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February 28, 2012

Mr. Caleb Shaffer, Manager
RCRA Facilities Management Office (WST-4)
U.S. EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

RE: Transmittal Letter for the US Ecology Nevada Screening Level Ecological Risk Assessment and Biological Evaluation – Final Report

Dear Mr. Shaffer:

Stantec Consulting Services Inc. (Stantec) is pleased to submit the attached US Ecology Nevada Screening Level Ecological Risk Assessment (SLERA) – Final Report and the Biological Evaluation, for the US Ecology (USE) Beatty, Nevada facility. The SLERA and BE were conducted in close consultation with John Beach and Ron Leach of the EPA Region 9 office. We have appreciated the responsiveness and detailed help and comments these gentlemen have provided during the planning, implementation, and report preparation phases of this work.

US Ecology is eager to obtain approval and concurrence with the findings of these reports. Please contact Bob Marchand or Scott Wisniewski with any questions.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Angus E. McGrath, Ph.D.
Principal Geochemist

cc: Bob Marchand, US Ecology
John Beach, EPA Region 9
Ron Leach, EPA Region 9

Attachment:

USEN – Screening Level Ecological Risk Assessment – Final Beatty, Nevada
USEN – Biological Evaluation – Beatty, Nevada

USEN – Screening Level Ecological Risk Assessment – FINAL

US Ecology Nevada Facility
Beatty, Nevada
Stantec PN: 185702329

Stantec

February 28, 2012

This US Ecology Screening Level Environmental Risk Assessment replaces all previous versions.

Limitations and Certifications

This report was prepared in accordance with the scope of work outlined in Stantec's contract and with generally accepted professional engineering and environmental consulting practices existing at the time this report was prepared and applicable to the location of the site. It was prepared for the exclusive use of US Ecology for the express purpose stated above. Any re-use of this report for a different purpose or by others not identified above shall be at the user's sole risk without liability to Stantec. To the extent that this report is based on information provided to Stantec by third parties, Stantec may have made efforts to verify this third party information, but Stantec cannot guarantee the completeness or accuracy of this information. The opinions expressed and data collected are based on the conditions of the site existing at the time of the field investigation. No other warranties, expressed or implied are made by Stantec.

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Reviewed by:

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Principal Geochemist

Executive Summary

Screening Level Ecological Risk Assessment (SLERA)

This report provides the Screening Level Ecological Risk Assessment (SLERA) conducted for the US Ecology Nevada (USEN) facility located near Beatty, Nevada (the Site). The USEN facility operates as a permitted hazardous waste landfill accepting polychlorinated biphenyl (PCB) containing wastes. The goal of this SLERA was to determine whether the 12 dioxin-like PCB congeners detected in surface soil near the facility could pose significant risks of harm to the environment and wildlife known or expected to occur near the Site. For purposes of this assessment, the 12 dioxin-like PCB congeners detected in Site soil will be referred to as chemicals of potential concern (COPCs) or Site COPCs. This SLERA was conducted in accordance with United States Environmental Protection Agency (EPA guidelines, with guidance and input provided by the EPA Region IX (EPA-IX) during this process. The sections of the SLERA are summarized below.

Selection of Receptor Species

Receptor species are defined as organisms that are likely to be exposed to contaminants and/or are likely to be vulnerable or sensitive to contaminants of potential concern (COPCs). The selection of ecological receptors was based on plant and animal species that do or could occur in the terrestrial habitat surrounding the USEN facility. The following species were selected as receptor species:

- Terrestrial plant communities;
- Terrestrial invertebrate communities;
- Little Pocket Mouse, *Perognathus longimembris* – representative of a herbivorous small mammal that feeds on vegetation;
- Southern Grasshopper Mouse, *Onychomys torridus* – representative of an invertivorous (insectivorous) small mammal species that feeds on invertebrates, and is an important component of the food chain for predatory species;
- Western Meadowlark *Sturnella neglecta* – representative of an invertivorous (insectivorous) bird species that feeds on invertebrates and vegetation in the local area;
- Red-tailed Hawk, *Buteo jamaicensis* – representative of a predatory bird that feeds in the local food web, including the Southern Grasshopper Mouse;
- Kit Fox, *Vulpes macrotis* – representative of a predatory mammal that feeds in the food web including the Southern Grasshopper Mouse; and,
- Desert Tortoise – representative of a sensitive reptilian species.

Due to its status as a federally threatened species, the desert tortoise was selected to represent a reptilian receptor species. However, no toxicity data were available in the literature for the effects from COPCs for tortoises or other reptiles. This prevented a quantitative analysis of potential impacts on the desert tortoise. However, a semi-quantitative exposure risk was estimated for the desert tortoise.

Exposure Pathways

Exposure pathways are routes by which COPCs may contact and enter the tissues of the receptor species. The exposure pathways considered in this SLERA were those which accounted for the majority of the exposure encountered by receptors. For animals, these include incidental soil ingestion and ingestion of plant or prey (invertebrates or small mammals). For plants, the exposure pathway considered was uptake of COPCs from soil.

Selection of Assessment and Measurement Endpoints

Assessment endpoints are general statements of the ecological values that are considered worthy of protection. Measurement endpoints are specified measures used to define which types of impacts are significant, as related specifically to the selected assessment endpoints. Therefore, assessment and measurement endpoints were selected to evaluate potential impacts of PCB exposure on communities or species in or near the area surrounding the USEN facility. Plant and invertebrate communities were selected as endpoints, as they represent the dietary basis of the food web, and thus exposure for the wildlife populations. Additionally, the wildlife endpoints that were identified for the selected receptors primarily assessed the sustainability of populations.

Exposure Assessment

For this SLERA, exposure point concentrations (EPCs) were set as the maximum concentrations of each COPC detected in soil and these were used to estimate receptor exposure in food chain modeling, as well as plant and invertebrate (qualitatively) communities. The maximum concentrations are used to model and evaluate worst-case scenario exposure. Exposure calculations for the elected receptor species and parameters specific to each species used, such as food ingestion rate and body weight, provided an overestimate or highly conservative evaluation of exposure. In the SLERA exposure and effects phases, concentrations or exposure doses were calculated using EPCs that were calculated using measured concentrations for soil, and modeled concentrations for plant tissue, pocket mice, and grasshopper mice as prey species. Potential exposures to the selected species were based on the maximum measured concentrations of COPCs in soil for the USEN facility.

PCB concentrations in prey items for the selected species were calculated based on the measured concentrations in soil. Exposure models were used to calculate concentrations in: 1) invertebrates ingested by the southern grasshopper mouse and western meadowlark; and 2) in prey (mice) consumed by the kit fox and the red-tailed hawk. Exposure assumptions are typically very conservative for SLERAs. Following EPA guidance, several assumptions about dietary exposure for each selected species included the following:

- 100 percent exposure to the maximum concentrations of each COPC;

- 100 percent diet consists of the item with the highest potential for COPC accumulation;
- 100 percent Area Use Factor (AUF), thus 100 percent of time is spent on the USEN study area, assuming the highest exposure potential; and,
- 100 percent COPCs in dietary items (plants and/or prey) and soil is bioavailable.

Effects Assessment

The effects (*i.e.,* toxicity) assessment is an attempt to relate the dose or amount of exposure to the occurrence of an adverse effect. For animals, the no observed adverse effect levels (NOAELs) and the lowest observed adverse effects levels (LOAEL) were compared to the calculated daily exposure concentrations. Risk assessments conducted with NOAELs are generally considered protective of individuals while risk assessments conducted with LOAELs are considered protective of populations. NOAELs are the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on animals. The potential toxicity of COPCs to the selected receptors was evaluated in accordance with regulatory guidance from EPA-IX.

Risk Characterization

The SLERA results were evaluated using a Hazard Quotient (HQ) approach in which calculated exposures to the selected species were divided by benchmarks and/or toxicity reference values (TRVs). A HQ is defined as follows:

$$HQ = \text{Exposure Dose} / \text{Benchmark of TRV}$$

The sum of the HQs for the COPCs provides a cumulative value, a Hazard Index (HI) to assess risk to the PCB mixture. If a HI is less than or equal to 1, the risk of adverse effect is unlikely to occur. If a HI exceeds 1, a potential adverse effect may occur, although this does not necessarily mean that an adverse effect will occur or is likely to occur.

For this approach, which is consistent with standard EPA practice, HQs less than a threshold of effects level of 1 indicate that adverse ecological effects are unlikely to occur. For this SLERA, HIs calculated for all of the selected ecological receptors indicated no significant threat of risk based on the HI-low, or NOAEL. The HI-lo (NOAEL) value for the kit fox was at the threshold effects level of 1, using the most conservative of assumptions (see above). When alternative, less conservative and more realistic exposure assumptions were used, the threshold effects level for HI calculated with NOAELs was well below “1”, thus the threshold of effects was not exceeded. The results for this SLERA demonstrate that none of the selected representative receptors are at significant risk from PCB congeners measured in soil from the USEN facility.

Numerous sources of uncertainty are a part of the exposure and HQ calculations for the SLERA. Because many of the parameters are biased high, the calculated values are expected to be greater than actual values and exposure. The greatest uncertainties resulted from the many assumptions that were required to model concentrations and from the limited toxicity information available.

This SLERA determined that potential risks associated with dioxin-like PCB congeners at the USEN Site are below regulatory and other target risk levels for ecological receptors under current conditions. Based on this analysis, dioxin-like PCB congeners near the USEN facility are not expected to cause an adverse impact on the ecological receptors.

Table of Contents

Table of Contents - continued

Table of Contents - continued

List of Attachments

LIST OF FIGURES

LIST OF APPENDICES

Note: Figures and Appendices appear at end of report.

List of Acronyms

AhR	aryl hydrocarbon receptor
ATL	Advanced Technology Laboratories
AUF	Area Use Factor
BAF	bioaccumulation factor
BCF	bioconcentration factor
BERA	Baseline Ecological Risk Assessment
BLM	Bureau of Land Management
BTF	biotransfer factor
CDP	census-designated place
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COPC	chemical of potential concern
CSM	conceptual site model
EC	effective concentration
ED	effective dose
EPA	United States Environmental Protection Agency
EPA-IX	EPA Region IX
EPC	exposure point concentration
ERA	ecological risk assessment
ESA	Endangered Species Act
FIR	food ingestion rate
ft-bgs	feet below ground surface
HI	Hazard Index
HQ	Hazard Quotient
km^2	kilometers
LC	lethal concentration
LD	lethal dose
LOAEL	lowest observed adverse effects levels
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NDEP	Nevada Department of Environmental Protection
ng	nanograms
ng/kg	nanograms per kilogram
NNHP	Nevada Natural Heritage Program
NOAEL	no observed adverse effect level
PCB	polychlorinated biphenyl
ppt	parts per trillion
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
SIR	soil ingestion rate

List of Acronyms - continued

SLERA	Screening Level Ecological Risk Assessment
TEF	toxic equivalency factors
TEQ	toxic equivalency
TRV	toxicity reference value
TSCA	Toxic Substances Control Act
TDD	total daily dose
UCL	Upper Confidence Limit
USEN	US Ecology Nevada
USFWS	United States Fish and Wildlife Service
WHO	World Health Organization

1.0 Introduction

The US Ecology Nevada (USEN) facility is a processing and disposal facility for a limited list of organic and inorganic contaminants that is located in Nye County, Nevada. The USEN facility is located approximately 11 miles south of Beatty, and approximately 125 miles northwest of Las Vegas, Nevada. The facility is owned by the State of Nevada, and is subsequently leased and operated by USEN. The USEN facility is permitted for the handling and disposal of articles and fluids containing polychlorinated biphenyls (PCB), chemicals regulated by the Toxic Substances Control Act (TSCA). The entire property (as leased by USEN) covers approximately 80 acres that consists of flat desert land. The facility is surrounded by several miles of federally-owned property abutting the facility. This surrounding property is operated as range land by the Bureau of Land Management (BLM). The BLM manages lands, such as sagebrush habitat, which are under statutory authority of the Federal Land Policy and Management Act of 1976 (43 U.S.C 1701 et seq.), as amended (NDW, 2005).

The USEN disposal area is surrounded by a buffer zone, which is comprised of approximately 400 acres, running an approximately 1,320 feet from the fence line that surrounds the 80-acre property. The property is completely surrounded by a 6-foot tall chain link fence topped with barbed wire. The base of the fence is bermed with gravel to prevent burrowing animals from gaining access to the facility. Regular inspections and maintenance ensure the integrity of this barrier. Access to the facility is via an entrance from U.S. Highway 95. An unimproved perimeter access road encircles the property. Waste transport vehicles accessing the interior portions of the facility are not allowed to exit the facility until they are confirmed to be free of any contamination as outlined in TSCA Permit Condition #2 (see Figure 1 for the Site location).

The USEN disposal facility provides full Resource Conservation and Recovery Act[1] (RCRA) and TSCA treatment and disposal services. The USEN Beatty facility provides RCRA treatment and solidification services for industrial and government customers. The facility also provides chemical oxidation for organic contaminated wastes and oil refinery catalysts.

Additional information in relation to the environmental description can be viewed in the Environmental Impact Statement, Ecological/Biological Assessments, January 2005, which was prepared and submitted as part of the TSCA Permit Renewal Application package in March of 2009 (US Ecology, 2009).

[1] RCRA: RCRA is the principal Federal law in the United States governing the disposal of solid waste and hazardous waste. RCRA is a federal law enacted in 1976 that established a regulatory system to track hazardous substances from their generation to their disposal. The law requires the use of safe and secure procedures in treating, transporting, storing, and disposing of hazardous substances.

The United States Environmental Protection Agency (EPA) Region IX (EPA-IX) requested in a letter[2] dated March 3, 2009, that as part of their TSCA permit renewal application and modification, USEN prepared a soil sampling plan and Screening Level Ecological Risk Assessment (SLERA) to support Endangered Species Act (ESA) requirements at their facility located in Beatty, Nevada.

Congener analysis, including the 209 PCB congeners, was conducted on surface soil samples in 2010 (Stantec, 2010). Following conversations with EPA-IX, it was determined that of the 209 congeners, the 12 dioxin-like PCB congeners identified by the World Health Organization (WHO) would be used in the SLERA to evaluate any potential ecological risks to the environment and off-Site receptors from PCB disposal activities at USEN. These 12 dioxin-like PCB congeners (hereafter referred to as COPCs) are listed in Table 1 below.

TABLE 1

Identification of the 12 dioxin-like PCBs evaluated in this SLERA.

PCB Congener	PCB Nomenclature	CAS No
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	CAS 32598-13-3
PCB 81	3,4,4',5-Tetrachlorobiphenyl	CAS 70362-50-4
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	CAS 32598-14-4
PCB 114	2,3,4,4',5-Pentachlorobiphenyl	CAS 74472-37-0
PCB 118	2,3',4,4',5-Pentachlorobiphenyl	CAS 31508-00-6
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl	CAS 65510-44-3
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	CAS 57465-28-8
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl	CAS 38380-08-4
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl	CAS 69782-90-7
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	CAS 52663-72-6
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl	CAS 32774-16-6
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	CAS 39635-31-9

Based on – World Health Organization (WHO)
PCB – Polychlorinated Biphenyls
SLERA – Screening Level Ecological Risk Assessment

The overall purpose of this SLERA is to characterize and quantify the potential ecological risk that may be posed by the PCB containing waste at USEN facility. This SLERA report includes the analytical results from soil samples collected in December 2010.

[2] *Notice of Deficiency, US Ecology Nevada-March 3, 2009 Toxic Substances Control Act Permit Application ("TSCA Application")*, August 3, 2009, EPA Region IX.

This SLERA incorporated a conservative approach for the characterization of potential risks posed to ecological receptors as a result of exposure to soils and diet at or near the USEN facility. This approach reflects exposure assumptions identified by EPA guidance, as well as EPA-IX, as appropriate for a conservative and comparable ecological risk evaluation on a general basis.

1.1 SLERA APPROACH

An ecological risk assessment (ERA) defines the likelihood of harmful effects on plants and animals as a result of exposure to environmental stressors, such as chemical and radiological constituents, which may occur at a Site. The EPA Ecological Risk Assessment Guidance Process Document (1997) outlines an 8-step approach to ERA, which consists of two tiers. The first tier is the SLERA and the second tier is a more comprehensive Baseline Ecological Risk Assessment (BERA). The SLERA consists of steps 1 and 2 of the 8–step process, and the BERA completes the 8-step process (steps 3-8). The SLERA depends on available Site data and is intended to be conservative. A BERA requires more complete Site-specific exposure and effects information, and can include such measurements as body burden concentrations, biosurveys, and bioassays; a BERA often uses less conservative, more Site-specific assumptions.

The SLERA has the following components:

- Screening level problem formulation;
- Exposure assessment;
- Effects assessment;
- Risk calculations; and,
- Uncertainty analysis.

The purpose of the SLERA being conducted for the USEN facility is to determine the potential for adverse ecological risks resulting from exposure to PCBs released to the environment during activities at the USEN facility. This SLERA will make a determination for one of the following outcomes:

- Ecological risk at the Site is negligible;
- The potential for ecological risk is great enough, and sufficient information exists to proceed with a remedial action; or,
- Further information and evaluation are needed to better define potential ecological risks at the Site.

1.1.1 Relevant Guidance Documents

Since the mid-1980s, a number of state and federal efforts have been made to standardize the process of toxicological risk evaluations for environmental constituents. EPA has published guidance manuals that summarize possible approaches and present issues for consideration in the performance of risk assessments.

The ERA process followed for the USEN facility was that prescribed in the EPA document entitled, *“Ecological Risk Assessment Guidance For Superfund, Process for Designing and Conducting Ecological Risk Assessments, 1997,”* (the Process Document; EPA, 1997). Additionally, as per recommendations by the EPA-IX, additional guidance followed for this SLERA included the document entitled, *“Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment”* (EPA, 2008). This SLERA is also consistent with the following guidance:

- Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments (Process Document; EPA, 1997);
- The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments, ECO Update (EPA, 1996);
- Guidelines for Ecological Risk Assessment (EPA, 1998); and,
- The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments, ECO Update (EPA, 2001).

Additional guidance documents, which are relevant and appropriate to the performance of ERA, include the following:

- Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS): Region IV Bulletins - Ecological Risk Assessment, Draft, April 2001 (EPA, 2001);
- Guidelines for Ecological Risk Assessment, Risk Assessment Forum, EPA/630/R-95/002F, April 1998 (EPA, 1998);
- EPA Framework for Ecological Risk Assessment, Risk Assessment Forum, EPA/630/R-92/001, February 1992 (EPA, 1992);
- Wildlife Exposure Factors Handbook: August 1993. EPA/600/P-95/002F;
- Guidance for Data Usability in Risk Assessment, OSWER Directive No. 9285.7-05, (EPA, 1990);
- National Contingency Plan (NCP: EPA, 1990);
- Regional Screening Levels Table, EPA April 2009 (EPA, 2009); and,
- Approach for Addressing Dioxin in Soil at Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and RCRA Sites. Office of Solid Waste and Emergency Response. OSWER Directive 9200.4-26, April 13, 1998a.

1.2 REPORT ORGANIZATION

The SLERA evaluates potential risks to ecological receptors using Site-related PCB concentrations in soil. It utilizes a screening approach to identify areas and/or receptors that can be eliminated from further analysis due to negligible risk. The SLERA results also provide information about the relative magnitude of risk contributed by dioxin-like PCB congeners. The remainder of this report is organized as follows:

- Section 2.0 presents a Site description, including the Site history, environmental resources, biological resources, and local physical settings (including a summary of topography, geology, hydrogeology, and surface water);
- Section 3.0 presents a Screening-Level Problem Formulation;
- Sections 4.0 and 5.0 include the Analysis portion of the report, including a Screening-Level Exposure Assessment (Section 4.0) and a Screening-Level Effects Assessment (Section 5);
- Section 6.0 presents the Screening-Level Risk Characterization;
- Section 7.0 presents Uncertainty;
- Section 8.0 summarizes the SLERA, and provides recommendations for additional activities (*i.e.*, if a BERA is necessary); and,
- Section 9.0 includes References.

2.0 Site Description and Environmental Setting

2.1 SITE BACKGROUND SUMMARY

The USEN facility is currently permitted for the handling, processing, and disposing of PCB articles and fluids.

2.1.1 Site Sampling Activities

On June 24, 2008, the EPA and the Nevada Division of Environmental Protection (NDEP) conducted a TSCA Section 6(e) PCB inspection of the USEN facility. During the inspection, eight soil samples were collected by EPA from locations near the tank farm and on the access road to the east of the facility. Laboratory analysis at the EPA laboratory in Richmond, California identified the presence of PCBs (reported as Aroclors 1248 and 1260 and Total PCBs) at concentrations ranging from 0.94 to 900 milligrams per kilogram (mg/kg) of Total PCBs in soil.

On August 20, 2009, USEN submitted a *Notification-Self Implementing On-site Cleanup and Disposal of PCB Remediation Waste* to the EPA RCRA Enforcement Office in San Francisco, California. The report documented PCB characterization activities in soil, which were performed in conformance with 40CFR § 761.61 (a)(2) and Subpart N. As noted in the document, USEN collected 92 near-surface soil samples within the tank farm. A 3-meter grid was established (40 CFR § 761.265 (a)) to completely overlay the area outside the PCB tank farm along the access road where EPA had previously documented PCBs in soil. A total of 225 near surface soil samples were collected from the following locations:

- A total of 63 samples from the access road and containment area east of the PCB tank farm;
- A total of 42 samples from the access road and containment berm directly north of the PCB tank farm;
- A total of 50 samples from the access road directly north of the PCB process building (Building 10); and,
- A total of 70 samples from directly west of the PCB process building and extending to a distance of 60 feet from the building.

According to USEN, all sampling was performed in accordance with 40 CFR § 761.286. Laboratory analysis was performed by Advanced Technology Laboratories (ATL) of Signal Hill, California, a Nevada-certified laboratory.

Laboratory analysis identified Total PCBs in soils outside the PCB tank farm at concentrations ranging from 0.20 mg/kg (dry-weight basis) to 1,410 mg/kg; only 5 of the 225 samples contained PCBs above the action level of greater than (>) 25 mg/kg (40 CFR § 761.3) established for low occupancy areas.

Total PCBs detected in soil samples collected from within the tank farm ranged from 27.5 to 279 mg/kg. Of the 92 soil samples collected, 33 samples were reported to contain PCBs greater than or equal to the action level of 25 mg/kg.

2.1.2 Site History

Region IX of the EPA informally requested that USEN submit additional information that would allow the Region to evaluate whether the USEN facility's PCB operations will be conducted in a manner that does not pose an unreasonable risk to public health and environmental quality. In response, USEN submitted the following information.

The USEN facility was issued prior TSCA approvals in 1978, 1982, 1987, 1988, 1989, and 1996 to operate a PCB storage and disposal facility. The approvals were issued by the EPA-IX. The 1978 approval was the nation's first permit for PCB disposal, and the 1996 approval remains current today. The PCB operations at the USEN facility have remained fundamentally the same during this time period, and there have been no changes in the surrounding land uses or ecological environment. The fundamental basis of the agency's prior approvals is that the USEN facility's operations do not pose an unreasonable risk to public health and environmental quality.

The disposal operations at the USEN facility are also permitted under the RCRA to treat, store, and dispose hazardous wastes. The RCRA permitting standard requires that facility operations prevent the migration of hazardous wastes to the surrounding environment, which is widely understood as being a more stringent standard than TSCA's standard of "*no unreasonable risk*."

The USEN facility is situated in a remote desert environment in southwestern Nevada. The topography is flat and there are no sensitive receptors within view of the facility (US Ecology, 2009). There are surrounding public lands including nearby mountains from which one can view the facility; however, public vehicle access is limited to existing roads. The closest mountains overlooking the facility with existing roadways include patented inactive mining claims which are posted with no trespassing signs (US Ecology, 2009). There are no known parks, recreation areas, or landmarks from which the USEN facility is visible.

2.2 ENVIRONMENTAL DESCRIPTION AND CONDITIONS

2.2.1 Local Environment and Conditions – Beatty, NV

The nearest town to the USEN facility is Beatty, Nevada. Beatty is a picturesque desert town in the Amargosa River Valley. Beatty is the closest town to Death Valley National Park and is only a 30-minute drive from the valley floor. The town is surrounded by three main mountain peaks, including Bare Mountain, Sawtooth Mountain, and the Bullfrog Hills (Desert USA, 2011a).

It is reported that Beatty has a typical Mojave Desert climate with hot summers, cool winters, and less than 5 inches of rain annually (Desert USA, 2011a). July is typically the warmest month of the year, when the average high temperature is 97 °F (36 °C), and the average low is 61 °F (16 °C). January and December are the coolest months with an average high of 54 °F (12 °C) and an average low of 28 °F (−2 °C) (Brussard, 2010).

2.2.2 Mojave Desert

The USEN facility is in the Amargosa Desert, and is approximately 12.5 miles east of Death Valley National Park. The Amargosa Desert is located in the northern Mojave Desert separated from Death Valley by the Amargosa Range, and is one of the driest regions in the United States. Additionally, the Mojave Desert is known for extremely hot summers, but it has cool winter temperatures. The Mojave Desert is a 'transition zone' from the hot Sonoran Desert (to the south) to the cooler and higher Great Basin Desert (to the north).

The Mojave Desert is a rain-shadow desert that is characterized by a combination of latitude, elevation, geology, and indicator plants (Weisberg, 2010). The Mojave Desert has a typical mountain-and-basin topography with sparse vegetation. It has been reported that approximately 200 endemic plant species are found in the Mojave Desert, but not in either of the two adjacent deserts (*i.e.,* Sonoran and Great Basin; Bryce et al., 2003). General plant communities of the Mojave Desert can include Mojave yucca and at higher elevations, desert Spanish bayonet (a narrow-leafed yucca), which are prominent vegetative species. Creosote bush, shadscale, big sagebrush, bladder-sage, bursages, and blackbush are common shrubs of the Mojave Desert. The Joshua-tree, an unusual tree-like yucca, has been considered a prime representative of Mojave Desert vegetation; it occurs only at higher elevations in this desert and only in this desert (Bryce et al., 2003; Desert USA, 2011a).

2.3 ENVIRONMENTAL RESOURCES

2.3.1 Geology

The USEN facility is located in the Amargosa Desert Basin. This basin was formed by normal block faulting, which displaced the surrounding strata upward with respect to the crustal block underlying the valley. This widespread structural process formed the characteristic topography of the entire Basin and Range province. Erosion of the uplifted areas, during and after their displacement, has filled the basin with a variety of sedimentary deposits. These deposits have reached a depth of 1,000 feet in the center of the basin near Lathrop Wells.

Deposited as alluvial fans, debris flows, streambeds, dunes, and lake or marsh beds, soils in the area exhibit a wide range of shapes and grain size distributions, as well as mineralogy. Alluvial deposits are primarily gravelly sands with poorly sorted gravel or sand deposits which occur in discontinuous intervals. The gravelly sand extends deeper (approximately 350 feet below ground surface or ft-bgs) at the southwestern area of the USEN facility. Deposits beneath the facility consist of silt, clay, and indurated deposits. The fine-grained soils are typical of playa deposits and may change composition relatively quickly with depth.

It has been reported that the facility does not fall on or within a recognized fault zone; the nearest zones being the Death Valley Fault Zone and the Las Vegas Fault Zone, 20 miles and 100 miles from the USEN facility, respectively.

2.3.2 Water Resources

Surface Water

There are no surface water resources available on or near the USEN facility. Surface water resources within the area surrounding the facility are dry river beds and washes, which flow only following significant rainfall. For the USEN facility, water is supplied by a well pulling from approximately 556 ft-bgs on the facility property.

The Amargosa River Channel is the closest surface water body; however, because the average annual rainfall is limited to approximately 4 inches per year. The river channel is predominantly dry, except after periods of heavy rainfall. The Amargosa River channel has a drainage area of 15,540 square kilometers (km^2) during heavy rain events. The Amargosa River, an intermittent river that ends in Death Valley, flows on the surface through part of the census-designated place (CDP), but has not been counted as water in the Census Bureau statistics (Brussard, 2010).

Groundwater

Groundwater flow is controlled by alluvium, volcanic rock, and carbonate rocks. Groundwater at the facility is approximately 285 feet deep. The closest public drinking water supply well is located in Beatty (11 miles away to the north of the USEN facility).

2.4 BIOLOGICAL RESOURCES

2.4.1 Vegetation

The overall structure of Mojave Desert vegetation is dominated by desert shrubs, generally of short to medium height and somewhat evenly spaced. Vegetation is sparse, in part due to the arid climate, but also due in part to the physiology of the dominant shrub species. Much of the Mojave Desert is covered in creosote bush (*Larrea tridentata*), a widely distributed shrub with olive-colored foliage that is resinous and exudes a strong creosote odor. Creosote bush occurs with white burrobush (*Ambrosia dumosa*) on deep, sandy soils and with shadscale (*Atriplex confertifolia*) on shallower soils. The shallow soils often have “desert pavement” on the surface or are underlain by caliche (hard layers of calcium carbonate that are nearly impervious to water penetration). At higher elevations, creosote bush diminishes and blackbrush (*Coleogyne ramosissima*) becomes more abundant.

Creosote bush and white bur-sage are known to secrete substances into the soil that keep the roots of adjacent creosote bushes and white bur-sage from elongating (MacKay, 2003). This plant technique tends to result in the shrub community being evenly spaced with open areas of desert floor. Additionally, creosote bush grows in clones (genetically identical clusters) of great longevity, dating as old as 11,000 years, making this species among the longest-lived plants (Weisberg, 2010). However, while the clones are long-lived in the sense that they continually resprout individual stems, they are seldom more than a few centuries old (Weisberg, 2010).

Grasses, herbaceous flowering plants, succulent (water-storing) species such as cacti and yucca, and even some trees are also important plant species found in the desert. There are many annual plant species in the Mojave that emerge only in years with: 1) heavy winter rains (referred to as winter annuals) or 2) summer rains (called summer annuals). These rain-blooming events cause the “desert to bloom” during irregular, favorable periods. Typically, the annual plants germinate, grow to reproductive maturity, flower, set seed, and die within a single growing season. Seeds, however, can persist and remain viable for many years in the soil, awaiting the next significant rainfall. Some annual plant species in the desert complete their entire life cycles in six to eight weeks or less (desert ephemeral species), thus avoiding the brutally hot summers (MacKay, 2003).

The vegetative community on the USEN facility was characterized by previous investigations (US Ecology, 2009). The species that were identified tend to be typical of the Mojave Desert vegetation. Creosote-bush, white bur-sage, hop-sage, and big sagebrush were the dominant shrub species observed in the USEN area (see Table 2 below).

TABLE 2

Plant communities and vegetation observed or expected to occur in association with the Mojave Desert near the USEN facility.

Scientific Name	Common Name	Group Type
Amaranthus fimbriatus	Fringed Amaranth	herb
Ambrosia dumosa	White Bur-sage	shrub
Artemisia tridentate	Big Sagebrush	shrub
Atriplex confertifolia	Shadscale	shrub
Chorizanthe rigida	Spiny-herb	herb
Cryptantha sp.	Forget-me-not	herb
Ephedra nevadensis	Mormon Tea	shrub
Eriogonum inflatum	Desert Trumpet	herb
Grayia spinosa	Hop-sage	shrub
Hymenoclea salsola	Cheesebush	shrub
Larrea tridentate	Creosote Bush	shrub
Plantago ovate	Desert Plantain	herb
Salsola targus	Russian Thistle	herb

Note: Source: TSCA Application for the USEN facility, March 2009.

Based on reported observations near the USEN facility, no visible or apparent signs of stressed vegetation were observed in the plant communities that were identified near the USEN facility.

2.4.2 WILDLIFE

Animal community structure in the Mojave Desert areas is highly functional, and can also be highly diverse and specialized. Invertebrates and microorganisms compose most of the animal biomass in deserts, and influence a wide range of community- and ecosystem-level processes in desert ecosystems. Invertebrates are prey for a suite of specialist predators that include birds and lizards, as well as mammals. Vertebrates also contribute significantly to ecosystem function in desert shrub lands and represent an important component of the biodiversity present in the Mojave Desert of Nevada (Chung-MacCoubrey et al., 2008).

Desert animals have been credited with playing an important role in the success of vegetation dispersal and recovery (Chung-MacCoubrey et al., 2008). Carnivores in the Mojave Desert environment can include the mountain lion (*Felis concolor*), coyote (*Canis latrans*), the desert kit fox (*Vulpes macrotis*), ringtails (*Bassariscus astutus*), and raptors (hawks, owls, eagles). Omnivores as well as scavengers can also play vital roles in the function and processes of the Mojave Desert; these species include skunks and various avian species (*e.g.*, ravens [*Corvus corax*], turkey vultures [*Cathartes aura*]). Reptiles can include the desert tortoise (*Gopherus agassizii*), gila monsters (*Heloderma suspectum*), sidewinders (*Crotalus cerastes*), and a high diversity of rattlesnakes (*Crotalus* spp.; Chung-MacCoubrey et al., 2008).

Wildlife typical of high desert communities would be expected in this regional habitat and would include mammals, birds, and reptiles. From reported observations at the USEN facility, there were eight species and/or sign of a species observed on the USEN facility (see Table 3 below). Of the species observed or expected to be present in the area, most of these species are not expected to occur within the boundaries of the facility. However, many may occur in the buffer zone surrounding the USEN facility. No suitable breeding habitat for amphibians was observed on or near the USEN facility. Therefore, amphibians are highly unlikely to occur in the area. However, it has been reported that potential breeding habitat (seasonal results of significant rain) for amphibians may be present approximately 10 miles north of the USEN facility where there is a roadside wetland dominated by bulrush (*Scirpus* sp.), which is near a cottonwood (*Populus fremontii*) dominated riparian forest. Desert tortoises are expected to occur locally, although no desert tortoises were seen during previous Site visits. The desert tortoise is listed as threatened at the federal level, and protected under N.R.S. 501 at the State level (see below for additional information on the desert tortoise).

TABLE 3

Wildlife species that were observed or evidenced near the USEN facility. Sightings were reported as either visual observation of species and/or evidence or sign (prints, scat, etc.) of the species being present on or near the Site.

Scientific Name	Common Name	Site Sighting Note
Mammals		
Lepus californicus	Blacktail Jackrabbit	Sighted in buffer area to north
Birds		
Amphispiza belli	Sage Sparrow	Sighted in buffer area to north
Carduelis psaltria	Lesser Goldfinch	Sighted in buffer area to north
Columba livia	Rock Dove (Pigeon)	Sighted within Facility
Corvus brachyrhynchos	American Crow	Throughout Facility and buffer area
Passer domesticus	House Sparrow	Sighted within Facility
Reptiles		
Gopherus agassizzii	Desert Tortoise	Burrows distributed throughout buffer area
Sceloporus magister	Desert Spiny Lizard	Throughout buffer area

Additional species that could be present or are expected to occur near the USEN facility, and/or in the surrounding buffer zone area are listed below (see Table 4 below).

2.4.3 Endangered, Threatened or Species of Concern

It is important to determine the presence or absence of threatened or endangered species that may occur on or near the USEN facility. Therefore, the United States Fish and Wildlife Service (USFWS), BLM, and Nevada Natural Heritage Program (NNHP) were contacted to ascertain the current status of any state or federally listed species of flora and fauna in the general vicinity. There was the potential for appropriate habitat to occur for three species: 1) the Endemic Ant (*Formica nevadensis*); 2) the Desert Tortoise (*Gopherus agassizii*); and 3) the banded Gila Monster (*Heloderma suspectum cinctum)*. A fourth species, the mountain plover (*Charadrius montanus*), was also noted by NNHP to potentially occur in the region. Although it was suggested that data were somewhat incomplete for the area, the NNHP stated that there were no mapped species within 2 miles of the USEN facility.

TABLE 4

Wildlife species that are expected or could potentially occur on the USEN facility and surrounding area.

Scientific Name	Common Name
Mammals	
Ammospermophilus leucurus	White-tailed Antelope Squirrel
Neotoma lepida	Desert Woodrat
Onychomys torridus	Southern Grasshopper Mouse
Perognathus longimembris	Little Pocket Mouse
Canis latrans	Coyote
Perognathus parvus	Great Basin Pocket Mouse
Masticophis taeniatus	Striped Whipsnake
Buteo jamaicensis	Red-tailed Hawk
Peromyscus emericus	Cactus Mouse
Citellus tereticaudatus	Round-tail Ground Squirrel
Dipodomys deserti	Desert Kangaroo Rat
Reptiles	
Callisaurus draconoides	Zebra-tailed Lizard
Chionactis occipitalis	Western Shovel-nosed Snake
Cnemidophorus tigrisl	Western Whiptail
Crotalus scutulatus	Mojave Rattlesnake
Crotaphytus insularis	Desert Collared Lizard
Phyllorhynchus decurtatus	Spotted Leaf-nosed Snake
Phrynosoma platyrhinos	Desert Horned Lizard
Rhinocheilus lecontei	Long-nosed Snake
Salvadora hexalepis	Western Patch-nosed Snake
Sceloporus graciosus	Sagebrush Lizard
Birds	
Cathartes aura	Turkey Vulture
Campylorhynchus brunneicapillus	Cactus Wren

Species observed or expected to be on or near the Site reported from investigations for the US Ecology Nevada TSCA Application, March 2009.

2.4.3.1 Endemic Ant (Formica nevadensis)

The NNHP considers the Endemic Ant in Nevada to be critically imperiled. The ant has a State ranking indicator of "*Unrankable*: present and possibly in peril, but not enough data yet to estimate rank." Additionally, the ranking of "*Unrankable***"** is defined as, "*currently unrankable due to lack of information or due to substantially conflicting information about status or trends"* (Nature Serve, 2010). Additionally, the State rank indicator is based on distribution within the state at the lowest taxonomic level (NNHP, 2004).

Formica species are ground-nesting ants with generalist foraging habits (Cole, 1956 as referenced in Ward, 2005). There are few species of this genus that occur in dry, low elevation sites, *Formica nevadensis* being one of them. *Formica nevadensis* has also been reported to occur in parts of California where the members of this genus are most prevalent in montane (mountain) habitats.

Although habitat for the Endemic Ant may be present in the surrounding area of the USEN facility, this species was not selected as a receptor for evaluation in this SLERA because as stated above, the NNHP stated that there were no mapped species within 2 miles of the USEN facility.

2.4.3.2 Banded Gila Monster (*Heloderma suspectum cinctum*)

The Banded Gila Monster (*Heloderma suspectum cinctum*) is one of two venomous lizards in the world (Fry et al., 2006) found within the southwestern United States. The venom is thought to be used for defensive purposes, rather than for assisting in prey capture. Gila monsters are large, thick-bodied lizards with a large-head, rounded body and short, thick tail, and can reach a total length of up to 22 inches (56 centimeters), and are recognized as a slow-moving lizard.

Gila monsters spend the majority of their life underground, and are active primarily during the day. The Banded Gila Monster is primarily ground dwelling and subterranean, spending greater than 95 percent of their lives underground (NDW, 2005), but will occasionally climb trees in search of food resources. Gila monsters often seek shelter or find refuge in self-excavated burrows or alternatively, those made by small mammals, and occasionally in wood rat nests, as well as in spaces under rocks, dense shrubs, or other natural cavities.

The Banded Gila Monster is found primarily in the Eastern Mojave Desert of southern California and southern Nevada and the northern Sonoran Desert in northern Arizona. In Nevada, the Gila monster is found across Clark, southeastern Lincoln, and extreme southern Nye counties (Heindl, 2006; NDW, 2005). Although the species is not expected to occur in or near the facility, Nye County is the northern-most distribution range that has been identified for the Banded Gila Monster, therefore, having only a slight potential of being found in the area. Distribution maps and records show the Gila monster is only present as far north as Ash Meadows (Stebbins, 1985). Therefore, no Banded Gila Monsters are expected to be present on or near the USEN facility.

The Banded Gila Monster is not currently federally listed or proposed as threatened or endangered, or a candidate for listing, under the Endangered Species Act (ESA) of 1973, as amended. Although the Gila monster is not a federally listed species and not recognized by USFWS as requiring federal protection, the State of Nevada extends special protection to certain species that are considered to be endangered or rare within Nevada. Therefore, species that fall within either of these State-protected classifications are offered state protection, thus including the Banded Gila Monster as a potentially rare species (Bechtel Nevada, 2001). This species is also recognized by BLM as a sensitive species in Nevada and Arizona (Bechtel Nevada, 2001).

In Nevada, the Banded Gila Monster is protected under the Nevada Revised Statutes (NRS) 501 (NNHP 2004). The NNHP lists this species as an S2 Imperiled[3], meaning that its continued presence in the state is imperiled (NatureServe, 2007). According to the most recent Nevada Natural Heritage database records, 12 occurrences of the Gila monster have been documented mainly in southeastern Lincoln County.

Although the Banded Gila Monster is not federally listed as threatened or endangered), it is a state protected species in Nevada and is classified as protected by the state of Nevada. Additionally, the Banded Gila Monster is identified as a sensitive species by the BLM. Therefore, for the purpose of this SLERA, the Banded Gila Monster was addressed as a cautionary note for the assessment of impacts from PCBs. However, as the USEN facility is at the northernmost distribution range of the Banded Gila Monster, and information suggesting that this species has not been observed on or near the USEN facility; it is unlikely that the Gila monster would be present near the facility.

Because the geographic range of the Banded Gila Monster approximates that of the Desert Tortoise (NDW, 2005), and they are a species of concern, the Banded Gila Monster will be considered in this SLERA, and included as part of the qualitative evaluation for reptiles.

2.4.3.3 Mountain Plover (*Charadrius montanus*)

The Mountain Plover (*Charadrius montanus*) is a medium-sized ground bird in the plover family (Charadriidae). Plovers are typically associated with water and/or wet environments. However, unlike most plovers, the mountain plover lives on level land, and is usually not found near bodies of water or even on wet soil. It prefers dry habitat with short grass such as grazing land, as well as bare ground (Knopf and Wunder, 2006). In 2003, USFWS withdrew its proposal to list the mountain plover, a grassland bird found in the mountain west, as a threatened species under the Endangered Species Act (USFWS, 2003). However, on June 29, 2010, the USFWS published a new proposed rule to list the mountain plover as threatened under the Endangered Species Act (USFWS, 2010a; Knopf and Wunder, 2006).

The desert shrub communities present adjacent to the USEN facility may not provide the resources required for the mountain plover. Therefore, it was determined through correspondences with USFWS

[3] S2 Imperiled: Classification of S2 Imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province .

and NNHP, literature sources, and Site conditions that the mountain plover, a federally proposed threatened species, would not be likely to occur on or near the USEN facility. Therefore, it was not considered for evaluation in this SLERA.

2.4.3.4 Desert Tortoise (*Gopherus agassizii*)

The Desert Tortoise *(Gopherus agassizii)* is one of four tortoise species found in the United States. Their range includes the Mojave and Sonoran deserts and extends southeastern into California, southern Nevada, and south through Arizona into Mexico. It is a high-domed turtle, with columnar or “elephant-shaped” legs. The Desert Tortoise is an herbivore that may attain a length of 9 to 15 inches in upper shell (carapace) length. The tortoise is able to live where ground temperatures may exceed 140 degrees Fahrenheit (F), because of its ability to dig underground burrows and escape the heat (USFWS, 2010b). At least 95 percent of its life is spent in burrows (USFWS, 2010b).

Habitat likely exists in the area of the USEN facility for the desert tortoise. Tortoises tend to demonstrate strong site fidelity. Tortoises have well established home ranges, with established resources of food, water, and minerals. The presence of soil suitable for digging burrows is a limiting factor to Desert Tortoise distribution. Additionally, a single tortoise may have a dozen or more burrows distributed over its home range. It has been reported that these burrows may be used by different tortoises at different times. The Desert Tortoise may live to be 80 to 100 years, although predation, disease, and habitat loss have created significant challenges for the population at large (USFWS, 2010b).

Sexual maturity is a function of size rather than age, approximately 7 to 8 inches mid- carapace length in females (USFWS, 2010b). Generally, Desert Tortoises do not reach sexual maturity for 15 to 20 years. Forage availability can often determine the growth rate of tortoises. Female size seems to be one factor that determines the number of eggs that are laid, four to eight eggs, generally twice a season, with a typical Incubation period of 90 to 120 days (USFWS, 2011). Minimal hatchlings survive to adulthood; reportedly very few out of hundreds.

The Desert Tortoise is easy prey to hunters, off-road vehicles, and urban development. Primary threats remaining to the Desert Tortoises include:

- Illegal collection and torture by humans;
- Urban area expansion that has destroyed habitat destruction from urban sprawl;
- Predation by several species (ravens, coyote, gila monsters, kit foxes, badgers, and roadrunners);
- Diseases;
- Grazing competition, and,
- The loss of forage plants by invasive species.

Desert Tortoise numbers have declined precipitously in the last 20 years (Desert USA, 2011b; USFWS, 2010b).

Populations of the Desert Tortoise have declined by as much as 90 percent since the 1980s, and the Mojave population of the Desert Tortoise has been recently federally listed as a threatened species (Federal Register, 2010; USFWS, 2010b; 2011). State and federal wildlife and land management agencies, as well as local jurisdictions are actively involved in conservation programs to help the recovery of the Desert Tortoise throughout the Mojave Desert. For these reasons, a semi-quantitative evaluation was conducted for the Desert Tortoise to determine potential for risk.

3.0 Screening Level Problem Formulation

Problem formulation is the process of generating and evaluating preliminary hypotheses regarding potential causes for ecological effects that have occurred, or may occur, due to anthropogenic releases of chemicals into the environment. Problem formulation evaluates the manner in which ecosystem characteristics influence when, how, and why particular ecological entities may become exposed to chemical contaminants, and then exhibit adverse effects due to these exposures (EPA, 1997; EPA, 1998). Problem formulation provides a systematic approach for organizing and evaluating available information on potential ecological receptors that are potentially at risk from exposure to Site-related PCBs.

This section of the SLERA presents the screening level problem formulation that consists of the following:

- Identification of ecological receptors and exposure pathways;
- The conceptual site model (CSM);
- Data evaluation and identification of constituents of potential concern (COPCs); and,
- Selection of assessment and measurement endpoints.

3.1 IDENTIFICATION OF EXPOSURE PATHWAYS, EXPOSURE ROUTES, AND ECOLOGICAL RECEPTORS

3.1.1 Exposure Pathways and Routes of Exposure

An exposure pathway is the means by which a COPC moves from a source through the environmental compartments to a receptor. Potentially complete exposure pathways have been identified for the terrestrial habitat of the USEN facility. In order for exposure to ecological receptors to be considered potentially complete, COPCs must exist in a medium where exposures to ecological receptors could occur. Therefore, COPCs must be present in surface soil, and the medium must be located in areas that constitutes suitable habitat for ecological receptors. Additionally, ecological receptors were selected to address the range of potentially complete exposure pathways, as well as the types of organisms that potentially could be exposed.

The SLERA focuses on pathways for which: 1) COPC exposures are the highest and most likely to occur, and 2) there are adequate data pertaining to the receptors, COPC exposures, and toxicity for completion of risk analyses.

Exposure to groundwater was determined to be an incomplete pathway for all terrestrial ecological receptors, because groundwater is too deep beneath ground level for there to be direct exposure to any of the receptors. Therefore, it was determined that ecological receptors would not have direct contact with groundwater, nor was groundwater considered to be a recharging source to surface water within the area of the USEN facility. Therefore, the screening level CSM (see Figure 2, CSM-pictorial) shows a complete exposure pathway of surface soil to terrestrial plants and animals, and an incomplete exposure pathway of upper groundwater to terrestrial plants and animals. Specifically, the major exposure routes for a COPC present in surface soil include ingestion (for terrestrial wildlife receptors), and direct contact (for terrestrial plants and invertebrates). Additionally, a complete exposure pathway for food ingestion between trophic levels is also demonstrated in the CSM. Potentially complete exposure pathways for terrestrial plants, invertebrates, birds, and mammals are discussed further below.

3.1.2 Selection of Ecological Receptors

The selection of ecological receptors for the Site-specific screening was based on plant and animal species that have been observed, or are likely to be present at the USEN facility. Receptor species were also selected with the assistance of the EPA-IX. The selected species were identified based on several factors including life history, available resources located at or near the facility to support the species, availability of toxicological data, position in the food chain, the known occurrence of the species in habitats in the vicinity of the USEN facility and surrounding area, and status as sensitive species. The selected ecological receptors to be evaluated serve as surrogates for species exposed by the same pathways, and accordingly were selected to characterize the upper bounds of the potential exposures to the various plants and animals that could be present. Smaller animals with higher metabolic rates were selected to characterize upper bounds on potential exposure to support their use as surrogates for other species. Selected ecological receptors include:

- Terrestrial Plant Communities;
- Terrestrial Invertebrate Communities;
- Herbivorous Mammal, Little Pocket Mouse, *Perognathus longimembris;*
- Invertivorous (insectivorous) Bird, Western Meadowlark, *Sturnella neglecta;*
- Invertivorous (insectivorous) Mammal, Southern Grasshopper Mouse, *Onychomys torridus;*
- Carnivorous Mammal, Kit Fox, *Vulpes macrotis;*
- Carnivorous Bird, Ret-tailed Hawk, *Buteo jamaicensis;* and,
- Herbivorous Reptile, Desert Tortoise *Gopherus agassizii.*

These receptors include plants, terrestrial invertebrates, birds, and mammals, and are depicted in the CSM (see Figure 2). Additionally, Table 5 provides a list of the selected ecological receptors.

TABLE 5

Selected ecological receptors for USEN facility.

Exposure Class	Representative Species	Feeding Guild (Dietary Level)	Primary Habitat
Terrestrial Vegetation	Plants	NA (Soil)	Terrestrial
Terrestrial Invertebrate	Terrestrial Invertebrates	NA (Soil)	Terrestrial
Herbivorous Small Mammal	Little Pocket Mouse	Grasses, shrubs, forbs	Terrestrial
Insectivorous Avian	Western Meadowlark	Invertebrates (63.3%) Plants (36.7%)	Terrestrial
Insectivorous Mammal	Southern Grasshopper Mouse	Invertebrates (90%) Plants/seeds (~3%) Small mammals (~7%)	Terrestrial
Carnivorous Avian	Red-tailed Hawk	Small Mammals	Terrestrial
Carnivorous Mammal	Kit Fox	Small Mammals	Terrestrial
Herbivorous Reptile	Desert Tortoise	Plants	Terrestrial

USEN – US Ecology Nevada Facility

NA – Not Applicable

3.1.2.1 Terrestrial Vegetation

Terrestrial vegetation exposure to soil is applicable to the Site-specific analysis. Terrestrial plants have ecological relevance because they represent the base of the food web and are the primary producers that turn energy from the sun into organic compounds that provide energy for many animals. Additionally, plants are important to provide shelter and nesting materials to many animals; thus plants are a major component of habitat. Plants also provide natural cover and stability to soil, thereby reducing soil erosion.

Terrestrial plants can be susceptible to toxicity from chemicals. Plants have roots that are in direct contact with surface soil, which can result in direct exposure to contaminants. They also can have exposure to contaminants via direct contact on the leaves. There typically are published toxicity benchmarks for plants (Efroymson et al., 1997a), as well as management goals for plants because of their importance in erosion control. Thus, there is sufficient justification to warrant plants as a receptor for the SLERA.

3.1.2.2 Terrestrial Invertebrates

Terrestrial invertebrate exposure to soil is applicable for the Site-specific analysis of potential of COPC impacts. Terrestrial invertebrates were selected as representative for the invertebrate class. However, only one exposure pathway was qualitatively accessed for terrestrial invertebrates, and that was exposure to PCBs though soil. Toxicity data were directly related to the soil concentrations of each individual COPC to terrestrial invertebrates via uptake. It has been reported that terrestrial invertebrates have a relatively low metabolic capacity, contributing to the exposure factors of invertebrates as prey items. Therefore, terrestrial invertebrates were mainly accessed as an exposure route for species that feed on them. This evaluation did not quantitatively evaluate PCB impacts to terrestrial invertebrates.

3.1.2.3 Mammalian Herbivore

Mammalian herbivore exposure to soil is applicable to the Site-specific analysis. The Little Pocket Mouse is the selected species to represent the mammalian herbivore receptor. This species has ecological relevance by consuming vegetation, which helps in the regulation of plant populations and in the dispersion of some plant seeds. As important, small herbivorous mammals such as the pocket mouse are components of the diet of terrestrial top predators.

The Little Pocket Mouse is susceptible to exposure to and toxicity from COPCs in soil and vegetation. Herbivorous mammals are exposed primarily through ingestion of plant material and incidental ingestion of contaminated surface soil that may contain chemical. Exposures by inhalation of COPCs in air or on suspended particulates, as well as exposures by direct contact with soil were assumed to be negligible. There are no specific management goals for pocket mice at the USEN facility. However, because of the ecological relevance and susceptibility to contamination, there is sufficient justification to warrant Little Pocket Mouse as receptors for the SLERA.

3.1.2.4 Insectivorous Mammal and Bird

Insectivorous mammal and bird exposure to soil is applicable to the Site-specific analysis. Grasshopper Mice and Western Meadowlarks will represent the receptors for the insectivorous mammal and bird terrestrial exposure class, respectively. Both species have ecological relevance because they help to control above-ground invertebrate communities by consuming large numbers of invertebrates. Mice and meadowlarks are also prey items for terrestrial high level consumers, also known as apex predators.

Both mice and meadowlarks are susceptible to exposure to and toxicity from dioxin-like PCBs in soil, as well as contaminants in vegetation and terrestrial invertebrates. Insectivorous mammals such as Grasshopper Mice and birds such as Western Meadowlark are primarily exposed by ingestion of contaminated prey (*e.g.,* spiders, insect larvae, beetles, other), as well as incidental ingestion of soil. There are often dietary toxicity benchmarks available for mammals and birds (Sample et al., 1997). Both species are included as receptors for this SLERA because there can be different toxicological sensitivity between mammals and birds exposed to the same contaminants. In particular, it has been demonstrated that birds and mammals tend to be sensitive to different PCB congeners (*e.g.,* birds – PCB 77; mammals

– PCB 126). Some management goals are present for meadowlarks, because they are federally protected under the Migratory Bird Treaty Act of 1993, as amended. There are no specific management goals for mice at the USEN facility. Based on the management goals for meadowlarks, plus the susceptibility to contamination and ecological relevance for both species, there is sufficient justification to warrant Grasshopper Mice and Western Meadowlarks as receptors for this SLERA.

3.1.2.5 Terrestrial Apex Predators

Exposure of terrestrial apex predators is applicable to the Site-specific analyses. Kit Foxes and Red-tailed Hawks represent the mammal and bird receptors, respectively, for the terrestrial top predator exposure class. Both species have ecological relevance because as representatives of the top of the food chain for a terrestrial site, they are also known to be a controlling factor for populations of prey animals such as small mammals and birds.

Both Kit Foxes and Red-tailed Hawks are susceptible to exposure to and toxicity from COPCs in soil, vegetation and/or animal prey. Terrestrial apex predators feed on small mammals and birds that may accumulate constituents in their tissues following exposure to COPCs at the Site. There is a potential difference in toxicological sensitivity between mammals and birds exposed to the same COPCs, so it is prudent to examine a species from each taxon (Mammalia and Aves, respectively). Kit Foxes are primarily carnivorous, but may also periodically consume some plant material. The Red-tailed Hawk consumes only animal prey. Kit Foxes also may incidentally consume soil; Red-tailed Hawks typically do not.

There are management goals for Red-tailed Hawks, as raptors are federally protected under the Migratory Bird Treaty Act, as amended. In addition, both species are susceptible to contamination and have ecological relevance as apex predators in the terrestrial ecosystem. Thus, there is sufficient justification to warrant these two species as receptors for the SLERA.

3.1.2.6 Herbivorous Reptile

The Desert Tortoise is federally listed as a threatened species. The Desert Tortoise feeds primarily on vegetation, thus potentially being exposed to PCBs via consumption of plants. A semi-quantitative evaluation was conducted for the Desert Tortoise. Toxicity values could not be identified for reptiles, especially the Desert Tortoise, and there are no toxic equivalency factors (TEFs, discussed below) for reptiles. As such food chain modeling could not be performed for this species. However, exposure dietary doses of PCBs were generally estimated using available soil data and supporting information. Input parameters for Site-specific soil data, estimated concentrations for plants (dietary item), and literature-derived exposure factors (*e.g.,* body weight, food ingestion rate) were used to evaluate exposure of Desert Tortoise.

3.2 CONCEPTUAL SITE MODEL (CSM)

The ecological CSM illustrates complete exposure pathways, selected ecological receptors, and initial estimates of contaminant fate and transport mechanisms. The initial ecological CSM is based on the current understanding of the Site conditions, and serves as a framework for evaluating the ecological exposure and risk. The initial ecological CSM for the USEN facility is shown in Figure 3.

The objective of the CSM is to clearly show complete exposure pathways and define assessment and measurement endpoints consistent with the transport, fate, and toxicological characteristics of the COPCs. The CSM for the USEN facility was developed using the available Site-specific information as well as professional judgment.

3.3 DATA EVALUATION & IDENTIFICATION OF COPCS

As stated above, PCB congener analysis, including the 209 PCB congeners (singly or in co-eluting groups), was conducted on surface soil samples in 2010 (Stantec, 2010). Following conversations with EPA-IX, it was determined that of the 209 congeners, the 12 dioxin-like PCB congeners identified by the WHO would be used in the SLERA to evaluate any potential ecological risks to the environment and off-Site receptors from PCB disposal activities at USEN. The 12 dioxin-like congeners are hereafter referred to as COPCs. The Site-specific maximum soil concentrations of each COPC assessed in the SLERA and are shown in the following table.

TABLE 6

The 12 dioxin-like PCB congeners and corresponding maximum concentration in soil collected for Site-related evaluation.

PCB Congener	Maximum Soil Concentration (ng/kg-dw)
PCB 77	5.1E+03
PCB 81	1.6E+02
PCB 105	1.7E+04
PCB 114	1.0E+03
PCB 118	2.7E+04
PCB 123	6.4E+02
PCB 126	3.3E+02
PCB 156 and 157	4.7E+03
PCB 169	2.9E+02
PCB 189	6.9E+02

PCB = Polychlorinated biphenyls

ng/kg-dw = nanograms per kilogram dry weight

Per discussions with EPA-IX, PCBs were confirmed as Site-related chemicals that could potentially be associated with adverse effects for ecological receptors. In general, PCBs and the 12 dioxin-like congeners were selected as the sole COPCs because those are the only chemicals regulated under the TSCA permit. The purpose of the sampling and risk analysis was to evaluate the potential impacts of chemical exposures related to the TSCA permit. The physicochemical properties of PCBs provide information regarding their persistence, bioavailability, and their bioaccumulation potential in terrestrial systems.

The maximum detected concentrations of PCBs in soil were compared to soil screening benchmarks. However, screening values for PCBs congeners in soil are either limited or unavailable. The following references were reviewed for selection of applicable screening benchmarks:

- Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones, 1997b. *Preliminary Remediation Goals for Ecological Endpoints*. ES/ER/TM-162/R2. Oak Ridge National Laboratory. November 1997.

- Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997c. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process*: *1997 Revision*. ES/ER/TM-126/R2. Oak Ridge National Laboratory. November 1997.

- Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-85/R3 (PDF file, tm85r3.pdf; WP file, tm85r3.wpd).

- The fourth stated source is *Ecological Data Quality Levels (EDQL), U.S. EPA, Region 5, Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Concern, 1999* (EPA 1999b). However, this reference has been superseded by *Region 5 Corrective Action, Ecological Screening Levels* (EPA, 2003c), http://www.epa.gov/reg5rcra/ca/edql.htm. August 2003.

- Sample, B.E., D.M. Opresko, and G.W Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-86/R3 (PDF file, tm86r3.pdf; self-extracting WP file, tm86r3.exe).

3.3.1 Environmental Fate and Behavior of PCBs in Soil

The ultimate fate and transport of contaminants at the USEN depends on a wide range of characteristics of the environment and on the physical and chemical properties of the individual contaminants (*i.e.,* PCBs). Potential transport mechanisms at the Site include biota uptake and soil erosion, and wind dispersion.

As PCBs are ubiquitous contaminants, their origin in soil can be from particulate deposition, wet deposition, and releases from electrical transformers (WHO, 1993). Because PCBs sorb strongly to soil colloids and are also resistance to physicochemical degradation and biodegradation, soil is an important environmental sink for PCBs. The degree of chlorination of individual congeners, soil type, organic matter content, soil pH, and soil moisture content determine the sorption of PCBs onto soil particles.

The adsorption of PCBs to soil particles is thought to be hydrophobic sorption, which is the partitioning of a nonpolar solute from the polar aqueous phase onto the hydrophobic surfaces of the earth materials (Gan and Berthouex, 1994). In general, higher chlorinated congeners adsorb more readily onto soil particles than lower chlorinated species (Cortes et al., 1991; Gan and Berthouex, 1994). Soil adsorption is also stronger for coplanar PCBs than non-coplanar congeners with the same degree of chlorination (Cortes et al., 1991; Paya-Perez et al., 1991).

The movement of PCBs in soil profiles is directly proportional to the solubility of PCBs in the leaching solvent and inversely proportional to the organic matter content of the soil (CCME, 1999). PCBs are nonpolar and sparingly soluble compounds in water; therefore, the penetration of PCBs into the soil profile by water flow is limited (CCME, 1999). However, PCBs are highly mobile when leached with organic solvents (Chou and Griffin, 1986).

PCBs can be biodegraded under both aerobic and anaerobic conditions. The biochemical pathway for aerobic degradation of PCBs involves initial addition of O_2 at the 2, 3-position by a dioxygenase enzyme, with subsequent metabolism to chlorobenzoic acid (CCME, 1999). Aerobic biodegradation generally metabolizes the less chlorinated congeners (Gan and Berthouex, 1994). The rate of microbial decomposition of PCBs depends on the degree of chlorination and the positions of chlorine atoms (Eisler, 1986). In general, the microbial degradation rate of PCBs in soils generally decreases as chlorine substitution increases (Furukawa, 1982).

The volatilization of PCBs from soil depends on the vapor pressures and solubilities of individual congeners, soil concentration, soil adsorption reactions, the water and organic matter solubility of individual congeners, temperature, wind velocity, depth of incorporation, photodegradation, and soil water content (Fairbanks et al., 1987; Gan and Berthouex, 1994, as cited in CCME, 1999). In general, lower chlorinated PCBs tend to be more volatile than higher chlorinated PCBs (Fairbanks et al., 1987). Vapor pressures of PCBs are reduced by their interaction with soil, mainly as the result of adsorption (Chou and Griffin, 1986; Fairbanks et al., 1987, as cited in CCME, 1999).

The persistence and toxicity of individual PCB congeners is determined by the structure and positions of the chlorine atoms on the molecule as well as the number of chlorine atoms present (Lech and Peterson, 1983; Safe, 1994). Coplanar PCBs, defined as congeners with four or more chlorines at both the *para* and *meta* positions, but none at the *ortho* positions, tend to have higher toxicities than other noncoplanar congeners. The toxicities of coplanar halogenated hydrocarbons relative to that of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), currently identified as the most potent compound in this class of chemicals, are compared through a calculated TEF. Application of the TEFs for individual congeners must be performed with caution, as it has been suggested that PCB mixtures show both additive and non-additive (antagonistic) interactions (Safe, 1994). Additionally, research has suggested that some dioxin-like PCB congeners demonstrate higher toxicity to some species than does 2,3,7,8-TCDD (Beckett et al., 2004, 2008).

Bioaccumulation is a critical aspect of the environmental fate and behavior of PCBs, as PCBs are highly lipophilic (lipid attractant). PCBs accumulate in almost all organisms as a result of their high lipid solubility and slow rates of metabolism and elimination (WHO, 1993). These characteristics permit PCBs to accumulate to relatively high levels in biota, even at low exposure rates. Thus, sustained low levels of PCBs in the abiotic environment may result in adverse chronic effects in the biota exposed to them over the long-term. Higher chlorinated PCBs and coplanar PCBs are more likely to be bioaccumulated in organisms than lower chlorinated congeners as a result of their lower water solubilities, lower volatilities, and greater resistance to biodegradation (Eisler and Belisle, 1996; Moore and Walker, 1991).

3.4 ASSESSMENT AND MEASUREMENT ENDPOINTS

An important step in the problem formulation process is the identification of assessment and measurement endpoints, which is completed before exposure, toxicity, or risk can be estimated. Endpoints are used in the ecological risk assessment to define the ecological attributes to be protected (assessment endpoints) and to define measurable characteristics of those attributes that can be used to gauge the degree of impact that may occur (measurement endpoints).

A typical assessment endpoint is an ecological attribute that, if found to be significantly affected, would indicate a need for remediation. Assessment endpoints most often relate to attributes of biological populations or communities. The selected endpoints contain an entity (*e.g.,* invertebrate population) and an attribute of that entity (*e.g.,* survival rate; Suter et al., 1993).

In general, the primary assessment endpoints for the SLERA are the protection and maintenance of terrestrial receptor populations at the USEN facility. The overall objective of the SLERA is to determine if exposure to contaminant (*i.e.,* PCB) concentrations detected in Site-related media is likely to cause a decline in receptor populations or to adversely affect the integrity of terrestrial communities. The general types of effects of concern (*i.e.,* measurement endpoints) may include:

- ❑ Mortality, growth, or reproductive effects resulting from direct exposure to contaminants that affect a significant proportion of a receptor population; and,
- ❑ Mortality, growth, or reproductive effects resulting from exposure to contaminants that have bioaccumulated in the ecological food chain that affect a significant proportion of a receptor (higher trophic level) population.

3.4.1 Selection of Assessment Endpoints

A primary objective of the SLERA is to determine if there are adverse impacts to the growth, survival, or reproduction of ecological receptor populations (or individuals of special status species). Impacts to populations may be caused either by direct mortality of a significant percentage of a population, or by adverse reproductive or growth effects.

Food chain modeling was used in this SLERA to evaluate risks from the 12 dioxin-like PCB congeners to the selected ecological receptors. As PCBs are known to be bioaccumulative contaminants, modeling was used to determine if there was a bioaccumulation hazard to higher trophic receptors (*i.e.,* predatory mammals and birds).

By evaluating and protecting the assessment endpoints, it is assumed that the ecosystem as a whole is also protected. For each assessment endpoint, a risk question is identified that clearly states the question to be answered. Each assessment endpoint and risk question is identified and discussed in detail below. It was determined through conversations with EPA-IX that at this stage, avian eggs would not be considered as an assessment endpoint. This decision was also based on the Kettleman Study (Wenck, 2010), which reported lower risk estimates in the meadowlark egg, than in the adult birds.

3.4.1.1 Assessment Endpoint #1: Terrestrial Plant Communities

Terrestrial plant communities are keystone components of a terrestrial ecosystem. Plants play vital roles as a primary producer and are an important food resource for herbivorous species or first-order consumers. In addition to providing forage, plants also provide several biological roles in an ecosystem, including bedding material, protection as refuge and shelter from the elements, and cover or protection from predators. Decreases in abundance or significant changes in plant community structure could have negative effects on trophic level organisms that rely on them.

Assessment Endpoint #1 is the protection of terrestrial plant community structure: *Are levels of Site COPCs sufficient to adversely affect terrestrial plant communities in the areas evaluated?*

3.4.1.2 Assessment Endpoint #2: Terrestrial Invertebrate Communities

The environment including and surrounding the USEN facility is recognized as desert flat land, and is part of the Amargosa Desert. The desert habitat is complex and provides a diversified niche for invertebrate structure and community development. Direct contact and direct ingestion of soil by terrestrial invertebrates can be important exposure pathways on the USEN facility. Terrestrial invertebrates were qualitatively assessed to evaluate the potential of PCB impacts. Particularly important, terrestrial invertebrates are a critical dietary pathway for higher trophic levels located on or near the facility. Therefore, protection of terrestrial invertebrate populations and communities is valuable to ecosystem functioning within the local area.

Assessment Endpoint #2 is the protection of terrestrial invertebrates: *Are levels of Site COPCs sufficient to cause survival, growth, or reproductive impairment of invertebrate communities?*

3.4.1.3 Assessment Endpoint #3: Herbivorous Mammal (Little Pocket Mouse: *Perognathus longimembris*)

Rodent populations are present near the USEN facility and the surrounding buffer zone areas. The Little Pocket Mouse would be exposed to dioxin-like PCBs in surface soil and vegetation (diet), which may have the potential to adversely affect populations of these mammals. The pocket mouse is an important prey species for the carnivorous species of the region. These mice may burrow for reproductive purposes as well as protection (predators and environment).

Assessment Endpoint #3 is the protection of herbivorous small mammals: Are levels of Site COPCs sufficient to cause adverse impacts such as survival, growth, or reproductive impairment in populations of herbivorous small mammals?

3.4.1.4 Assessment Endpoint #4: Insectivorous Avian (Western Meadowlark: *Sturnella neglecta*)

The area and activities within the USEN facility limits use for avifauna, making the available habitat and suitable resources on the USEN facility limited at best for avifauna. However, habitat and resources are still present to some degree especially beyond the facility area and the surrounding buffer zone, and do provide the potential for the occurrence of avifauna within the area. Dioxin-like PCBs in surface soil and/or invertebrates may have the potential to adversely affect populations of insectivorous birds. The Western Meadowlark is a year-round resident of the Amargosa region (Davis and Lanyon, 2008). The predominant portion of their diet consists of invertebrates (63.3%) and vegetation (36.7% grains and seeds), and soil is incidentally ingested as well (Davis and Lanyon, 2008; Cal/Ecotox, 1999d; Sample et al., 1997).

Assessment Endpoint #4 is the protection of insectivorous birds: Are levels of Site COPCs sufficient to cause adverse impacts such as survival, growth, or reproductive impairment in populations of insectivorous birds?

3.4.1.5 Assessment Endpoint #5: Insectivorous Mammal (Southern Grasshopper Mouse: *Onychomys torridus*)

The Southern Grasshopper Mouse is an observed rodent in the region of the USEN facility and facility, and known to occur throughout the Amargosa region. The Southern Grasshopper Mouse consumes invertebrates (especially scorpions, beetles, other) almost exclusively (over 90% of diet composition), but may include other mice and small amounts of vegetation as well. Additionally, this mouse is a primary component of the food chain as prey for carnivorous birds and mammals. This assessment endpoint is to estimate dietary doses of Site-related PCBs to insectivorous mammalian species present near the USEN facility boundaries, as well as the surrounding area using a food chain model. Input parameters are based on Site-specific environmental medium (surface soil) and modeled biota tissue (invertebrate) concentration data to represent dioxin-like PCB concentrations in prey items, as well as literature-derived exposure factors (*e.g.,* receptor-specific food ingestion rate, body weight, home range, and dietary composition).

Assessment Endpoint #5 is the protection of insectivorous mammal: *Are levels of Site COPCs sufficient to cause adverse impacts such as survival, growth, or reproductive impairment in populations of insectivorous mammals?*

3.4.1.6 Assessment Endpoint #6: Carnivorous Avian (Red-tailed Hawk: *Buteo jamaicensis*)

Red-tailed Hawks were observed over and near the USEN facility during an earlier Site evaluation, confirming their presence in the area. The Red-tailed Hawk has a relatively large home range, especially in a desert environment with somewhat limited resources. However, habitat and resources are presumed to also be present to some degree in the surrounding buffer zone area, and thus potentially can support limited numbers of the species in the area. Hawks represent the apex avifauna in the area, are year-round residents, and are known to consume primarily rodents as well as other prey items (*i.e.,* birds, reptiles). For this SLERA, the diet of the Red-tailed Hawk was assumed to consist entirely of small mammals (*i.e.,* mice) with a high potential for exposure to contaminants in soil, vegetation, and invertebrates (the Southern Grasshopper Mouse). Incidental ingestion of soil is considered to be negligible in Red-tailed Hawks. The Red-tailed Hawk could possibly have a relatively high exposure potential to COPCs assuming bioaccumulation of contaminated prey items, thus providing a conservative representation of risk to this species as well as other predatory birds.

Assessment Endpoint #6 is the protection of carnivorous birds: *Is exposure to Site COPCs sufficient to cause adverse impacts such as survival, growth, or reproductive impairment in populations of predatory birds?*

3.4.1.7 Assessment Endpoint #7: Carnivorous Mammal (Kit Fox: *Vulpes macrotis*)

Mammals such as Kit Fox are expected to utilize the habitats around the USEN facility, possibly the surrounding buffer zone. However, use of the areas evaluated is not likely to be significant given the limited size of the property. The Kit Fox is a carnivorous mammal, feeding on rodents and other prey within the Mojave Desert environment (*i.e.,* rabbits and hares, birds, insects, and reptiles). The Kit Fox is expected to have a substantial potential for exposure to PCBs in the environment through the food chain. Therefore, evaluating the bioaccumulation of dioxin-like PCBs from prey species and their impacts on growth and reproduction to Kit Fox is important. If significant, transfer and biomagnification (*i.e.,* increased bioaccumulation up the levels of the food chain) in predatory species may pose threats to the sustainability of populations.

Assessment Endpoint #7 is the protection of carnivorous mammals: *Are levels of Site COPCs sufficient to cause survival, growth, or reproductive impairment in predatory mammalian populations?*

3.4.1.8 Assessment Endpoint #8: Reptiles (Desert Tortoise: *Gopherus agassizii*)

As discussed above in Section 2.4.3.3, the Desert Tortoise is federally listed as a threatened species. The Desert Tortoise feeds primarily on vegetation, thus potentially being exposed to PCBs via consumption of plants. Through communications with NNHP and USFWS, as well as Site investigations, there is the potential that Desert Tortoise could occur near the USEN facility or the surrounding area. Based on the environmental attributes and factors, in general the area around the facility provides the necessary resources to support the Desert Tortoise. However, there is no evidence of tortoises on-Site or in the surrounding area, and there are currently no known confirmed sightings in the area of the USEN facility. Because of the precautions taken to prevent/minimize burrowing along perimeter fencing, it is unlikely that there would be tortoises found on-Site, and thus the potential for its occurrence there would be low. As a result of the listing status of the Desert Tortoise and the potential for occurrence in the area, this species was included as an assessment endpoint.

A semi-quantitative evaluation was conducted for the Desert Tortoise. Toxicity values could not be identified for reptiles, especially the Desert Tortoise, and there are no TEFs for reptiles. As such food chain modeling could not be performed for the tortoise. However, dietary doses of Site-related PCBs were generally estimated using available data and information. Input parameters for Site-specific soil data, concentrations estimated for plants (dietary item), and literature-derived exposure factors (*e.g.,* body weight, food ingestion rate) were used to evaluate exposure of the Desert Tortoise. Comparison of estimated doses to literature-derived TRVs provides a measure of effect.

Assessment Endpoint #8 is the protection of sensitive species of reptile: *Is exposure to Site COPCs associated with the site sufficient to cause survival, growth, or reproductive impairment in desert tortoise individuals?*

3.4.2 Measurement Endpoints

Measurement endpoints are defined as measures of exposure and effects as they relate to the selected assessment endpoints. Risk questions based on the assessment endpoints are assessed using measurement endpoints. Measurement endpoints for this SLERA evaluate the responses of receptors to levels of exposure to COPCs soil and through the food chain. The general type of measurement endpoint used in the SLERA is comparison of estimated or measured exposure levels of dioxin-like PCB congeners to levels known to cause adverse effects.

The following types of measurement endpoints are considered for this SLERA including measured levels of dioxin-like PCB congeners in environmental media, modeled levels of dioxin-like PCB congeners in food chains, calculated exposure doses, and toxicity values from the literature. Specific measurement endpoints selected to address each assessment endpoint (identified above) are discussed in the following sections of this report.

4.0 Screening Level Exposure Assessment

The level of adverse effects or risks of dioxin-like PCB congeners to plants, invertebrates, and wildlife depends on the magnitude, extent, and duration of exposure. These characteristics of exposure are examined and quantified within the Exposure Assessment. The SLERA evaluates exposure to selected receptors using modeled concentrations of PCBs. The Exposure Assessment is organized as follows:

- Estimating Exposure;
- Dietary Exposure Modeling;
- Quantifying Exposure, Uptake Factors (bioconcentration factors [BCFs] and bioaccumulation factors [BAFs]);
  - Exposure concentrations in plants and invertebrates
  - Exposure to avian wildlife
  - Exposure to mammalian wildlife
- Toxic Equivalency (TEQ) Approach; and,
- Resulting Exposure Estimates.

PCBs enter the terrestrial food chain primarily via food uptake of contaminated prey. The exposure pathways for the selected representative receptors, developed with input from EPA-IX, include ingestion of dioxin-like PCB congeners through the food chain and incidental ingestion of soil containing dioxin-like PCB congeners. There is the potential that terrestrial animals may inhale volatilized PCBs. However, there are very limited data for inhalation in wildlife receptors. The inhalation exposure pathway therefore, is not considered further in this SLERA.

As stated previously, the receptors were selected to evaluate risks using multi-level feeding guilds (any set of species that share the same resources) within the food chain. Species representative of the mammalian and avian receptors were selected, which may be most representative of the USEN facility and those that were at greatest risk from bioaccumulation dioxin-like PCBs.

Mammalian receptors that were evaluated included:

- An herbivorous rodent, the Little Pocket Mouse (*Perognathus longimembris);*
- A insectivorous rodent, the Southern Grasshopper Mouse (*Onychomys torridus*); and,
- A carnivorous, high-trophic level predator, the Kit Fox (*Vulpes macrotis*).

Avian receptors evaluated included:

- An insectivore/granivore, the Western Meadowlark (*Sturnella neglecta*); and,
- A carnivorous predatory raptor, the Red-tailed Hawk (*Buteo jamaicensis*)

Reptilian receptors evaluated included:

- A representative reptilian species, the Desert Tortoise (*Gopherus agrassizii*), which has been federally listed as a sensitive species.

4.1 ESTIMATING EXPOSURE

The exposure assessment for the SLERA included defining the exposure assumptions associated with the receptor species for the USEN facility. For complete pathways (soil and diet), the exposure evaluation involved the selection of appropriate exposure parameters for use in calculating a daily exposure dose for the selected receptor species. Exposure parameters used in the derivation of the exposure estimates include bioavailability of constituents, BAF, endpoint species body weight, food ingestion rates, and area-use factors. The exposure (*i.e.,* daily dose) to any ecological receptor may be a function of a number of parameters including:

- Diet Composition;
- Contaminant residues in the prey;
- Food intake rate;
- Soil contamination level;
- Soil ingestion rate; and,
- Body weight of the receptor.

Receptor parameters are not needed for plants or invertebrates, because doses for these receptors are empirically based on contaminant concentrations in soil, and are not derived via calculation.

4.1.1 Terrestrial Plants

The plant community near the facility and the surrounding area is an important component of the desert ecosystem, and therefore, was selected for general evaluation as an assessment endpoint. Plants are not nearly as sensitive to PCBs as animals, which appears to be a function of uptake and particle size as well as PCB molecular weight. There are few screening benchmark concentrations that could be identified in the literature. The identified benchmark for phytotoxicity from PCBs in soil was 40 mg/kg (Efroymson et al., 1997a), which is orders of magnitude higher than the measured total PCB soil concentrations at the USEN facility. For comparison purposes, the total PCB concentration in soil was compared to the identified benchmark to determine if there was the potential for impacts to localized plant communities. No apparent impacts are expected from PCBs to plants, as the mean (as well as the maximum) total PCB concentration in soil was well below the benchmark for phytotoxicity.

Phytotoxicity of Total PCBs in Soil to Terrestrial Plants:

- Phytotoxicity Benchmark – 40 mg/kg
- USEN Total PCB concentration in soil (maximum) – 0.86 mg/kg

The soil concentration used as the phytotoxicity benchmark in the ecological model for total PCBs is 40 mg/kg. This value is a screening benchmark published by the Oak Ridge National Laboratory (Efroymson et al., 1997a) on the basis of effects observed in plants grown in 40 ppm PCB surface soil (Strek and Weber, 1980 as cited in Efroymson et al., 1997).

Plants have relatively low susceptibility to PCBs; however, plant concentrations were modeled in order to use these data for species consuming vegetative diets. No mechanism of toxicity has been convincingly determined for plants. Cumulative water use has been suggested as the vehicle or mechanism of PCB uptake in plants (Weber and Mrozek, 1979), and that adverse effects on plants may be indirect (Strek and Weber, 1982a). Fletcher et al. (1987) determined that i*n vitro* cultures of plant cells are capable of metabolizing and detoxifying PCBs, potentially decreasing the potential for adverse effects on plants.

A review of the literature indicated that PCBs are not leachable in soils and depending on organic matter content are readily adsorbed by soil constituents (Strek and Weber, 1982). There have been few reports of the effect of PCBs on plants. These reports indicate that plants absorb PCBs, but in very low amounts. It was reported that PCBs appear to have some effect on photosynthesis and respiration in plants (Strek and Weber, 1982).

4.1.2 Terrestrial Soil Invertebrates

Exposure equations are not needed for terrestrial invertebrates because their exposure is assumed to be directly related to the concentration of PCBs measured in soil. Therefore, the measure of exposure for terrestrial invertebrates was estimated through the application of a BAF estimating soil-to-invertebrate concentrations of PCBs. Soil concentration was multiplied by the BAF-invertebrate as determined by Blankenship et al. (2005), to estimate the terrestrial invertebrate tissue concentration. However, impacts to invertebrate populations were only qualitatively assessed.

4.1.3 Model for Estimating Intake and Dose

The exposures to the representative bird and mammal receptors were estimated by calculating a daily exposure dose of each dioxin-like PCB congener as a function of each receptor's body weight and chemical intake (mass of chemical ingested per day), generally due to food ingestion. The equation is below, in which the mass of dioxin-like PCB congeners is expressed in nanograms (ng):

Exposure Dose (ng/kg/day) = Intake (ng/day) / Body Weight (kg)

Species-specific exposure models were used to calculate intakes by estimating the uptake and transfer of dioxin-like PCB congeners through the food chain, as well as the incidental ingestion of dioxin-like PCB congeners from soil. The models utilized a variety of ecological factors, as described above. To evaluate the potential exposures of some receptors, multiple exposure models utilizing different dietary assumptions and types of transfer factors were utilized.

4.2 DIETARY EXPOSURE MODELING

The dietary exposure model estimated the exposure of the bird and mammal receptor species to the PCBs through their diet. The direct toxicity characteristics of PCBs and their bioaccumulative properties were also evaluated by incorporating the COPC concentrations in soil and key food items of each receptor species in the dietary exposure model.

The general structure of the model to estimate daily exposure dose of PCB congeners by a receptor species is as follows:

$$ED = (([soil] \times BAF \times FIR) + ([soil] \times SIR)) \times AUF / BW$$

where:

$ED_{ingestion}$	Estimated dose; Species-specific total rate of PCB intake by ingestion;
FIR_h	Food Ingestion Rate: Species-specific rate of PCB intake by ingestion
$[Soil]_i$	Concentration of the PCB in environmental medium *i* (Soil)
BAF_i	Bioaccumulation Factor specific to *i* - invertebrates, plants, etc.
SIR_i	Rate of ingestion of environmental medium *i* (kg/day dry weight for solids); *i.e.,* soil ingestion rate (SIR)
AUF	Proportion of USEN facility relative to receptor foraging range (unitless), also Area Use Factor (AUF), assume 100% in SLERA, equal to “1”
BW	Body weight of receptor species

The individual, species-specific values that were selected and used in the exposure models in this SLERA are summarized and provided in Table B – USEN Model Input Parameters. This table provides the species-specific values for the parameters above, as well as the sources with notes and/or justification for the selected value.

To model a conservative exposure scenario, *Time Allocation* and *Area Use Factors*, were overestimated to include a maximum possible exposure for the receptors. Initially, only maximum concentrations of each of the 12 dioxin-like PCB congeners were applied in the assessment, significantly overestimating the potential exposure to PCBs.

- **Conservative Exposure Scenario applied in this SLERA**
    - Maximum observed PCB concentrations

The dose that results from the exposure of a receptor to PCBs in soil, both directly and through food chains, is the product of the concentration of the chemical in the ingested medium and exposure factors. Exposure factors are used to quantify how much of the available chemical is assimilated by the receptor per unit of concentration in the medium. Exposures were calculated for the USEN facility based upon the following assumptions:

- ❑ The most likely contaminated food item makes up 100 percent of the diet;
- ❑ The receptor is present at the Site 100 percent of the time; and,
- ❑ 100 percent of the COPC in the ingested food is bioavailable, and therefore, absorbed.

The dietary exposure model assumes that 100 percent of a species' diet consists of the higher tropic level prey. For example, although the Western Meadowlark consumes 63.3 percent invertebrates and 36.7 percent plant material (Sample et al., 1997), this SLERA assumed that 100 percent of the meadowlark's diet consisted of invertebrates.

The percent composition of diet for each receptor species was taken from EPA Wildlife Exposure Factors Handbook (EPA, 1993), where available, as well as other literature sources. These species-specific values were used to calculate the total amount of each foodstuff that each receptor species may ingest per day.

4.3 TOXIC EQUIVALENCY (TEQ) APPROACH

In the environment, PCBs tend to occur as mixtures of compounds that vary in physicochemical properties and toxicity. It was determined that a single approach to estimate the current and potential future exposures of PCB mixtures to plants, invertebrates, and wildlife, was needed to relate such exposures to available information on toxic effects. An objective of the Exposure Assessment therefore, was to estimate exposure concentrations or doses that could be related to the toxicity of the PCB compounds.

4.3.1 Exposure Point Concentrations

The potential exposure to area-specific COPCs for each receptor is represented by a daily exposure concentration. The daily exposure concentration for an individual receptor is estimated from the EPCs of area-specific COPCs in each environmental medium and key food item. EPCs for the environmental media and for the key food items were derived from data collected during previous sampling activities (Stantec, 2010). EPCs were compared to appropriate media benchmarks and were used in food chain models to determine an exposure dose to estimate risk of harm to wildlife receptors.

For conservative ecological exposure evaluations, the EPCs used in the SLERA are the maximum and average COPC concentrations in each environmental medium and key food item. For possible future alternative ecological exposure evaluations, the EPCs for estimating ecological exposures include the mean and the lesser of the maximum detected concentration for each COPC or the 95% UCL of the mean concentration assuming a log-normal distribution of the data set, as specified in Region IV Supplemental Guidance (EPA, 1995). The 95% UCL was not used in this SLERA.

The EPCs provided consist of the detected concentrations and, for non-detected congeners, one-half the reporting limit.

4.3.2 Toxic Equivalency (TEQ) Approach

This SLERA employed the TEQ of 2,3,7,8-TCDD Approach to evaluate the exposure to dioxin-like PCB congeners. For chlorinated dioxin-like PCBs, observed concentrations were converted to a corresponding TEQ using the following methodology:

- WHO, TEF methodology for mammalian, avian and fish species as presented in Van den Berg et al., (1998, 2006) in Environmental Health Perspectives (see Table 7 below); and,

- EPA (2001). Workshop Report on the Application of 2,3,7,8-TCDD Toxicity Equivalence Factors to Fish and Wildlife. Risk Assessment Forum.

Because most dioxins, furans, and dioxin-like PCB compounds lack individual screening benchmarks, this approach allows congener-specific dioxin-like PCB data to be consolidated into a single measure, a TEQ. For this SLERA, the TEQ was calculated by multiplying the concentrations of each of the 12 dioxin-like PCB congeners (which contain chlorine at the 2, 3, 7, and 8 positions) by a TEF and then summing those products. The TEFs are numerical estimates of the potency of individual dioxin-like PCB congeners relative to 2,3,7,8-TCDD. As referenced above, the TEFs for the 12 dioxin-like PCB congeners for mammals and birds were obtained from Van den Berg et al. (1998, 2006). These values can also be obtained from Table 2 of the *Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment* (EPA, 2008).

The TEF normalizes the toxicity of those PCB congeners to the toxicity of the 2,3,7,8-TCDD congener, generally considered to be the most toxic of the dioxin, furan, and dioxin-like compounds. In effect, the TEQ indicates the concentration of 2,3,7,8-TCDD that would have the same toxicity as the mixture of PCBs, dioxins, and furans being evaluated. PCB congeners that do not contain chlorine at the 2, 3, 7, and 8 positions are not assigned a TEF because they do not have the same stereochemistry as the 2,3,7,8-TCDD congener. The TEFs used in this SLERA reference the WHO values for mammals, birds, and fish (Van den Berg et al., 1998, 2006). TEFs are the ratios of the toxicities of the congeners relative to that of 2,3,7,8-TCDD.

TABLE 7

World Health Organization Congener TEFs for Mammals, Birds, and Fish.

Dioxin	**2006 (1)**	**1998 (2)**	**1998 (2)**
2,3,7,8-TCDD	1	1	1
Non-ortho PCBs	**Mammals**	**Birds**	**Fish**
3,3',4,4'-TCB (77)	0.0001	0.05	0.0001
3,4,4',5-TCB (81)	0.0003	0.1	0.0005
3,3',4,4',5-PeCB (126)	0.1	0.1	0.005
3,3',4,4',5,5'-HxCB (169)	0.03	0.001	0.00005
Mono-ortho PCBs			
2,3,3',4,4'-PeCB (105)	0.00003	0.0001	<0.000005
2,3,4,4',5-PeCB (114)	0.00003	0.0001	<0.000005
2,3',4,4',5-PeCB (118)	0.00003	0.00001	<0.000005
2',3,4,4',5-PeCB (123)	0.00003	0.00001	<0.000005
2,3,3',4,4',5-HxCB (156)	0.00003	0.0001	<0.000005
2,3,3',4,4',5'-HxCB (157)	0.00003	0.0001	<0.000005
2,3',4,4',5,5'-HxCB (167)	0.00003	0.00001	<0.000005
2,3,3',4,4',5,5'-HeCB (189)	0.00003	0.00001	<0.000005

Sources: (1) Van den Berg *et al.,* 2006; (2) Van den Berg *et al.,* 1998
2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TCB = tetrachlorobiphenyl
PeCB = pentachlorobiphenyl
HxCB = hexachlorobiphenyl
HeCB = heptachlorobiphenyl

The TEQ approach is based on results of numerous studies of laboratory animals and cell culture bioassays which demonstrate that some of the most toxic planar halogenated hydrocarbons cause similar adverse effects, but have different potencies.

4.4 QUANTIFYING EXPOSURE

Ecological uptake factors are used in the exposure models to estimate the potential exposure in wildlife receptors. More specifically, these uptake factors are used to estimate the potential of chemicals to move up the food chain and accumulate in various ecological receptors. There are various types of uptake factors, including BCFs, BAFs and/or biotransfer factors (BTFs). However, typically BAFs were used in this ERA.

4.4.1 Uptake Factors (BAFs, BCFs and BAFs)

A BAF is defined by the EPA (2010) as "*the ratio of the concentration of a contaminant in an organism to the concentration in the ambient environment at steady state, where the organism can take in the contaminant through ingestion with its food as well as through direct contact*".

Similarly, BCFs are defined as *"a net accumulation of a chemical directly from an exposure medium into an organism"* (EPA, 2010). These uptake factors can often result in biomagnification, defined as "*the process of bioaccumulation and biotransfer by which tissue concentrations of chemicals in organisms at one trophic level exceed tissue concentrations in organisms at the next lower trophic level in a food chain*" (EPA, 2010).

4.4.1.1 BAFs for Terrestrial Invertebrates (BAF-Inv)

There are few published BAFs for uptake of COPCs from soil by terrestrial invertebrates. As no Site-specific data on measured dioxin-like PCB concentrations in invertebrates were available, chemical concentrations in terrestrial invertebrates were calculated using an uptake factor from soil to invertebrate tissue as referenced in Blankenship et al. (2005). The concentration accumulated in invertebrate tissue through direct contact with and ingestion of soil and detritus is a function of the chemical-specific soil concentration and chemical-specific invertebrate bioaccumulation factors (BAF-Inv).

The soil-to-invertebrate BAF was used in estimating the PCB concentrations in terrestrial invertebrates. This value was then applied to the concentration in prey (invertebrates) that were consumed by invertivorous receptors, including the Grasshopper Mouse and the Western Meadowlark to estimate PCB uptake from ingestion of invertebrates (BAF-Inv). Therefore, this method was relatively conservative in estimating the uptake of dioxin-like PCB congeners from soil.

The effects of dioxin-like PCB congeners on invertebrate populations were qualitatively assessed; however, impacts were evaluated in relation to invertebrates as prey items for higher trophic level species.

4.4.2 BAFs for Terrestrial Mammals and Birds (BAF-mb)

Bioaccumulation factors for terrestrial mammals and birds (mb) are defined as the ratio of a chemical concentration in animal tissue (wet weight) to the daily intake of the chemical by the animal. BAFs were used in estimating tissue concentrations of dioxin-like PCBs in the prey (mice) consumed by predators (*i.e.,* Kit Fox and Red-tailed Hawk).

4.5 EXPOSURE FACTORS

Exposure factors were identified based on several literature references, but primarily Sample et al., (1997). For avian and mammalian receptors, the ranges of body weights and associated ingestion rates were based on adult body weights, both male and female. For the avian receptors, models were evaluated based on both adult male and adult female/juvenile ranges for body weights and food ingestion rates. However, no significant differences were determined, so adult male and female factors were averaged for the models presented in the SLERA.

Additionally, exposure model equations for each of the receptors are also provided in Appendix A, on species-specific exposure tables.

4.5.1 Exposure Pathway Factors

The exposure equations to calculate receptor daily doses are similar for bird and mammal receptors, which are equal to the sum of diet and soil exposure. The direct ingestion of surface water was not included as an exposure parameter as the Site and exposure occur in a desert environment with no available regular surface water.

Incidental ingestion of soil is considered a generic exposure pathway. Depending on the species, soil ingestion was developed based upon allometric relationships and guidance described in EPA (1993) and Beyer et al., (1994), or as a percentage of food ingestion rate (FIR); frequently 2 percent of the FIR is used in the exposure model. Dietary exposure is the most variable pathway, including variables such as the percentage of a mammalian receptor's diet derived from the USEN facility (Area Use Factor), type and amount of prey consumed (*i.e*., plants or invertebrates), and size selectivity of prey species differs between receptors.

5.0 Effects Assessment

This chapter provides a general overview of the toxicology of PCBs and describes the methods used to characterize particular toxicological effects of PCBs on terrestrial organisms. TRVs, used to estimate the potential risk to receptor species resulting from exposure to PCBs are presented following the background on PCB toxicology. TRVs are levels of exposure associated with either LOAELs or NOEALs. They provide a basis for judging the potential effects of measured or predicted exposures that are above or below these levels.

Use of both NOAELS and LOAELs provides perspective on the potential for risk as a result of exposure to PCBs. LOAELs are values at which there is a probability of adverse effects or effects may have been observed in either laboratory or field studies. The NOAEL represents the highest dose or body burden at which an adverse effect was not observed. Exceedance of a NOAEL or LOAEL indicates a greater potential for risk.

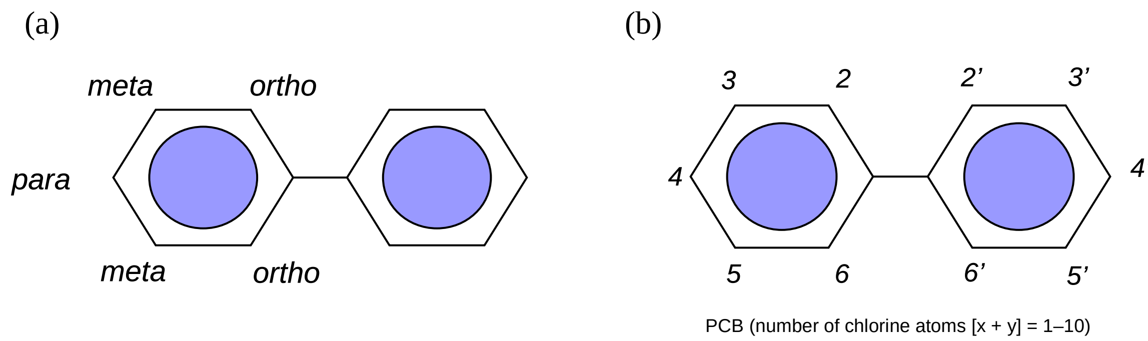
Effects benchmarks are used to identify concentrations of COPC in environmental media known to cause harm based either on Site-specific observations or experiments conducted elsewhere. The degree of certainty that an effect will occur if an effects benchmark is exceeded varies greatly depending on a number of factors including but not limited to bioavailability, similarity of ecosystems, and similarity of species used to measure effect. Effects benchmarks are often reported based on the degree of measured response observed at a particular site (*e.g.,* EC50[4]).

This section of the SLERA identifies and describes the ecotoxicological benchmarks that were compared with PCB concentrations to evaluate ecological risks. A series of effects metrics are selected; the values selected are typically based on growth, reproductive, or mortality endpoints for plants, soil invertebrates, and wildlife. This section identifies toxic effect levels relevant to the representative receptors for the dioxin-like PCB congeners detected at the Site.

5.1 STRUCTURE, TOXICITY, AND ENVIRONMENTAL BEHAVIOR OF PCBS

PCBs are a class of synthetic organic chemicals introduced in the 1940's for a variety of purposes. PCBs consist of biphenyl molecules that are linked by a carbon-carbon bond at the 1-1' position of the phenyl rings. The other ten positions on the phenyl rings located at the *meta*-, *para*-, *ortho*-positions of the rings, are substituted with one to ten chlorine atoms, resulting in 10 isomer families (mono-, di-, tri-, etc.). Two significant factors relate to the chemical structure of the PCB congener, including the degree of chlorination and the position of the chlorines on the biphenyl structure as provided in the diagrams below (Safe, 1990).

[4] EC50: Is the concentration at which an effect was observed in 50 percent of the population.



PCB Structure Diagram (a) and (b). (a) The basic PCB structure: Two phenyl rings are connected at the 1 and 1' positions, with chlorine atoms distributed around the biphenyl at the *ortho*, *meta*, and/or *meta* positions. (b) A PCB has the basic formula of $C_{12}H_{10-n}Cl_n$, where n = 1 – 10.

Physical and chemical properties of PCBs are affected by the numbers and positions of chlorine atoms. The degree and pattern of substitution affects the stereochemistry of the congener, and is responsible for inter-congener differences in environmental behavior and toxicity. PCBs with fewer chlorine atoms tend to be more soluble in water, more volatile, and more easily metabolized. Larger numbers of chlorine atoms are associated with increased resistance to biodegradation, which can increase bioaccumulation in the environment. PCBs are practically insoluble in water, but tend to be more soluble in organic solvents and fats (IPCS 1993).

5.1.1 DIOXIN-LIKE PCBs

PCB congeners have been categorized as "dioxin-like" or "non-dioxinlike," based on their ability to exert biochemical and toxic effects similar to those of 2,3,7,8-TCDD through activation of the aryl hydrocarbon receptor (AhR; Safe, 1990, 1994). Dioxin-like activity is seen for PCB congeners with chlorine atoms occupying the *meta* (carbon atoms 3, 3′, 5, or 5′) and *para* (carbon atoms 4 or 4′) positions, with no more than one *ortho* (carbon atoms 2, 2′, 6, or 6′) chlorine; these molecules are likely to exist with a planar conformation. PCBs lacking two chlorines in the *ortho* position are called "coplanar" congeners. Coplanar PCBs stereochemically resemble dioxins and bind to the AhR with a relatively high affinity. In general, coplanar congeners exhibit enzyme induction and certain other toxic effects indicative of Ah receptor-binding.

Therefore, the WHO and the EPA have designated a series of 12 individual congeners as being "dioxin-like" in their toxicities and potential health effects to receptors. These 12 PCB congeners, consisting of t*etra-, penta-, hexa-, or hepta*-chlorobiphenyls, have met the established criteria (Safe, 1990, 1994).

In contrast to individual congener toxicity that have been studied, total PCB concentrations in a sample comprising a complex mixture of congeners may reveal relatively little about its toxicity. Therefore, the most robust current approach to evaluating the potential risks posed by such mixtures is to estimate the toxicities of the congeners relative to that of 2,3,7,8-TCDD (the most well-studied and generally the most toxic of the dioxin and dioxin-like chemicals). A rating classification has been developed that relates the relative toxic potency of the dioxin-like PCB congeners to that of 2,3,7,8-TCDD, known as Toxicity Equivalency Factors (TEFs; Safe, 1990, 1994; Van den Berg et al., 1998; 2006). This WHO list of TEFs for the dioxin-like PCB congeners ranges from 0.00001 to 0.1, compared to the maximum TEF value assigned to 2,3,7,8-TCDD, which has the highest toxic potency for activation of the Ah receptor (TEF = 1.0). PCB 126 has a TEF of 0.1, which is the highest value for this PCB class of molecules. These TEF values are used to calculate the Dioxin TEQs, to accomplish this, the concentration of each congener is converted to the equivalent 2,3,7,8-TCDD concentration (TEQ) using TEFs. The dioxin 2,3,7,8-TCDD is one of the most toxic compounds yet tested, eliciting adverse effects in some organisms at dose concentrations in the parts per trillion (ppt) range (Murray et al., 1979; Nosek et al., 1992; EPA, 1993).

These dioxin-like PCBs reportedly exhibit increased toxicity compared to other PCB congeners. Because these compounds act through the same mechanism, their toxicity is generally additive in environmentally relevant mixtures (Van den Berg et al., 1998). Thus, the total TEQ exposure is estimated by summing the TEQs for all the dioxin-like PCB congeners as those compounds share the same mechanism of action.

Thus, the final TEQ value is a measure of the total toxicity of the mixture relative to 2,3,7,8-TCDD, and can be compared with TRVs for that congener, as well as collectively for the group of 12 dioxin-like PCB congeners.

5.1.2 EFFECTS of PCBs

PCBs are a highly lipophilic group of global pollutants, and the 209 congeners can vary widely in their toxic effects and other biological effects (Kannan et al., 1989 Eisler and Belisle, 1996). Dioxin-like PCB congeners can readily bind to the crucial AhR, which is part of the enzymatic response pathway in vertebrates. This molecular event is reportedly responsible for the adverse toxicological effects of many of the dioxin-like PCB congeners (NRC, 2001; Safe, 1990, 1993). Because these congeners are lipophilic and can be more resistant to degradation and metabolism, they tend to readily accumulate in biota. Metabolic activation is believed to be the major process contributing to PCB toxicity.

Because of their toxicities, biochemistries, and environmental chemistries, PCBs can pose risks to ecological receptors at relatively low exposures. Organisms at the top of food chains (*i.e.,* vertebrate predators) generally experience higher levels of exposure than those at lower trophic levels. Also, early life stages of organisms tend to be more sensitive than older life stages. Thus, their adverse effects in laboratory and free-ranging populations are most often manifested in the young or embryos of top predators (*e.g.,* Giesy et al., 1994; Nosek et al., 1993; Powell et al., 1996; Summaries in: Eisler, 1986; Hoffman et al., 1996).

The toxic effects of PCBs have been shown to manifest in many different ways, among various species of animals. Typical responses to PCB exposure in animals include wasting syndrome, hepatotoxicity, immunotoxicity, neurotoxicity, reproductive and developmental effects, gastrointestinal effects, respiratory effects, dermal toxicity, and mutagenic and carcinogenic effects.

5.2 ESTIMATING THE ECOLOGICAL EFFECTS OF PCBS

The effects assessment phase of the SLERA consists of the technical evaluation of data on existing and potential ecological effects of contaminants in the USEN facility in Nevada. Following the EPA risk assessment model (EPA, 1997, 1998), the effects analyses described in this section are integrated with the results of the exposure assessment, culminating in the risk characterization. The focus of the effects assessment is on evaluating effects data where exposure measures were either directly made or could be estimated with acceptable uncertainty. The role of the effects assessment is to interpret effect studies (whether Site-specific or literature-based) in the context of the CSM and assessment endpoints.

This SLERA focuses on effects that relate to the survival, growth, and reproduction of individuals within the local populations of terrestrial wildlife species. Most PCB toxicity research has concentrated on fish, birds, and mammals and therefore, individual toxicity values are developed for species in these groups (EPA, 1999a,b). In contrast, few studies have been performed on amphibians and reptiles, and hence toxicity values are not readily available from the literature.

5.2.1 Screening Benchmark Criteria

Screening benchmarks (also called screening values or benchmark values) represent conservative thresholds for adverse ecological effects. Selected screening values were based on conservative assumptions. The SLERA used ecotoxicological screening benchmarks derived from the literature where available, to assess the potential for ecological risk due to exposure of receptors to surface soil and prey items.

Ecological screening benchmarks are used to identify concentrations of COPC in environmental media that are at or below thresholds for effects to ecological receptors. In short, if measured concentrations are below screening benchmarks, then there is assumed to be no risk to the environment or receptors. These conservative screening benchmarks were applied to determine if the dioxin-like PCB concentrations measured in soil may cause risk, but may not indicate if actual effects are occurring to most organisms at these concentrations. When using screening benchmarks, it is also conservatively assumed that the PCBs are 100 percent bioavailable.

While comparisons of benchmarks are useful in assessing potential risk, they can be imprecise because Site-specific factors affecting bioavailability vary between sites, as does species sensitivity. Bioavailability is the extent to which a substance can be absorbed by a living organism, potentially causing an adverse response.

There are various types of effects measures or benchmarks available in the literature. Some of these include:

- NOAEL: The highest exposure level shown to be without adverse effect in organisms exposed to a range of doses. NOAELs may be expressed as dietary doses (*e.g.*, mg PCBs consumed/kg body weight/d), as concentrations in external media (*e.g.*, mg PCBs/kg food), or as concentrations in tissue of the effected organisms (*e.g.*, mg chemical/kg egg).

- LOAEL: The lowest exposure level shown to produce adverse effect in organisms exposed to a range of doses. LOAELs may also be expressed as dietary doses (*e.g.*, mg PCBs consumed/kg body weight/d), as concentrations in external media (*e.g.*, mg PCBs/kg food), or as concentrations in tissue of the effected organisms (*e.g.*, mg chemical/kg egg).

- LD_{50}: The Lethal Dose that results in death of 50 percent of the exposed organisms. Expressed in units of dose (*e.g.*, mg PCBs administered/kg body weight of test organism/d).

- LC_{50}: The Lethal Concentration in some external media (*e.g.* food, water, or sediment) that results in death of 50% of the exposed organisms. Expressed in units of concentration (*e.g.*, mg PCBs/kg wet weight food).

- ED_{50}: The Effective Dose that results in a sublethal effect in 50 percent of the exposed organisms (mg/kg/d).

- EC_{50}: The Effective Concentration in some external media that results in a sublethal effect in 50 percent of the exposed organisms (mg/kg).

5.2.1.1 Soil Benchmarks

The terrestrial soil screening benchmarks are based on the lowest concentration from several sources including:

- *EPA Guidance for Developing Ecological Soil Screening Levels* (ECO-SSLs; EPA, 2005a);

- EPA Region IX Regional Screening Levels (EPA, 2009); and,

- Oak Ridge National Laboratory Toxicological Benchmarks for soil, litter invertebrates, heterotrophic processes (Efroymson et al., 1997b), and terrestrial plants (Efroymson et al., 1997a).

Additional sources that were also evaluated include:

- EPA Region IV Soil Benchmarks (EPA, 1998b); and,
- NOAA SQuiRT Tables (Buchman, 1998; 2008).

Eco-SSLs are the preferred screening values because they are based on protection of plants, terrestrial invertebrates, and wildlife, but these values are only available for a limited number of analytes. There are no other widely-accepted published wildlife screening values for surface soil. For those analytes lacking Eco-SSLs, the lowest value of other available benchmarks was used for screening purposes.

5.2.1.2 Plant Benchmarks

Plant community was selected for evaluation as an assessment endpoint. Plant/vegetation is an important dietary source for primary consumers (herbivores), and a potential exposure pathway. Plants appear to be much less sensitive to adverse effects from PCBs than animals. The screening benchmark concentration identified by Efroymson et al. (1997a) for phytotoxicity effects from PCBs in soil was 40 mg/kg. This value is orders of magnitude higher than the detected concentrations of total PCBs in soil at the USEN facility.

5.2.1.3 Toxicity Reference Values

A TRV is a contaminant dose or body burden that is compared to Site-specific doses or body burdens to assess the potential risk to an ecological receptor. A TRV can be based on results from laboratory or field studies. Wildlife TRVs were used in the food chain model to evaluate risks to wildlife from exposure to Site-specific PCBs via the food chain. TRVs are based on ingested doses (typically expressed as mg/kg BW-day) that are not anticipated to cause unacceptable survival, growth, or reproductive effects. For the TEQ method used in this SLERA, TRVs for 2,3,7,8-TCDD were identified and used to evaluate risk from the 12 dioxin-like PCB congeners. TRVs for 2,3,7,8-TCDD were identified that are representative of both NOAELs and LOAELs for each assessment endpoint. TRVs were selected from Sample et al. (1996) if available, as well as references listed previously in this SLERA. The following hierarchy, in order of preference, was used to identify TRVs for wildlife measurement endpoint receptors:

1) Chronic NOAEL;
2) Subchronic NOAEL;
3) Chronic LOAEL;
4) Subchronic LOAEL; and,
5) Estimates of acute LD affecting 50 percent of test organisms (LD_{50}).

Site-specific exposure doses of dioxin-like PCB congeners ingested in the diet were estimated for the selected avian and mammalian receptors. These doses were multiplied by congener-specific TEFs to calculate avian EDs, and were compared to TRVs.

TRVs directly applicable to reptiles for dioxin-like PCBs or 2,3,7,8-TCDD were not available in the literature for evaluating toxicity to the Desert Tortoise. Additionally, data demonstrating toxic effects due to dioxin-like PCBs in reptiles are extremely limited. Studies that have analyzed exposure and effects in amphibians and/or reptiles due to PCBs and dioxins have reported that effects have occurred at relatively high concentrations. This would indicate that reptiles and amphibians are relatively insensitive to dioxin-like compounds (EPA, 2008). Thus, it would be expected that the Desert Tortoise would also be less sensitive to dioxin-like PCBs than birds and mammals evaluated in this ERA to the toxic effects of PCBs.

Therefore, the avian and mammalian TRVs discussed above are likely to be conservative when used as surrogate TRVs for evaluating the potential for toxic effects on the Desert Tortoise.

Best professional judgment was used to identify the most appropriate study and corresponding toxicity value for TRV selection if more than one toxicity study met the set of qualifying criteria applicable for study endpoint and exposure duration.

5.3 SELECTION OF MEASURES OF EFFECTS

Many studies examine the effects of PCBs on aquatic and terrestrial organisms, and results of these studies are compiled and summarized in several reports and reviews (*e.g.*, Hoffman et al., 1998; ATSDR, 1996; Eisler, 1986). For the present assessment, a comprehensive literature search was conducted on the toxicity of PCBs to animals. A variety of databases were searched for references containing toxicity information.

Lethality, growth, and reproductive-based endpoints typically present the greatest risk to the viability of the individual organism and therefore survival of the population. When exposures are expected to be long-term, data from studies of chronic exposure are preferable to data from medium-term (subchronic), short-term (acute), or single-exposure studies (EPA, 1997). Because of the persistence of PCBs, exposure of ecological receptors to PCBs at the USEN facility is expected to be long-term.

6.0 Screening Level Risk Characterization

Risk characterization involves the integration of exposure and effects data to evaluate the likelihood of adverse effects to the selected ecological receptors that may be posed by the combination of exposure and effects. The risk characterization encompasses both qualitative and quantitative presentations of the exposure and effects assessments for risk that are relative to each assessment endpoint. The risk characterization is conducted for each of the assessment endpoints identified and discussed previously. For each assessment endpoint, individual measurement endpoints are evaluated. For each measurement endpoint, the magnitude of the risk of population-level effects is characterized and described for receptors. Additionally, these decisions rely on professional judgment, are qualitative, and are intended to provide a general indication of the likelihood and severity of adverse effects.

An inference weight is assigned to each measurement endpoint and is based on how closely the measurement endpoints represent the assessment endpoint. When more than one measurement endpoint is available for an assessment endpoint, conclusions regarding risks to that assessment endpoint are reached by considering the inference weight for each measurement endpoint (*i.e.,* the overall weight of evidence). Conclusions regarding each assessment endpoint are based upon consideration of both the findings of the various measurement endpoints and their inference weight. Those conclusions also characterize the magnitude of the risk associated with that assessment endpoint.

At the conclusion of this SLERA, there are four possible decision points, as discussed below. Therefore, the result of this characterization for each of the assessment endpoints will result in one of the following conclusions for risk:

1. **No unacceptable risk**. No further action is warranted. This decision is appropriate if the SLERA indicates that sufficient data are available on which to base a conclusion that no unacceptable risk is present within the USEN facility.

2. **Potential for unacceptable risks.** Further evaluation may be warranted. This decision is appropriate if the SLERA indicates that there is the potential for unacceptable risks for some pathways, receptors, and chemicals.

3. **Insufficient data to determine the potential for risk**. Additional evaluation of data is required and/or additional data require evaluation. This decision is appropriate if the SLERA indicates that there are insufficient data on which to base a risk estimate. This decision may also be appropriate if the potential for unacceptable risks is identified following the SLERA, and additional data to refine these estimates (*e.g.,* additional analytical data, measures of bioavailability, etc.) are needed.

4. **Potential for unacceptable risks was determined**. This decision may be appropriate for circumstances in which the potential for unacceptable risks was identified following the SLERA,

and these potential risks could best be addressed through remedial action (*e.g.,* remedial activities to property boundaries) rather than additional study.

6.1 HAZARD QUOTIENT ESTIMATION

Consistent with EPA guidance (EPA, 1997), the ecological risk characterization implements the HQ Method as an indicator of the risks posed to the ecological endpoint from COPCs available on-Site. In this SLERA, 12 dioxin-like PCB congeners are described as toxic equivalency (TEQ) relative to the toxicity of the potent dioxin 2,3,7,8-TCDD. The HQ method compares an estimated exposure level or daily dose with TRVs for each ecological COPC under consideration at the Site. The HQ method was used primarily to characterize the magnitude of risks associated with exposure to the identified COPCs for most of the measurement endpoints.

Several types of measurement endpoints have been used in the SLERA:

- Comparison of soil EPCs with risk-based toxicity benchmarks to calculate HQs for surface soil;
- Comparison of total body doses (calculated via food chain modeling) for wildlife species (representing selected receptors) with risk-based toxicity benchmarks to derive HQ and HI (sum of HQs for the 12 dioxin-like PCB congeners) values; and,
- Qualitative observations regarding occurrence and overall appearance/health of receptors applied to terrestrial communities.

It is important to note that the interpretation of ecological risks, as estimated using HQ and HI methods, is different from the interpretation of human health risks. In human health risk assessment, any HQ or HI greater than ‘1’ warrants close scrutiny and may be interpreted as posing a risk to human receptors. The focus of a human health risk assessment is the protection of each individual that might be exposed, and therefore, any HQ greater than ‘1’ may be of concern. The focus of an ecological risk assessment, on the other hand, is typically the protection of populations of receptors. Constituents may cause population level effects, by affecting birth and mortality rates, immigration, and emigration (EPA, 1989). In many circumstances, individual organisms may be affected with little impact to population or community levels; however, as the number of individual organisms experiencing toxic effect increases, the probability that population-level effects will occur also increases. The number of affected individuals in a population presumably increases with increasing HQ or HI values; therefore, the likelihood of population level effects occurring is generally expected to increase with higher HQ or HI values.

When medium-specific concentrations (*i.e.,* EPCs in surface soil) are compared with toxicity benchmarks, the HQ is expressed as follows:

$$HQ = \frac{\mathrm{EPC_{medium}}}{\mathrm{TRV_{medium}}}$$

where:

EPC_{medium} = Exposure Point Concentration in a medium (ng/kg)
TRV_{medium} = Toxicity Reference Value for the COPC in the given medium (ng/kg)

When food chain modeled doses are compared with toxicity benchmarks, the HQ is expressed as follows:

$$HQ = \frac{TDD}{TRV}$$

where:

TDD = Total Daily Dose (ng/kg BW-day)
TRV = Toxicity Reference Value (ng/kg BW-day)

The quantitative assessment relies on a toxicity quotient approach in which measured or modeled concentrations are compared to appropriate benchmarks for the receptors. The approach used to interpret each type of measurement endpoint is discussed below.

6.1.1 Comparison of Soil EPCs with Risk-Based Toxicity Benchmarks

If the calculated HQ is less than or equal to ‘1’, it is concluded that risk of harm from Site-related COPCs would appear to be *negligible* (based upon the specific measurement endpoint). If the HQ is greater than ‘1’, it is concluded that the risk of harm from Site-related COPCs may be *low, moderate, or substantial*, depending upon the magnitude of the HQ. If it is concluded that the risk of harm is anything other than negligible, a discussion of the ecological significance of the HQ is provided. This discussion addresses the extent to which the HQs are driven. If a toxicity value is exceeded, adverse effects to ecological receptors may not automatically be implied; however, as the magnitude of the exceedance increases, the probability of adverse effects also increases. These results are then extrapolated to potential effects on the population.

6.1.2 Risk Estimation

The HQ method provided insight into the potential for general effects on the local populations resulting from exposure to dioxin-like PCBs. This approach is consistent with EPA’s Risk Management Guidance (EPA, 1999d) and is used specifically because population data alone would not distinguish among changes due to the PCBs in the environment and changes due to non-Site related factors. Below, to determine the risk estimation, the HQ is calculated for the representative receptors.

$$\text{Hazard Quotient} = \frac{\text{Intake or Concentration}}{\text{NOAEL or NOAEC}}$$

The likelihood and ecological significance of any estimated risks above the threshold level of concern are also discussed. As reference, the risk characterization for the USEN facility is based on the following assessment endpoints:

- Sustainability of **plant communities**;
- Sustainability of **terrestrial invertebrate** populations, which are considered a valuable food source for local wildlife;
- Sustainability (*i.e.*, survival, growth, and reproduction) of **herbivorous mammal**, Little Pocket Mouse;
- Sustainability (*i.e.*, survival, growth, and reproduction) of **insectivorous bird**, Western Meadowlark;
- Sustainability (*i.e.*, survival, growth, and reproduction) of **insectivorous mammal**, Grasshopper Mouse;
- Sustainability (*i.e.*, survival, growth, and reproduction) of **carnivorous bird**, Red-tailed Hawk;
- Sustainability (*i.e.*, survival, growth, and reproduction) of **carnivorous mammal**, Kit Fox; and,
- Sustainability (*i.e.*, survival, growth, and reproduction) of **reptile**, Desert Tortoise; representative of federally listed threatened species.

Risks from exposure to PCBs were computed by dividing the TDD for each dioxin-like PCB congener in a medium (soil) by the corresponding TRV. This yields the HQ, which is the ratio of the daily exposure to the allowable daily dose for that COPC congener. The HQs are summed to provide the HI. If the HI for all receptors is less than or equal to '1', it is determined that the Site does not pose risk of harm and may not need further evaluation. If the HI is greater than '1', it is possible that the screening evaluation would move to the next step (Baseline Ecological Risk Assessment).

In risk estimation, the calculated exposure doses were used in conjunction with the conservative TRVs (previously identified) to calculate the HQs for each of the 12 dioxin-like PCB congeners and receptors. The risks posed to the assessment endpoints by the PCB congeners detected in Site-related soils were estimated based on the calculated HQs. The exposure dose estimates and TRVs for each receptor resulted in the calculation of the HQ that provides an estimate of potential risks posed to each receptor in the USEN facility. The HQ equations for the receptors were the following:

$$HQ_{low} = \text{adult intake / TRV-Low (NOAEL)}$$

$$HQ_{high} = \text{adult intake / TRV-High (LOAEL)}$$

The decision guidelines for interpreting these HQs were the following:

- An HQ_{low} that is greater than '1' would indicate the need for further evaluation of the ecological significance of the potential effects.

- If an HQ_{high} is greater than '1', the potential for the dioxin-like PCB congeners to pose risk to that receptor in that exposure area would be considered of concern, and these compounds would warrant further evaluation in subsequent steps of the ERA process.

As shown below in the HI table, which summarizes the HQs to derive HIs (NOAEL and LOAEL) per species, none of the ecological HIs based on NOAEL exceeded a value of '1' (based on using one significant figure as previously discussed with EPA-IX) for any of the representative receptors. However, the resulting exposure estimate for the Kit Fox for the Hi-lo (NOAEL) value was at '1'. The risk estimates for each of the representative receptors are summarized (Table 8) and discussed below.

TABLE 8

Summary of NOAEL and LOAEL Hazard Index (HI) values calculated for the assessment endpoints and receptor species.

Endpoint/Receptor	Hazard Index	
	HI-Lo (NOAEL)	HI-Hi (LOAEL)
Little Pocket Mouse	0.3	0.03
Western Meadowlark	0.3	0.03
Grasshopper Mouse	0.18	0.018
Red-tailed Hawk	0.4	0.04
Kit Fox	1	0.1
Desert Tortoise	NA	NA

NA – Not Applicable
HI – Hazard Index
NOAEL – No Observed Adverse Effect Level
LOAEL – Lowest Observed Adverse Effect Level

6.2 ECOLOGICAL RISK ASSESSMENT – RESULTS

The SLERA assessed the potential for impacts to the environment and ecological receptors from Site-related PCBs in soil by conducting the exposure and effects assessments. Results of the SLERA indicated that PCBs did not pose unacceptable risk of harm or adverse impacts to plants, birds, or wildlife. There were no HQs or HIs that significantly exceeded the threshold of effects value of '1'. The results for each indicator species are discussed below.

6.2.1 Plants

Risk to plants was considered to be from soil uptake and was estimated from EPCs in soil. The resulting estimated plant concentration, for the sum of all 209 PCB congeners or total PCBs, for that maximum concentration found in relation to the USEN facility was 856,000 ng/kg or 0.86 mg/kg (Appendix A, Table A-1). This value was then compared to the plant benchmark of 40 mg/kg (or 40,000,000 ng/kg), demonstrating the multiple orders of magnitude that the estimated concentration is below the benchmark.

6.2.2 Terrestrial Invertebrates

Risk to terrestrial invertebrates was only evaluated qualitatively in this SLERA. Exposure of terrestrial invertebrates is considered to be from soil uptake. Uptake factors for soil-to-terrestrial invertebrates are generally only reported for earthworms due to the availability of information in the literature, and a relative paucity of information with regards to insects. In fact, most species of terrestrial invertebrate other than earthworms lack fundamental information on toxicity data and effects.

There is a larger body of work on earthworm ecotoxicology, including toxicity testing for earthworms including the species *Lumbricus terrestris and Eisenia fetida*, and there is interest of their use as indicator organisms for the biological impact of soil pollutants. However, earthworm populations are not considered abundant in the desert communities, and therefore, were not considered a plausible receptor group.

It is important to note that the study conducted by Blankenship et al. (2005), which reported soil PCB concentrations of 6.53 mg/kg at the contaminated site (Trowbridge), does not appear to be problematic for terrestrial invertebrate populations. Although it was not designed as an invertebrate study, Blankenship et al. (2005) reported the presence of productive and functioning insect communities, as they collected Coleoptera (*i.e.*, beetles) samples with a considerable quantity of June bugs (*Phyllophaga* sp.) and Japanese beetles (*Popillia japonica*), as well as the larval stage of some coleopteran species of which reside in soil as grubs.

Therefore, although only a qualitative evaluation was conducted, it is expected that the insect community would not experience adverse effects due to the concentrations of PCBs reported for the USEN facility area.

6.2.3 Little Pocket Mouse

The SLERA used two exposure pathways to predict the risks to the Little Pocket Mouse, including ingestion of plant tissue and incidental soil ingestion (Appendix A, Table A-2). The HQs for the 12 dioxin-like PCBs were summed to provide the HI for low and high effects. The HI-lo was calculated to be 0.32 (NOAEL) and the HI-hi calculation resulted in 0.032 (LOAEL), which are well below the threshold level of concern of ‘1’. The dose via the food ingestion pathway for the Little Pocket Mouse was calculated using the maximum soil concentration, and an estimated plant tissue concentration. Thus, it was determined that exposure to dioxin-like PCB congeners within or near the Site would not pose unacceptable risk of harm to pocket mice.

6.2.4 Southern Grasshopper Mouse

HIs low and high for the Southern Grasshopper Mouse, which has an insectivorous diet, are calculated and presented in Appendix A (Table A-3). The HQs were essentially the same for males and females, and therefore, a mean was calculated combining both sexes to use in this assessment. Based on the HQ-Lo, there were two PCB congeners that contributed significantly (95% of the overall HI) to the overall HI value, PCBs 126 and 169. These HQ-lo values resulted in 0.14 and 0.037 for PCBs 126 and 169, respectively. These individual HQ values were well below the threshold level of concern of ‘1’, as was the overall HI-lo (NOAEL) of 0.184. Thus, the dioxin-like PCB congeners do not pose significant risk to grasshopper mice at the USEN facility or outside in the boundaries in the surrounding area.

6.2.5 Western Meadowlark

Total HIs for the Western Meadowlark, which has an omnivorous diet, are calculated and presented in Appendix A (Table A-4). The HQs were very similar for adult males, adult females, and juveniles, as body weight tended to be normalized by sex-specific exposure factors, like food ingestion rate. Therefore, a mean was calculated combining both sexes to use in this assessment. The highest HQ contributing value was for PCB congener 77, which had a value of 0.25. Although this value is below the threshold level of concern of ‘1’, it contributed approximately 83 percent of the total HI-lo (NOAEL), which resulted in a value of 0.3. Based on the modeled estimates of exposure for the Western Meadowlark, the dioxin-like PCB congeners do not pose significant risk to either Western Meadowlark at the USEN facility or outside in the boundaries in the surrounding area.

6.2.6 Kit Fox

HQs for the Kit Fox are calculated and presented in Table A-5 (Appendix A). The HQs for males and females were not significantly different as body weight and food intake normalized the exposure to similar levels. It was assumed for the Kit Fox that it would consume a diet consisting entirely of carnivorous prey (Grasshopper Mouse), which is highly unlikely. Under this conservative exposure scenario and use of the TRV-Low, based on a NOAEL, the highest congener-specific HQ had a value of 0.99 (PCB 126), which is just below the threshold value of concern of ‘1’. For the cumulative estimate of risk using the HI, the highest resulting HI for this highly unrealistic and conservative scenario was ‘1’, just at the threshold level of concern. Because this risk estimate fell at the threshold level of ‘1’, additional exposure estimates were developed to run more realistic exposure scenarios. For an exposure scenario assuming more realistic exposure factors, it would include feeding area usage patterns and home range (not 100%), mixed prey species of herbivores and insectivores (not 100% invertivores), assuming that not all of their prey is the maximum congener concentration for all congeners 100 percent of the time; therefore, changing the exposure factor for diet, and the highest HI (NOAEL) based on a diet of herbivorous prey had a value of only 0.06, a value far below the threshold of risk.

The scenario used in this SLERA for the Kit Fox is based on:

- An animal consuming 100 percent carnivorous prey, which significantly overestimates consumption since the majority of their prey are typically herbivorous;
- All prey are exposed from the Site;
- The Kit Fox are on-Site 100 percent of the time;
- 100 percent of PCBs in tissue and soil is 100 percent bioavailable; and,
- On the BAF approach, in which the fox is assumed to forage on-Site 100 percent of the time, foraging is on the maximum exposed prey items 100 percent of the time, assumes the prey items were 100 percent bioaccumulative and assumes the exposures would be additive.

Even under these conservative exposure parameters, the fox would not be at risk from dioxin-like PCB congeners.

6.2.7 Red-tailed Hawk

HQs and summarizing HI values for the Red-tailed Hawk are calculated and presented in Appendix A, Table A-6. The cumulative HI (NOAEL) value was 0.44, and as would be expected, the congener contributing the most to that value was PCB congener 77 with an HQ-lo of 0.37. The scenario used in this SLERA assumed that the hawk would consume a diet consisting entirely of carnivorous prey, the Southern Grasshopper Mouse, although this is highly unlikely and unrealistic. The resulting HIs for this scenario were conservatively based on the use of the BAF approach (as referenced in Blankenship et al., 2005) for calculating food-chain exposures. Based on the assumptions and exposure factors used in this screening assessment being highly conservative, it was determined that the Red-tailed Hawk would not be at risk from PCB concentrations observed at the USEN facility. Again, it is anticipated that dioxin-like PCB congeners do not pose unacceptable risk to hawks regardless of their dietary composition near the USEN facility or exposure in the surrounding area.

6.2.8 Desert Tortoise

Dietary exposure of the Desert Tortoise to dioxin-like PCB congeners was compared semi-qualitatively, as limited to no toxicological data were available for tortoise. The food chain model evaluated the exposure factors, including food ingestion rate and incidental soil ingestion. The resulting ED was estimated at 25.4 ng/kg bw/day (Appendix A, Table A-7). As there are no TEF values available for reptiles, TEQs could not be calculated to determine an HQ value. To provide perspective on this level of exposure dose, the ED values for the tortoise were compared to the pocket mouse, both herbivores.

Therefore, exposure risk (25.4 ng/kg) was compared to the herbivore rodent (Little Pocket Mouse) that was also evaluated in this assessment. The pocket mouse had an ED value of 854, with a corresponding TEQ of 0.63, and a resulting HI of 0.32 (NOAEL). For comparison, it must also be noted that the tortoise has a far lower consumptive rate based on much lower metabolic demand. The tortoise is a poikilothermic[5], meaning that they do not need to maintain their core body temperature (homeothermic), like the pocket mouse which does need to maintain thermal homeostasis. It would appear that these values are far higher than that calculated for the Desert Tortoise, suggesting lower risk to the tortoise. Data demonstrating dioxin-like effects in reptiles are extremely limited, but according to the EPA, reptiles appear to be relatively insensitive to dioxin-like compounds (EPA, 2008). Additionally, it was demonstrated that plants are highly insensitive to PCBs, and therefore, exposure and uptake via the diet would potentially limit exposure to PCBs. Thus, the Desert Tortoise is likely to be less sensitive to the toxic effects of the dioxin-like PCB congeners than are the birds and mammals evaluated in this SLERA. Given both the lower exposure and lower sensitivity of the tortoise, the avian and mammalian HIs discussed above are likely to be conservative when used to evaluate the potential for toxic effects on the desert tortoise. The Desert Tortoise would not be expected to be at risk of harm near the USEN facility.

[5] The term ***Poikilothermic*** is used as a more exact description of the vernacular "cold-blooded", which can also refer to organisms which are ectothermic (primarily obtain heat from their environment). Poikilothermic animals include types of vertebrate animals, specifically fish, amphibians, and reptiles, as well as a host of invertebrate animals.

7.0 Uncertainty Analysis

A qualitative or quantitative assessment of risk is inherently uncertain. At each step of the risk assessment process there are sources of uncertainty. Therefore, the following section provides discussion of the general uncertainties that are associated with conducting a SLERA.

The primary goal of the uncertainty analysis is to provide a discussion of the key assumptions made in the risk assessment process that can significantly influence the estimate of risk. Uncertainties are inherent in all of the principle components of the risk assessment. Identification of the effects of uncertainty on the resulting risk estimates is useful in risk management decisions.

Uncertainty refers to the lack of knowledge about specific factors, parameters, or models. Uncertainty includes parameter uncertainty (*e.g.*, measurement errors, sampling errors, systematic errors), model uncertainty (*e.g.*, uncertainty due to necessary simplification of real world processes, model misuse, use of inappropriate surrogate values), and scenario uncertainty (*e.g.*, descriptive errors, errors in professional judgment, incomplete analysis).

Variability refers to observed differences in true heterogeneity or diversity in a population or exposure parameter. Sources of variability are the result of natural random processes and stem from environmental, lifestyle, genetic differences within and among species. Examples include physiological variation (*e.g.*, natural variation in body weight, ingestion rates), natural variability in habitat, and differences in constituent concentrations in environmental media. As such, variability is usually not reducible by further measurement or study.

In the absence of empirical or adequate Site-specific data, assumptions are developed based on best estimates of exposure or dose-response relationships. To assist in the development of these estimates, EPA recommends the use of guidelines and standard conservative factors in risk assessments. The use of these standard factors is intended to promote consistency among risk assessments where assumptions must be made. Though the use of standard factors is intended to promote comparability for this study, their use may limit an accurate assessment of Site-specific conditions.

The ecological risk estimates for the USEN facility were based on a number of assumptions that incorporate varying degrees of uncertainty resulting from many sources, including the following:

- ❑ Environmental monitoring and data evaluation;
- ❑ Assumptions in the selection of exposure pathways and scenarios; and,
- ❑ Assumptions in the expression of ecological risk.

As a screening level assessment, there are several factors introduced in the risk assessment that contribute to the uncertainty of the ecological risk estimates on a more conservative side, including the following:

- Sampling concentrated in areas at the Site believed to be affected by constituents (biased sampling) is likely to overestimate ecological exposure;

- Using upper-bound exposure point concentrations (*i.e.*, maximum detected concentrations) is likely to overestimate intakes since actual exposure is probably at lower concentrations;

- Compounding conservative assumptions in the exposure assessment (*i.e.*, 100% home range/foraging factors, conservative feeding behaviors, biased diet composition, etc.) likely yield extremely conservative (overestimated) risk estimates;

- Assuming constituents present in the surface soil have a significant tendency to desorb from the soil/foods and pass through the gastrointestinal tract likely overestimates exposure;

- Using EPA-approved toxicity values with low confidence ratings and high uncertainty factors typically overestimates risk; and,

- Selection of sensitive species for the evaluation may overestimate potential for overall ecosystem effects.

The purpose of the uncertainty analysis is to define the strengths and limitations of the risk assessment by placing the output of the risk assessment in perspective and providing concise information that can be used for risk management. Uncertainty evaluation procedures for both the conservative and Site-specific risk assessment approaches are presented below.

7.1 UNCERTAINTY ANALYSIS FOR THE CONSERVATIVE APPROACH

The uncertainty analysis conducted for the conservative risk assessment (SLERA) approach involves deterministic evaluations of uncertainty in exposure levels and exposure-response. HQ ranges for assessment endpoints are calculated using combinations of two sets of exposure level and exposure-response assumptions. Uncertainties in exposure levels are bracketed by considering the maximum observed concentration, the average observed concentration, and the calculated 95% UCL of observed concentrations as estimates of the exposure point concentration. Uncertainties in exposure-response are bracketed by calculating HQ using both the NOAEL and the LOAEL. The relative differences between the HQ calculated with each set of assumptions provide an indication of the relative extent to which the spatial variability in the detected concentrations versus the sensitivity of the dose-response influence the HQ calculations.

The TEQ methodology provides a mechanism to estimate potential health or ecological effects of exposure to a complex mixture of dioxin-like PCBs. However, the TEQ method must be used with an understanding of its limitations. This methodology estimates the dioxin-like effects of a mixture by assuming dose-additivity and describes the mixture in terms of an equivalent mass of 2,3,7,8-TCDD. Although the mixture may have the toxicological potential of 2,3,7,8-TCDD, it should not be assumed that individual PCB congeners follow the same environmental fate and transport mechanisms as 2,3,7,8-

TCDD. Different PCB congeners have different physical properties such as rate of photolysis, binding affinity to organic matter, and water solubility. Consequently, the makeup of the mixture will change as the congeners move through the environment (EPA, 2001).

7.2 GENERAL ASSUMPTIONS AND SITE-ASSOCIATED UNCERTAINTY

It is unlikely that receptors outside the study area would have lower toxicity thresholds for PCBs than the thresholds used for receptors within the study area, and there is little reason to expect that PCBs migrating outside the study area would be concentrated above predicted concentrations at the exposure locations. In general, the risk to receptors outside the study area is likely to be overestimated rather than underestimated by the risk estimate for receptors within the USEN facility.

Initially, only maximum concentrations of each of the 12 dioxin-like PCB congeners were applied in the assessment, significantly over-estimating the potential exposure to PCBs to receptors. If maximum concentrations demonstrated no estimated unacceptable risk of harm due to PCB exposure, it is typically not necessary to use the 95% UCL or the mean. However, two alternative exposure scenarios were available to evaluate the potential of harm from PCBs if necessary.

- **Alternative Exposure Scenario available, if necessary**
    - 95% UCL (or maximum) of observed PCB concentrations
    - Mean of observed PCB concentrations

For example, additional alternative exposure estimates were conducted for the Kit Fox to evaluate the level of exposure under realistic (less conservative) assumptions. With realistic exposure parameters, it was determined the dioxin-like PCB congeners are not expected to pose unacceptable risk to the Kit Fox. Kit foxes are unlikely to be consuming prey at the edge of the USEN property immediately outside the fence line, given the level of activity at the Site. Kit Fox would not be consuming prey directly on the facility property as the USEN facility is protected by a chain-link fence, which should prevent the Kit Fox from entering the facility property. Therefore, their diet located in the surrounding area of the facility would most likely have a lower body burden, as concentrations of PCB congeners are expected to be less than those estimated from soil directly. The feeding range of the Kit Fox is far greater than the small area adjacent to the USEN facility with measured concentrations of PCBs, suggesting that a significant portion of the prey being consumed would come from extended areas outside the surrounding area, thus decreasing the potential exposure even further. The home range of the Kit Fox in shrub community environments can be as large and expansive as 12 km^2, depending on available resources (Zoellick and Smith, 1992 as referenced in Cal/Ecotox, 1999).

As an additional note, there is a great deal of uncertainty surrounding the evaluation of terrestrial invertebrates for this SLERA. As stated previously, there is a paucity of toxicity data available for terrestrial invertebrates other than earthworms; toxic effects information on PCB congeners was not available for terrestrial insects.

8.0 Summary and Conclusions

This SLERA was conducted for the USEN facility to determine if there is ecological risk posed by the 12 dioxin-like PCB congeners to the environment and wildlife known or expected to occur near the USEN facility and surrounding area. Guidance and input was also provided by the EPA-IX during this process.

The following species were evaluated to determine if exposure to PCBs related to the USEN facility would cause adverse effects and risk to the sustainability of the populations. Risk conclusions for each of the ecological receptors are also summarized below:

- ❑ Plant communities near the USEN facility were not expected to be at risk of harm;
- ❑ Terrestrial invertebrate communities near the USEN facility were not expected to be at risk of harm from potential PCB exposure;
- ❑ Little Pocket Mouse populations were not expected to be at risk from potential exposure near the USEN facility;
- ❑ Grasshopper Mouse populations, as well as their role as an important component of the food chain for predatory species was not at risk from Site-related activities;
- ❑ Western Meadowlark populations were not expected to be at risk from exposure near the USEN facility;
- ❑ Red-tailed Hawk, a significant and local predatory bird, is not expected to be at risk of harm from PCBs near the USEN facility;
- ❑ Kit Fox, a predatory mammal in the area is not expected to be at risk of harm from PCBs near the USEN facility; and,
- ❑ Desert Tortoise, which was semi-quantitatively evaluated based on the absence of available toxicity data and its status as a threatened species, is not expected to be at risk of harm from PCBs near the USEN facility.

The SLERA results were evaluated relative to a HI threshold level of concern of ‘1’. If a HI is less than or equal to ‘1’, the potential for adverse effect is unlikely to occur. If a HI exceeds ‘1’, a potential for risk may be present, although this does not necessarily mean that an adverse effect will occur or is likely to occur, especially using the conservative assumptions as previously defined. None of the HIs (NOAEL) exceeded ‘1’, which is the designated threshold level of effects. Although, the Kit Fox was equal to threshold of ‘1’, it was determined that under alternative exposure scenarios that were still conservative yet realistic, the threshold level was far below ‘1’. Therefore, it was determined that adverse ecological effects due to dioxin-like PCB congeners would not be expected to occur near the USEN facility or surrounding areas for any of the selected receptor groups.

For this SLERA, HIs calculated for the selected ecological receptors indicated no significant threat of risk based on the HI-low, or NOAEL. None of the HI-hi or LOAEL values for any of the receptor groups exceeded '1'.

Uncertainty is inherent in any SLERA, as uncertainties are present in every step of the SLERA process (EPA, 1997). Because many of the parameters are biased high, the calculated values are expected to be greater than actual values and exposure. The most important uncertainties in the ecological portion of the SLERA for exposure locations are those surrounding the estimates of the contaminant concentrations to which ecological receptors are actually exposed (EPCs) and the concentrations that present an acceptable level of risk or harmful effects (toxicity thresholds or reference values). The many assumptions that were required to model concentrations and from the limited toxicity information available included:

- 100 percent exposure to the maximum concentrations of each PCB congener (highly unlikely);
- 100 percent diet consisted of the item with the highest potential for PCB accumulation (for example, if the lark's diet consisted of 64 percent invertebrates and 36 percent plants, the exposure modeling assumed 100 percent consumption of invertebrates, thus overestimating the potential for exposure);
- 100 percent AUF, thus, 100 percent of time was spent near the USEN facility, assuming the highest exposure potential; and,
- 100 percent PCBs in dietary items (plants and/or prey) and soil was bioavailable.

Additional uncertainties arise from multiple sources, for example, the lack of Site-specific data on contaminant transport and transformation processes, organismal toxicity, animal behavior and diet, population dynamics, and the response of plant and animal populations to stressors other than COPC exposure in their environments. Despite these uncertainties, the modeled exposure concentrations and published exposure and effects information allowed risks to be characterized for various receptor/effects scenarios.

This SLERA determined that potential risks associated with dioxin-like PCB congeners at the USEN facility are below regulatory and other target risk levels for ecological receptors under current conditions. Based on this analysis, dioxin-like PCB congeners surrounding the USEN facility or in the larger BLM buffer zone are not expected to cause an adverse impact on the environment or ecological receptors.

As stated in the introduction, this SLERA completes Steps 1 and 2 of the eight-step ERA process. Risk of harm to ecological receptors has been addressed adequately and successfully completed an evaluation to determine: ***No Apparent Risk of Harm.***

9.0 References

ATSDR. 2000. *Toxicological profile for polychlorinated biphenyls.* U.S. Department of Health and Human Services, Public Health Service. November 2000.

Bechtel Nevada. 2001 Ecology of the Nevada Test Site: an annotated Bibliography with narrative summary, keyword index, and species lists. Can be accessed at: http://www.nv.doe.gov/library/publications/Environmental/DOENV_11718_594.pdf

Beckett, K.J., S.D. Millsap, A.L. Blankenship, M.J. Zwiernik, J.P. Giesy, and S.J. Bursian. 2005. Squamous epithelial lesion of the mandibles and maxillae of wild mink (Mustela vison) naturally exposed to polychlorinated biphenyls. *Environmental Toxicology and Chemistry*, Vol. 24, No. 3:674-677.

Beckett, K.J., B. Yamini and S.J. Bursian. 2008. The effects of 3,3',4,4',5-pentachlorobiphenyl (PCB 126) on mink (*Mustela vison*) reproduction and kit survivability and growth. *Archives of Environmental Chemistry and Toxicology*, published on-line 03 August, 2007. Journal publication (2008), 54:123-129.

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. Estimates of Soil Ingestion by Wildlife. *J. Wildlife Manage*, 58(2):375-382.

Brussard, P. 2010. Nevada's Physical Setting. Accessed online at: http://www.onlinenevada.org/nevada_s_physical_setting

Bryce, S.A., A.J. Woods, J.D. Morefield, J.M. Omernik, T.R. McKay, G.K. Brackley, R.K. Hall, D.K. Higgins, D.C. McMorran, K.E. Vargas, E.B. Petersen, D.C. ,Zamudio, and J.A. Comstock. 2003. Ecoregions of Nevada (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,350,000). Accessed online at: *www.epa.gov/wed/pages/ecoregions/pub_list.htm*

Buchman, M.F., 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pages.

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.

Cal/Ecotox. 1999a. Exposure Factors for Desert Tortoise (*Gopherus agassizi*). Accessed online at: http://www.oehha.ca.gov/cal_ecotox/report/gopheef.pdf.

Cal/Ecotox. 1999b. Exposure Factors for Kit Fox (*Vulpes macrotis*) Accessed online at http://www.oehha.ca.gov/cal_ecotox/report/vulpeef.pdf

Cal/Ecotox. 1999c. Exposure Factors for Little Pocket Mouse (*Perognathus longimembris*). Accessed at: http://www.oehha.ca.gov/cal_ecotox/report/perogef.pdf

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian soil quality guidelines for the protection of environmental and human health: Polychlorinated biphenyls (total) (1999). *In*: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Chou, S.F.J., and R.A. Griffin. 1986. Solubility and soil mobility of polychlorinated biphenyls. *In*: *PCBs and the Environment*, J.S. Waid (Ed), CRC Press, Boca Raton, FL.

Chung-MacCoubrey, A.L., R.E. Truitt, C.C. Caudill, T.J. Rodhouse, K.M. Irvine, J.R. Siderius, and V.K. Chang. 2008. Mojave Desert Network vital signs monitoring plan. NPS/MOJN/NRR—2008/057. National Park Service, Fort Collins, Colorado.

Cole, A.C., Jr. 1956f. Studies of Nevada ants. III. The status of *Formica nevadensis* Wheeler (Hymenoptera: *Formicidae*). *Journal of the Tennessee Academy of Science*, 31, 256–257.

Connell, Des W. 1990. *Bioaccumulation of Xenobiotic Compounds.* Boca Raton, FL: CRC Press.

Cortes, A., J. Riego, A.B. Paya-Perez, and B. Larsen. 1991. Soil sorption of co-planar and non-planar PCBs. *Toxicol. Environ. Chem*., 31/32:79–86.

Davis, S.K. and W.E. Lanyon. 2008. Western Meadowlark (*Sturnella neglecta*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/104

Desert USA. 2011a. *Beatty*, *Nevada*. Accessed at: http://www.desertusa.com/Cities/nv/beatty.html

DesertUSA, 2011b. The Desert Tortoise. Accessed at: http://www.desertusa.com/june96/du_tort.html

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. 128 pp, ES/ER/TM-85/R3 (PDF file, tm85r3.pdf; WP file, tm85r3.wpd).

Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones, 1997b. *Preliminary Remediation Goals for Ecological Endpoints*. ES/ER/TM-162/R2. Oak Ridge National Laboratory. November 1997.

Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997c. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process*: *1997 Revision*. ES/ER/TM-126/R2. Oak Ridge National Laboratory. November 1997.

Eisler R. 1986. Polychlorinated biphenyl hazards to fish, wildlife, and invertebrates: A synoptic review. Biological Report 85(1.7). Contaminant Hazard Reviews Report No. 7. U.S. Department of the Interior, Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD.

Eisler, R. 1986. *Dioxin Hazards to Fish, Wildlife, and Invertebrates: a Synoptic Review.* Contaminant Hazard Reviews Report No. 8. U.S. Department of the Interior, Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD.

Eisler, R., and A.A. Belisle. 1996. Planar PCB hazards to fish, wildlife and invertebrates: A synoptic review. Contaminant Hazard Reviews Report No. 31. U.S. Department of the Interior, National Biological Service, Washington, DC.

Fairbanks B.C., G.A. O'Connor, and S.E. Smith. 1987. Mineralization and volatilization of polychlorinated biphenyls in sludge-amended soils. *J. Environ. Qual*., 16(1):18–25.

Federal Register. 2010. December 14, 2010. 75 FR 78094 7814612-Month Finding on a Petition To List the Sonoran Population of the Desert Tortoise as Endangered or Threatened; Proposed Rule. Federal Register**,** Vol. 75, No. 239 / Tuesday, December 14, 2010 / Proposed Rules. Accessed at: http://www.gpo.gov/fdsys/pkg/FR-2010-12-14/pdf/2010-31000.pdf#page=1

Fletcher J., A. Groeger, J. McCrady, and J. McFarlane. 1987. Polychlorobiphenyl (PCB) metabolism by plant cells. *Biotech. Letters,* 9(11):817-820.

Fry B.G., N. Vidal, J.A. Norman, F.J. Vonk, H. Scheib, S.F.R. Ramjan, S. Kuruppu, K. Fung, S.B. Hedges, M.K. Richardson, Wayne. C. Hodgson, V. Ignjatovic, R. Summerhayes, and E. Kochva. 2006. Early evolution of the venom system in lizards and snakes. *Nature,* 439(7076):584–588.

Furukawa, K. 1982. Microbial degradation of polychlorinated biphenyls (PCBs). *In*: Biodegradation and Detoxification of Environmental Pollutants, A.M. Chakrabarty (Ed), CRC Press, Boca Raton, FL.

Gan D.R., and P.M. Berthouex. 1994. Disappearance and crop uptake of PCBs from sludge-amended farmland. *Water Environ. Res*., 66:54–69.

Giesy, J.P., J.P. Ludwig, and D.E. Tillitt. 1994. Dioxins, dibenzofurans, PCBs and colonial, fish-eating water birds. *In*: Dioxins and Health (A. Schecter ed). Plenum Press, New York, NY.

Giesy, A. Hanberg, R. Hasegawa, S.W. Kennedy, T. Kubiak, J.C. Larsen, F.X. Rolaf van Leeuwen, A.K.D. Liem, C. Nolt, R.E. Peterson, L. Poellinger, S. Safe, D. Schrenk, D.Tillitt, M. Tysklind, M. Younes, F. Waern, and T. Zacharewski. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. *Environ. Health Perspect*., 106:775-792.

HCP. 2009. Pahrump Valley Desert Tortoise Habitat Conservation Plan DRAFT. Nye County Planning Department, October 2009 Version.

Hoffman, D.J., C.P. Rice, and T.J. Kubiak. 1996. PCBs and dioxins in birds. *In*: *Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations,* (Beyer, Heinz, and Redmon-Norwood, *Eds*),. Special Publication of Society of Environmental Toxicology and Chemistry (SETAC), Lewis Publishers, Pensacola, FL.

IPCS. 1993. *Environmental Health Criteria No.140. Polychlorinated Biphenyls*. International Programme on Chemical Safety (IPCS). Accessed online at: http://www.inchem.org/documents/ehc/ehc/ehc140.htm.

Jorgensen, S.E., S.N. Nielsen, and L.A. Jorgensen. 1991*. In: Handbook of Ecological Parameters and Ecotoxicology*. Elsevier. New York.NY.

Kannan, N., S. Tanabe, M. Ono, and R. Tatsukawa. 1989. Critical evaluation of polychlorinated biphenyl toxicity in terrestrial and marine mammals: increasing impact of non-ortho and mono-ortho coplanar polychlorinated biphenyls from land to ocean. *Archives of Environmental Contamination and Toxicology*, 18:850-857.

Kenagy, G. J. 1973. Daily and seasonal patterns of activity and energetics in a heteromyid rodent community. *Ecology*, 54(6):1201-1219.

Knopf, Fritz L. and M. B. Wunder. 2006. Mountain Plover (*Charadrius montanus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Accessed online at Birds of North America Online: http://bna.birds.cornell.edu/bna/species/211.

Lech, J.J., and R.E. Peterson. 1983. Biotransformation and persistence of polychlorinated biphenyls (PCBs) in fish. *In*: PCBs: Human and Environmental Hazards. F.M. D'Itri and M.A. Kamrin, (Eds). Butterworth Publishers, Toronto, ONT.

Mackay, P. 2003. *Mojave Desert Wildflowers: A field guide to wildflowers, trees, schrubs of the Mojave Desert, including the Mojave National Preserve, Death Valley National Park, and Joshua Tree national Park.* Falcon Publishing, Helena, Montana 352 pages.

Moore, D.R., and S.L. Walker. 1991. Canadian water quality guidelines for polychlorinated biphenyls in coastal and estuarine waters. Environment Canada. Inland Waters Directorate, Water Quality Branch, Ottawa.

Murray, F.J., F.A. Smith, K.D. Nitschke, C.G. Humiston, R.J. Kociba, and B.A. Schwetz. 1979. Three-generation reproduction study of rats given 2,3,7,8-tetrachlorodibenzo-pdioxin (TCDD) in the diet. *Toxicol. Appl. Pharmacol*., 50:241-252.

NatureServe. 2010. National, State, and Subnational Conservation Status Rank Definitions. Accessed at: http://www.natureserve.org/explorer/nsranks.htm.

Navy Environmental Health Center (NEHC). 2005. PCB Analysis and Risk Assessment at Navy Installations. December.

NDW (Nevada Department of Wildlife). 2005. State of Nevada Comprehensive Wildlife Conservation Strategy 2005. Nevada Department of Wildlife, Reno, NV.

Nosek, J.A., J.R. Sullivan, S.S. Hurley, J.R. Olson, S.R. Crave, and R.E. Peterson. 1992. Metabolism and disposition of 2,3,7,8-tetrachloro-*p*-dioxin in ring-necked pheasant hens, chicks, and eggs. *Toxicol. Environ. Health*, 35:153-164.

Nosek, J.A, J.R. Sullivan, S.R. Craven, A. Gendron-Fitzpatrick, and R.E. Peterson. 1993. Embryotoxicity of 2,3,7,8-tetrachloro-*p*-dioxin in the ring-necked pheasant. *Environ. Toxicol. Chem*., 12:1215-1222.

NNHP (Nevada Natural Heritage Program). 2004. Endemic Animals and Plants. (18 March 2004). Department of Conservation and Natural Resources, Carson City, Nevada. Accessed at: http://heritage.nv.gov/endemic.htm.

NRC (National Research Council). 2001. *A Risk-management Strategy for PCB contaminated Sediments*. National Academy Press, Washington, DC.

Paya-Perez, A.B., M. Riaz, and B.R. Larsen. 1991. Soil sorption of 20 PCB congeners and six chlorobenzenes. *Ecotoxicol. Environ. Saf.,* 21:1–17.

Powell, D.C., R.J. Aulerich, J.C. Meadows, D.E. Tillitt, J.P. Giesy, K.L. Stromborg, and S.J. Bursian. 1996. Injection of 3,3,4,4,5-pentachlorobiphenyl and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) into the yolks of chicken (*Gallus domesticus*) eggs prior to incubation. *Arch. Environ. Contam. Toxicol*., 31:404-409.

Safe, S. 1990. Polychlorinated biphenyls (PCBs), dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), and related compounds: Environmental and mechanistic considerations which support the development of toxic equivalency factors (TEFs). *Crit Rev Toxicol* 21:51-88.

Safe, S. 1993. Development of bioassays and approaches for the risk assessment of 2,3,7,8-tetrachlorodibenzo-p-dioxin and related compounds. *Environ. Health Perspectives*, 101:317-325.

Safe, S.H. 1994. Polychlorinated biphenyls (PCBs): Environmental impact, biochemical and toxic responses, and implications for risk assessment. *Crit. Rev. Toxicol*., 24(2):87–149.

Sample, B.E., D.M. Opresko, and G.W Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp, ES/ER/TM-86/R3 (PDF file, tm86r3.pdf; self-extracting WP file, tm86r3.exe).

Sample, B.E., M.S. Aplin, R.A. Efroymson, G.W. Suter II, and C.J.E. Welsh. 1997. Methods and Tools for Estimation of the Exposure of Terrestrial Wildlife to Contaminants. Oak Ridge National Laboratory, Oak Ridge, TN. 113pp. ORNL/TM-13391

Stantec. 2010. Ecological Risk Assessment Work Plan Soil Sampling Work Plan, US Ecology Nevada, Beatty, Nevada Facility.

Strek, H.J. and J.B. Weber. 1982. Behaviour of polychlorinated biphenyls (PCBs) in soils and plants. *Environmental Pollution Series A, Ecological and Biological*, 28(4): 291-312.

Suter, G.W. II, and C.L. Tsao. 1996. Toxicological Benchmarks for Screening of Potential Contaminants of Concern for Effects on Aquatic Biota on Oak Ridge Reservation: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. 104pp, ES/ER/TM-96/R2.

Suter II, G. W., L. W. Barnthouse, S. M. Bartell, T. Mill, D. Mackay, and S. Paterson. 1993. *Ecological Risk Assessment*. Lewis Publishers.

USACHPPM. 2004. Development of Terrestrial Exposure and Bioaccumulation Information for the Army Risk Assessment Modeling System (ARAMS). U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), Contract Number DAAD050-00-P-8365, Aberdeen Proving Ground, Maryland, 2004.

US Ecology. 2009. Toxic Substances Control Act (TSCA) Permit Renewal Application, US Ecology Nevada. Environmental Impact Statement – January 2005. Ecological / Biological Assessments. Proposed Installation and Operation of a WAO System, SWNSSC06-D03.3.6-A. March 03, 2009.

US EPA (United States Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund (RAGS): Volume I -- Human Health Evaluation Manual (Part A).* EPA/540/1-89/002.

EPA. 1992. "Framework for Ecological Risk Assessment." EPA/630/R-92/001.

EPA . 1993. *Wildlife Exposure Factors Handbook. Volumes I and II*. EPA Office of Research and Development, Washington, DC., EPA/600/R-93/187a and 187b.

EPA. 1995. EPA Region 4: Supplemental Guidance to RAGS: Region 4 Bulletins No. 2. Ecological Risk Assessment. Region IV, Waste Management Division. Office of Health Assessment. Values presented are as updated Aug. 1999. (http://www.epB.gov/region4/wastepgs/oftecser/epatab4.pdf)

EPA. 1996. *Ecotox Thresholds*. ECO Update 3(2):1-12. Office of Solid Waste and Emergency Response (OSWER).

EPA 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final. Office of Solid Waste and Emergency Response. EPA 540-R-97-006. June 5, 1997.

EPA. 1998. Guidelines for Ecological Risk Assessment. Risk Assessment Forum. EPA, Washington, DC. EPA/630/R-95/002F.

EPA. 1998b. EPA Region IV Soil Benchmarks.

EPA. 1999a. Toxicity Reference Values. Screening Level Ecological Risk Assessment Protocol. Appendix E. accessed at: http://www.epa.gov/wastes/hazard/tsd/td/combust/eco-risk/volume3/appx-e.pdf.

EPA. 1999b. *Ecological Data Quality Levels (EDQL), EPA, Region 5, Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Concern, 1999*.

EPA. 2001. Workshop Report on the Application of 2,3,7,8-TCDD Toxicity Equivalence Factors to Fish and Wildlife. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, DC. EPA/630/R-01/002. August 2001. www.epa.gov/ncea/raf.

EPA. 2003a. Non-dioxin-like PCBs: Effects and Consideration in Ecological Risk Assessment. National Center for Environmental Assessment (NCEA), NCEA-C-1340. June, 2003.

EPA. 2003b. Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. EPA/600/P-00/001Cb. National Center for Environmental Assessment. December, 2003.

EPA 2003c. *Region 5 Corrective Action, Ecological Screening Levels* (EPA 2003c), http://www.epa.gov/reg5rcra/ca/edql.htm. August, 2003.

EPA. 2004. User's Guide and Background Technical Document for EPA Region IX's Preliminary Remediation Goals Table. http://www.epa.gov/region9/waste/sfund/prg/files/04usersguide.pdf and http://www.epa.gov/region9/waste/sfund/prg/files/04prgtable.pdf.

EPA. 2005a. Guidance for Developing Ecological Soil Screening Levels (ECO-SSLs) OSWER Directive 9285.7-55, November 2003, Revised February, 2005.

EPA. 2005b. Memorandum: Response to Ecological Risk Assessment Forum Request for Information on the Benefits of PCB Congener-specific Analyses. NCEA-C-1315. March, 2005.

EPA. 2008. Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment. EPA 100/R-08/004.

EPA. 2010. EPA Risk Assessment Glossary. Accessed online at: (http://www.epa.gov/oswer/riskassessment/glossary.htm.

EPA. 2011. ECOTOX Database. Accessed at: http://www.epa.gov/ecotox/.

USFWS. 2003. U.S. Fish and Wildlife Service withdraws proposal to list the mountain plover as a threatened species, September 8, 2003. Accessed at: http://www.fws.gov/mountain-prairie/pressrel/03-71.htm.

USFWS. 2010a. Endangered and Threatened Wildlife and Plants; Listing the Mountain Plover as Threatened. Department of the Interior, USFWS, 50 CFR Part 17. [Docket No. FWS-R6-ES-2010-0038]. Federal Register: June 29, 2010 (Volume 75, Number 124). Proposed Rules, Pp. 37353-37358. From the Federal Register Online via GPO Access: (wais.access.gpo.gov) Accessed at: http://edocket.access.gpo.gov/2010/2010-15583.htm

USFWS. 2010b. Desert Tortoise Recovery Plan. Accessed online at: http://www.fws.gov/nevada/desert_tortoise/dt_reports.html.

USFWS 2010c. Nye County Species Information Nevada – F&W. accessed online at: http://www.fws.gov/nevada/protected_species/species_by_county.html

USFWS, 2011. Species profiles: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C04L#recovery

Van den Berg, M., L. Birnbaum, A.T.C. Bosveld, B. Brunstrom, P. Cook, M. Feeley, J.P. Giesy, A. Hanberg, R. Hasegawa, S.W. Kennedy, T. Kubiak, J.C. Larsen, F.X. Rolaf vanLeeuwen, A.K.D. Liem, C. Nolt, R.E. Peterson, L. Poellinger, S. Safe, D. Schrenk, D. Tillitt, M. Tysklind, M. Younes, F. Waern, and T. Zacharewski. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. *Environ. Health Perspect*., 106:775-792.

Van den Berg, M. L.S. Birnbaum, M. Denison, M.De Vito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Tuomisto, M. Tysklind, N.I Walker, and R.E. Peterson. 2006. REVIEW: The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. *Toxicological Sciences*, 93(2):223–241.

VanderWall, S.B., W.S. Longland, S. Pyare and J.A. Veech. 1998. Cheek pouch capacities and loading rates of heteromyid rodents. *Oecologia*. 113:21-28.

Ward, P.S. 2005. *Zootaxa* 936: A synoptic review of the ants of California (Hymenoptera: Formicidae). *Zootaxa,* 936:1–68. Magnolia Press, Auckland, New Zealand. Can also be accessed at: www.**ant**web.org/california/Ward2005.pdf

Weber, J. B. and E. Mrozek, Jr. 1979. Polychlorinated biphenyls: Phytotoxicity, absorption and translocation by plants, and inactivation by activated carbon. *Bull. Environ. Contam. Toxicol*., 23:412-17.

Weisberg, P. 2010. Nevada Online - Mojave Desert. Accessed online at: http://www.onlinenevada.org/nevada_vegetation_overview

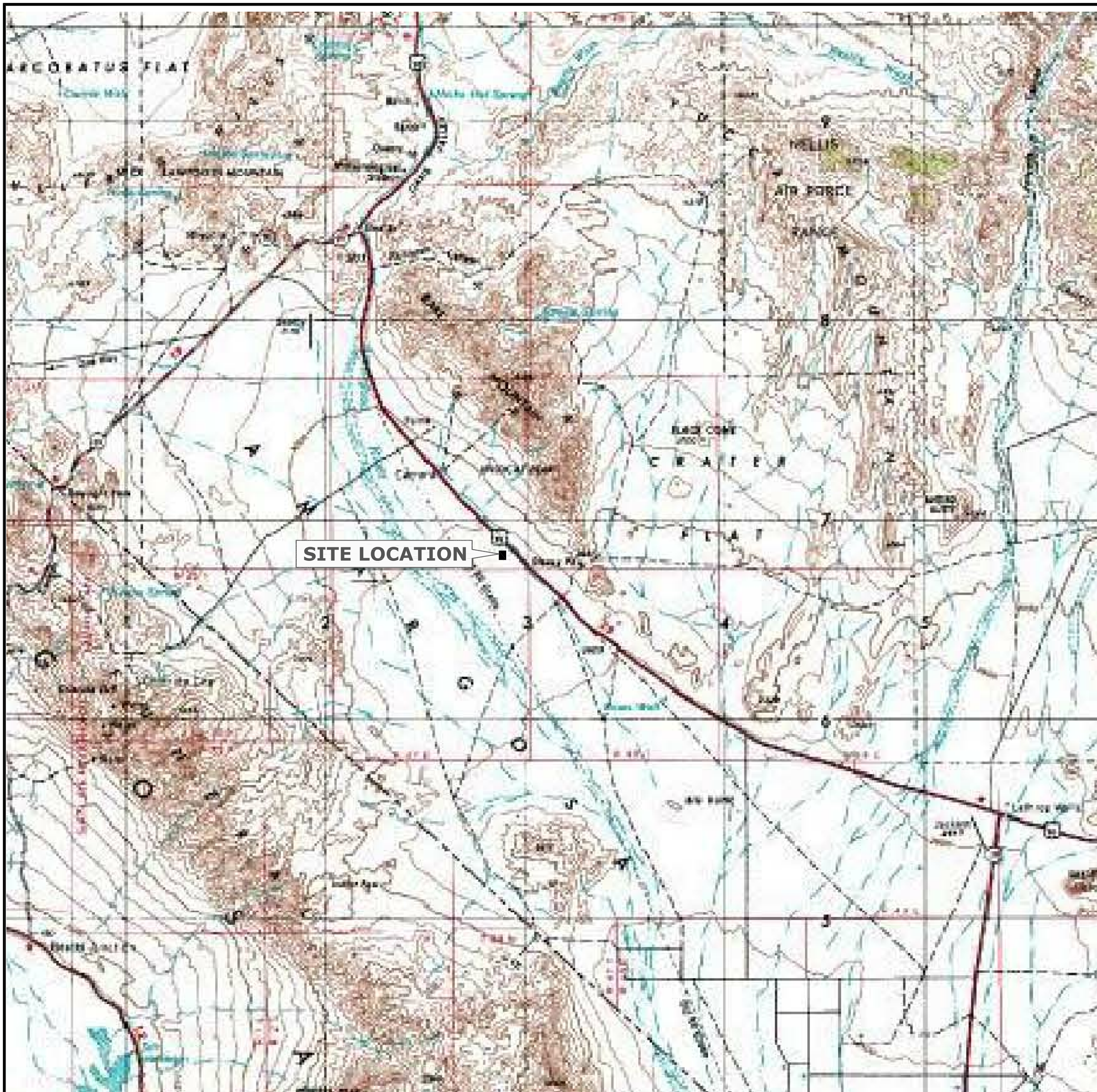
Wenck. 2010. Final Dioxin-like Polychlorinated Biphenyl (PCB) Congeners Study Report: Chemical Waste Management, Inc. Kettleman Hills Facility (KHF). Wenck Associates, Inc.

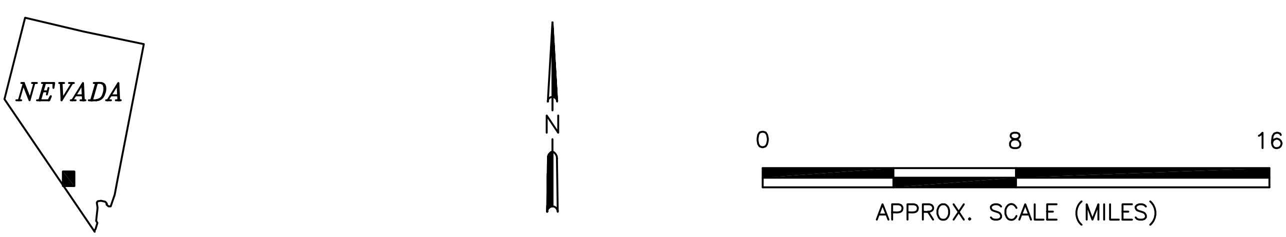
WHO (World Health Organization). 1993. Polychlorinated biphenyls and terphenyls. Environmental Health Criteria 140. Geneva.

Zoellick, B.W. and N.S. Smith. 1992. Size and spatial organization of home ranges of kit foxes. *Arizona. J. Mammal*., 73(1):83-88.

FIGURES

USEN – Screening Level Ecological Risk Assessment
US Ecology Nevada Facility
Beatty, Nevada
PN: 185702329
February 28, 2012





REFERENCE: USGS 7.5 MINUTE QUADRANGLE; BEATTY, NEVADA; 1983

Stantec
7730 SW MOHAWK STREET
TUALATIN, OREGON
PH (503) 691-2030 FAX (503) 692-7074

FOR:		SITE LOCATION MAP		FIGURE:
US ECOLOGY NEVADA, INC. HAZARDOUS WASTE MANAGEMENT FACILITY BEATTY, NEVADA				1
JOB NUMBER: 185702176	DRAWN BY: DJH	CHECKED BY: AM	APPROVED BY: PHV	DATE: 12/18/09

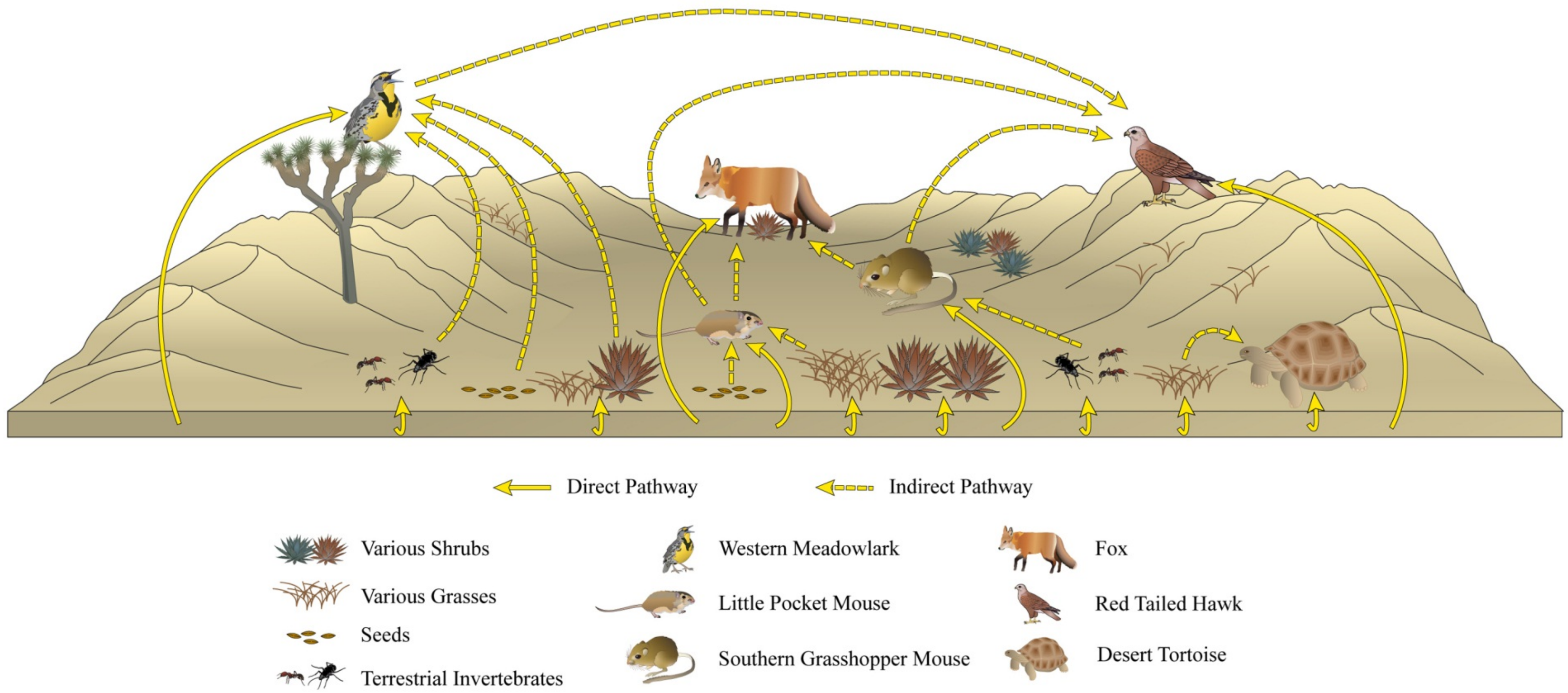
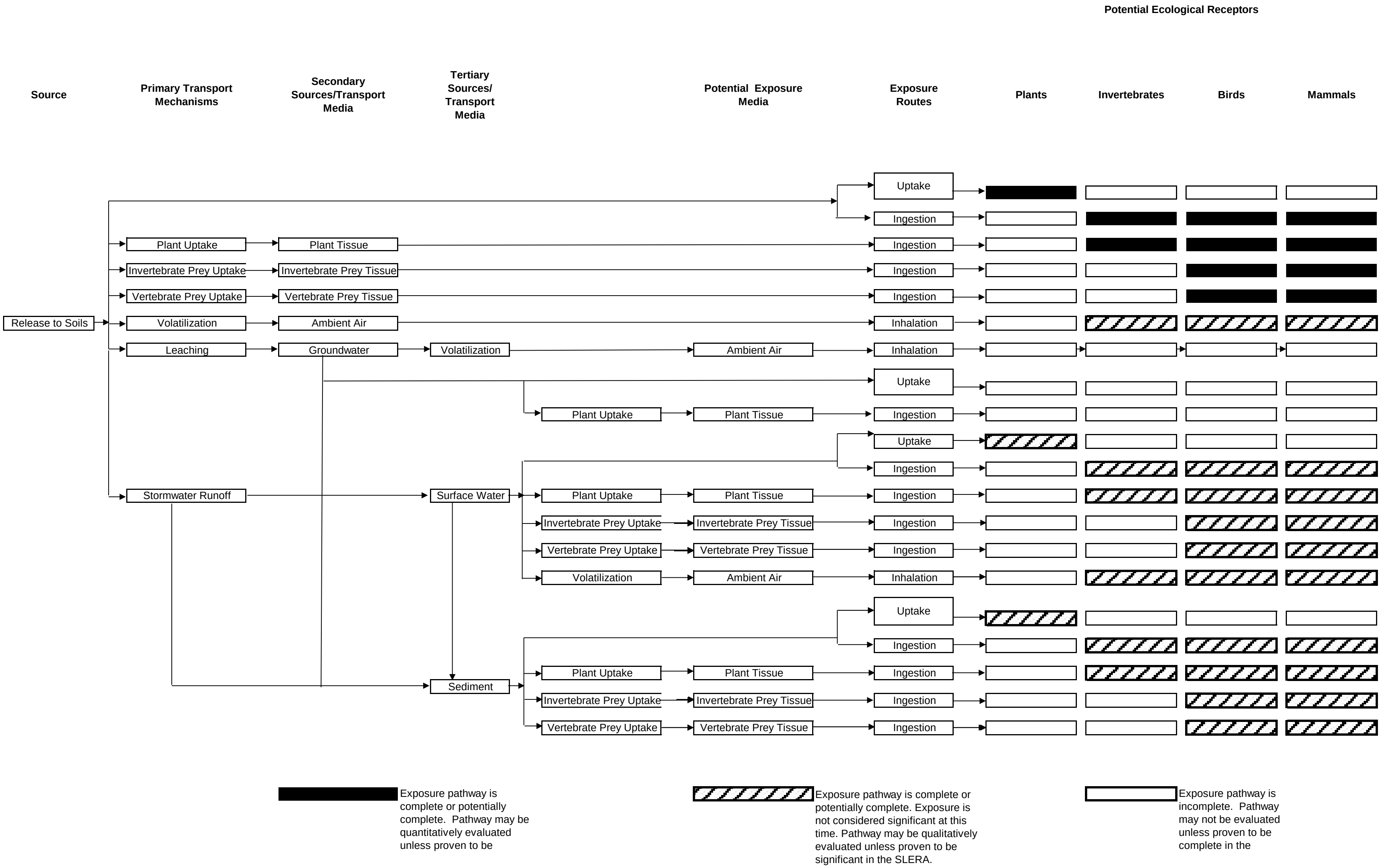


Figure 2: Conceptual Site Model – Pictorial

Figure 3.
Conceptual Site Model
for Ecological Receptors - Terrestrial Habitat



APPENDIX A
Species-specific Exposure Tables

USEN – Screening Level Ecological Risk Assessment
US Ecology Nevada Facility
Beatty, Nevada
PN: 185702329
February 28, 2012

Table A-1a
Summary Statistics: Composite Soils Site-wide

				Sample Quantitation Limits (SQLs)			
COMPOUNDS	**Number of Samples**	**Number of Detects**	**Frequency of Detection**	**Minimum ng/kg**	**Maximum ng/kg**	**Minimum Detected ng/kg**	**Maximum Detected ng/kg**
Dioxin-like Congeners							
PCB 77	17	17	100%	---	---	3.0E+02	5.1E+03
PCB 81	17	16	94%	<478*	<478*	8.9E+00	1.6E+02
PCB 105	17	17	100%	---	---	1.2E+03	1.7E+04
PCB 114	17	17	100%	---	---	5.9E+01	1.0E+03
PCB 118	17	17	100%	---	---	1.8E+03	2.7E+04
PCB 123	17	17	100%	---	---	4.8E+01	6.4E+02
PCB 126	17	17	100%	---	---	3.4E+01	3.3E+02
PCBs 156 + 157	17	17	100%	---	---	6.2E+02	4.7E+03
PCB 167	17	17	100%	---	---	2.5E+02	1.8E+03
PCB 169	17	11	65%	<425**	<498**	2.4E+01	2.9E+02
PCB 189	17	17	100%	---	---	9.1E+01	6.9E+02

Notes:
ng/kg = Nanograms/kilogram
EPA recommends the use of maximum composite result (not 95% UCL) as exposure point concentration (EPC) (EPA, 1996)
* SQL greater than two times the maximum detect is eliminated from the dataset
**1/2 SQL was used to compute statistical results

Table A-1. Potential uptake and plant exposure to polychlorinated biphenyls as a result of sources from the USEN Facility.

Dioxin-like PCB Congener	CAS_No.	Soil Conc- MAXIMUM (ng/kg)	
PCB 77	32598-13-3	5.1E+03	
PCB 81	70362-50-4	1.6E+02	
PCB 126	57465-28-8	3.3E+02	
PCB 169	32774-16-6	2.9E+02	
PCB 105	32598-14-4	1.7E+04	
PCB 114	74472-37-0	1.0E+03	
PCB 118	31508-00-6	2.7E+04	
PCB 123	65510-44-3	6.4E+02	
PCBs 156 + 157	PCB156= 38380-08-4; PCB157=69782-90-7	4.7E+03	
PCB 167	52663-72-6	1.8E+03	
PCB 189	39635-31-9	6.9E+02	
Total PCBs		**8.6E+05**	
		(ng/kg)	(mg/kg)
Estimated Exposure for Plants:		856,000	0.86
Plant Screeening Benchmark:		40,000,000	40

Abbreviations:

PCB	Polychlorinated Biphenyls
ng/kg	nanograms per kilogram
mg/kg	milligrams per kilogram
CAS_No	Chemical Abstracts Service Registry Numbers (unique numerical identifiers assigned to chemicals)

Table A-2. Little Pocket Mouse: Food chain modeling conducted for exposure to polychlorinated biphenyls as a result of sources from the USEN Facility.

Dioxin-like PCB Congeners	CAS_No	Max Soil Conc	BAF plant (soil to plant)	FIR	SIR (8%)	BW	Exposure Dose (ED)	WHO TEF	TEQ-Dose	TRV-Lo	HQ -Lo	TRV-Hi	HQ -Hi
		ng/kg	unitless	kg/day	kg/day	kg	ng/kg BW/day	Mammals		(NOAEL)		(LOAEL)	
PCB 77	32598-13-3	5.1E+03	0.016	0.0011248	0.000089984	0.0074	7.41E+01	0.0001	7.41E-03	2.00E+00	3.71E-03	2.00E+01	3.71E-04
PCB 81	70362-50-4	1.6E+02	0.016	0.0011248	0.000089984	0.0074	2.32E+00	0.0003	6.96E-04	2.00E+00	3.48E-04	2.00E+01	3.48E-05
PCB 126	57465-28-8	3.3E+02	0.016	0.0011248	0.000089984	0.0074	4.74E+00	0.1	4.74E-01	2.00E+00	2.37E-01	2.00E+01	2.37E-02
PCB 169	32774-16-6	2.9E+02	0.016	0.0011248	0.000089984	0.0074	4.25E+00	0.03	1.27E-01	2.00E+00	6.37E-02	2.00E+01	6.37E-03
PCB 105	32598-14-4	1.7E+04	0.016	0.0011248	0.000089984	0.0074	2.51E+02	0.00003	7.53E-03	2.00E+00	3.76E-03	2.00E+01	3.76E-04
PCB 114	74472-37-0	1.0E+03	0.016	0.0011248	0.000089984	0.0074	1.47E+01	0.00003	4.42E-04	2.00E+00	2.21E-04	2.00E+01	2.21E-05
PCB 118	31508-00-6	2.7E+04	0.016	0.0011248	0.000089984	0.0074	3.88E+02	0.00003	1.16E-02	2.00E+00	5.82E-03	2.00E+01	5.82E-04
PCB 123	65510-44-3	6.4E+02	0.016	0.0011248	0.000089984	0.0074	9.38E+00	0.00003	2.81E-04	2.00E+00	1.41E-04	2.00E+01	1.41E-05
PCBs 156 + 157	PCB156= 38380-08-4; PCB157=69782-90-7	4.7E+03	0.016	0.0011248	0.000089984	0.0074	6.92E+01	0.00003	2.07E-03	2.00E+00	1.04E-03	2.00E+01	1.04E-04
PCB 167	52663-72-6	1.8E+03	0.016	0.0011248	0.000089984	0.0074	2.57E+01	0.00003	7.70E-04	2.00E+00	3.85E-04	2.00E+01	3.85E-05
PCB 189	39635-31-9	6.9E+02	0.016	0.0011248	0.000089984	0.0074	1.01E+01	0.00003	3.03E-04	2.00E+00	1.51E-04	2.00E+01	1.51E-05
						Total ED-Max	853.63	**Total TEQ**	**0.63**	**HI-lo**	**3.16E-01**	**HI-hi**	**3.16E-02**

Model Equations	*Little Pocket Mouse*	
Exposure Model Equation:	**ED = (([soil] x BAF x FIR) + ([soil] x SIR))/ BW**	
1	**Exposure Dose**	**(Food Exp +Soil Exp)/BW**
2	**TEQ**	**TEQ= ED*TEF**
3	**HQ**	**HQ = TEQ/TRV**

Significant Model / Exposure Assumptions

1=conservative (max concentrations of EACH congener) exposure - highly unlikely
2=100% diet consists of plants
3= 100% AUF (1)
4=100% PCBs in plants and soil is bioavailable

NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species

Effects Metrics for Little Pocket Mouse	2,3,7,8-TCDD	NOAEL	LOAEL	Units
	Based on:	2.00E-06	2.00E-05	mg/kg/day
Sample et al. 1996	**White-footed Mouse**	2.00E-03	2.00E-02	ug/kg/day
		2	**20**	ng/kg/day

*effects metric is in ng/kg bw/d
NOAEL- and LOAEL-based toxicological benchmarks for selected avian and mammalian wildlife species

Abbreviations:

AUF	Area use factor
BAF	bioaccumulation factor
BW	body weight
CAS_No	Chemical Abstract Service chemical number
ED	exposure dose
FIR	food ingestion rate
HI	hazard index
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
PCB	Polychlorinated biphenyls
SIR	soil ingestion rate
TEF	Toxicity equivalency factors
TEQ	toxicity equivalennts
TRV	toxicity reference values
WHO	World Health Organization
HQ -Lo	(=TED/TRV-lo)
HQ -Hi	(=TED/TRV-hi)

Table A-2. Little Pocket Mouse

Exposure Parameters for Little Pocket Mouse:	BW	FIR	SIR (8% FIR)	soil to plant factor
CalTox, 1999	0.0074 (b)	0.00112	0.000089984	0.016
Units	kg	kg/d	kg/d	(a)
(a) Based on Blankenship et al., 2005		(See below)	8% of FIR	
(b) Kenagy 1973 as referenced in Cal Ecotox 1999				

Units of Measure:

ng/kg	nanograms per kilogram
ug/kg	micrograms per kilogram
mg/kg	milligram per kilogram

Average FIR Normalized to Mouse		
FIR per BW	0.152	g/g bw/d
Mouse BW	0.0074	kg
FIR per mouse	1.1248E-06	kg/mouse/d

Additional References:

Chew, Robert M. and Bernard B. Butterworth. 1964. Ecology of rodents in Indian Cove (Mojave Desert), Joshua Tree National Monument, California. J. Mammal. 45:203-225.

VanderWall, Stephen B., William S. Longland, Sanjay Pyare and Joseph A. Veech. 1998. Cheek pouch capacities and loading rates of heteromyid rodents. Oecologia. 113:21-28.

Kenagy, G. J. and George A. Bartholomew. 1985. Seasonal reproductive patterns in five coexisting California desert rodent species. Ecol. Monogr. 55(4):371-397.

Kenagy, G. J. 1973. Daily and seasonal patterns of activity and energetics in a heteromyid rodent commuinity. Ecology. 54(6):1201-1219.

Table A-3. Grasshopper Mouse: Food chain modeling conducted for exposure to polychlorinated biphenyls as a result of sources from the USEN Facility.

Dioxin-like PCB Congeners	CAS_No	Soil Conc-MAXIMUM ng/kg	BAF inv (soil to invert) unitless	FIR kg/day	SIR (8% of FIR) kg/day	BW kg	Exposure Dose (ED) ng/kg BW/day	WHO TEF Mammals	TEQ-Dose	TRV-Lo (NOAEL)	HQ -Lo	TRV-Hi (LOAEL)	HQ -Hi
PCB 77	32598-13-3	5.1E+03	0.052	0.0029	0.000232	0.041	4.75E+01	0.0001	4.75E-03	2.20E+00	2.16E-03	2.20E+01	2.16E-04
PCB 81	70362-50-4	1.6E+02	0.052	0.0029	0.000232	0.041	1.49E+00	0.0003	4.46E-04	2.20E+00	2.03E-04	2.20E+01	2.03E-05
PCB 126	57465-28-8	3.3E+02	0.052	0.0029	0.000232	0.041	3.04E+00	0.1	3.04E-01	2.20E+00	1.38E-01	2.20E+01	1.38E-02
PCB 169	32774-16-6	2.9E+02	0.052	0.0029	0.000232	0.041	2.72E+00	0.03	8.17E-02	2.20E+00	3.71E-02	2.20E+01	3.71E-03
PCB 105	32598-14-4	1.7E+04	0.052	0.0029	0.000232	0.041	1.61E+02	0.00003	4.83E-03	2.20E+00	2.19E-03	2.20E+01	2.19E-04
PCB 114	74472-37-0	1.0E+03	0.052	0.0029	0.000232	0.041	9.45E+00	0.00003	2.84E-04	2.20E+00	1.29E-04	2.20E+01	1.29E-05
PCB 118	31508-00-6	2.7E+04	0.052	0.0029	0.000232	0.041	2.49E+02	0.00003	7.47E-03	2.20E+00	3.39E-03	2.20E+01	3.39E-04
PCB 123	65510-44-3	6.4E+02	0.052	0.0029	0.000232	0.041	6.02E+00	0.00003	1.81E-04	2.20E+00	8.21E-05	2.20E+01	8.21E-06
PCBs 156 + 157	PCB156= 38380-08-4; PCB157=69782-90-7	4.7E+03	0.052	0.0029	0.000232	0.041	4.44E+01	0.00003	1.33E-03	2.20E+00	6.05E-04	2.20E+01	6.05E-05
PCB 167	52663-72-6	1.8E+03	0.052	0.0029	0.000232	0.041	1.65E+01	0.00003	4.94E-04	2.20E+00	2.25E-04	2.20E+01	2.25E-05
PCB 189	39635-31-9	6.9E+02	0.052	0.0029	0.000232	0.041	6.48E+00	0.00003	1.94E-04	2.20E+00	8.83E-05	2.20E+01	8.83E-06
						Total ED-Max	547.43	**Total TEQ**	**0.41**	**HI-Lo**	**1.84E-01**	**HI-Hi**	**1.84E-02**

Model Equations	*Southern Grasshopper Mouse*	
Exposure Model Equation:	**ED = (([soil] x BAF x FIR) + ([soil] x SIR)) / BW**	
1	**Exposure Dose**	**(Food Exp +Soil Exp)/BW**
2	**TEQ**	**TEQ= ED*TEF**
3	**HQ**	**HQ = TEQ/TRV**

Significant Model / Exposure Assumptions

1=conservative (max concentrations of EACH congener) exposure - highly unlikely

2=100% diet consists of invertebrates

(actual dietary composition is about 63.3% invertebrates and 36.7% plant material)

3= 100% AUF (1)

4=100% PCBs in prey and soil are bioavailable

Effects Metrics for Grasshopper Mouse	2,3,7,8-TCDD	NOAEL	LOAEL	Units
	Based on:	2.20E-06	2.20E-05	mg/kg/day
Sample et al. 1996	**Short-tailed Shrew**	2.20E-03	2.20E-02	ug/kg/day
		2.2	**22**	ng/kg/day

*effects metric is in ng/kg bw/d

NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species

Exposure Parameters for Grasshopper Mouse:	BW	FIR	SIR	BAF
USACHPPM, 2004	0.041	0.0029	0.000232	0.0523
	kg	kg/d	kg/d	Unitless
		(b)	8% of FIR	(a)

(a) soil to invertebrates; based on Blankenship et al., 2005

(b) FIR value of 0.0029 kg/d is from Wenck 2010; a value of 0.002091 was calculated using data from USACHPPM, 2004 which is less conservative. Therefore, the value from Wenck 2010 was used to increase conservativism.

Abbreviations:

AUF	Area use factor
BAF	bioaccumulation factor
BW	body weight
CAS_No	Chemical Abstract Service chemical number
ED	exposure dose
FIR	food ingestion rate
HI	hazard index
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
PCB	Polychlorinated biphenyls
SIR	soil ingestion rate
TEF	Toxicity equivalency factors
TEQ	toxicity equivalennts
TRV	toxicity reference values
WHO	World Health Organization
HQ -Lo	(=TED/TRV-lo)
HQ -Hi	(=TED/TRV-hi)

Units of Measure:

ng/kg	nanograms per kilogram
ug/kg	micrograms per kilogram
mg/kg	milligram per kilogram

Table A-4. Western Meadowlark: Food chain modeling conducted for exposure to polychlorinated biphenyls as a result of sources from the USEN Facility.

Dioxin-like PCB Congener	CAS_No.	Soil Conc- MAXIMUM ng/kg	Sample ID of [MAX]	BAF prey (based on invert) unitless	FIR (dw) kg-d	SIR (5%) kg/d	BW kg	Exposure Dose (ED) ng/kg BW/d	Avian* TEF	TEQ-Dose	TRV-Lo (NOAEL)	HQ -Lo	TRV-Hi (LOAEL)	HQ -Hi
PCB 77	32598-13-3	5.1E+03	E/W-09-1	0.052	0.0143	0.0007	0.112	69.9	0.05	**3.50E+00**	14	2.50E-01	1.40E+02	2.50E-02
PCB 81	70362-50-4	1.6E+02	E/W-09-1	0.052	0.0143	0.0007	0.112	2.19	0.1	**2.19E-01**	14	1.56E-02	1.40E+02	1.56E-03
PCB 126	57465-28-8	3.3E+02	E/W-09-1	0.052	0.0143	0.0007	0.112	4.47	0.1	**4.47E-01**	14	3.19E-02	1.40E+02	3.19E-03
PCB 169	32774-16-6	2.9E+02	E/W-10-1	0.052	0.0143	0.0007	0.112	4.00	0.001	**4.00E-03**	14	2.86E-04	1.40E+02	2.86E-05
PCB 105	32598-14-4	1.7E+04	E/W-09-1	0.052	0.0143	0.0007	0.112	236.7	0.0001	**2.37E-02**	14	1.69E-03	1.40E+02	1.69E-04
PCB 114	74472-37-0	1.0E+03	E/W-09-1	0.052	0.0143	0.0007	0.112	13.90	0.00001	**1.39E-04**	14	9.93E-06	1.40E+02	9.93E-07
PCB 118	31508-00-6	2.7E+04	E/W-09-1	0.052	0.0143	0.0007	0.112	366.1	0.00001	**3.66E-03**	14	2.61E-04	1.40E+02	2.61E-05
PCB 123	65510-44-3	6.4E+02	E/W-09-1	0.052	0.0143	0.0007	0.112	8.85	0.0001	**8.85E-04**	14	6.32E-05	1.40E+02	6.32E-06
PCBs 156 + 157	PCB156= 38380-08-4; PCB157=69782-90-7	4.7E+03	E/W-08-1	0.052	0.0143	0.0007	0.112	65.23	0.0001	**6.52E-03**	14	4.66E-04	1.40E+02	4.66E-05
PCB 167	52663-72-6	1.8E+03	E/W-08-1	0.052	0.0143	0.0007	0.112	24.22	0.00001	**2.42E-04**	14	1.73E-05	1.40E+02	1.73E-06
PCB 189	39635-31-9	6.9E+02	E/W-08-1	0.052	0.0143	0.0007	0.112	9.52	0.0001	**9.52E-04**	14	6.80E-05	1.40E+02	6.80E-06
							Total ED (Max)	**805.10**	**Total TEQ**	**4.20**	**HI-lo**	**3.00E-01**	**HI-hi**	**3.00E-02**

Model Equations *Western Meadowlark*		
Exposure Model Equation:	**ED = (([soil] x BAF-inv x FIR) + ([soil] x SIR)) / BW**	
1	**Exposure Dose**	**(Food Exp +Soil Exp)/BW**
2	**TEQ**	**TEQ= ED*TEF**
3	**HQ**	**HQ = TEQ/TRV**

Significant Model / Exposure Assumptions

1=conservative (max concentrations of EACH congener) exposure - highly unlikely
2=100% diet consists of terrestrial invertebrates as prey
(actual dietary composition is 63.3% invertebrates, approxiamtely 36.7% plant material)
3=100% AUF, unlikely, this certainly would overestimate time foraging on site
4=100% PCBs in prey and soil are bioavailable

Exposure Parameters for Western Meadowlark	BW *	FIR (Intake) **	SIR	BAF
	0.1115	0.01432	0.000716	0.022
Units	kg	kg/d dw	kg/d	Unitless
USACHPPM 2004; Sample et al., 1997	0.1115 (for Nevada population)	USACHPPM, 2004; Nagy et al., 1999	5% of FIR	(a)
		0.026 kg/d (ww)		

* Males used in model; results for females were similar when taking into account BW and FIR
** FIR is on dw basis; approximately 0.0026 kg/d is estimated for invertebrates at ~ 73% moisture
a) Blankenship et al., 2005

FIR: FIR = (FMR/ME) = (257.8 kJ/day) / (18 kJ/g) = 14.32 g/day = 0.0143 kg/day (dw)

where: FMR = Field Metabolic Rate = 10.4 x BW in g) ^ 0.681 = 257.8 kJ/day (based on a BW of 111.5 g)
ME = Metabolic Energy of Food = 18 kJ/g dry matter
- based on estimated MEs for avian insectivore (18.0 kJ/g dry matter)

Nagy et al. 1999 For passerine birds, Nagy et al., 1999 provides an allometric equation for food ingestion rate using bird body weight
Nagy, K.A., I.A. Girard, and T.K. Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. Ann. Rev. Nutr. 19: 247-277.

SIR: A value for SIR was not available for meadowlark. Therefore, a more conservative SIR of 5% was used (compared to 2% for other species).
(See Input Parameters Table for additional explanation for SIR for WML)

Effects Metrics for Western Meadowlark	2,3,7,8-TCDD	NOAEL	LOAEL	Unit
	Based on:	0.000014	0.00014	mg/kg/day
Sample et al. 1996	**Rough-winged Swallow**	0.014	0.14	ug/kg/day
		14	**140**	ng/kg/day

*effects metric is in ng/kg bw/d
NOAEL- and LOAEL-based toxicological benchmarks for selected avian wildlife species

Abbreviations:

AUF	Area use factor
BAF	bioaccumulation factor
BW	body weight
CAS_No	Chemical Abstract Service chemical number
ED	exposure dose
FIR	food ingestion rate
FMR	Free Metabolic Rate
HI	hazard index
HQ	hazard quotient
kJ	kilojoules
LOAEL	lowest observed adverse effect level
ME	Metabolizable Energy
NOAEL	no observed adverse effect level
PCB	Polychlorinated biphenyls
SIR	soil ingestion rate
TEF	Toxicity equivalency factors
TEQ	toxicity equivalennts
TRV	toxicity reference values
WHO	World Health Organization
HQ -Lo	(=TED/TRV-lo)
HQ -Hi	(=TED/TRV-hi)

Units of Measure:

ng/kg	nanograms per kilogram
ug/kg	micrograms per kilogram
mg/kg	milligram per kilogram

Table A-5. Kit Fox: Food chain modeling conducted for exposure to polychlorinated biphenyls as a result of sources from the USEN Facility.

Dioxin-like PCB Congeners	CAS_No	Max Soil Conc ng/kg	BAF prey (based on shrew) unitless	FIR kg/day	SIR (2.8% FIR) kg/day	BW kg	Exposure Dose (ED) ng/kg BW/day	WHO TEF Mammals	TEQ-Dose Kit Fox	TRV-Lo (NOAEL)	HQ -Lo	TRV-Hi (LOAEL)	HQ -Hi
PCB 77	32598-13-3	5.1E+03	0.2	0.1303	0.0036484	1.95	7.74E+01	0.0001	7.74E-03	5.00E-01	1.55E-02	5.30E+00	1.46E-03
PCB 81	70362-50-4	1.6E+02	0.2	0.1303	0.0036484	1.95	2.42E+00	0.0003	7.27E-04	5.00E-01	1.45E-03	5.30E+00	1.37E-04
PCB 126	57465-28-8	3.3E+02	0.2	0.1303	0.0036484	1.95	4.95E+00	0.1	4.95E-01	5.00E-01	9.90E-01	5.30E+00	9.34E-02
PCB 169	32774-16-6	2.9E+02	0.2	0.1303	0.0036484	1.95	4.43E+00	0.03	1.33E-01	5.00E-01	2.66E-01	5.30E+00	2.51E-02
PCB 105	32598-14-4	1.7E+04	0.2	0.1303	0.0036484	1.95	2.62E+02	0.00003	7.86E-03	5.00E-01	1.57E-02	5.30E+00	1.48E-03
PCB 114	74472-37-0	1.0E+03	0.2	0.1303	0.0036484	1.95	1.54E+01	0.00003	4.62E-04	5.00E-01	9.23E-04	5.30E+00	8.71E-05
PCB 118	31508-00-6	2.7E+04	0.2	0.1303	0.0036484	1.95	4.05E+02	0.00003	1.22E-02	5.00E-01	2.43E-02	5.30E+00	2.29E-03
PCB 123	65510-44-3	6.4E+02	0.2	0.1303	0.0036484	1.95	9.80E+00	0.00003	2.94E-04	5.00E-01	5.88E-04	5.30E+00	5.54E-05
PCBs 156 + 157	PCB156= 38380-08-4; PCB157=69782-90-7	4.7E+03	0.2	0.131	0.001	1.95	7.22E+01	0.00003	2.17E-03	5.00E-01	4.33E-03	5.30E+00	4.09E-04
PCB 167	52663-72-6	1.8E+03	0.2	0.131	0.001	1.95	2.68E+01	0.00003	8.04E-04	5.00E-01	1.61E-03	5.30E+00	1.52E-04
PCB 189	39635-31-9	6.9E+02	0.2	0.131	0.001	1.95	1.05E+01	0.00003	3.16E-04	5.00E-01	6.33E-04	5.30E+00	5.97E-05
						Total ED-Max	891.25	**Total TEQ**	**0.66**	**HI-lo**	**1.32E+00**	**HI-hi**	**1.247E-01**

Model Equations *Kit Fox*		
Exposure Model Equation:	**ED = (([soil] x BAF x FIR) + ([soil] x SIR)) / BW**	
1	**Exposure Dose**	**(Food Exp +Soil Exp)/BW**
2	**TEQ**	**TEQ= ED*TEF**
3	**HQ**	**HQ = TEQ/TRV**

Significant Model / Exposure Assumptions

1=conservative (max concentrations of EACH congener) exposure - highly unlikely
2=100% diet consists of carnivorous prey
3=100% AUF, fox has a large home range realistically, feeding range for fox will be limited to only outside of the facility
4=100% PCBs in prey and soil are assumed to be bioavailable

Effects Metrics for Kit Fox	2,3,7,8-TCDD	NOAEL	LOAEL	Units
	Based on:	5.00E-07	5.30E-06	mg/kg/day
Sample et al., 1996	**Red Fox**	5.00E-04	0.0053	ug/kg/day
		0.5	**5.3**	ng/kg/day

*effects metric is in ng/kg bw/d

NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species

Exposure Parameters: Kit Fox	BW *	FIR **	SIR	BAF -Prey
	1.95	0.1303	0.0036484	0.2 (a)
Units	kg	kg/d	kg/d	Unitless
	(c.) Average males and feemales	(b)	2.8% FIR	(a)

* BW averaged data provided in CalTox 1999
** FIR average of 2 ranges provided in CalTox 1999
(a) Blankenship et al., 2005
(b) CalTox 1999
(c) USACHPPM 2004

Abbreviations:

AUF	Area use factor
BAF	bioaccumulation factor
BW	body weight
CAS_No	Chemical Abstract Service chemical number
ED	exposure dose
FIR	food ingestion rate
HI	hazard index
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
PCB	Polychlorinated biphenyls
SIR	soil ingestion rate
TEF	Toxicity equivalency factors
TEQ	toxicity equivalennts
TRV	toxicity reference values
WHO	World Health Organization
HQ -Lo	(=TEQ-D /TRV-lo)
HQ -Hi	(=TEQ-D /TRV-hi)

Units of Measure:

ng/kg	nanograms per kilogram
ug/kg	micrograms per kilogram
mg/kg	milligram per kilogram

Table A-6. Red-tailed Hawk: Food chain modeling conducted for exposure to polychlorinated biphenyls as a result of sources from the USEN Facility.

Dioxin-like PCB Congener	CAS_No.	Soil Conc-MAXIMUM	BAF prey (based on shrew)	FIR	SIR (1% FIR)	BW	Exposure Dose (ED)	Avian*	TEQ-Dose	TRV-Lo	HQ -Lo	TRV-Hi	HQ -Hi
		ng/kg	unitless	kg/d	kg/d	kg	ng/kg BW/d	TEF		(NOAEL)		(LOAEL)	
PCB 77	32598-13-3	5.1E+03	0.2	0.109	0.001	1.126	1.03E+02	0.05	5.16E+00	1.40E+01	3.69E-01	1.40E+02	3.69E-02
PCB 81	70362-50-4	1.6E+02	0.2	0.109	0.001	1.126	3.23E+00	0.1	3.23E-01	1.40E+01	2.31E-02	1.40E+02	2.31E-03
PCB 126	57465-28-8	3.3E+02	0.2	0.109	0.001	1.126	6.61E+00	0.1	6.61E-01	1.40E+01	4.72E-02	1.40E+02	4.72E-03
PCB 169	32774-16-6	2.9E+02	0.2	0.109	0.001	1.126	5.92E+00	0.001	5.92E-03	1.40E+01	4.23E-04	1.40E+02	4.23E-05
PCB 105	32598-14-4	1.7E+04	0.2	0.109	0.001	1.126	3.50E+02	0.0001	3.50E-02	1.40E+01	2.50E-03	1.40E+02	2.50E-04
PCB 114	74472-37-0	1.0E+03	0.2	0.109	0.001	1.126	2.05E+01	0.00001	2.05E-04	1.40E+01	1.47E-05	1.40E+02	1.47E-06
PCB 118	31508-00-6	2.7E+04	0.2	0.109	0.001	1.126	5.41E+02	0.00001	5.41E-03	1.40E+01	3.86E-04	1.40E+02	3.86E-05
PCB 123	65510-44-3	6.4E+02	0.2	0.109	0.001	1.126	1.31E+01	0.0001	1.31E-03	1.40E+01	9.34E-05	1.40E+02	9.34E-06
PCBs 156 + 157	PCB156= 38380-08-4; PCB157=69782-90-7	4.7E+03	0.2	0.109	0.001	1.126	9.64E+01	0.0001	9.64E-03	1.40E+01	6.88E-04	1.40E+02	6.88E-05
PCB 167	52663-72-6	1.8E+03	0.2	0.109	0.001	1.126	3.58E+01	0.00001	3.58E-04	1.40E+01	2.56E-05	1.40E+02	2.56E-06
PCB 189	39635-31-9	6.9E+02	0.2	0.109	0.001	1.126	1.41E+01	0.0001	1.41E-03	1.40E+01	1.00E-04	1.40E+02	1.00E-05
						Total ED (Max)	1189.22	Total TEQ	6.21	HI-lo	4.43E-01	HI-hi	4.43E-02

Model Equations *Red-tailed Hawk*		
Exposure Model Equation:	**ED = (([soil] x BAF x FIR + ([soil] x SIR)) / BW**	
1	**Exposure Dose**	**(Food Exp +Soil Exp)/BW**
2	**TEQ**	**TEQ= ED*TEF**
3	**HQ**	**HQ = TEQ/TRV**

Significant Model / Exposure Assumptions

1=conservative (max concentrations of EACH congener) exposure - highly unlikely
2=100% diet consists of carnivorous prey
3=100% AUF, realistically, fox should not be able to access the Site, only the surrounding buffer zone
4=100% PCBs in prey and soil are assumed to be bioavailable

Exposure Parameters: Red-tailed Hawk	BW	FIR (Intake)	SIR	BAF -Prey
Wildlife Exposure Handbook	1.126 kg	0.109 kg/d	0.00109 kg/d	0.2 (a) Unitless
(a) Blankenship et al., 2005 Sample et al. 1996			1% of FIR	(a)

Effects Metrics for Red-tailed Hawk	2,3,7,8-TCDD	NOAEL	LOAEL	Units
	Based on:	1.40E-05	1.40E-04	mg/kg/day
Sample et al. 1996	**Red-tailed Hawk**	1.40E-02	1.40E-01	ug/kg/day
		14	**140**	ng/kg/day

*effects metric is in ng/kg bw/d

NOAEL- and LOAEL-based toxicological benchmarks for selected avian wildlife species.

Abbreviations:

AUF	Area use factor
BAF	bioaccumulation factor
BW	body weight
CAS_No	Chemical Abstract Service chemical number
ED	exposure dose
FIR	food ingestion rate
HI	hazard index
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
PCB	Polychlorinated biphenyls
SIR	soil ingestion rate
TEF	Toxicity equivalency factors
TEQ	toxicity equivalennts
TRV	toxicity reference values
WHO	World Health Organization
HQ -Lo	=TEQ-D /TRV-lo)
HQ -Hi	=TEQ-D /TRV-hi)

Units of Measure:

ng/kg	nanograms per kilogram
ug/kg	micrograms per kilogram
mg/kg	milligram per kilogram

Table A-7. Desert Tortoise: Food chain modeling conducted for exposure to polychlorinated biphenyls as a result of sources from the USEN Facility.

Note: This table is based on the food chain modeling conducted throughout this SLERA, but it is NOT considered a complete model, as no TEF values exist for reptiles. Therefore, the model ran for the Desert Tortoise was a semi-qualitative model that estimated an Exposure Dose. That Exposure Dose was then qualitatively compared to that of the Little Pocket Mousse - as an herbivore.

Dioxin-like PCB Congeners	CAS_No	Soil Conc MAXIMUM	BAF plant (soil to plant)	FIR	SIR (8% of FIR)	BW	Exposure Dose (ED)
		ng/kg	unitless	kg/day	kg/day	BW-kg	ng/kg BW/day
PCB 77	32598-13-3	5.1E+03	0.016	0.0090174	0.000721392	1.995125	2.20E+00
PCB 81	70362-50-4	1.6E+02	0.016	0.0090174	0.000721392	1.995125	6.90E-02
PCB 126	57465-28-8	3.3E+02	0.016	0.0090174	0.000721392	1.995125	1.41E-01
PCB 169	32774-16-6	2.9E+02	0.016	0.0090174	0.000721392	1.995125	1.26E-01
PCB 105	32598-14-4	1.7E+04	0.016	0.0090174	0.000721392	1.995125	7.46E+00
PCB 114	74472-37-0	1.0E+03	0.016	0.0090174	0.000721392	1.995125	4.38E-01
PCB 118	31508-00-6	2.7E+04	0.016	0.0090174	0.000721392	1.995125	1.15E+01
PCB 123	65510-44-3	6.4E+02	0.016	0.0090174	0.000721392	1.995125	2.79E-01
PCBs 156 + 157	PCB156= 38380-08-4; PCB157=69782-90-7	4.7E+03	0.016	0.0090174	0.000721392	1.995125	2.06E+00
PCB 167	52663-72-6	1.8E+03	0.016	0.0090174	0.000721392	1.995125	7.64E-01
PCB 189	39635-31-9	6.9E+02	0.016	0.0090174	0.000721392	1.995125	3.00E-01

Total ED-Max 25.38

Model Equations		
Exposure Model Equation:	**ED = (([soil] x BAF x FIR) + ([soil] x SIR)) / BW**	
1	**Exposure Dose**	**(Food Exp +Soil Exp)/BW**

Significant Model / Exposure Assumptions

1=conservative (max concentrations of EACH congener) exposure - highly unlikely
2=100% diet consists of plants
3= 100% AUF (1) on Site
4=100% PCBs in plants and soil is bioavailable

Exposure Parameters for Desert Tortoise:	BW	FIR	SIR	soil to plant factor
CalTox, 1999	1.995	0.0090174	0.000721392	0.016
Units	kg	(dry weight) kg/d	kg/d 8%	(a)
(a) Based on Blankenship et al., 2005				

Abbreviations:

AUF	Area use factor
BAF	bioaccumulation factor
BW	body weight
CAS_No	Chemical Abstract Service chemical number
ED	exposure dose
FIR	food ingestion rate
HI	hazard index
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
PCB	Polychlorinated biphenyls
SIR	soil ingestion rate
TEF	Toxicity equivalency factors
TEQ	toxicity equivalennts
TRV	toxicity reference values
WHO	World Health Organization

Units of Measure:

ng/kg	nanograms per kilogram
ug/kg	micrograms per kilogram
mg/kg	milligram per kilogram

Additional References:

O'Connor, M.P., L.C. Zimmerman, D.E. Ruby, S.J. Bulova and J.R. Spotila. 1994. Home range size and movements by desert tortoises, Gopherus agassizii, in the eastern Mojave desert. Herpetol. Monogr. 8:60-71. (as citedin CalTox, 1999).
Nagy, K.A. and P.A. Medica. 1986. Physiological ecology of desert tortoises in southern Nevada. *Herpetologica.* 42(1):73-92. (as citedin CalTox, 1999).
Turner, F.B., P.A. Medica and C.L. Lyons. 1984. Reproduction and survival of the desert tortoise (Scaptochelys agassizii) in Ivanpah Valley, California. Copeia. 1984(4):811-820. (as citedin CalTox, 1999).

APPENDIX B
USEN Facility Food Chain Modeling Input Parameters Table

USEN – Screening Level Ecological Risk Assessment
US Ecology Nevada Facility
Beatty, Nevada
PN: 185702329
February 28, 2012

Table B. USEN Facility Food Chain Modeling Input Parameters. Informaiton for input parameters for screening level ecological risk modeling for exposure to co-planar polychlorinated biphenyls (PCBs) at the US Ecology Nevada Facility in Beatty, Nevada.

Significant Model Inputs and Exposure Assumptions:

1 = Exposure dose is overly conservative and based on maximum concentrations of EACH congener - highly unlikely
2 = 100% Diet consists of most exposed prey (i.e., 100% carnivorous prey) - highly improbable
3 = 100% Area Use Factor (AUF) is assumed for each species - highly unrealistic
4 = 100% PCBs in prey, plants, and soil is bioavailable

Variable	Value	Units	Source	Notes
Red-tailed Hawk (*Buteo jamaicensis*)				
Exposure Parameters: Red-tailed Hawk			USEPA 1993; Sample et al., 1996	Wildlife Exposure Handbook - Vol I (USEPA 1993)
Mean Adult Body Weight - Male and Female -Red-tailed Hawk	1.126	kg	USEPA 1993 calculated from Dunning 1984	USEPA 1993 (Wildlife Exposure Handbook - Vol I); Sample et al., 1996
Food Ingestion Rate - Red-tailed Hawk	0.109	kg/day	USEPA 1993 calculated from Craighead and Craighead, 1969; Sample et al., 1996	Mean was calculated combining available data for male and female hawk (and compared back to reported average in Sample et al., 1996) .
Water Ingestion Rate - Red-tailed Hawk	0.064	L/d	USEPA 1993; Sample et al., 1996	Although WIR was provided, minimal to no water ingested from site is expected, and therefore not included in this calculation based on desert environment.
Soil Ingestion Rate - Red-tailed Hawk	0.00109	kg/day	Beyer et al., 1994	SIR is calculated at 1% of FIR, as reports suggest SIR is negligable. Therefore, 1% provides some conservativism for uncertainty. **SIR = 1% of FIR**
% Diet comprising carnivorous prey - Red-tailed Hawk	100	%	USEPA guidance	Oversetimation of diet consisting of carnivorous prey. Reported diet consists of the following: Squirrel (61%); Rabbit (26.5%); Other small mammal (6.9%); Snakes / lizards (4.1%); Birds (1.3%) reported in Sample et al. (1996).
BAF prey for Red-tailed Hawk	0.2	unitless	Blankenship et al., 2005	Bioaccumulation factor for the shrew (carnivorous species consumed by predators). This value is conservative and expected to overestimate the potential for bioaccumulation based on prey species type. Values from Supplemental Data Tables from Blankenship et al. (2005) were used to derive this BAF value.
Area Use Factor (AUF) - Red-tailed Hawk	100	%	USEPA guidance	AUF of 100% is highly unlikely, individual red-tailed hawk (or pair) has a home range of up to 1500 hectares (USEPA 1993), therefore, 100% is an overly conservative assumption.
NOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure - Red-tailed Hawk	14	ng/kg	Sample et al., 1996	NOAEL-based toxicological benchmarks for selected avian wildlife species - reported for the Red-tailed Hawk.
LOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure - Red-tailed Hawk	140	ng/kg	Sample et al., 1996	LOAEL-based toxicological benchmarks for selected avian wildlife species - reported for the Red-tailed Hawk.
Toxicity Equivalents Factors (TEFs) - Avian	congener specific	unitless	Van den Berg et al., 1998	See tablein this SLERA for congener-specific TEF values. Avian TEF values were not updated in the Van den Berg et al. (2006) document.
Kit Fox (*Vulpes macrotis*)				
Exposure Parameters: Kit Fox			CalTox 1999	CalTox 1999 (http://oehha.ca.gov/cal_ecotox/report/vulpeef.pdf)
Mean Adult Body Weight - Male and Female - Kit Fox	1.95	kg	CalTox 1999	Mean was calculated combining available data for male and female fox (and compared back to reported average in CalTox, 1999) . Adult weight ranges from 1.5 to 2.5 kg. Females are 15 percent lighter on average than males (Fitzgerald et al., 1994), but there is no other obvious sexual dimorphism (Meaney et al., 2006). Adult male and female weights were averaged (seven BW values as reported in Caltox, 1999).
Food Ingestion Rate (FIR) - Kit Fox	0.1303	kg/day	CalTox 1999	Mean was calculated combining available data for male and female kit fox reported in CalTox (1999). This value is comparable to data in USACHPPM (2004), suggesting a FIR of 0.0875 g/g/d.
Water Ingestion Rate (WIR) - Kit Fox	x	L/d		WIR was not calculated at this point minimal to no water ingested from site is expected (red fox WIR from USEPA (1993) is reportedly 0.38 L/d).
Soil Ingestion Rate (SIR) - Kit Fox	0.0036	kg/day	Beyer et al., 1994	SIR isassumed to be conservative. A SIR value of 2.8% of the FIR was reported in Beyer et al. (1994) for red fox. This value was used for kit fox. **SIR = 2.8% of FIR**
NOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (red fox)	0.5	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species. This value was used to represent the kit fox.
LOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (red fox)	5.3	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species. This value was used to represent the kit fox.
BAF prey for Kit Fox	0.2	unitless	Blankenship et al., 2005	Bioaccumulation factor for the shrew (carnivorous species consumed by predators). This value is conservative and expected to overestimate the potential for bioaccumulation based on prey species type. Values from Supplemental Data Tables from Blankenship et al. (2005) were used to derive this BAF value.
% Diet comprising carnivorous prey - Kit Fox	100	%	USEPA guidance	Oversetimation of diet consisting of carnivorous prey. Up to 94 % of the kit fox diet consisted of jackrabbits during whelping season (Egoscue 1962). The significant majority of prey is herbivorous species (lagomorphs, prairie dogs, kangaroo rats).
Area Use Factor (AUF) - Kit Fox	100	%	USEPA guidance	AUF of 100% is highly unlikely, individual kit fox has a home range average of 251 to 1,160 ha (Cypher 2003). Home range sizes of radio-collared kit foxes in Colorado averaged 5.2 km2 (Fitzgerald 1996). Therefore, 100% is an overly conservative assumption.
Mammalian Toxicity Equivalents Factors (TEFs)	congener specific	unitless	Van den Berg et al., 2006	See table in this SLERA for TEF values that are used, where appropriate.
Western Meadowlark (*Sturnella neglecta*)				
Exposure Parameters: Western Meadowlark (WML)			Davis et al., 2008	Davis et al., 2008 (general informaiton on Western Meadowlark (WML)
Mean Adult Body Weight - WML	0.1115	kg	USACHPPM 2004; Sample et al., 1997	Body weight average is reportedly for males in a Nevada population. Females were not reported for this population. Males are larger than females, therefore, male body weight was used to represent both male and female to approximate exposure. (Females may average approximately 0.084 kg BW).
Food Ingestion Rate (FIR) - WML	0.0143 (dw)	kg/day	Nagy et al., 1999	Food Ingestion Rate (FIR) - WML was calculated using an allometric equation from Nagy et al. (1999); see calculation example below. The FIR value is presented as dw; estimated 0.026 kg/d ww, based on 73% moisture content of invertebrates.
Average Adult Food Ingestion Rate (FIR) - (Male) - WML	0.026 (ww)	kg	USACHPPM 2004	Mean was calculated combining available data for male and female (and compared back to reported average in USACHPPM 2004).
Food Composition - WML	x	unitless	Lanyon 1994 as referenced in USACHPPM 2004	63.3% invertebrates; 36.7% seeds/plant material (throughout North America). For the purpose of this evaluaiton, it was assumed that WML consumed 100% invertebrates.
Water Ingestion Rate (WIR) - WML	x	L/d		WIR was not calculated at this point minimal to no water ingested from site is expected (WML from USACHPPM (2004) is reportedly 0.12 L/kg BW/d).
Soil Ingestion Rate (SIR) - WML	0.0014	kg/day	Beyer et al., 1994	SIR was calculated at 5% of FIR, as a conservative estimation based on prey items and foraging strategy. This value was estimated using limited available data for soil ingestion rates in birds - as such 2.1% SIR was suggested for the American robin that consumes earhtworms that have an estimated 60% soil. Additionally, 9.3% was reported for wild turkey by Beyer et al. (1994). 3.3% was reported for the mallard (Beyer et al., 1994). Therefore, based on the feeding strategy of the WML, the SIR was calculated at a rate of soil ingestion fas 5 % of the diet. **SIR = 5% of FIR**
NOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (Red-tailed Hawk)	14	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species. This value was used to represent the WML.
LOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (Red-tailed Hawk)	140	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species. This value was used to represent the WML..
BAF inv (soil to invert) - prey for WML	0.052	unitless	Blankenship et al., 2005	BAF of invertivorous prey using soil to terrestrial invertebrates; based on Blankenship et al. (2005). This value is conservative and expected to overestimate the potential for bioaccumulation based on prey species type and percent consumption. Values from Supplemental Data Tables from Blankenship et al. (2005) were used to derive this BAF value.
% Diet comprising invertivorous prey - WML	100	%	USEPA guidance	Oversetimation of diet consisting of 100% insects/invertebrates as prey.
Area Use Factor (AUF) - WML	100	%	USEPA guidance	AUF of 100% is highly unlikely, individual kit fox has a home range average of 251 to 1,160 ha (Cypher 2003). Home range sizes of radio-collared kit foxes in Colorado averaged 5.2 km2 (Fitzgerald 1996). Therefore, 100% is an overly conservative assumption. WML territories ranged from 1.2 to 6.1 ha (WI), but were generally 2.8 to 3.2 ha. Kendeigh (1941) reports WML territories to range from 4 to 13 ha in Iowa. Schaef and Picman (1988) report a mean territory size of 7 ha in Manitoba. Range size is dependent on sustainability and availability of resources. Additionally, Kendeigh (1941) observed approximately 0.05 WMLs/ha.
Toxicity Equivalents Factors (TEFs) - Avian	congener specific	unitless	Van den Berg et al., 2006	See table in this SLERA for TEF values that are used, where appropriate.

Example Calculation for FIR for WML

Nagy et al., 1999

Equation: FIR = (FMR/ME)

For passerine birds, Nagy et al., 1999 provides an allometric equation for food ingestion rate using bird body weight based on estimated MEs for avian insectivore (18.0 kJ/g dry matter).

FIR = (257.8 kJ/day) / (18 kJ/g) = 14.7 g/day = 0.015 kg/da (dw)
FIR = 14.32 g/day = 0.0143 kg/da (dw)
FIR = 0.0143 kg/day (dry weight)

where: FMR = Field Metabolic Rate = 10.4 x BW in g) ^ 0.681 = 257.8 kJ/day (based on a BW of 111.5 g)
ME = Metabolic Energy of Food = 18 kJ/g dry matter (estimate for diet of insects only) value from Wenck 2010

Southern Grasshopper Mouse (*Onychomys torridus*)				
Exposure Parameters: Grasshopper Mouse			Kester 1999	Kester, D. 1999. "Onychomys torridus" (On-line), Animal Diversity Web. Accessed May 05, 2011 http://animaldiversity.ummz.umich.edu/site/accounts/information/Onychomys_torridus.html.
Mean Adult Body Weight - Male and Female - Grasshopper Mouse	0.041	kg	USACHPPM 2004	Mean was calculated combining available data for male and female Grasshopper Mouse, based on a laboratory study from Harriman (1973).
Food Ingestion Rate (FIR) - Invertebrates - Adult Male and Female Grasshopper Mouse	0.0029	kg/day	Wenck Assoc. 2010	The value of 0.0029 presented is that which was used in Wenck (2010, Table 5.4.2), this value was used in the calculations as it is more conservative than the value which follows. A value of 0.0021 was calculated from the data available in USACHPPM (2004), using an average consumption of 51.36 mg/g BW/day or 0.051 kg/kg BW/day when given a self-selection array of foodstuffs over 60 days (Harriman, 1973). This calculuation resulted in 0.0021 kg/d for FIR. When attempting to reproduce the value in USACHPPM (2004), it could not be recalculated, suggesting that the value reported and/or the equation used in USACHPPM (2004) may have an error (orginial data were reviewed where available, but not all data could be confirmed). and therefore was not used). Thus, the value from Wenck Assoc (2010) was selected for use in these equations.
Water Ingestion Rate (WIR) - Male and Female - Grasshopper Mouse	x	L/d	USACHPPM 2004	Mouse drinks water in captivity, but probably obtains moisture from food under natural conditions. No specialized physiological adaptations to arid conditions (USACHPPM 2004). Expected that minimal to no water ingested from site, and therefore not included in this calculation based on desert environment.
Soil Ingestion Rate (SIR) - Adult Male and Female Grasshopper Mouse	0.000232	kg/day	Sample et al., 1997	A SIR value of 2% is referenced in Wenck (2010), and used in that ERA. However, SIR in Sample et al. (1997) states a SIR range of <2-7.7% for burrowing rodents (woodchucks and prairie dogs). Values between 2 and 8% were calculated without significant differences in results. Based on species behavior compared to study species, 2% was considered representative of the grasshopper mouse. However, 8% was used to remain over-conservative through this process. **SIR = 8% of FIR**
NOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (Short-tailed Shrew)	2.2	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species, in this case the short-tailed shrew. This value was used to represent the Grasshopper Mouse.
LOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (Short-tailed Shrew)	22	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species, in this case the short-tailed shrew. This value was used to represent the Grasshopper Mouse.
BAF inv (soil to invert) - prey	0.052	unitless	Blankenship et al., 2005	BAF of invertivorous prey - soil to terrestrial invertebrates; based on Blankenship et al. (2005). This value is conservative and expected to overestimate the potential for bioaccumulation based on prey species type and percent consumption. Values from Supplemental Data Tables from Blankenship et al. (2005) were used to derive this BAF value.
% Diet comprising invertivorous prey - Grasshopper Mouse	100	%	USEPA guidance	Feeds almost exclusively on arthropods, especially scorpions and orthopteran insects (Horner et al., 1964) 10-25% of the diet of *O. torridus* consists of seeds, plants, and vegetables. The remainder includes mainly scorpions, but also grasshoppers, beetles, as well as small mammals and lizards. thus, providing a conservative estimate using the provided value.
Area Use Factor (AUF) - Grasshopper Mouse	100	%	USEPA guidance	In Nevada desert scrub, density averaged 1.83 mice/ha (0.74 mice/ac). (Kester et al., 1999) May occur in male-female pairs, widely separated from neighbors, and is highly territorial (Horner and Taylor 1968).
Mammalian Toxicity Equivalents Factors (TEFs)	congener specific	unitless	Van den Berg et al., 2006	See table in this SLERA for TEF values that are used, where appropriate.

Little Pocket Mouse (*Perognathus longimembris*)				
Exposure Parameters: Little Pocket Mouse				
Mean Adult Body Weight - Male and Female - Little Pocket Mouse	0.0074	kg	CalTox 1999	An adult average BW for mice near Reno NV was reported as 7.4 g by VanderWall et al, 1998 (as reported in CalTox, 1999); this value was selected for use in this evaluation. Additional data were available form Kenagy and and Bartholomew (1985), Kenagy (1973), and Chew et al. (1964) as cited in CalTox (1999), that confirmaed range of BW for the adult male and female Little Pocket Mouse.
Food Ingestion Rate (FIR) - Adult Male and Female Little Pocket Mouse	0.00112	kg/day	CalTox 1999	Mean FIR was calculated combining available data. FIR values were provided in CalTox(1999) on a mg/g BW/d basis; and average was calculated. The average value was then normalized and converted to a kg/mouse/day basis to yield the value used in these calculations. (See equation below)
Water Ingestion Rate (WIR) - Male and Female - Little Pocket Mouse	x	L/d	CalTox 1999	No WIR value was reported in CalTox (1999), however, mice drinks water in captivity, but probably obtain moisture from food under natural conditions, Expected that minimal to no water ingested from site, and therefore not included in this calculation based on desert environment.
Soil Ingestion Rate (SIR) - Adult Male and Female Little Pocket Mouse	0.00009	kg/day	Sample et al., 1997	Sample et al. (1997) states a SIR range of <2-7.7% for burrowing rodents (woodchucks and prairie dogs). Values between 2 and 8% were calculated without significant differences in results. Based on species behavior compared to study species, 2% is likely representative of the Little Pocket Mouse. However, to remain conservative, 8% SIR was used here. **SIR = 8% of FIR**
NOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (White-footed Mouse)	2	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species, in this case the short-tailed shrew. This value was used to represent the Little Pocket Mouse.
LOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure (White-footed Mouse)	20	ng/kg	Sample et al., 1996	NOAEL- and LOAEL-based toxicological benchmarks for selected mammalian wildlife species, in this case the short-tailed shrew. This value was used to represent the Little Pocket Mouse.
BAF plant (soil to plant)	0.016	unitless	Blankenship et al., 2005	BAF of plant- soil to plant; based on Blankenship et al. (2005). This value is conservative and expected to overestimate the potential for bioaccumulation from consumption of plant material. Values from Supplemental Data Tables from Blankenship et al. (2005) were used to derive this BAF value.
% Diet comprising plants or vegetation - Pocket Mouse	100	%	USEPA guidance	Herbivorous mouse species feeding exclusively on plants/vegetation (seeds, grasses, forbes, and other plant parts).
Area Use Factor (AUF) - Pocket Mouse	100	%	USEPA guidance	Home range of the Little Pocket Mouse was reported as 0.33 ha/mouse, with a population density reported as0.73-1.74 mice/ha (as citedin CalTox, 1999).
Mammalian Toxicity Equivalents Factors (TEFs)	congener specific	unitless	Van den Berg et al., 2006	See table in this SLERA for TEF values that are used, where appropriate.
Calculation for FIR (Little Pocket Mouse):	FIR - on per BW basis			It is noted that there is uncertainty surrounding this FIR value.
FIR - on per BW basis =	0.152	g/g bw/d	CalTox 1999	Two ranges for FIR were provided in Caltox (1999) based on Kenagy (1973), 76-197 and 20-316. The average was taken of these values resulting in 152.25 mg/g/d.
Average BW per mouse =	7.4	g	CalTox 1999	BW for Little Pocket Mouse near Reno NV was reported as 7.4 g by VanderWall et al. (1998)
FIR - on per mouse basis =	0.0011248	kg/mouse/d		

Desert Tortoise (*Gopherus agassizii*)				
Exposure Parameters: Desert Tortoise				CalTox (1999); http://oehha.ca.gov/cal_ecotox/report/gopheef.pdf
Average Body Weight for adult Desert Tortoise	1.995125	kg	CalTox 1999	This value includes the averaging of available data as reported in CalTox (1999); adults/juveniles, males/females were often but not always distinguished in data references. Data referencing embryos were not included for body weight. Data (7 data points) were from CalTox (1999).
Food Ingestion Rate (FIR) - Adult Desert Tortoise	0.0090174	kg/day	Nagy and Medica, 1986	A value for FIR was provided in CalTox (1999), and was applied to the semi-qualitative evaulation for Desert Tortoise.
Water Ingestion Rate (WIR) - Male and Female - Desert Tortoise	x	L/day	NA	A value for WIR for the Desert Tortoise was not indentified in the literature. However, it is expected that the Desert Tortoise would get its water rations from the plant material in which it consumes. Therefore, the assumption that minimal or no water would be consumed from the site area was applied.
Soil Ingestion Rate (SIR) - Adult Male and Female - Desert Tortoise	0.00072139	kg/day		SIR for Desert Tortoise was not identified from the literature. However, based on burrowing behavior of the species, a value of 8% was selected to be representative of incidental soil ingestion for the Desert Tortoise.
NOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure - Reptile	None Available			
LOAEL-Based Effects Metrics for 2,3,7,8-TCDD exposure - Reptile	None Available			
BAF plant (soil to plant)	0.016	unitless	Blankenship et al., 2005	BAF of plant- soil to plant; based on Blankenship et al. (2005). This value is conservative and expected to overestimate the potential for bioaccumulation from consumption of plant material. Values from Supplemental Data Tables from Blankenship et al. (2005) were used to derive this BAF value.
% Diet comprising plants or vegetation - Desert Tortoise	100	%	USEPA guidance	Herbivorous reptiles residing in desert environments consume a varied of plantsand vegetation. CalTox (1999) reported various dietary items as the following: Threeawn (Aristida spp., 16 +/- 5%); Globemallow (Sphaeralcea spp., 6 +/- 3%); xSlim tridens (Tridens muticus, 50 +/- 8%); Bush muhly (Muhlenbergia porteri, 17 +/- 7%); and Slender janusia (Janusia gracilis, 11 +/- 5%); Foxtail brome (Bromus rubens, 64 +/- 4%); Redstem filaree (Erodium cicutarium, 23 +/- 5%); Common winterfat (Eurotia lanata, 6 +/- 4%) and Vetch (Astragalus and Oxytropis, 4 +/- 2%).
Area Use Factor (AUF) - Desert Tortoise	100	%	USEPA guidance	O'Connor et al. (1994) reported home range size of desert tortoises at 12.7 to72.1 ha, in the eastern Mojave desert (as citedin CalTox 1999).
Reptile Toxicity Equivalents Factors (TEFs)	None Available	unitless		None available for reptiles.

Abbreviations:	For Food Chaim Modeling and Input Parameters
AUF	area use factor
BAF	bioaccumulation factor
BW	body weight
ED	exposure dose
FIR	food ingestion rate
FMR	free metabolic rate
kJ	kilojoules
LOAEL	lowest observed adverse effect level
ME	metabolizable energy
NOAEL	no observed adverse effect level
NA	Not Applicable
PCB	polychlorinated biphenyls
SIR	soil ingestion rate
TEF	toxicity equivalency factors
TRV	toxicity reference values
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
Units of Measure:	
g/g	gram per gram
L/day	liters per day
kg/day	kilogram per day
kJ/day	kilojoules per day
mg/kg	milligram per kilogram
ng/kg	nanograms per kilogram
ug/kg	micrograms per kilogram