E+02	Methylphenol[2-]	121
2.7E-09	7.8E-09	2.0000000E+02	Nitroaniline[2-]	122
2.3E-08	6.6E-08	2.0000000E+02	Nitroaniline[3-]	123
6.9E-10	1.4E-09	2.0000000E+02	Nitroaniline[4-]	124
1.8E-09	5.4E-09	2.0000000E+02	Nitrophenol[2-]	125
4.4E-09	1.2E-08	2.0000000E+02	Nitrophenol[4-]	126
8.1E-08	2.5E-07	2.0000000E+02	Nitrosodi-n-propylam	127
3.8E-04	1.1E-03	2.0000000E+02	Nitrosodimethylamine	128
7.3E-09	2.4E-08	2.0000000E+02	Oxybis(1-chloropropa	129
7.1E-07	1.9E-06	2.0000000E+02	Pentachlorophenol	130
6.9E-10	1.8E-09	2.0000000E+02	Trichlorobenzene[1,2,4-]	131
7.7E-10	2.6E-09	2.0000000E+02	Trichlorophenol[2,4,5-]	132

Table E-1b. (Con't.)

Mean HQ	Standard Dev.	Number Observations	Analyte	Observation Number
5.9E-09	1.7E-08	2.0000000E+02	Boron	133
4.2E-07	1.2E-06	2.0000000E+02	Amino-4,6-dinitrotol	134
3.4E-09	1.1E-08	2.0000000E+02	Dinitrobenzene[1,3-]	135
5.1E-12	1.3E-11	2.0000000E+02	Butanone[2-]	136
3.4E-11	8.2E-11	2.0000000E+02	Tetrachloroethene	137
1.5E-12	2.5E-12	2.0000000E+02	Neptunium-237	138
6.9E-09	2.4E-08	2.0000000E+02	Endosulfan I	139
2.8E-06	1.1E-05	2.0000000E+02	Aroclor-1248	140
2.1E-06	6.8E-06	2.0000000E+02	Strontium	141
3.4E-12	1.1E-11	2.0000000E+02	Dichlorodifluoromethane	142
6.1E-06	1.9E-05	2.0000000E+02	Molybdenum	143
9.6E-09	3.3E-08	2.0000000E+02	Diphenylamine	144
1.1E-10	3.7E-10	2.0000000E+02	Methylphenol[3-]	145
7.0E-14	2.4E-13	2.0000000E+02	Thorium-229	146
5.0E-12	1.2E-11	2.0000000E+02	Carbon Disulfide	147
2.6E-12	9.4E-12	2.0000000E+02	BHC[beta-]	148
2.3E-08	9.3E-08	2.0000000E+02	Aroclor-1016	149
1.3E-09	5.0E-09	2.0000000E+02	Trinitrobenzene[1,3,5-]	150
4.6E-08	2.2E-07	2.0000000E+02	Chromium(+6)	151
2.9E-12	1.5E-11	2.0000000E+02	Bromodichloromethane	152
2.6E-09	9.5E-09	2.0000000E+02	Benzene	153
1.4E-10	5.2E-10	2.0000000E+02	Chlorobenzene	154
9.8E-10	3.6E-09	2.0000000E+02	Dichloroethylene[1,1	155
5.8E-10	7.5E-09	2.0000000E+02	Nitrotoluene[2-]	156
6.4E-10	8.4E-09	2.0000000E+02	Nitrotoluene[4-]	157
2.1E-06	1.7E-05	2.0000000E+02	Aroclor-1242	158

Table E-2a. HI for 200 American Robin Nest Sites

Nest x-coord	Nest y-coord	HI	Observation Number
298	321	0	1
447	506	0	2
422	538	0	3
465	413	0	4
51	494	0	5
244	371	0.73	6
67	342	1.48	7
370	132	0	8
475	332	0	9
357	153	2.57	10
218	344	2.07	11
333	484	0	12
426	443	5.79	13
138	490	0	14
501	541	0	15
248	310	0	16
413	352	0	17
445	281	0	18
518	555	0	19
344	474	0	20
30	299	0	21
217	347	1.66	22
132	339	0	23
265	175	0	24
347	358	0	25
225	241	0	26
72	493	0	27
138	363	0	28
104	448	0	29
99	414	10.3	30
132	408	0.08	31
250	404	0	32
136	481	0	33
267	462	0	34
269	451	0	35
140	367	0	36
103	337	1.40	37
220	533	0	38
476	417	0	39
240	504	0.39	40
186	228	0	41
180	302	1.37	42
190	514	1.73	43
266	162	0	44
268	478	7.19	45
25	314	0	46
124	473	1.94	47
284	482	17.8	48
207	336	1.03	49

Table E-2a. (Con't.)

Nest x-coord	Nest y-coord	HI	Observation Number
64	476	0	50
93	394	0.0004	51
138	455	0.16	52
161	564	0	53
142	347	0	54
178	240	0	55
69	385	0.02	56
189	490	5.31	57
156	436	0	58
381	392	0	59
166	496	0	60
338	345	0	61
141	554	0	62
128	303	0	63
34	440	0	64
332	305	0	65
73	313	0	66
59	309	0	67
65	316	0	68
19	296	0	69
297	591	0	70
218	358	0.96	71
319	346	1.36	72
43	463	0	73
239	477	6.13	74
131	511	0	75
56	447	0	76
46	450	0	77
6	334	0	78
262	561	0	79
240	528	0	80
181	543	0	81
343	138	11.3	82
169	583	0	83
232	520	0	84
240	417	1.29	85
505	299	0	86
174	587	0	87
197	477	6.03	88
169	574	0	89
100	427	0.10	90
36	313	0	91
165	521	0	92
140	401	0	93
489	202	0	94
101	423	4.38	95
281	549	0	96
278	607	0	97
478	281	0	98

Table E-2a. (Con't.)

Nest x-coord	Nest y-coord	HI	Observation Number
9.5	523	0	99
144	449	0.58	100
168	552	0	101
483	195	0	102
291	579	0	103
491	298	0	104
485	188	0	105
218	394	0	106
43	455	0	107
37	455	0	108
263	528	0	109
188	519	0.29	110
264	544	0	111
527	301	0	112
193	560	0.49	113
154	525	0	114
506	286	0	115
274	412	0	116
198	550	0.73	117
188	586	0.0005	118
337	460	5.66	119
35	297	0	120
479	206	0	121
202	307	0	122
236	583	0	123
289	529	0	124
169	499	0.38	125
120	410	0.17	126
245	390	0	127
54	456	0	128
220	575	0	129
241	475	6.41	130
162	400	4.73	131
193	556	0.73	132
473	210	0	133
446	281	0	134
399	315	0	135
512	308	0	136
473	212	0	137
149	521	0	138
267	397	3.84	139
305	450	0	140
36	412	0	141
38	470	0	142
169	445	0	143
62	499	0	144
512	293	0	145
483	205	0	146
60	501	0	147
151	454	1.29	148

Table E-2a. (Con't.)

Nest x-coord	Nest y-coord	HI	Observation Number
233	529	0	149
349	547	0.41	150
293	516	0	151
316	449	0	152
516	299	0	153
160	458	4.55	154
299	585	0	155
397	315	0	156
478	286	0	157
190	572	0	158
177	570	0	159
215	544	0	160
23	358	0	161
282	480	19.9	162
500	278	0	163
239	553	0	164
488	177	0	165
457	458	0.52	166
260	587	0	167
145	521	0	168
484	179	0	169
473	250	0	170
185	499	0.35	171
378	319	0	172
167	548	0	173
335	460	6.01	174
54	498	0	175
33	445	0	176
155	303	0	177
149	464	0.42	178
481	295	0	179
518	301	0	180
219	504	0	181
32	332	0	182
200	495	0.66	183
133	490	0	184
404	313	0	185
151	367	0.76	186
493	294	0	187
400	309	0	188
160	511	0.38	189
492	210	0	190
25	453	0	191
33	457	0	192
41	336	0	193
101	514	0	194
24	393	0	195
44	437	0	196
270	470	7.54	197
93	486	0	198
226	592	0	199
251	599	0	200

Table E-2b. Mean HQ by COPC for Robin Baseline Modeling Scenario

Mean HQ	Standard Dev.	Number Observation	Analyte	Observation Number
7.5E-02	2.4E-01	2.0000000E+02	Aluminum	1
1.4E-02	7.7E-02	2.0000000E+02	Antimony	2
4.0E-02	1.2E-01	2.0000000E+02	Arsenic	3
2.6E-03	8.3E-03	2.0000000E+02	Barium	4
8.1E-04	2.8E-03	2.0000000E+02	Beryllium	5
4.4E-03	3.7E-02	2.0000000E+02	Cadmium	6
5.1E-02	1.9E-01	2.0000000E+02	Calcium	7
3.4E-01	1.3E+00	2.0000000E+02	Cobalt	8
2.0E-03	8.0E-03	2.0000000E+02	Copper	9
1.3E-01	5.7E-01	2.0000000E+02	Lead	10
8.0E-04	3.0E-03	2.0000000E+02	Magnesium	11
1.4E-03	4.7E-03	2.0000000E+02	Manganese	12
5.6E-03	4.7E-02	2.0000000E+02	Mercury	13
2.6E-04	1.3E-03	2.0000000E+02	Nickel	14
8.0E-04	4.0E-03	2.0000000E+02	Sodium	15
3.3E-06	2.5E-05	2.0000000E+02	Thorium-230	16
8.8E-04	7.0E-03	2.0000000E+02	Uranium-234	17
1.7E-04	1.3E-03	2.0000000E+02	Uranium-238	18
1.2E-02	3.9E-02	2.0000000E+02	Vanadium	19
2.0E-03	7.1E-03	2.0000000E+02	Zinc	20
2.9E-06	1.5E-05	2.0000000E+02	Anthracene	21
4.0E-05	1.9E-04	2.0000000E+02	Bis(2-ethylhexyl)phthalate	22
2.2E-08	2.0E-07	2.0000000E+02	Butyl benzyl phthalate	23
2.3E-09	2.3E-08	2.0000000E+02	Di-n-octylphthalate	24
7.6E-06	4.3E-05	2.0000000E+02	Fluoranthene	25
3.7E-07	2.0E-06	2.0000000E+02	Fluorene	26
3.9E-05	5.2E-04	2.0000000E+02	HMX	27
4.2E-04	2.3E-03	2.0000000E+02	Naphthalene	28
2.7E-04	1.5E-03	2.0000000E+02	Pyrene	29
1.6E-03	1.7E-02	2.0000000E+02	Selenium	30
2.8E-07	1.5E-06	2.0000000E+02	Acenaphthene	31
2.5E-04	1.5E-03	2.0000000E+02	Cyanide (total)	32
9.1E-04	6.0E-03	2.0000000E+02	Di-n-Butyl Phthalate	33
5.1E-09	5.6E-08	2.0000000E+02	Dimethylphenol[2,4-]	34
2.7E-09	2.9E-08	2.0000000E+02	Methylphenol[2-]	35
1.3E-07	9.6E-07	2.0000000E+02	Methylphenol[4-]	36
8.0E-05	4.0E-04	2.0000000E+02	Silver	37
8.9E-05	1.1E-03	2.0000000E+02	RDX	38
1.6E-04	1.2E-03	2.0000000E+02	Uranium	39
2.6E-04	2.0E-03	2.0000000E+02	Cesium-137	40
4.5E-10	3.6E-09	2.0000000E+02	DDD[4,4'-]	41
6.7E-02	2.9E-01	2.0000000E+02	DDE[4,4'-]	42
1.6E-03	7.2E-03	2.0000000E+02	DDT[4,4'-]	43
2.0E-04	9.7E-04	2.0000000E+02	Radium-226	44
2.8E-03	3.3E-02	2.0000000E+02	Aroclor-1242	45
8.5E-04	9.7E-03	2.0000000E+02	Polychlorinated Biphenyls	46
8.6E-03	4.5E-02	2.0000000E+02	Aroclor-1254	47
3.2E-03	4.6E-02	2.0000000E+02	Dinitrobenzene[1,3-]	48
1.1E-05	8.9E-05	2.0000000E+02	Dinitrotoluene[2,4-]	49
1.6E-06	2.3E-05	2.0000000E+02	Nitrotoluene[3-]	50

Table E-2b. (Con't.)

Mean HQ	Standard Dev.	Number Observation	Analyte	Observation Number
4.8E-03	4.2E-02	2.0000000E+02	Thallium	51
8.5E-06	1.1E-04	2.0000000E+02	Trinitrobenzene[1,3,5-]	52
3.3E-06	3.8E-05	2.0000000E+02	Trinitrotoluene[2,4,6-]	53
2.7E-05	2.4E-04	2.0000000E+02	Americium-241	54
7.6E-05	6.6E-04	2.0000000E+02	Uranium-235	55
6.6E-09	3.3E-08	2.0000000E+02	Europium-152	56
4.7E-05	2.2E-04	2.0000000E+02	Aldrin	57
9.7E-09	6.0E-08	2.0000000E+02	Americium-241 (gamma spec)	58
1.5E-02	1.4E-01	2.0000000E+02	Aroclor-1260	59
1.0E-06	7.3E-06	2.0000000E+02	Cesium-134	60
2.5E-06	1.1E-05	2.0000000E+02	Chlordane[alpha-]	61
2.0E-06	1.0E-05	2.0000000E+02	Chlordane[gamma-]	62
4.5E-05	2.2E-04	2.0000000E+02	Chromium (total)	63
1.1E-07	6.7E-07	2.0000000E+02	Cobalt-60	64
1.3E-05	1.3E-04	2.0000000E+02	Plutonium-238	65
7.6E-08	4.0E-07	2.0000000E+02	Plutonium-239, 240	66
2.6E-08	2.1E-07	2.0000000E+02	Sodium-22	67
1.1E-04	9.5E-04	2.0000000E+02	Strontium-90	68
6.7E-05	5.1E-04	2.0000000E+02	Plutonium-239	69
1.0E-08	7.0E-08	2.0000000E+02	Lead-210	70
2.9E-10	2.9E-09	2.0000000E+02	Radium-228	71
3.7E-06	2.6E-05	2.0000000E+02	Thorium-228	72
3.2E-08	2.2E-07	2.0000000E+02	Methylene Chloride	73
1.0E-09	1.4E-08	2.0000000E+02	Carbon Disulfide	74
6.4E-09	7.4E-08	2.0000000E+02	Toluene	75
4.1E-10	2.8E-09	2.0000000E+02	Acetone	76
3.3E-08	3.1E-07	2.0000000E+02	Endosulfan I	77
1.3E-06	1.9E-05	2.0000000E+02	Methoxychlor[4,4'-]	78
4.8E-04	4.7E-03	2.0000000E+02	Endrin	79
1.3E-08	1.5E-07	2.0000000E+02	Diethyl Phthalate	80
4.0E-08	4.0E-07	2.0000000E+02	BHC[gamma-]	81
1.2E-06	9.9E-06	2.0000000E+02	Dieldrin	82
7.2E-08	5.6E-07	2.0000000E+02	Endosulfan II	83
1.4E-08	1.4E-07	2.0000000E+02	Heptachlor	84
1.8E-06	1.5E-05	2.0000000E+02	Benzoic acid	85
3.0E-08	1.9E-07	2.0000000E+02	Neptunium-237	86
4.7E-07	4.3E-06	2.0000000E+02	Tritium	87
3.7E-06	3.5E-05	2.0000000E+02	Molybdenum	88
2.1E-06	1.5E-05	2.0000000E+02	Lithium	89
1.4E-06	1.9E-05	2.0000000E+02	Chloro-3-methylphenol[4-]	90
1.4E-07	1.7E-06	2.0000000E+02	Chlorophenol[2-]	91
6.0E-07	8.5E-06	2.0000000E+02	Pentachlorophenol	92
3.9E-08	4.1E-07	2.0000000E+02	Phenol	93
5.3E-06	3.9E-05	2.0000000E+02	Thorium-232	94
5.4E-08	7.7E-07	2.0000000E+02	Trichlorobenzene[1,2,4]	95
9.1E-11	7.9E-10	2.0000000E+02	Trichlorofluoromethane	96
1.5E-08	2.1E-07	2.0000000E+02	Trichloroethane[1,1,1-]	97
9.5E-03	1.1E-01	2.0000000E+02	Aroclor-1248	98
9.5E-09	6.9E-08	2.0000000E+02	Tetrachloroethene	99
2.8E-08	2.8E-07	2.0000000E+02	Xylene (Total)	100

Table E-2b. (Con't.)

Mean HQ	Standard Dev.	Number Observation	Analyte	Observation Number
3.8E-08	2.9E-07	2.0000000E+02	Endrin Aldehyde	101
1.2E-10	1.6E-09	2.0000000E+02	BHC[beta-]	102
1.1E-09	9.4E-09	2.0000000E+02	Endosulfan Sulfate	103
4.3E-09	6.1E-08	2.0000000E+02	Azobenzene	104
1.6E-07	2.3E-06	2.0000000E+02	D[2,4-]	105
2.2E-04	3.2E-03	2.0000000E+02	Aroclor-1016	106
5.7E-04	8.1E-03	2.0000000E+02	Aroclor-1221	107
2.8E-04	3.9E-03	2.0000000E+02	Aroclor-1232	108
6.5E-07	9.3E-06	2.0000000E+02	Dinoseb	109
7.9E-11	7.9E-10	2.0000000E+02	Hexanone[2-]	110
5.3E-09	5.2E-08	2.0000000E+02	Methyl-2-pentanone[4-]	111
7.9E-09	1.1E-07	2.0000000E+02	Trichloro-1,2,2-trifluoroethane[1,1,2-]	112
1.5E-06	2.2E-05	2.0000000E+02	Heptachlor Epoxide	113
6.5E-07	9.2E-06	2.0000000E+02	Benzene	114
1.6E-08	2.3E-07	2.0000000E+02	Chlorobenzene	115

Table E-3a. HI for 200 Deer Mouse Nest Sites

Nest x-coord	Nest y-coord	HI	Observation No.
298	321	0	1
447	506	0	2
422	538	0	3
465	413	0	4
51	494	0	5
244	371	0	6
67	342	0	7
370	132	0	8
475	332	0	9
357	153	0	10
218	344	0	11
333	484	0	12
426	443	68.8	13
138	490	0	14
501	541	0	15
486	119	0	16
248	310	0	17
413	352	0	18
445	281	0	19
518	555	0	20
344	474	0	21
371	313	0	22
407	329	0	23
30	299	0	24
491	477	0	25
217	347	0	26
266	337	0	27
473	301	0	28
132	339	0	29
204	211	0	30
355	69	0	31
265	175	0	32
347	358	0	33
225	241	0	34
72	493	0	35
410	403	0	36
138	363	0	37
104	448	0	38
483	188	0	39
99	414	66.9	40
132	408	0	41
250	404	0	42
136	481	0	43
267	462	0	44
370	160	0	45
258	461	0	46
140	367	0	47
103	337	4.17	48
220	533	0	49
476	183	0	50
549	532	0	51

Table E-3a. (Con't.)

Nest x-coord	Nest y-coord	HI	Observation No.
353	537	0	52
476	417	0	53
537	440	0	54
355	332	0	55
240	504	0	56
308	367	0	57
186	228	0	58
180	302	9.97	59
352	440	0	60
266	162	0	61
386	224	0	62
370	225	0	63
418	222	0	64
25	314	0	65
479	315	0	66
124	473	0	67
284	482	166	68
207	336	0	69
64	476	0	70
441	294	0	71
93	394	0	72
138	455	0	73
545	506	0	74
161	564	0	75
142	347	0	76
178	240	0	77
236	419	0	78
473	159	0	79
69	385	0	80
189	490	0	81
156	436	0	82
209	289	0	83
355	11	0	84
324	525	0	85
141	554	0	86
471	503	0	87
488	337	0	88
128	303	0	89
34	440	0	90
512	167	0	91
194	470	0	92
128	396	0	93
495	518	0	94
73	313	0	95
59	309	0	96
65	316	0	97
19	296	0	98
402	224	0	99
218	358	0	100
37	375	0	101
347	122	2E-05	102

Table E-3a. (Con't.)

Nest x-coord	Nest y-coord	HI	Observation No.
319	346	0	103
348	21	0	104
43	463	0	105
192	229	0	106
239	477	278	107
544	537	0	108
439	157	0	109
152	423	0	110
131	511	0	111
541	544	0	112
157	345	0	113
128	413	0	114
547	436	0	115
360	480	0	116
457	456	0	117
175	405	0	118
332	277	0	119
109	341	0	120
279	164	0	121
307	476	15.1	122
62	354	4.18	123
389	130	0	124
175	335	0	125
237	321	0	126
309	454	0	127
365	471	0	128
320	350	0	129
119	352	0	130
262	561	0	131
283	176	0	132
214	591	0	133
241	398	0	134
240	528	0	135
307	157	0	136
181	543	0	137
162	339	0	138
169	360	0	139
343	138	198	140
44	305	0	141
110	403	0	142
24	309	0	143
169	583	0	144
164	333	0	145
93	514	0	146
240	417	0	147
154	394	0	148
60	485	0	149
215	361	0	150
505	299	0	151
160	315	0	152
191	305	0	153

Table E-3a. (Con't.)

Nest x-coord	Nest y-coord	HI	Observation No.
135	289	0	154
294	478	463	155
168	392	0	156
230	260	0	157
169	397	67.7	158
468	290	0	159
87	497	0	160
138	427	66.3	161
238	362	0	162
169	574	0	163
167	425	0	164
100	27	0	165
118	506	0	166
119	396	0	167
271	465	0	168
173	342	0	169
74	437	0	170
57	380	0	171
165	521	0	172
218	369	0	173
489	202	0	174
103	383	0	175
51	339	0	176
359	474	0	177
57	353	4.19	178
114	438	0	179
39	358	0	180
210	212	0	181
101	423	0	182
247	510	0	183
134	349	0	184
478	281	0	185
146	368	0	186
300	523	0	187
100	341	104	188
144	449	0	189
120	475	0	190
168	552	0	191
13	375	0	192
47	339	0	193
65	435	0	194
238	317	0	195
489	124	0	196
433	79	0	197
387	60	0	198
287	137	0	199
358	36	0	200

Table E-3b. Mean HQ by COPC for Deer Mouse Baseline Modeling Scenario

Mean HQ	Standard Dev.	Number Observations	Analyte	Observation Number
7.0E-06	8.1E-05	2.0000000E+02	Aldrin	1
5.8E+00	3.8E+01	2.0000000E+02	Aluminum	2
7.2E-10	7.2E-09	2.0000000E+02	Americium-241 (gamma	3
4.0E-06	3.7E-05	2.0000000E+02	Americium-241	4
5.8E-04	5.9E-03	2.0000000E+02	Antimony	5
6.6E-02	8.5E-01	2.0000000E+02	Aroclor-1254	6
3.6E-01	4.9E+00	2.0000000E+02	Aroclor-1260	7
2.8E-01	1.3E+00	2.0000000E+02	Arsenic	8
3.1E-02	1.5E-01	2.0000000E+02	Barium	9
7.2E-04	4.0E-03	2.0000000E+02	Beryllium	10
3.0E-02	1.6E-01	2.0000000E+02	Cadmium	11
7.0E-07	7.0E-06	2.0000000E+02	Cesium-134	12
6.3E-05	4.6E-04	2.0000000E+02	Cesium-137	13
9.6E-06	1.1E-04	2.0000000E+02	Chlordane[alpha-]	14
9.6E-06	1.1E-04	2.0000000E+02	Chlordane[gamma-]	15
3.7E-07	4.2E-06	2.0000000E+02	Chromium (total)	16
3.2E-02	1.5E-01	2.0000000E+02	Cobalt	17
6.2E-06	8.7E-05	2.0000000E+02	Cobalt-60	18
4.0E-03	2.2E-02	2.0000000E+02	Copper	19
5.2E-05	5.8E-04	2.0000000E+02	DDE[4,4'-]	20
2.9E-03	3.2E-02	2.0000000E+02	DDT[4,4'-]	21
1.8E-09	1.8E-08	2.0000000E+02	Europium-152	22
5.9E-02	4.8E-01	2.0000000E+02	Lead	23
2.0E-03	1.1E-02	2.0000000E+02	Manganese	24
9.8E-04	1.1E-02	2.0000000E+02	Mercury	25
7.7E-02	4.3E-01	2.0000000E+02	Nickel	26
1.5E-06	1.4E-05	2.0000000E+02	Plutonium-238	27
7.6E-09	8.1E-08	2.0000000E+02	Plutonium-239, 240	28
4.8E-04	4.2E-03	2.0000000E+02	Selenium	29
8.5E-07	1.1E-05	2.0000000E+02	Silver	30
1.0E-07	1.1E-06	2.0000000E+02	Sodium-22	31
4.9E-05	3.6E-04	2.0000000E+02	Strontium-90	32
7.4E-03	7.1E-02	2.0000000E+02	Thallium	33
3.3E-05	2.4E-04	2.0000000E+02	Uranium-234	34
7.1E-07	6.6E-06	2.0000000E+02	Uranium-235	35
2.7E-05	1.9E-04	2.0000000E+02	Uranium-238	36
4.3E-03	2.2E-02	2.0000000E+02	Vanadium	37
3.1E-01	1.7E+00	2.0000000E+02	Zinc	38
2.2E-07	2.0E-06	2.0000000E+02	Bis(2-ethylhexyl)pht	39
8.8E-05	9.9E-04	2.0000000E+02	Plutonium-239	40
2.4E-04	1.9E-03	2.0000000E+02	Lithium	41
9.4E-05	7.2E-04	2.0000000E+02	Strontium	42
2.1E-07	2.0E-06	2.0000000E+02	Tritium	43
1.1E-04	8.7E-04	2.0000000E+02	Uranium	44
6.4E-06	7.0E-05	2.0000000E+02	Thorium-228	45
5.7E-06	6.2E-05	2.0000000E+02	Thorium-230	46
7.8E-06	8.2E-05	2.0000000E+02	Thorium-232	47
1.0E-04	1.4E-03	2.0000000E+02	Benzo(b)fluoranthene	48
8.7E-03	1.2E-01	2.0000000E+02	Pyrene	49

Table E-3b. (Con't.)

Mean HQ	Standard Dev.	Number Observations	Analyte	Observation Number
2.1E-08	3.0E-07	2.0000000E+02	Di-n-Butyl Phthalate	50
2.3E-03	3.2E-02	2.0000000E+02	Aroclor-1016	51
2.2E-02	3.1E-01	2.0000000E+02	Aroclor-1221	52
1.1E-02	1.5E-01	2.0000000E+02	Aroclor-1232	53
4.5E-02	6.4E-01	2.0000000E+02	Aroclor-1242	54
3.7E-01	5.2E+00	2.0000000E+02	Aroclor-1248	55
1.4E-08	2.0E-07	2.0000000E+02	Acetone	56
5.2E-12	7.4E-11	2.0000000E+02	Methylene Chloride	57
6.1E-07	8.7E-06	2.0000000E+02	Trinitrobenzene[1,3,	58
1.2E-04	1.8E-03	2.0000000E+02	Anthracene	59
1.9E-04	2.6E-03	2.0000000E+02	Benzo(a)anthracene	60
7.4E-03	1.0E-01	2.0000000E+02	Benzo(a)pyrene	61
1.7E-05	2.4E-04	2.0000000E+02	Benzo(g,h,i)perylene	62
2.0E-05	2.8E-04	2.0000000E+02	Benzo(k)fluoranthene	63
2.3E-04	3.2E-03	2.0000000E+02	Chrysene	64
5.8E-05	8.2E-04	2.0000000E+02	Fluoranthene	65
1.9E-05	2.6E-04	2.0000000E+02	Indeno(1,2,3-cd)pyre	66
1.3E-03	1.8E-02	2.0000000E+02	Phenanthrene	67
8.1E-07	1.1E-05	2.0000000E+02	Acenaphthene	68
2.1E-05	3.0E-04	2.0000000E+02	Dibenzo(a,h)anthrace	69
4.6E-02	6.6E-01	2.0000000E+02	Dibenzofuran	70
4.3E-06	6.0E-05	2.0000000E+02	Dinitrotoluene[2,4-]	71
8.1E-06	1.1E-04	2.0000000E+02	Fluorene	72
3.1E-06	4.4E-05	2.0000000E+02	Methylnaphthalene[2-	73
5.3E-06	7.6E-05	2.0000000E+02	Naphthalene	74
2.1E-05	2.9E-04	2.0000000E+02	Tetryl	75
7.9E-07	1.1E-05	2.0000000E+02	Benzoic acid	76

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