Hero Lands, LLC v. Chevron U.S.A. Inc., Total Petrochemicals & Refining USA, Inc., Pioneer Natural Resources, Inc., Key Operating & Production Company, L.L.C., Key Exploration Company, Wagner Oil Company, Hillcorp Energy L.L.P., Manti Operating Company, and Henderson Oil Company, Inc.
Plaquemines Parish, Louisiana

Appendix D: Ecological Risk Assessment

Hero Lands LLC v. Chevron U.S.A. Inc. et al
Docket No. 64320, Div. "A", 25th JDC

8 September 2020

Project No.: 0494255

The business of sustainability

ERM

Signature Page

September 8, 2020

Appendix D: Ecological Risk Assessment

Hero Lands LLC v. Chevron U.S.A. Inc. et al Docket No. 64320, Div. "A"
25th JDC

Helen R. Connelly, Ph.D.

Toxicologist

John H. Rodgers, Jr., Ph.D.

Professor Emeritus, Ecotoxicology Program
Forestry and Environmental Conservation
Department, Clemson University

Environmental Resource Management Southwest, Inc.
Two United Plaza, 8550 United Plaza
Baton Rouge, Louisiana 70809
(225) 292-3001

CONTENTS

List of Tables

List of Figures

ATTACHMENTS

Acronyms and Abbreviations

Name	Description
AUF	Area Use Factor
AVS	Acid Volatile Sulfide
BAF	Bioaccumulation Factor
BCFs	Bioconcentration Factors
BERA	Baseline Ecological Risk Assessment
COPECs	Constituents of Potential Ecological Concern
CSM	Conceptual Site Model
DNR	Department of Natural Resources
DQOs	Data Quality Objectives
EEC	Estimated Environmental Concentration
ERAs	Ecological Risk Assessments
ERM	Environmental Resources Management, Inc.
ERAGS	Risk Assessment Guidelines for Superfunds
ESV	Ecotoxicity Screening Value
HQ	Hazard Quotient
HRA	Human Risk Assessment
ICON	ICON Environmental Services, Inc.
LDEQ	Louisiana Department of Environmental Quality
LDWF	Louisiana Department of Wildlife and Fisheries
LOAEL	Lowest Observed Adverse Effect Level
NOAEL	No Observed Adverse Effect Level
NRCS	Natural Resources Conservation Service
SAP	Sampling and Analysis Plan
SLERA	Screening Level Ecological Risk Assessment
SMDP	Scientific Management Decision Point
2,3,7,8 TCDD	2,3,7,8 Tri-chloro dibenzo-dioxin
TPH	Total Petroleum Hydrocarbon
TRVs	Toxicity Reference Values
UCL	Upper Confidence Limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WOE	Weight of Evidence
WP	Work Plan

EXECUTIVE SUMMARY

This ecological risk assessment (ERA) was prepared for the Hero Lands Property in accordance with Louisiana Department of Environmental Quality (LDEQ 2003) and U.S. Environmental Protection Agency (e.g. USEPA 1997 and 1998) guidance. It is provided as a component of a site assessment to evaluate potential or actual "environmental damage" related to oilfield exploration and production operations on the Hero Lands Property. This ERA demonstrates that there are no unacceptable risks to ecological receptors on this property and that additional remedial action based on ecological risk is not warranted. This conclusion is supported by the following lines of evidence:

- Site inspection and characterization.
- Information from an investigation conducted in 2020 regarding the wildlife, vegetation as well as measurements of potential constituents of concern in samples from site soils.
- A conservative (protective) Screening-Level Ecological Risk Assessment (SLERA).
- A conservative (protective) site-specific Baseline Ecological Risk Assessment (BERA).

The Hero Lands Property is largely a bottomland hardwood wetland and herbaceous wetland as well as adjacent upland as would be expected given the elevation and location of the property. A portion of the property was used since 1940 for oil and gas production. The vegetation on the Hero Lands Property is growing vigorously and does not exhibit any diagnostic symptoms of exposure or adverse effects due to oil and gas exploration and production on the property. There is no evidence of population-level stress or toxicity due to salt from exploration or production activities.

The Hero Lands Property is providing some wildlife habitat as would also be expected for bottomland hardwood wetlands and herbaceous wetlands in this area. This property is also providing habitat for species of special concern or interest such as the Bald eagle, Mississippi kite, Great egret, Snowy Egret and Barred owl. There is clear evidence of healthy wildlife and game animals such as deer and swamp rabbits, and no evidence of adverse effects on wildlife from past or ongoing exploration and production activities. Based on site inspection, ecological populations have not been adversely affected on the Hero Lands Property. Further, the ecological populations of plants and animals on the Hero Lands Property and ecosystem represent an intact food web with diverse species, and the bottomland hardwood wetland and herbaceous wetland as well as adjacent upland provide services and functions to ecological and human communities.

Wetlands and other areas on the Hero Lands Property are providing valuable functions and services for both wildlife and people. The structural components of this ecosystem (e.g. plants and animals) are abundant, diverse and in obvious good health. Other services expected for these properties in this area such as water storage and soil stabilization are clearly being provided.

Based on the results from the SLERA and in order to be conservative, Arsenic, Barium, Cadmium, Lead, Mercury, Zinc, and 2,3,7,8 TCDD were retained for more detailed evaluation in a site-specific Baseline Ecological Risk Assessment (BERA). The BERA considered site- and species-specific data, including the biogeochemistry existing in these bottomland hardwood wetland and herbaceous wetland as well as adjacent upland. The BERA quantitatively confirms that historical impacts from exploration and production activities on this property do not pose an unacceptable risk to wildlife. The various lines of evidence each independently demonstrate that no unacceptable risks exist on the property.

1. INTRODUCTION

The property involved in this case (Hero Lands Property, ~ 155 acres total) is located in the Stella Oil and Gas Field near Belle Chasse, Louisiana. Situated in Plaquemines Parish, Louisiana, the property is located within Section 2, Township 15 South, Range 24 East; and Sections 16, 17 and 18, Township 14 South, Range 24 East, on the west side of the Mississippi River. The property consists of four tracts on both sides of LA Highway 23, east of the United States Naval Air Station and south of the City of Belle Chasse (Holloway 2020). The Hero Lands tracts are located on the west natural levee of the Mississippi River to the south of the town of Belle Chasse, Louisiana. A portion of the property lies on the batture side of the Mississippi River Levee. This area is periodically flooded. The remainder of the Hero Lands property is located west of the levee and is bisected by LA Highway 23 and the New Orleans and Gulf Coast Railway Company line that runs north to south between the east and west property tracts. For purposes of this report, the four Hero Lands tracts are designated as northeast (NE), southeast (SE), northwest (NW) and southwest (SW). All four tracts total approximately 155 acres. Elevations on the Hero Lands tracts range from 2 to 12 feet. Historically, the land was used for pasture and crops. Drainage has been altered to support these and subsequent activities on the property. In more recent times, the property has been used for oil and gas development and some exploration and production is still ongoing. The property can support recreational activity such as hunting. A house and two trailers are located on the northwest side of the property. The southwest tract has an impoundment that is operated by the Chevron Oronite Company that is located across the highway/railroad tracks to the east. Future use of the property will likely continue to be for oil field activities and the impoundment facility (Holloway 2020). Hero Lands LLC filed suit against Chevron USA, Inc. and others for alleged damage of the property.

We prepared this ecological risk assessment (ERA) for the Hero Lands Property in accordance with Louisiana Department of Environmental Quality (LDEQ 2003) and U.S. Environmental Protection Agency (e.g. USEPA 1992, 1997 and 1998) guidance. This ERA is being provided as a component of the site investigation that was initiated to evaluate potential or actual "environmental damage" related to oilfield exploration and production operations on the Hero Lands Property. ERAs evaluate ecological effects caused by human activities or stressors. The term "stressor" is used here to describe any chemical, physical, or biological entity that can induce adverse effects on individuals, populations, communities, or ecosystems. Thus, the ERA process must be flexible while providing a logical and scientific structure to accommodate a broad array of stressors or potential stressors (USEPA, 1992).

USEPA guidance uses a tiered approach to determine whether site constituents of potential ecological concern (COPECs) particularly in soils or hydrosoils present an unacceptable risk to ecological receptors. This ERA focuses on chemicals detected on the Hero Lands Property in certain media (i.e. site soils). An important fundamental principle of ERAs is embodied in USEPA (1998) policy: "It is USEPA policy that risk characterization should be consistent with the values of 'transparency, clarity, consistency, and reasonableness.'" Compliant with USEPA regulatory guidance framework, this ERA includes the following lines of evidence:

- Site inspections and characterizations conducted by various parties and individuals including ERM, Holloway Environmental Services, Dr. John Frazier, ICON, Omega Environmental, and CEI.
- Information from investigations conducted in 2020 of the wildlife, vegetation as well as soils (e.g. ERM 2020).
- A Screening-Level Ecological Risk Assessment (SLERA) that was developed based on comparison of soil and wetland hydrosoil COPEC concentrations with appropriate soil quality guidelines or ecological screening levels. Soil quality guidelines were developed for protection of ecological health and are not site-specific in the SLERA. The screening guidelines are intended to be conservative

and, if exceeded, can serve as a point of departure for more detailed site-specific ecological risk analysis. If the conservative soil quality guidelines are not exceeded, then concern for ecological risks can be dismissed.

- Development of a site-specific Baseline Ecological Risk Assessment (BERA) for the Hero Lands Property for those COPECs exceeding SLERA screening guidelines. The site-specific ERA uses accurate and realistic exposure modifying factors to provide accurate and realistic measures and estimates of ecological risks.
- Evaluation of a site inspection, ERA, and associated data for the Hero Lands Property (CEI 2019; Rogers 2019).

The purpose of this ERA is to conduct a SLERA as well as a more thorough, site-specific BERA for the Hero Lands Property to determine if 1) there is a need for additional study, 2) whether mitigation action is needed, or 3) no further action is warranted. The SLERA includes Steps 1 and 2 from the USEPA (1997) guidance: 1) a screening-level problem formulation and ecological effects evaluation, and 2) preliminary exposure estimates and risk calculations. The site-specific BERA consists of Steps 3-8 of the USEPA (1997) guidance document as shown in Figure D1 below.

1.1 Site Inspections and Observations

Dr. Connelly inspected the Hero Lands Property on July 6 – 8, 2020, and at those times she was able to observe the condition of the site and species on the property. The Hero Lands Property supports a healthy and functioning ecosystem that provides services to wildlife populations, the human population, and to the general watershed itself (Appendix B). The populations of vegetation, amphibians, birds, and other wildlife in the ecosystem are thriving, abundant, and diverse.

The ecosystems in the Hero Lands Property are dominated by a bottomland hardwood and herbaceous wetland as well as adjacent uplands with associated plant species as well as other species, as would be expected. Based on field observations, the vegetation observed at the site was appropriate and healthy for systems of this type and this geography. The bottomland hardwood wetland areas on the Hero Lands Property contain iconic plant species such as Water Oak (Quercus nigra), Persimmon (Diastyros virginiana), Sugarberry (Celtis laevigata), Box Elder (Acer negundo), Green ash (Fraxinus pennsylvanica), Sweetgum (Liquidambar styraciflua), White Mulberry (Morus alba), Red Mulberry (Morus rubra), Pecan (Carya illinoiensis), Eastern baccharis (Baccharis halimifolia), and Dwarf palmetto (Sabal minor). Adjacent wetlands and uplands with different elevations and hydrology are populated with other herbaceous and some woody plant species such as American elm (Ulmus americana), Chinese tallow (Triadeca sebifera), Chinese privet (Ligustrum senense), Deciduous holly (Ilex decidua), Rough leaved dogwood (Cornus drummondii), Red Maple (Acer rubrum var. drummondii), and Arrowhead (Sagittaria latifolia).

The animal species that would be expected on the Hero Lands Property were observed during site inspection. Numerous bird species were observed using habitat on the property including species of special interest or concern such as Great egret, Snowy egret, Mississippi kite and Barred owl. Mammals observed on the property included species of American beaver, swamp rabbit and whitetail deer. Sensitive species such as dragonflies and iconic species such as crawfish and amphibians were abundant. There were no missing components of the food web. Based on field observations, biota observed at the site was appropriate and healthy and indicative of highly functioning systems of this type and geography (Appendix B).

Based on direct observations and field investigations, it is clear that ecological populations have not been adversely affected by impacts from oil and gas exploration and production activities on the Hero Lands Property. Dr. Connelly observed thriving diverse ecological populations at the Hero Lands Property.

Further, the ecological populations in the ecosystem on the property represent an intact food web with diverse species, and provide services and functions to humans and ecological communities. This analysis clearly indicated that the bottomland hardwood wetlands and herbaceous wetlands on the Hero Lands Property are providing valuable functions and services for both wildlife and people living in the area (Appendix B). The structural components of this ecosystem (e.g. plants and animals) are abundant, diverse, and thriving.

2. USEPA (1997) STEP 1 – ECOLOGICAL RISK ASSESSMENT

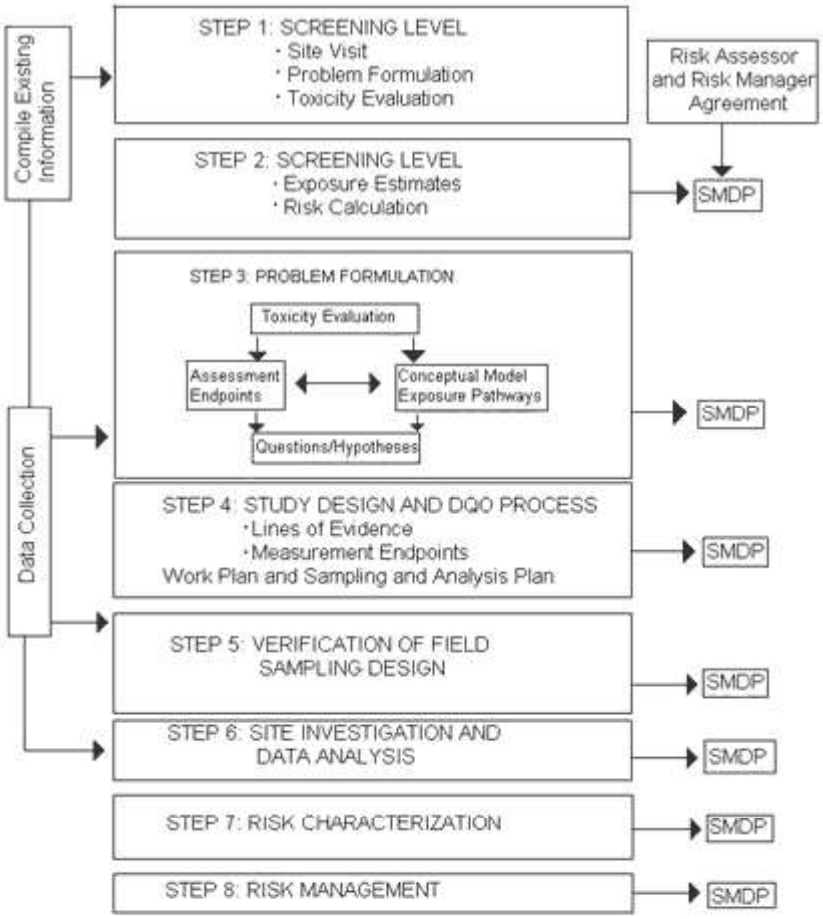


Figure D1: The eight steps recommended for Ecological Risk Assessment (USEPA 1997).

2.1 Screening Level Problem Formulation and Effects Evaluation

2.2 Screening Level Problem Formulation

Problem formulation is a formal process for developing and evaluating hypotheses about why adverse ecological effects may occur due to the presence of physical, chemical, or biological stressors on the property (USEPA 1998). This SLERA focuses on potential chemical (COPECs) associated with media on the property (e.g. soil and hydrosoil). Specific issues evaluated in problem formulation include the environmental setting, COPEC fate and transport, ecotoxicity and potential receptors, exposure pathway analysis, and endpoints to screen for potential ecological risks.

2.2.1 Environmental Setting

The property involved in this case (Hero Lands Property, ~ 155 acres total) is located in the Stella Oil and Gas Field near Belle Chasse, Louisiana. Situated in Plaquemines Parish, Louisiana, the property is located within Section 2, Township 15 South, Range 24 East; and Sections 16, 17 and 18, Township 14 South, Range 24 East, on the west side of the Mississippi River. The property consists of four tracts on both sides of LA Highway 23, east of the United States Naval Air Station and south of the City of Belle Chasse (Holloway 2020). The Hero Lands tracts are located on the west natural levee of the Mississippi River to the south of the town of Belle Chasse, Louisiana. A portion of the property lies on the batture side of the Mississippi River Levee. This area is periodically flooded. The remainder of the Hero Lands property is located west of the levee and is bisected by LA Highway 23 and the New Orleans and Gulf Coast Railway Company line that runs north to south between the east and west property tracts. For purposes of this report, the four Hero Lands tracts are designated as northeast (NE), southeast (SE), northwest (NW) and southwest (SW). All four tracts total approximately 155 acres. Elevations on the Hero Lands tracts range from 2 to 12 feet. Historically, the land was used for pasture and crops. Drainage has been altered to support these and subsequent activities on the property. In more recent times, the property has been used for oil and gas development and some exploration and production is still ongoing. The property can support recreational activity such as hunting. A house and two trailers are located on the northwest side of the property. The southwest tract has an impoundment that is operated by the Chevron Oronite Company that is located across the highway/railroad tracks to the east. Future use of the property will likely continue to be for oil field activities and the impoundment facility (Holloway 2020).

The soil survey for Plaquemines Parish prepared by the Soil Conservation Service (SCS; Trahan 2000) indicated that this area has a mild, humid subtropical climate. Summers are hot, with the sun shining the majority of the time. Average daily temperatures are 82 degrees Fahrenheit (°F) and an extreme high of 97° F was recorded. Winters are mild with few cold days, and the sun shines approximately 64% of the time. Average daily temperature in the winter is about 55° F. The average low temperature in the winter is 48° F and an extreme low temperature of 15° F was recorded. Thunderstorms occur in Plaquemines Parish about 70 days a year and annual precipitation is approximately 58 inches. Average relative humidity is relative high ranging from about 60% to 87%. Prevailing winds are out of the south to southeast. Hurricanes occur occasionally severely impacting Plaquemines Parish.

Plaquemines Parish is entirely within the Mississippi Delta and is bounded on the south by the Gulf of Mexico. Elevations in Plaquemines Parish range from about 5 feet below sea level to about 12 feet above sea level. Several general soil types are found in Plaquemines Parish (Trahan 2000) and the Hero Lands Property likely contains remnants of several of these soils. Soils on the Hero Lands Property are ponded and occasionally flooded, mucky, fluid soils forming a bottomland hardwood wetland and herbaceous wetland. The soils on the Hero Lands Property are heterogeneously distributed and contain some upland soils that have been moved by historic floods (Trahan 2000). As would be expected, lowland or alluvial soils are dominant due to low elevations. The Natural Resources Conservation Service (NRCS) Soil Survey (Trahan 2000) lists a few soil types in the area around the Hero Lands Property, but silty clay loams and flooded mucks are widespread on the Hero Lands Property. Other clays and clayey alluvial soils are found on the property (e.g. silty clay loams, silt loams and clays). The soils on the Hero Lands Property have not been altered substantially by agriculture, and due to low elevations on the property, soils are poorly drained. The hydrology has been altered and the soils on the Hero Lands Property are occasionally flooded. The Hero Lands Property supports bottomland hardwood and herbaceous wetland vegetation due to hydrology and accompanying soil redox potential, which controls biogeochemistry and bioavailability of elements.

Most of the Hero Lands Property has relatively little elevation and drainage has been altered in the area (Trahan 2000). Due to hydrologic conditions in the area and hydric soils, the property supports a bottomland hardwood wetland and herbaceous wetland as well as upland species. Some of the Hero Lands Property could be used for hunting and other recreational activities (e.g. bird watching). No evidence was found to indicate any commercial fishing on the property. A portion of the property was altered to support exploration and production.

Wetlands and vegetation in Louisiana have changed with time and changes in hydrology (Teal et al. 2012; Chabreck 1972). As noted above and in Appendix B, the property supports diverse and densely growing plants. These plants do not exhibit any diagnostic symptoms of exposure or adverse effects due to oil and gas exploration and production on the property (National Acid Precipitation Assessment Program 1987; Holloway 2020). Bottomland hardwood wetlands and herbaceous wetlands provide many benefits, not only to organisms living in and around these areas, but also to local communities. Benefits provided include storm attenuation, flood protection, water quality enhancement, wildlife habitat and aesthetic beauty, and food and resting sites for migratory birds.

There was clear evidence of healthy wildlife and game animals, and no evidence of adverse effects on wildlife from past exploration and production activities. Wildlife observed directly or indirectly (i.e. by tracks, scat, calls, etc.) on this property included deer, birds, amphibians, crawfish, and many other species. The animal species observed by Coastal Environments Inc. (CEI 2019) during a site inspection are listed in Tables 3 and 4 of that report. Of the species observed on or near the property by CEI, many were birds. The birds observed on the property (155 acres) represent a significant portion of 367 species of birds reported for Plaquemines Parish by the Louisiana Bird Records Committee of the Louisiana Ornithological Society (2019). Notable birds observed on the property included Great egret, Red-shouldered hawk, Mississippi kite, Snowy egret, Barred owl and Red-winged blackbird (CEI 2019; Table 3). The Hero Lands Property provides ecological habitat for numerous animal species. Evidence of mammals was present on the property (e.g. deer tracks). There was clear evidence of healthy wildlife and game animals, and no evidence of adverse effects on wildlife from past or ongoing exploration and production activities. Animal species observed during site inspections are listed in Appendix B and CEI (2019). The Hero Lands Property provides ecological habitat for numerous animal species especially considering the limited size of the property (~155 acres).

The Hero Lands Property is a thriving bottomland hardwood wetland, herbaceous wetland and upland. Exploration and production activities have been conducted on the property. It is alleged that these exploration and production activities conducted on the property have left residual materials on the property that have harmed plants or wildlife or have the potential to do so. The landowners have claimed that exploration and production activities deposited constituents on the property including elements such as Arsenic, Barium, Cadmium, Lead, Mercury and Zinc, as well as salts (e.g. chlorides and sodium) and oil and grease (e.g. diesel- and oil range organics). Habitats potentially affected by site-related contaminants include bottomland hardwood wetland and herbaceous wetland and associated upland elevated areas. Potential ecological receptors associated with these habitats include a variety of plants and animals as noted above.

An Ecological Checklist (Form 18 of RECAP; LDEQ 2003) was prepared as part of the site inspection on July 6 – 8, 2020. The Ecological Checklist (Appendix B) contains information regarding additional site characterization and potentially sensitive areas. As noted on the Ecological Checklist and based on the site inspections, there were no indications of any onsite or off-site adverse ecological population effects due to historic or ongoing oil and gas operations on the property.

2.2.2 Constituent (COPEC) Fate and Transport

Hypothetically, constituents of potential ecological concern (COPECs) released from site-related exploration and production activities could possibly be transported on the property by different means. The potential primary transport mechanisms are surface runoff and erosion. This area has likely been inundated over the years by storms such as hurricanes and other major rainfall events (Plaquemines Parish Soil Survey; SCS; Trahan 2000). Most COPECs on the property are also naturally occurring in surficial soils and sediments throughout this geographical area.

2.3 Ecotoxicity of COPECs

For purposes of this ERA, COPECs are conservatively (protectively) assumed to originate from site-related exploration and production activities. However, most of the COPECs or conditions are also naturally occurring or present due to natural events such as storms and storm surges. To characterize the COPECs at the property, soil and hydrosoil samples were collected by ERM (2018-2020), ICON (2017-2020), and HET (2020). Figure D2 shows soil sample locations in the vicinity of the NW, NE, SW, and SE tracts. The COPECs analyzed in these samples included inorganics/metals (e.g. arsenic, barium, cadmium, lead, mercury, and zinc), Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), and dioxins and furans. If these COPECs are present in toxic forms and amounts, and exposure can occur, they have the potential to adversely affect survival, growth, or reproduction for some ecological receptors. For initial screening assessment of this ERA, conservative (protective) screening thresholds for soils and hydrosoils such as USEPA Soil Screening Levels (USEPA 2003; USEPA Eco-SSLs) and National Oceanic Atmospheric Administration (NOAA) freshwater sediment Threshold Effect Concentrations (TECs) for COPECs present in soil and hydrosoils are used. The limitations of the use of screening values has been discussed by the National Research Council (2003).

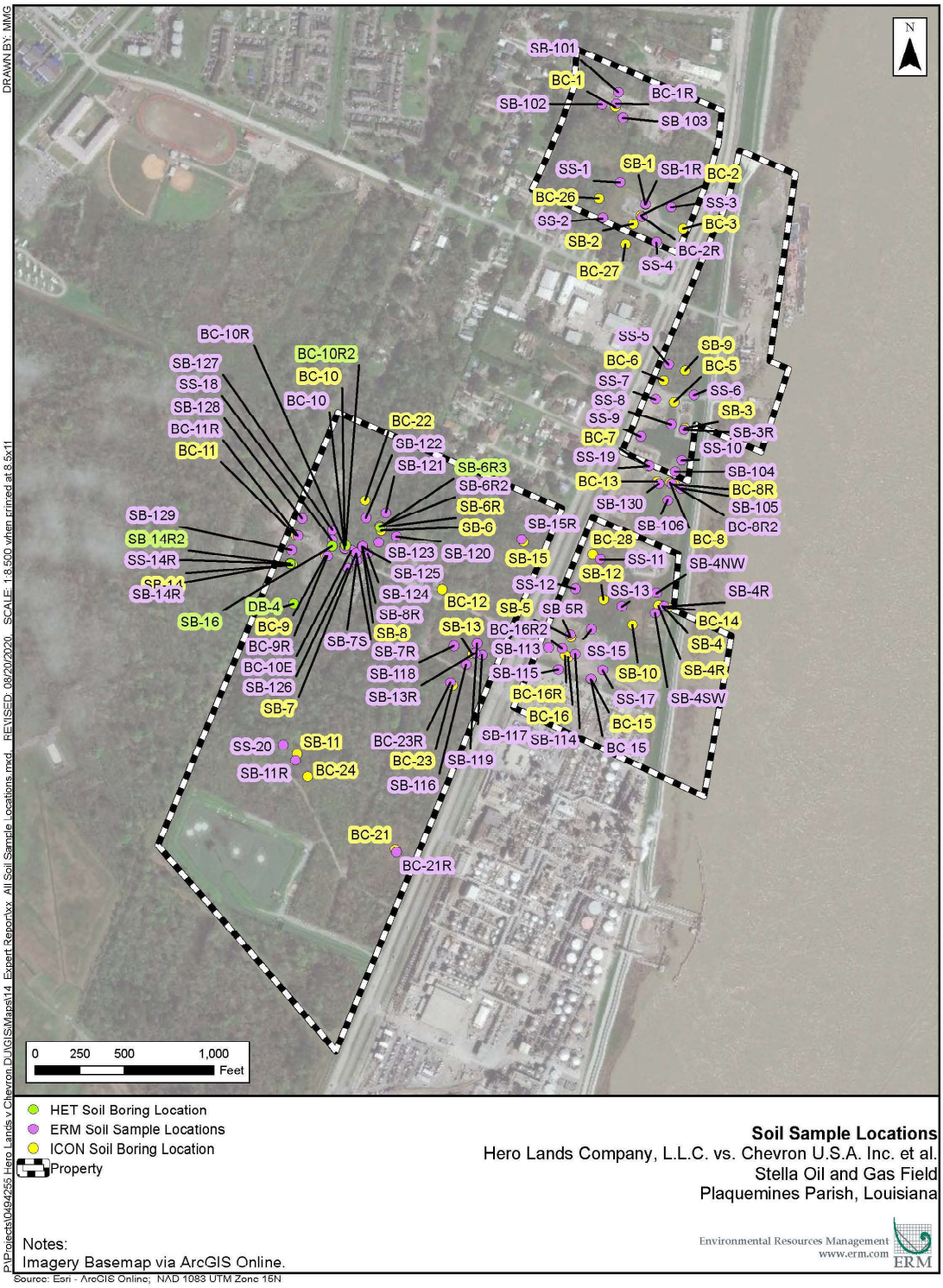


Figure D2: Soil Sample Locations for ERM (2018-2020), ICON (2017-2020), and HET (2020) Data

2.3.1 Potential Receptors and Routes of Exposure

This ERA focuses on the possibility and probability of adverse effects on ecological receptors that may be affected by COPECs found on the property, with an emphasis on selected phylogenetic groups, often referred to as populations or communities. The regulatory focus is usually on organisms that are generally recognized by the public to be of direct or indirect value to humans (i.e. larger and typically more mobile animals ["wildlife"]), as well as plants that serve as cover or forage for wildlife). Another reason for this focus is that relevant toxicological and ecological information is more abundant and available for these groups of organisms. The major receptor groups of interest here are described below.

2.4 Plants

Two basic plant communities (i.e. woody and herbaceous plants) are considered for habitats at the property. For bottomland hardwood wetlands and herbaceous wetlands, generally large, physiologically and structurally complex woody plants are rooted in soil or hydrosoils. Herbaceous plants rooted in soils and hydrosoils are also prevalent on the property.

2.4.1 Invertebrates

There are several groups of invertebrate animals associated with aquatic and terrestrial habitats at the property. Of particular interest are benthic invertebrates, which include a variety of crustaceans (e.g. amphipods, isopods, decapods), mollusks (e.g. snails), and larval insects (especially dragonflies and flies such as "midges"). The benthic invertebrates spend most if not all of their time in direct contact with sediments, some of which are immersed in the matrix. The "benthos" community is generally regarded as a major source of secondary production in aquatic systems, providing important prey for many members of both of the last two major aquatic communities (nekton and wildlife). As appropriate, this ERA addresses potential adverse effects for benthic invertebrates by comparing sediment or soil concentrations of COPECs to published soil or sediment quality guidelines or screening values. The other major aquatic invertebrate group is referred to as "zooplankton". These microscopic animals are suspended in water columns, and include crustaceans (e.g. copepods and cladocerans), protozoans, rotifers, and numerous early-life stages of a wide variety of invertebrate species (e.g. larvae of many species of crustaceans, mollusks, insects, and other taxa). The terrestrial invertebrates include annelids, isopods, butterflies, and other insects. Other aquatic insects such as dragonflies have a terrestrial stage (and spend a portion of their life cycle in the water).

2.4.2 Nekton (Aquatic Animals)

Nektonic animals ("swimmers") are relatively large, physiologically and structurally complex animals such as fish that spend all (or virtually all) of their time in water. They generally respire by means of gills, although in some cases they are capable of obtaining oxygen via dermal or cloacal tissues from water or the atmosphere.

2.4.3 Wildlife (Vertebrates)

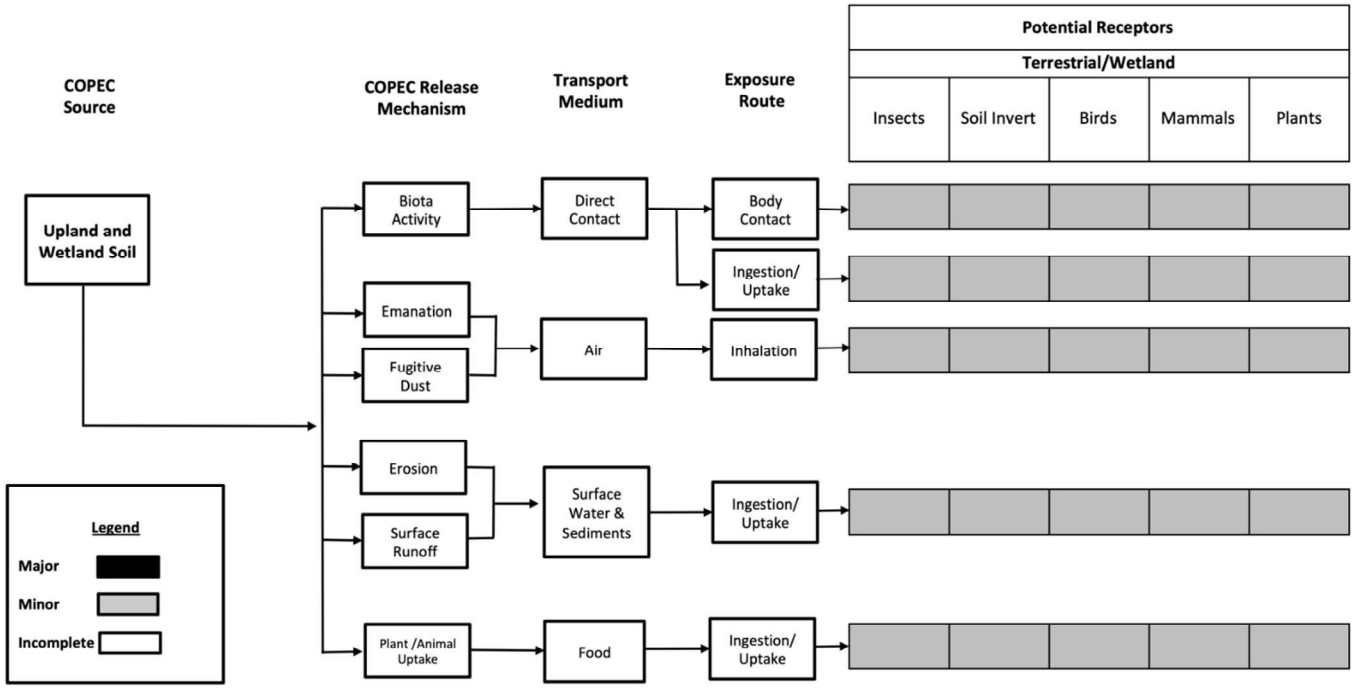
The final category of animals that occurs on the Hero Lands Property is vertebrates. These animals are relatively large and mobile, characterized by relatively complex physiology and structure, and generally perceived by the public to be more charismatic or "important" from an anthropocentric perspective. For most people, to the extent that they are not domesticated, these vertebrates are considered "wildlife". They belong to four phylogenetic classes: amphibians, reptiles, birds, and mammals. In the ERA, animals are evaluated as species (e.g. American robin, bald eagle, red fox, etc.). The animals of those species living on the property or near the property are populations (a group of organisms of a species). The "health" or well-being of the population is the fundamental consideration for ERA; however, for select

species such as the Bald Eagle, we are even more conservative or protective and consider protection of the individual.

Due to their mobility and size, wildlife species are exposed indirectly to COPECs, primarily via ingestion of other organisms and physical media (soils and hydrosoils). There are other potential pathways (e.g. dermal contact and inhalation), although the latter typically is irrelevant unless COPECs include highly volatile substances. Dermal contact is also ordinarily minimal because most "higher" vertebrates (birds and mammals) have feathers or fur to protect their skin.

2.5 Exposure Pathways and Conceptual Site Model

A Conceptual Site Model (CSM) was developed that depicts the potential ecological exposure pathways considered for the Hero Lands Property (Figure D3). The CSM is a component of the USEPA's problem formulation phase that addresses: 1) sources of COPECs, 2) probable COPEC fate and transport mechanisms, 3) identification of potential complete exposure pathways, and 4) endpoints (receptors) to screen for ecological risk. For the Hero Lands Property, the viable potential exposure pathway is through surficial soil/hydrosoil with dermal contact and oral uptake as possible mechanisms depending upon the habits of the receptors of interest. For this ERA, the biologically active zone of soils/hydrosoil was considered; therefore, subsurface soils (> 4 feet depth) are not potential pathways for ecological exposure (USEPA 2015).



Note: Adapted from USEPA 1989

Figure D3: Conceptual Site Model for Hero Lands Property Ecological Risk Assessment

2.6 Effects Evaluation

The next step in the SLERA is the preliminary ecological evaluation and establishment of COPEC exposure levels (i.e. concentrations) that represent conservative thresholds for adverse ecological effects (USEPA 1997). Those conservative thresholds for adverse effects are also referred to as ecotoxicity screening values (ESVs) or soil and sediment screening levels. ESVs are concentrations of COPECs that essentially represent general background levels of analytes or levels that pose no risks of adverse effects for exposed wildlife. Toxicity cannot necessarily be expected in soils or sediments for which only a single guideline or even multiple guidelines were exceeded because those screening guidelines were not intended as toxicity thresholds or absolute predictors of toxicity (e.g. Long and MacDonald 1998).

ESVs are based on endpoints such as lowest observed adverse effect level (LOAEL) and the no observed adverse effect level (NOAEL). The LOAEL is the lowest dose or exposure concentration that results in a statistically significant effect compared to a control. The NOAEL is the highest dose or exposure concentration at which there is no statistically significant difference from the untreated control response in a laboratory study. By definition, the NOAEL represents a dose or concentration at or below which ecological risk is not expected to occur. Practically, a NOAEL cannot be exceeded if concentrations of COPECs do not exceed background. Similarly, soil and hydrosoil screening values are levels or concentrations that are not expected to result in a significant exposure or consequent dose.

ESVs are also not site-specific. The published values are intended to be conservative, and when exceeded can serve as a point of departure for more detailed site-specific ecological risk analysis. Soil (or sediment) screening levels alone do not trigger the need for response actions or define "unacceptable" levels of contaminants in soils (USEPA 1997). In USEPA guidance, "screening" refers to the process of identifying and defining areas, COPECs, and conditions, at sites on a property that do not require further attention. Generally, at sites where COPEC concentrations fall below screening levels, no further action or study is warranted. Also, where COPEC concentrations exceed ESVs, further study or investigation, but not necessarily "cleanup" or remediation, may be warranted.

Appropriate soil/hydrosoil and sediment screening values for the Hero Lands Property include USEPA ecological soil/hydrosoil screening levels (e.g. USEPA Eco-SSLs) and NOAA Threshold Effects Concentrations (TEC) for freshwater sediments that are applicable for assessing exposures at the site. Eco-SSLs are based on primary ecotoxicity literature studies for the protection of plants, soil invertebrates, birds, and mammals. Appropriate screening values are not available for some constituents (e.g. dioxins, furans, and strontium). Strontium was not carried forward in the risk assessment, due to concentrations being at or near background and due to lack of ecological toxicity information. Dioxins and furans were carried forward in the risk assessment, as ecological toxicity data are available and background values are not available. The screening values used in this SLERA are listed in Tables D2 and D3.

Background concentrations for metals were also developed for reference using data collected by the United States Geological Survey (USGS; Smith et al., 2013) at locations across Louisiana. Potential background threshold values were calculated using USGS background data and a USEPA- and LDEQ-recommended statistical software program and associated technical guidance (USEPA, 2015). The background threshold values account for variability and distribution of the data set and comparison of individual Site concentrations to the background threshold concentration. LDEQ-approved soil background concentration of 12 mg/kg arsenic was also used for comparison in this ecological assessment. Except for very small areas, COPEC concentrations on the property are below background concentrations. Background threshold values are shown on Table D2.

3. USEPA (1997) STEP 2

3.1 Screening Level Estimates of Exposure and Risk Calculations

Methods used in the SLERA to calculate screening level exposure and risk estimates are provided in the following sections 3.2 through 3.4.

3.2 Screening Level Exposure Estimates

To estimate environmental exposure concentrations, very conservative assumptions are initially employed to ensure protection of ecological receptors on the Hero Lands Property. Strategic remediation is proposed by ERM for a limited portion of the Hero Lands Property. The areas on the property designated for remediation by ICON were included in this assessment and to consider the risk of remedy. For this SLERA, receptors are initially assumed to be exposed to the maximum COPEC concentrations (from the areas not planned for remediation by ERM) detected in the soil/hydrosoil samples collected from the site (ERM, 2018-2020; ICON, 2017-2020; and HET,2020. Other conservative assumptions include: 1) home range of ecological receptors is 100% on site; 2) COPECs are 100% bioavailable; 3) the most sensitive life stages of receptors are continually exposed to COPECs; and 4) receptor diets are composed of 100% of the most contaminated food source (i.e. the soil or hydrosoil). Thus, exposure estimates are inherently "worst case" initially for the SLERA. These types of conservative parameters are also typically inherent in the toxicity studies used to derive screening levels (as used in the SLERA) and result in very conservative (protective) and even unrealistic estimates of risks for a property and a population of animals. Results from the SLERA are used to screen out areas from further investigation (at or below the screening values), or to include areas for further study (above screening values).

ERM (2018-2020), ICON (2017-2020), and HET (2020) reported results for soil/hydrosoil samples from multiple depth intervals. Per LDEQ RECAP recommendations for ecological risk assessment (p.111 Data Requirements), analytical results for the shallow depth intervals were used for the SLERA in order to best approximate the biologically active zone (i.e. 0 to 3-4 feet bgs). For example, the general pattern for distribution of infaunal benthic invertebrates is that the greatest numbers of organisms occur within 2 to 5 centimeters (1 to 2 inches) of the sediment surface, with very few numbers of organisms found deeper than 20 centimeters (8 inches) (e.g. Bosworth and Thibodeaux 1990). Surficial dwelling organisms generally contact the top 0 to 2 feet bgs of soil or less (Suter 2007; USEPA 2015). Maximum COPEC concentrations from the ERM (2018-2020), ICON (2017-2020), and HET (2020) samples collected from the Hero Lands Property are summarized in Table D1. COPEC concentrations are shown on Figures D4 through D31. The screening level approach is much more conservative than a site-specific analysis, and offers the possibility of indicating potential risk where none exists ("indicating the need to repair something that is not broken"). A sequential approach (SLERA followed by site-specific BERA) is scientifically appropriate and needed for accurate assessment of this site. As usual, the risk assessor must make rational decisions and all decisions must be clearly presented and defended for each assessment (USEPA 1997).

3.3 Screening Level Risk Calculations

In accordance with USEPA (1997) guidance, the screening-level ecological risk can be estimated using the hazard quotient approach by comparing point estimates of ESVs and exposure values. For this SLERA, the hazard quotient (HQ) is defined by the estimated environmental concentration (EEC) divided by the ESV:

$$HQ = EEC / ESV$$

where the EEC is the maximum concentration detected in the medium (mg substance/kg medium dry weight) on the property and the ESV is a concentration representing an estimate of the threshold of a

safe exposure. Thus, for each COPEC and environmental medium, the hazard quotient (HQ) is expressed as the ratio of a potential exposure level to an applicable toxicity-based threshold. For HQ values exceeding unity (1.0), the potential for adverse effects to the receptor is initially concluded to be possible (cannot be ruled out). In contrast, if the resulting HQ is equal to or less than unity, the potential for risks due to that COPEC can be considered negligible and therefore may be dropped from further consideration of risk for that exposure pathway. The logic is supported through the consistent application of conservative (protective) assumptions, biasing towards overestimating potential risks. If the information currently available is insufficient to determine potential risks of exposure to the COPECs (e.g. there are no reliable screening values) that COPEC is retained pending further review (e.g. 2,3,7,8,-TCDD). It is important to remember that an HQ>1.0 does not mean that unacceptable ecological risks are extant on a property or that any risk mitigation activities are indicated, only that further analyses are required (e.g. a site-specific risk assessment or BERA).

Table D1: Maximum Soil/Hydrosoil COPEC Concentrations Reported at the Hero Lands Property (ERM 2018-2020; ICON 2017-2020; HET 2020)

Constituent	Maximum Reported Concentration (mg/kg dry)	Location (depth feet bgs)	Sample Date
Arsenic	18.6	BC-9 0-2'	10/24/2018
Barium	6280	SB-14R 2-4'	1/22/2020
Cadmium	1.163	BC-9 0-2'	10/24/2018
Chromium	37.2	SB-14 2-4'	6/24/2019
Iron	26000	BC-23 0-2'	2/1/2019
Lead	123	BC-11 2-4'	10/26/2018
Mercury	0.148	SB-15 2-4'	6/24/2019
Selenium	<4.0	BC-12 0-4'	11/1/2018
Silver	<0.404	SB-8 2-4'	10/25/2018
Strontium	313	BC-5 0-4'	8/20/2018
Zinc	250	BC-10 0-4'	10/24/2018

Table D2: Soil/Hydrosoil Screening Values for Estimation of Potential Ecological Risks. All concentrations are reported as mg/kg (dry wt.). N/S indicates that reliable screening value is not available.

Constituent	Site Concentration [Maximum Value]	Eco-SSL Avian USEPA	Eco-SSL Mammal USEPA	Eco-SSL Invertebrate USEPA	Eco-SSL Plant USEPA	TEC NOAA	Screening Comparison		
							Ecological Screening Value	Background USGS	Screening Exceedance [Y/N]
Arsenic	18.6	43	46	N/S	18	9.79	9.79	12[a]	Y
Barium	6280	N/S	2000	330	N/S	NA	330	775	Y
Cadmium	1.163	0.77	0.36	140	32	0.99	0.36	0.8	Y
Chromium	37.2	26	34	N/S	N/S	43.4	26	83.64	N
Lead	123	11	56	1700	120	35.8	11	43.92	Y
Mercury	0.148	N/S	N/S	0.05	0.3	0.18	0.05	0.11	Y
Selenium	<4.0	1.2	0.63	4.1	0.52	N/S	0.52	1	N
Silver	<0.404	N/S	N/S	N/S	560	N/S	560	ND	N
Strontium	313	N/S	N/S	N/S	N/S	N/S	N/S	203	N
Zinc	250	46	79	120	160	121	46	140	Y

Notes:

Eco-SSL, USEPA: Ecological Soil Screening Level, United States Environmental Protection Agency

TEC, NOAA: Threshold Effect Concentration, Freshwater Sediment, National Oceanic and Atmospheric Administration

Ecological Screening Value is the lowest of the Eco-SSL and TEC values.

Background, USGS: Background Data for Louisiana, 95% Upper Tolerance Limit, United States Geological Survey.

[a]Arsenic value is LDEQ-approved background for Louisiana.

Table D3: COPECs Used for Calculating Screening Level HQs for the Hero Lands Property

Constituent	Site Concentration [Maximum Value] (mg/kg dry)	Location (depth feet bgs)	Lowest Ecological Screening Value (mg/kg dry)	Screening Hazard Quotient (HQ) [Based on Lowest ESV]
Arsenic	18.6	BC-9 0-2'	9.79	1.9
Barium	6280	SB-14R 2-4'	330	19
Cadmium	1.163	BC-9 0-2'	0.36	3.2
Lead	123	BC-11 2-4'	11	11
Mercury	0.148	SB-15 2-4'	0.05	3.0
Zinc	250	BC-10 0-4'	46	5.4

3.4 Risk Characterization

Risk characterization, the final phase of the initial SLERA process, integrates data for exposures and effects into a statement about risk focused on the assessment endpoints established during problem formulation. The screening values used in the SLERA are not site-specific and are intended to be very conservative or protective. If the screening values are not exceeded, there should be no risk due to exposures of COPECs at the property, and if the values are exceeded, this can serve as a point of departure for more detailed and focused site-specific ecological risk analysis prior to any risk mitigation planning. Based on the conservative nature of this SLERA (e.g. maximum detected concentrations for COPECs, etc.), HQs at or near unity are not considered significant (USEPA 1997). It is important to note that most of the samples from extensive sampling of targeted exploration and production areas of the Hero Lands Property did not indicate concentrations of constituents that would pose any ecological risks. To the extent where HQs were not at or near unity (e.g. HQ > 5), COPECs were carried forward for a further site-specific evaluation in the BERA.

The maximum reported soil oil and grease content was 3.83% on the Hero Lands Property (SB-7 0-2'). Six other sample locations on site exceeded 1% oil and grease (BC-11R 0-2' [1.06%], BC-16R2 0-2' [1.78%], SB-4 0-2' [1.7%], SB-6 2-4' [1.7%], SB-6R2 [1.27%], and SB-114 2-4' [1.78%]). Diesel range (TPH-DRO) and oil range organics (TPH-ORO) were measured, and had detectable aromatic and aliphatic compounds. In general, lower molecular weight aromatic and aliphatic compounds are generally more toxic than "weathered" hydrocarbons (i.e. higher molecular weight aliphatic compounds) (Battelle, 2007; USEPA, 2010). At the Hero Lands Property, lower molecular (>C10-C12) weight aromatic and aliphatic compounds were detected at low concentrations (maximum: 227 mg/kg dry weight for aliphatic >C10-C12 and 50.1 mg/kg dry weight for aromatic >C10-C12).

Barium and other elements were somewhat elevated above background (USGS) for a limited area on the Hero Lands Property. Importantly, the few samples that exceeded the conservative ESVs were samples located in a relatively small area on the Hero Lands Property. For most of the Hero Lands Property, COPECs in 0-4' soil samples were at or near USGS Louisiana background levels (15.31 mg/kg As; 0.99 mg/kg Cd; 43.92 mg/kg Pb; 0.11 mg/kg Hg; 203 mg/kg Sr; 140 mg/kg Zn). It is important to remember that these samples were collected from former or ongoing exploration and production sites, and the results do not accurately represent the larger property.

Risk is initially calculated in the SLERA using maximum soil/hydrosoil COPEC concentrations detected on the property (not including soils planned for remediation by ERM). See Angle and Pisani (2020) for

soils/hydrosoils planned for remediation. Risk is calculated in the BERA using the 95%UCL and average COPEC soil/hydrosoil concentrations (not including soils/hydrosoils planned for remediation by ERM). Risk calculated using all on site COPEC soil/hydrosoil concentrations (including those soils/hydrosoils planned for remediation by ERM) is included in Attachment 2. Risk is also calculated in the BERA using maximum soil/hydrosoil COPEC concentrations.

The Hero Lands Property is largely a bottomland hardwood wetland and herbaceous wetland and upland habitat, as indicated by the flora and fauna as well as elevations present at the site. In the higher-tier risk evaluation (i.e. BERA), site-specific conditions at the Hero Lands Property which influence the exposure (e.g. bioavailability) of COPECs were considered. Factors controlling bioavailability of Arsenic, Barium, Cadmium, Lead, Mercury, and Zinc in soils and wetland sediments are outlined below as well as a summary of Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), dioxins and furans.

Arsenic

Arsenic is present naturally in soils and sediments throughout Louisiana (LDEQ 2001). In wetlands, arsenic is typically associated with sulfide mineral deposits or bound to iron oxyhydroxides (Henke, 2009; Rahman et al., 2006). Wetlands facilitate arsenic sequestration by accommodating the necessary biogeochemical conditions, including sediment redox potential, dissolved oxygen (DO) concentration, and pH (Dorman et al., 2009; Eggert et al., 2008; Spacil et al., 2011). Wetlands promote co-precipitation and sorption of arsenic with iron oxyhydroxides under oxidizing conditions, and precipitation of arsenic with sulfide and co-precipitation of arsenic with iron sulfide under reducing conditions. The biogeochemistry at the Hero Lands Property site supports the sequestration of arsenic into non-bioavailable forms.

Barium

Based on the conditions present at the Hero Lands Property and analytical results, barium in surficial soil and hydrosoil is in the mineral form barite (barium sulfate; BaSO4). Barite has a relatively low water solubility (i.e. <0.003 g/L) compared to other forms or salts of barium (greater than 87 g/L; Menzie et al. 2008). Barium exposures in surficial soils on this property are not of concern because the barium at the site is barite, which would essentially not be bioavailable (Menzie et al. 2008, Alberta Environment 2009). Barium is an alkaline earth element with a molecular weight of 137.36. Barium ions adsorb on clay particles and organic matter, and readily combine (in seconds to minutes) with sulfates to form barite. The concentrations of sulfate in waters of the Gulf of Mexico as well as those of the Mississippi River (2,760 mg/L and 30-50 mg/L, respectively; Hanor and Chan 1977; Lin and Morse 1991) are more than sufficient to ensure complexation of barium and lack of bioavailability. The area on the Hero Lands Property containing barium in sediments or soils measured above relevant background is a relatively small area of legacy exploration and production activities. There is no evidence of harm due to barium on the Hero Lands Property and barium accumulation from barite is not a risk, so no adverse effects due to barium on the property would be possible.

Cadmium

In naturally occurring surface waters, cadmium is present normally as Cd (II). In a wetland environment, this transitional metal can form strong covalent bonds with reduced forms of sulfur (pK CdS = 27.0; Brookings 1988) and partition to organic matter by weak non-specific sorption reactions. Sulfide bound species of cadmium are relatively insoluble (Ksp CdS = 1×10-27). In reducing conditions, CdS minerals are relatively stable, as indicated by the pK value of Cd, and require strongly acidic or oxidizing conditions to release Cd from these minerals (Kirk, 2004). On the Hero Lands Property, bioavailability of cadmium would be minimal.

Lead

Lead occurs typically in aqueous systems as Pb (II), but can exist as a fully oxidized species, Pb (IV). In aerobic soils, lead is attracted onto clay surfaces and oxide formations or it can complex with organic matter and reduced sulfur compounds. Lead can also form insoluble hydroxides, carbonates and phosphate complexes. In anaerobic wetland soils where sulfides are present, galena (PbS) forms as a highly insoluble precipitate (pK = 27.5; Brookings 1988; Kirk, 2004). Given the propensity of lead to readily combine with sulfides, lead bioavailability would be minimal on the Hero Lands Property.

Mercury

The biogeochemical cycling of mercury (Hg) is complex. Mercury has three oxidation states including elemental (Hg0), mercurous (Hg I), and mercuric (Hg II) with solubility generally increasing with oxidation (Kaplan et al. 2002). Due to physical and chemical characteristics, Hg has a tendency to be mobile through gas, liquid, and solid phases, but can also form relatively stable complexes such as cinnabar (HgS) (Kosolapov et al. 2004). Wetland environments that favor production of HgS contain soluble sulfides from microbial degradation of organic carbon (e.g. dissimilatory sulfate reduction) and permit complexation reactions between Hg and S2- to proceed before microbial reduction of Hg (II) can occur (Kadlec and Wallace 2009). Formation of mercuric polysulfides can also occur in low Eh environments (< -100 mV) and is a result of exceptional concentrations of reactive sulfide (Paquette and Helz 1995). Conditions on the Hero Lands Property and the characteristics of mercury support the conclusion that bioavailability of mercury on the property is likely minimal.

Zinc

Under reducing wetland environments, zinc can be reduced to an insoluble sulfide form (ZnS, pK = 24.7). Zinc is readily precipitated with sulfide, forming insoluble sulfide species that are relatively non-bioavailable (Brookings 1988; Gillespie et al., 1999; Gillespie et al., 2000). In aerobic conditions, zinc is mostly immobile, but under acidic oxidizing conditions, zinc can form soluble and mobile species of Zn. In higher pH ranges (pH 8-11), Zn (II) combines with calcium and magnesium carbonates to form co-precipitants (hydroxyl-carbonates; Stumm and Morgan 1996). In wetlands, Zn is primarily associated with insoluble sulfides, and minimally retained in plants (Gillespie et al., 1999; Gillespie et al., 2000). Based on the conditions present on the Hero Lands Property, the bioavailability of zinc is likely minimal.

Total Petroleum Hydrocarbons / Polycyclic Aromatic Hydrocarbons

Total Petroleum Hydrocarbon (TPH) measurements are not reliable for prediction of ecotoxicity. TPH is a term intended to refer to the total mass of hydrocarbons present without identifying individual compounds. In practice, TPH is defined by the analytical method that is used to measure the hydrocarbon content in samples. To the extent that the hydrocarbon extraction efficiency is not identical for each method, the same soil or hydrosoil sample analyzed by different TPH methods will produce different TPH concentrations. TPH measurements for soils and hydrosoils are also subject to interferences that can contribute to "false positive" estimates of concentrations. TPH provides little basis for performing a risk assessment because it supplies limited information about the composition and, therefore, the properties that determine potential fate and toxicity of the material. However, it may be useful for determining the extent of these constituents or the locations of the greatest concentrations. Identification and quantification of specific fractions of TPH can shed more light on the potential for toxicity in a soil or sediment. The fractions can be used to indicate differences in oil composition and differential weathering patterns among chemical species within the crude. Definitive, scientific values for higher tier ecological risk assessment have not been developed. There are no indications of ecological risks due to TPH on the Hero Lands Property and therefore TPH was not included in the BERA.

PAH are the components of TPH that have been identified in the scientific literature to pose the highest risk of ecotoxicity (Edwards, 1997). Supporting the conclusion of no ecological risk due to TPH is the fact that data for PAHs on the Hero Lands Property were non-detect or very low (below levels of ecological

concern) at the locations that will not be remediated and where maximum concentrations of TPH were measured. For example, the maximum detected total 16 PAH concentration at the property is very low at 0.58 mg/kg dry weight (BC-16R2, 0-2') and the total TPH concentration at that location is 5757 mg/kg dry weight (sum of aliphatic and aromatic fractions). Other locations with elevated total TPH (sum of aliphatic and aromatic fractions) have associated PAH concentrations that are non-detect. For example at location SB-7R (2-4') the total TPH is 3887 mg/kg dry weight and the associated total 16 PAH concentration is non-detect. The same is true for location BC-11R with total TPH of 2050 mg/kg dry weight (0-2') and non-detect PAH. This is as expected for weathered hydrocarbons that have aged for decades and supports the conclusion of no ecological risk associated with the weathered TPH and PAH hydrocarbons on the property.

2,3,7,8-Tetrachlorodibenzo-p-Dioxin (2,3,7,8,-TCDD)

2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is an unintentional by-product of incomplete combustion. It may be released to the environment during combustion of fossil fuels and wood, as well as during incineration of municipal and industrial wastes. The largest current contributors of dioxin to the environment are combustion sources, including forest and grass fires (USEPA 1985). Most of the exposure of the general population to 2,3,7,8-TCDD is from food, mainly meat, dairy products, and fish. In some laboratory situations, it has been a developmental toxicant in animals, causing skeletal deformities, kidney defects, and weakened immune responses in the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy. Very low levels of 2,3,7,8-TCDD are found throughout the environment, including air, food, and soil. TCDD is used as the reference, or index congener to assess the toxicity of dioxins and furants as toxicity equivalents (TEQ) to TCDD (ATSDR 1998).

2,3,7,8-TCDD is not intentionally produced by industry, but it can be inadvertently produced in very small amounts as an impurity during the incineration of municipal and industrial wastes and during the manufacture of some chemicals. 2,3,7,8-TCDD may be formed during the chlorine bleaching process used by some pulp and paper mills, and as a by-product of the manufacture of some chlorinated organic chemicals, such as chlorinated phenols. The only current use for 2,3,7,8-TCDD is in chemical research.

Once deposited in the environment, dioxins stay tightly bound; binding is relative to total organic carbon (TOC) content of the soil or sediment. Only if co-located with acids or strong organic solvents could dioxins be mobilized once bound to the soil or sediment matrix. Environmental investigations focus on the potential for direct-contact pathways for human and ecological receptors, as dioxins are generally not sufficiently soluble to pose a leaching threat to underlying groundwater (USEPA 2010).

Dioxins are ubiquitous in the environment at low levels and will be present in many areas even when no historical release has occurred. TCDD and dioxin levels as TEQ may be compared to TEQ background ranges suggested by USEPA (2008). Background levels of dioxin in soil range from 1 – 11 TEQ in rural soils and may be higher in urban soils (Lorber et al. 2009).

Based on the results from this SLERA and in order to be conservative, Arsenic, Barium, Cadmium, Lead, Mercury, Zinc, and 2,3,7,8-TCDD were retained for more detailed evaluation in a BERA. These COPECs are likely bound to soil particles with limited mobility and do not pose unacceptable risks for transport off property. Nor do they likely pose risks to biota on the property. The ecological screening values assume 100% utilization of the soil or hydrosoil sample core by organisms (feeding, etc.) and maximum bioavailability. Much of the soils and hydrosoils on this property have weathered for decades and there has been no evidence of adverse effects to biota. In a precautionary approach and to assuage residual concerns, the following site-specific risk assessment is provided.

4. USEPA (1997) STEP 3

4.1 Problem Formulation

Based on the results from Step 2 of the USEPA (1997) ERA process, maximum concentrations of the following COPECs on the Hero Lands Property have been retained for evaluation at a higher level of risk assessment, due to exceeding the very conservative screening levels, or a determination that the potential for harmful effects to the ecological receptors cannot be ruled out using the initial screening process. COPECs retained for further investigation included:

- Arsenic
- Barium
- Cadmium
- Lead
- Mercury
- 2,3,7,8,-TCDD
- Zinc

Based on the screening results and the embodied data and assumptions, the Scientific Management Decision at the conclusion of Step 2 was to progress to a site-specific BERA. To ensure the integrity and transparency required in the BERA, the assessment proceeded through the following steps as recommended by the USEPA (1997).

BERA is a detailed site-specific ecological evaluation that accounts for the nature and spatial extent of the COPECs retained, their ecotoxicity, and any complete exposure pathways. In general, the BERA differs from Human Risk Assessment (HRA) in that the BERA evaluates the potential or actual toxicological impacts to populations of ecological receptors or their habitat rather than to individual receptors evaluated in the HRA. The ERA process includes identification of the potentially exposed habitats and indicator or surrogate species that may utilize those habitats.

Due to the number of potential species that can be found within a habitat such as this bottomland hardwood wetland and herbaceous wetland with associated upland, the ERA process includes guidance for selecting indicator species that are representative of the potentially impacted habitat and the potential toxicity of the COPECs. In the BERA, the risk assessor evaluates the potential bioavailability of the COPECs and their physical and biological fate and transport including potential for bioconcentration, bioaccumulation and biomagnification in the food chain. Selection of indicator species typically relies on guilds as presented in USEPA Risk Assessment Guidance (USEPA 1997). In this process, the risk assessor evaluates the COPEC/trophic level/food chain relationships as well as physical aspects of the habitat to select appropriate species to act as indicators of the COPEC toxicity. Endpoints in the BERA are typically based on potential for mortality or impact on reproduction or growth within the indicator or surrogate species populations.

Species were selected for detailed evaluation based upon recommendations provided by USEPA (1997). In order to address a variety of exposures via ingestion, several species are required. Feeding or trophic guilds are useful concepts to categorize the components of the diets (food habits) and feeding mechanisms (behaviors) among wildlife species. Diverse diets and feeding methods are a major factor allowing variety among co-existing or sympatric species. Numerous birds and mammals that use the bottomland hardwood wetlands, herbaceous wetlands and elevated areas on the Hero Lands Property were evaluated as potential candidate wildlife receptors based on this trophic-guild approach. The following factors were considered in the selection process:

- Ecological relevance to site
- Vulnerability to exposures
- Sensitivity to toxic effects of site COPECs
- Social and economic importance
- Protected status (e.g. endangered species, species of special concern)
- Availability of species-specific behavioral, physiological and toxicological information.

For this site-specific BERA for the Hero Lands Property, several avian and mammal indicator species were selected for evaluation: American Robin, Spotted Sandpiper, Mallard Duck, Snowy Egret, Great Blue Heron, Bald Eagle, Least Shrew, Swamp Rabbit, Red Fox, and American Mink. As presented below, these species represent a variety of feeding habits as well as behavior patterns and sensitivities. Species descriptions are outlined below:

American Robin *(Turdus migratorius)*

American robins are common birds across the continental United States as well as Louisiana. These robins are both numerous and widespread, and American robin populations are stable or increasing throughout their range. Morphometrically, American robins vary somewhat over the ecoregions that they occupy. Typical life span of robins is about 2-3 years. Robins adapt to a variety of nesting and breeding habitats. Robins move in response to factors such as temperature, food availability and predation. With the onset of winter, robins generally move to moist woods where berry-producing trees and shrubs are common.

American robins are well adapted to living near people and populated areas and they can be observed foraging on lawns although they eat a lot of fruit in fall and winter. Food for American robins consists largely of both invertebrates and fruit with their digestive system modified to readily accommodate either food source. Particularly during spring and summer months, robins eat mostly earthworms as well as insects and some snails. During the fall months, robins eat a variety of fruits, including chokecherries, pin cherries, hawthorn, dogwood, and sumac fruits, as well as juniper berries. There is a suggestion in the peer reviewed literature that robins may try to augment their diet by selectively eating fruits that have insects in them.

References:

Aldrich, J.W. and F.C. James. 1991. Ecogeographic variation in the American Robin (Turdis migratorius). The Auk 108: 230-249.

Farner, D.S. 1945. Age groups and longevity in the American Robin. The Wilson Bulletin 57: 56-74.

Farner, DS. 1949. Age Groups and Longevity in the American Robin: Comments, Further Discussion, and Certain Revisions. The Wilson Bulletin, Vol. 61, No. 2 (Jun., 1949), pp. 68-81.

Howell. J.C. 1942. Notes on the nesting habits of the American Robin (Turdis migratorius L.). American Midland Naturalist 3: 529-603.

James, F.C. and H.H. Shugart, Jr. 1974. The phenology of the nesting season of the American Robin (Turdis migratorius) in the United States. The Condor 76: 159-168.

Levey, D.J. and W. H. Karasov. 1992. Digestive modulation in a seasonal frugivore, the American Robin (Turdis migratorius). American J. Physiology 262: 711-718.

Great Blue Heron (*Ardea herodias*)

The Great Blue Heron is one of the largest and most widespread wading birds in North America using shorelines and wetlands as habitat. Adult Great Blue Herons are generally large birds, standing up to 100 cm tall or more and with a wingspan of more than 150 cm. The wings of the Great Blue Heron are sturdy and strong. In flight, the neck of a Great Blue Heron is doubled back in an S-shape and the head rests against the bird's shoulders.

The breeding range of the Great Blue Heron is extensive, ranging from the southern Canadian provinces to southern Mexico and South America. Wintering and permanent range includes southeastern Massachusetts south along the coastal states and west across the south half of the U.S. into Mexico and northern South America. Most Great Blue Herons are active migrators to the south during the winter after breeding in the north in the summer. Great Blue Herons have been observed migrating alone or in small groups.

In the breeding season, Great Blue Herons are attracted to many different wetland habitats. They spend time feeding in shoreline areas associated these aquatic systems although they can occasionally be observed feeding in agricultural fields. Great Blue Herons usually build nests in trees near water, but they may also build nests in a variety of other sites when trees are not available. Great Blue Herons typically nest in colonies but may also choose to be solitary. Most Great Blue Herons nest within 2 to 4 miles of feeding areas and herons forage and roost alone or in loose flocks. Herons are sight predators and eat a wide variety of prey, including fish, frogs, salamanders, turtles, snakes, insects, rodents, and small birds. Seeking food, Great Blue Herons patrol the shores of rivers, marshes, ponds, and lakes. Herons are efficient and effective predators.

References:

Custer, C.M., S.A. Suarez, and D.A. Olsen. 2004. Feeding habits of the Great Blue Heron and great egret nesting along the upper Mississippi River, 1995-1998. Waterbirds 27 454-468.

Fleury, B.E. and T.W. Sherry. 1995. Long-term population trends of colonial wading birds in the southern United States: The impact of crayfish culture on Louisiana populations. The Auk 112: 613-632.

Kushlan, J.A. 1976. Wading bird predation in a seasonally fluctuating pond. The Auk 93: 464 – 476.

Kushlan, J.A. 1976. Feeding behavior of North American herons. The Auk 93: 86-94.

Seston, R.M. et al. 2009. Utilizing the Great Blue Heron (*Ardea herodias*) in ecological risk assessments of bioaccumulative contaminants. Environ Monitoring Assess 157: 199-210.

Mallard Duck (*Anas platyrhynchos*)

In Louisiana, mallards are abundant and well recognized ducks. In comparison with other ducks, mallards are relatively large, dabbling ducks with broad wings. The male mallard's characteristic and conspicuous green head, grey flanks, and black tail-curl make it readily identifiable. The female mallard (hen) is marked in a mottled pattern of light and dark brown streaks with a dark brown streak through the eye. Both male and female mallards have a violet-blue speculum on their wings. Mallards have excellent eyesight and hearing, often providing the duck an escape opportunity when a predator approaches. The mallard is more vocal than most other ducks and uses a variety of sounds to communicate its actions and moods. Mallards are popular game birds and source of food for hunters.

The majority of mallard populations are migratory in North America. Beginning in the fall of the year, mallards leave nesting sites in the north and fly as far south as northern Mexico. Factors that influence the mallard's range or alter its patterns include human interference, habitat and food quality and abundance, and lack of a mate. Mallards are multivores and opportunistic feeders. They consume insects and aquatic invertebrates, acorns, seeds, tubers and vegetative parts of aquatic plants, as well as crops, such as corn, soybeans, rice, barley, and wheat.

References:

Delnicki, D. and K.J. Reinecke. 1986. Mid-winter food use and body weights of mallards and wood ducks in Mississippi. The Journal of Wildlife Management 50: 43-51.

Johnson, W.P. and F.C. Rohwer. 2000. Foraging behavior of green-wing teal and mallards on tidal mudflats in Louisiana. Wetlands 20: 184-188.

Nichols, J.D. et al. 1983. Factors affecting the distribution of mallards wintering in the Mississippi alluvial valley. The Auk 100: 932-946.

Tamisier, A. 1976. Diurnal activities of the green-wing teal and pintail wintering in Louisiana. Wildfowl 27: 19-32.

Bald Eagle (*Haliaeetus leucocephalus*)

Bald eagles are iconic birds that are becoming more widely established in Louisiana in recent years. Distinguished by their white head and tail feathers, bald eagles are powerful, brown birds that may weigh as much as 14 pounds and have a wingspan of approximately 8 feet. Male eagles are smaller, weighing up to 10 pounds and have a wingspan of about 6 feet.

Bald eagles require a good food base, perching areas, and nesting sites. Their preferred habitat includes estuaries, large lakes, reservoirs, rivers, and some coastal areas. In winter, bald eagles congregate near open water in tall trees for spotting prey and in night roosts for sheltering. In Louisiana, bald eagles live near water resources such as rivers, lakes, and marshes where they can find fish. Although bald eagles feed primarily on fish, they will also feed on waterfowl, turtles, rabbits, snakes, and other small animals as well as carrion.

Bald eagles usually mate for life, choosing the tops of large trees to build nests, which they typically use and enlarge each year. Nests may be as large as 10 feet across and weigh as much as 1000 pounds. Bald eagles travel great distances but usually return to breeding grounds within 100 miles of the place where they were raised. Breeding bald eagles typically lay one to three eggs each year, and the eggs hatch after about 35 days. The young bald eagles are flying within three months and are on their own about a month later. However, disease, lack of food, bad weather, or human interference can kill many eaglets. Recent studies show that approximately 70 percent survive their first year of life. Bald eagles may live up to 15 to 25 years in the wild.

References:

Bailey, A.M. 1919. The Bald eagle in Louisiana. The Wilson Bulletin 31, No. 2: 52-55.

Bowermann, W.W. et al. 2002. Using bald eagles to indicate the health of the Great Lakes' environment. Lakes and reservoirs: research and Management 7: 183-187.

Hesse,Jr., T.J. 1994. Effect of Hurricane Andrew on Louisiana's nesting bald eagles. Proc. Ann. Conf. Southeast. Assoc. Fish and Wildlife Agencies 48: 395-400.

Mc Ewan, L.C. and D.H. Hirth. 1980. Food Habits of the Bald Eagle in North-Central Florida. The Condor 82, No. 2: 229-231.

Smith, N.R. et al. 2016. History and nesting population of bald eagles in Louisiana. Southeastern Naturalist 15: 12-25.

Smith, N.R. 2014. History, Nesting Population, Migration, Home Range and Habitats Used by Louisiana Bald Eagles. Thesis, Louisiana State University, School of Renewable Natural Resources.122 pp.

Least Shrew (*Cryptotis parva*)

The least shrew (Cryptotis parva) is one of the smallest mammals in Louisiana. It has dense fur that is usually grayish-brown or reddish-brown with a white belly. The least shrew's eyes are relatively small and its ears are completely concealed within its short fur, resulting in very poor eyesight and hearing.

The least shrew occupies habitat from the grasslands of southern Canada through the eastern and central United States and Mexico. The least shrew mostly inhabits grasslands, marshes, and meadows. They generally prefer somewhat wet habitats, but least shrews also live in dry upland regions. A key aspect associated with distribution of least shrews is the presence of vegetation that attracts insects, which are the preferred food for this species.

The least shrew is a relatively active animal with some movement during daylight hours, but they are most active at night. The least shrew digs through loose soil and leaf litter on the ground surface for its prey. These small mammals hunt by smell and tactile stimuli. The diet of the least shrew consists mostly of small insects and other animals, such as caterpillars, beetle larvae, earthworms, centipedes, slugs, and sow bugs. Least shrews will also feed on the corpses of dead animals, and consume small amounts of seeds or fruits. Generally, the least shrew eats its prey whole, but when eating crickets and grasshoppers, they will bite off the head of its prey and eat only the internal organs. When engaging larger animals, least shrews usually attack the legs and try to cripple its adversary. In pursuing lizards, which are often too large for the least shrew to kill, they will bite the lizard's tail, which then falls off (tail autonomy) and provides the shrew with a meal while the lizard escapes. The North American least shrew will also sometimes consume bees by living in beehives and eating larvae.

References:

Briese, L.A. and M.H. Smith. 1974. Seasonal abundance and movement of nine species of small mammals. Journal of Mammalogy 55: 3: 615-629.

Genoways, H.H. and J.R. Choate. 1998. Natural history of the southern short-tail shrew, *Blarina carolinensis*. Mammalogy Papers, University of Nebraska State Museum, Paper 244.

Hamilton, Jr., W.J. 1944. The biology of the little short-tailed shrew, *Cryptotis parva*. Journal of Mammalogy 25: 1-7.

Lucas, L. and J.D. Hoffman. 2015. Reproductive notes on shrews (Family Soricidae) in Louisiana. Western North American Naturalist 75: 374-376.

Martin, R.P. et al. 1991. Habitat usage by small mammals in coastal marshes of southwestern Louisiana. Estuaries 14: 107-110.

McCay, T.S. 2001. *Blarina carolinensis*. Mammalian Species, American Society of Mammalogists. 1-7.

American Mink (*Neovison vison*)

The fur of American mink is usually deep brown or black in color, although they also have white markings on their chests as well as some other parts of their bodies. These smooth-furred mammals have short limbs, slender bodies, tiny ears and lengthy necks. Adult males range in total length from 19 to 29 inches and females can grow to lengths of 18 to 28 inches. American mink males are approximately twice the size of females.

American mink inhabit much of Canada and the United States, although they have not colonized a few states and regions like Arizona and Hawaii. These nocturnal mammals usually inhabit forested areas, especially those that are near water sources including ponds, rivers, marshes and swamps. American mink often use rocks and hollow logs for denning purposes.

American mink are primarily carnivores. Mink will generally eat almost any prey item that they can catch and kill, including fish, birds, bird eggs, insects, crabs, clams, and small mammals. Food items that are preferred by American mink include rabbits, chipmunks, ducks, birds, snakes, mice, shrews, frogs, muskrats and fish. There are both seasonal and annual (temporal) differences in the diet depending on availability of prey. Mammals are the preferred food of American mink in cold weather. The distribution of prey animals such as rabbits or mice may cause American mink to move closer to their food. In food limited situations, adult mink will kill and eat young mink.

References:

Basu, N., A.M. Scheuhammer, S.J. Bursian, J. Elliott, K. Rouvinen-Watt and H.M. Chan. 2007. Mink as sentinel species in environmental health. Environmental Research 103 (2007) 130–144.

Linscombe, G. 2000. An evaluation of the no.2 victor and 220 conibear traps in coastal Louisiana. Louisiana Wildlife and Fisheries Commission, Baton Rouge, LA 70804 pp.560-568.

MacDonald, D.W. and L.A. Harrington. 2003. The American mink: The triumph and tragedy of adaptation out of context, New Zealand Journal of Zoology 30: 421-441.

Svihla, A. 1931. Habits of the Louisiana Mink (Mustela vulgivagus) Journal of Mammalogy12: 366-368.

Thom, M.D. et al. 2004. Why are American mink sexually dimorphic? A role for niche separation. Oikos 105: 525-535.

Red Fox (*Vulpes vulpes*)

The red fox is a widely distributed canine in North America. In general, the red fox is a non-migratory carnivore that maintains its territory throughout the year. The red fox occupies a wide range of habitats and appears to thrive in heterogeneous and fragmented landscapes as opposed to large unbroken tracts of land. Based on population studies, the red fox prefers a mix of forest, cropland, and pastureland. Other habitats used by the red fox include upland fields, savannas, orchards, alpine zone, palustrine wetland systems (excluding ponds), riparian zones, coastal beaches, sand/gravel banks, and areas with exposed bedrock, cliffs, or rocky debris. Availability of food and suitable den sites are key factors influencing habitat selection by red fox. Accessible prey biomass and the patchiness of prey animals can affect territory size. Red foxes prefer to locate their dens in a forested area but will locate in other protected areas. Often the dens are located close to an open area, or in areas that provide thick cover, usually within 300 feet of a source of water. Red foxes remain active throughout the year and do not hibernate.

Red foxes are multivores and feed on a variety of prey as well as plant material. They consume insects, small mammals, birds, turtles, frogs, snakes, fish, eggs, carrion, earthworms, berries, fruits, seeds, and garbage. Relatively large mammals are also eaten by red fox. A variety of birds including ducks and geese are eaten by red foxes. The diet of the red fox varies throughout the year and changes with food availability. During the winter, their diet may include mice, rabbits, birds, carrion, apples, and berries. Their spring and summer diet includes rabbits, rodents and other small mammals, woodchucks, poultry, birds, snakes, turtles and their eggs, deer fawns, raspberries, and blackberries. Wild cherries, grapes, grasshoppers, and mice may be consumed during the fall.

References:

Ables, E. D. 1969. Activity studies of Red Foxes in southern Wisconsin. The Journal of Wildlife Management 33: 145-153.

Lariviere, S., and M. Pasitschniak-Arts. 1996. Vulpes vulpes. Mammalian Species No. 537. American Society of Mammalogists. 11pp.

Trewhella, W.J. et al. 1988. Dispersal distance, home-range size and population density in the Red Fox (Vulpes vulpes): A quantitative analysis. Journal of Applied Ecology 25: 423-434.

Sargeant, A. B. 1972. Red Fox spatial characteristics in relation to waterfowl predation. Journal of Wildlife Management. 36:225-236.

Sargeant, A. B. 1978. Red Fox prey demands and implications to prairie duck production. Journal of Wildlife Management. 42:520-527.

Sargeant, A. B., S. H. Allen, and R. T. Eberhardt. 1984. Red Fox predation on breeding ducks in midcontinent North America. Wildlife Monographs. 89:1-41.

Storm, G. L., R. D. Andrews, P. L. Phillips, R. A. Bishop, D. B. Siniff, and J. R. Tester. 1976. Morphology, reproduction, dispersal, and mortality of Midwestern Red Fox populations. Wildlife Monograph No. 49. 82pp

White, P.C.L. and S. Harris. 1994. Encounters between Red Foxes (Vulpes vulpes): Implications for territory maintenance, social cohesion and dispersion. Journal of Animal Ecology 63: 315-327.

Snowy Egret (*Egretta thula*)

The snowy egret is a common wading bird in Louisiana. It ranges widely in search of food in shallow waters. The snowy egret has been described as a "dashing hunter" by ornithologists because this wading bird employs a gated walking technique that is successful in flushing small prey items in the shallow aquatic habitats where they forage. The snowy egret's black legs and yellow feet have been suggested to aid in pursuit of food as the bird wades in shallow water. Small fish are normally prey items for the snowy egret. However, farmers raising crayfish have indicated that crayfish are also a preferred food item.

Snowy egrets nest in colonies in vegetation in somewhat isolated places, such as wetlands, marshes, swamps and even elevated areas. The rookeries and resting sites often change location from year to year. During their breeding season, snowy egrets feed in areas that provide a ready source of prey items. Snowy egrets generally spend the winter months in more protected areas conserving energy.

The diet of the snowy egret consists largely of aquatic animals, including fish, frogs, worms, crustaceans, and insects. These birds use their feet to probe in sediments to find prey items that they secure with their bill. During their feeding activities, snowy egrets may exhibit a variety of behaviors that assist in successful acquisition of prey items. For example, they may stalk prey in shallow water, often running or shuffling their feet, flushing prey into view, as well "dip-fishing" by flying with their feet just above the

water. Snowy egrets may also stand still in order to ambush prey, or hunt for insects mobilized up by domestic animals in open fields.

References:

Custer, T.E. and D.W. Peterson, Jr. 1991. Growth rates of great egret, Snowy Egret and black-crowned night- heron chicks. Colonial Waterbirds 14: 46-50.

Custer, TW and RC Osborn. 1978. Feeding habitat use by colonially-breeding herons, egrets, and ibises in North Carolina. The Auk 95: 733-743.

Huner, J.V. et al. 2002. Managing agricultural wetlands for waterbirds in the coastal region of Louisiana, USA. Waterbirds; The International Journal of Waterbird Biology 25: 66-78.

King, D.T. and D. Leblanc. 1995. Foraging behavior of Snowy Egrets (Egretta thuja) and yellow-crowned night herons (Nyctanassa violacea) in south Louisiana. USDA National Wildlife Research Center – Staff Publications (Paper 545).

Kushlan, J.A. 1976. Feeding behavior of North American herons. The Auk 93: 86-94.

Spotted Sandpiper (*Actitis macularius*)

Spotted sandpipers are widely distributed in Louisiana, and this bird has an unusual breeding system for birds -- polyandry (one female mating with more than one male bird). Spotted sandpipers have successfully occupied temperate areas for breeding. Polyandry is a successful reproductive strategy for taking advantage of the relatively long breeding season in temperate areas (compared with the breeding season in the arctic and subarctic areas used for breeding by most spotted sandpipers and related species of birds). Spotted sandpipers have been characterized as a "pioneering species" with related attributes: rapidly and frequently colonizing new sites, emigrating in response to reproductive failure, breeding at an early age, living a relatively short time (breeding females live an average of only 3.7 years), laying many eggs per female per year, and having relatively low nesting success.

Spotted sandpipers feed by probing, stalking and gathering insects. They also catch some insects on the wing. Spotted sandpipers wade in relatively shallow water and forage on sediment biota. Spotted sandpipers mostly eat insects, including beetles, crickets, dipterans, grasshoppers, midge larvae, and ants. If available, Spotted sandpipers will also eat small fish and aquatic invertebrates. Spotted sandpipers typically migrate for breeding season and their migration usually occurs at night.

References:

Czech, H.A. and K.C. Parsons. 2002. Agricultural wetlands and waterbirds: A review. Waterbirds: International Journal of Waterbird Biology 25: 56-65.

Moore, K. 2002. "*Actitis macularius*" (On-line), Animal Diversity Web. Accessed September 19, 2016

Oring, L.W. and D.B. Lank. 1982. Sexual selection, arrival times, philopatry, and site fidelity in the polyandrous spotted sandpiper. Behavioral Ecology and Sociobiology 10: 185-191.

Stevenson,Jr., H.M. 1944. Southeastern limits of the spotted sandpiper's breeding range. The Auk 61: 247-251.

Swamp Rabbit (*Sylvilagus aquaticus*)

Swamp rabbits (Sylvilagus aquaticus) are relatively large cottontail rabbits that live in swamps and wetlands of Louisiana. Swamp rabbits usually inhabit areas close to water in bayous, cypress swamps, marshes, and adjacent floodplains. Swamp rabbits burrow into tall grasses and leaves that provide cover during the daylight hours. These rabbits forage at night.

The ears of the swamp rabbits are smaller than other cottontails. Male swamp rabbits are larger than females. Swamp rabbits have dark (rusty brown to black) heads and backs. The lower portions of swamp rabbits are covered with white fur. Swamp rabbits have a pinkish-cinnamon eye-ring.

Swamp rabbits are herbivores and they consume a variety of plants including grasses, sedges, shrubs, tree bark, twigs and seedlings. They also consume aquatic vegetation and succulent herbaceous vegetation. Although swamp rabbits feed mostly at night, cloudy days and rain showers often provide them an opportunity to feed during daytime as well.

References:

Allen, A.W. 1985. Habitat suitability index models: Swamp rabbit. U.S. Fish and Wildlife Service Biological Report 82 (10.107) 20 pp.

Chapman, J.A. and G.A. Feldhammer. 1981. Sylvilagus aquaticus. Mammalian Species 151: 1-4.

Scharine, P.D. et al. 2009. Swamp rabbits in flood plain ecosystems: Influence of landscape- and stand-level habitat on relative abundance. Wetlands 29: 615-623.

Smith, W.P. and P.A. Zollner. 2001. Seasonal habitat and distribution of swamp rabbits, white-tailed deer, and small mammals in old growth and managed bottomland hardwood forests. U.S. Forest Service General Technical Publication SRS-42.

Zollner, P.A. et al. 2000. Microhabitat characteristics of sites used by swamp rabbits. Wildlife Society Bulletin 28: 1003-1011.

5. USEPA (1997) STEP 4

5.1 Study Design and Data Quality Objectives

5.2 Work Plan and Sampling Plan

Exposure Assessment: For this site-specific BERA, exposures were assessed on the basis of the CSM that was developed during the SLERA process. The CSM was updated to include information that was obtained during the field inspection and formed the basis for assessing exposures. All reasonable source areas, intermedia transport mechanisms, receptors, and exposure routes were evaluated in this activity.

For assessing exposures, available monitoring data (ERM 2018-2020; HET 2020; ICON 2017-2020) for the Hero Lands Property were used, potential chemical releases were analyzed, exposure point concentrations were estimated, the environmental fate and transport of chemicals released were evaluated qualitatively and quantitatively, and potential exposed populations were identified. As discussed above, the BERA considered ingestion and dermal contact exposure routes from the potentially affected environmental media at the site. For this BERA, conservative estimates of exposures were used (95% UCL of arithmetic means of site concentrations and maximum values or average sample concentrations; USEPA 1997; LDEQ 2003). It is important to note that the exposure estimates were derived from a biased data base of samples collected from likely legacy and ongoing exploration and production areas. Consequently, these exposure estimates are conservative and very likely overestimate actual exposures of the modeled animal populations.

5.3 Measurement Endpoints

Toxicity Reference Values (TRVs) that are conservative estimates of "safe" levels of exposures for the surrogate species were used for this BERA. TRVs were obtained from peer review literature as indicated in the problem formulation step (Table D9). TRVs are often developed with the most bioavailable form or species of an element or compound. Typically, this is not the form of an element or compound encountered at a site. To model the exposure accurately, exposure modifying factors must be used for site specific studies.

5.4 Study Design

The BERA is a detailed site-specific ecological evaluation that accounts for the nature and extent of the COPECs retained from the screening-level assessment, their ecotoxicity, and potential complete exposure pathways to surrogate receptors. Some of the conservative assumptions used for development of the SLERA are discussed below to contrast or compare with the site-specific BERA:

Area-use factor: The SLERA assumes the home ranges of the animals are entirely within the sampled area, and thus the animals are exposed 100 percent of the time to the COPEC measured in the soil or hydrosoil core or sample. The BERA utilizes species- and site-specific home range information and potential use of the habitat, to estimate more accurately the percentage of time an animal would use a potentially contaminated area. This BERA also considers the possibility that some species might actually focus their activities in contaminated areas of the site (Table D8).

Bioavailability: The SLERA assumes that the bioavailability of contaminants at the site is 100 percent. The BERA provides an opportunity for bioavailability to be addressed specifically based on site conditions as discussed above. The BERA considers the form of the COPEC and the environment to utilize a conservative but more realistic estimate of bioavailability (Table D11).

Life stage: The SLERA assumes that the most sensitive life stages are present and exposed on the property. If an early life stage is the most sensitive, the population should be assumed to include or to be

in that life stage. For vertebrate populations, it is likely that most of the population is not in the most sensitive life stage most of the time. However, for many invertebrate species, the entire population can be at an early stage of development during certain seasons but the duration of exposure is limited. The site-specific BERA employs a more realistic average or adult life stage.

Body weight and food ingestion rates: The BERA uses conservative estimates of body weight and food ingestion rates to maximize the dose (intake of contaminants) on a body-weight basis and to avoid underestimating risk (Table D7).

Bioaccumulation: Bioaccumulation factors obtained from scientific literature are used to estimate contaminant accumulation and food-chain transfer at a site at the screening stage. Because many environmental factors influence the degree of bioaccumulation, sometimes by several orders of magnitude, SLERA uses the most conservative (i.e. highest) bioaccumulation factor (referred to in this ERA as "BCF") reported in the literature. Bioaccumulation factors (BCFs) are refined in the BERA to more accurately represent exposures to COPECs at the site (Table D10).

Dietary composition: For species that feed on more than one type of food, the SLERA assumes their diet is composed entirely of the type of food that is most contaminated. For example, if some foods (e.g. earthworms) are likely to be more contaminated than other foods (e.g. seeds and fruits) typical in the diet of a receptor species, it was assumed that the receptor species feeds exclusively on the more contaminated type of food for the SLERA. This parameter was refined in the BERA to more accurately represent exposures to COPECs at the site (Table D7).

Exposures: To determine soil-based ecotoxicity screening levels for the SLERA, a receptor-based approach was chosen to evaluate the risk of each COPEC to different guilds of organisms (birds, mammals, plants, invertebrates, benthic invertebrates and other aquatic organisms). For each group of receptors, the lower of the USEPA Eco-Soil Screening Level or Freshwater Sediment Threshold Effects Concentration (TEC) was used.

For the Baseline Ecological Risk Assessment (BERA), the factors that were conservatively or even unrealistically estimated in the SLERA were adjusted to be site-specific and more reasonable (for the exposures and the receptors as well as habitats). The toxicity values (TRVs) remain conservative in the BERA. The 95% UCL for COPECs and maximum values as well as sample means were used to capture more accurately the potential exposure at this site. The use of means and 95% UCLs is very conservative in assuming concentration levels across a broad area of interest that significantly exceed actual site conditions.

Areas of Investigations (AOIs) were not practical for Hero Lands Property for several reasons. An attempt to discern AOIs by traditional means was not useful because background and non-detect concentrations of COPECs were widely distributed leading to very small and ecologically inconsequential areas with elevated or slightly elevated COPECs. The ecological risk of these small areas represented by a soil boring is evaluated in this ERA using the maximum concentrations of COPECs and realistic assumptions about consequent exposures. Barium was more prevalent on the Hero Lands Property and was determined by analysis to be barite (essentially nontoxic, Appendix C). Since the primary purpose for designating AOIs for ecological risk assessment is to accurately estimate and evaluate exposures, distribution of COPECs on this relatively small property (~155 acres) did not indicate a potential to significantly affect populations or habitat of any biota.

Following assessment and measurement endpoint selection and development of a testable hypothesis and site conceptual model, a study plan is designed to ensure that adequate data are collected to support the BERA. There are a number of fundamental approaches for conducting site-specific investigations of COPECs.

5.5 Data Quality Objectives and Statistical Considerations

The updated sample locations, depths, and numbers of samples used for the SLERA were adequate to initiate preparation of the BERA for this property. The sampling scheme is consistent with the CSM. Data Quality Objectives (DQOs) for all data collection activities are adequate, and contain the following information: sample location, sample depth, analytical method requirements, quantitation limit requirements, and identification of data use. The analytical quantitation capabilities were evaluated against protective levels and are adequate for the BERA. Before they were used in the BERA, all analytical data were reviewed by their analysts, and appropriate data qualifiers were applied, as required (see USEPA 1992). The data collected were of sufficient quantity and quality to meet their intended use. Data regarding potential exposures were refined by additional sampling and analyses conducted by ERM (2020).

6. USEPA (1997) STEP 5

6.1 Field Sampling Plan Verification

For assessing exposures, available monitoring data (ERM 2018-2020; HET 2020; ICON, 2017-2020) for the Hero Lands Property were used. Based on the available site-specific data, sufficient information for the Hero Lands Property site was available to accomplish the BERA and render opinions.

6.2 Site Conditions after Initial Sampling

Field Verification of Sampling Design: Accompanied by some additional sampling to re-measure COPECs in surface soils and hydrosoils (ERM, 2020), the field sampling effort was deemed practical and appropriate for this site-specific BERA.

7. USEPA (1997) STEP 6

7.1 Site Investigation and Data Analysis

7.2 Site Investigation (sampling conducted)

The site investigation and COPEC sampling were accomplished. Samples were analyzed according to the sampling plan. The most current data available were used in this ERA.

7.3 Data Analysis – analyze data; evidence for effects or potential effects

Site Investigation and Analysis Phase: This step in the BERA process involved implementation of the field effort outlined in Step 5 (above) and analyzed the data produced, characterizing actual exposures and potential ecological effects, leading to the risk characterization in Step 7 (below).

***Step 6 SMDP*:** This Scientific Management Decision Point (SMDP) is required only if it is necessary to alter the Work Plan/Sampling Plan, as noted above. The risk assessors are responsible for the appropriateness of any changes, as well as how the information is used in the site-specific BERA.

***Analysis of Ecological Exposures and Effects*:** In the analysis phase of the BERA, the data on existing and potential exposures and ecological effects at the site were technically evaluated (USEPA 1997). The procedures for characterizing exposures and ecological effects were documented in the Step 4 (SMDP at the end of Step 4).

a) ***Characterizing Exposures***: The exposure analysis combines the spatial and temporal distributions of the selected endpoints with those of the COPECs to evaluate exposures. The result of the exposure analysis is an exposure profile. This profile quantifies the magnitude and spatial and temporal patterns of exposure as they relate to the assessment endpoints and risk hypotheses developed during problem formulation (USEPA 1997).

b) ***Characterizing Ecological Effects***: The ecological effects characterization includes a summary of the types of adverse effects on biota associated with exposure to COPECs and evaluates any relationship between magnitude of exposures and adverse effects.

c) ***Exposure-Response Analysis*:** Relationships between the magnitude, frequency, or duration of exposures to the COPECs and the magnitude of any responses were evaluated. The relationships between exposures and responses were described to the extent possible and the linkage between the measurement and assessment endpoints were explained if observed. Effects (i.e. potential or observed) or lack of potential effects were identified and a discussion of the confidence in these relationships, either qualitatively or quantitatively, as allowed by the data was presented.

The equation used for calculating potential risk (HQs) for COPECs in the site-specific BERA for the Hero Lands Property is as follows (USEPA 2003 p. 4-2):

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai} \;]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ_a = Hazard Quotient for analyte $_a$ (COPEC $_a$) (unitless)
$Soil_a$ = Concentration of analyte $_a$ (COPEC $_a$) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B_i = Analyte $_a$ (COPEC $_a$) in biota type (i) (mg/kg dry weight)
P_I = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF_{ai} = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF_{as} = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV_a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor (based on home range and time [temporal] factor)

Results from this analysis are summarized in Tables D4 and D5.

d) ***Evidence of Causality***: Importantly, the strength of the causal association between COPECs and effects on the selected endpoints was assessed. For example, demonstrating a correlation between a COPEC gradient and ecological impacts is a key component of establishing causality, but is not strictly required. The procedures and methods outlined in USEPA (1997) were used to assist in evaluating the cause and effect relationships or lack of relationships.

8. USEPA (1997) STEP 7

8.1 Risk Characterization

8.2 Risk Estimation and Characterization

Risk Characterization: Risk Characterization includes two major steps: risk estimation and risk description.

1. ***Risk Estimation***: To estimate risk, the exposure profiles and the exposure-effects information gathered during the field effort were integrated, and the uncertainties associated with the process were assessed. All assumptions, defaults, uncertainties, use of professional judgment, and any other inputs to the risk estimate were clearly identified. The details of those calculations, analyses and inputs are presented in Tables D7 through D11.
2. ***Risk Description***: The risk description consisted of a summary of the results of the risk estimation and an assessment of confidence in the risk estimates through a discussion of the weight of evidence. An analysis and discussion of all identifiable uncertainties were also included below.

9. USEPA (1997) STEP 8

9.1 Risk Management Decision

Risk Management: At the conclusion of the BERA, information was provided in summary form for the current situation (Tables D4 and D6) to accurately assess existing and potential ecological risks for the Hero Lands Property. An accurate BERA is essential to support decisions regarding any need for risk mitigation for the property. The risk of any remedy or remediation proposed must be evaluated (USEPA 1997; Donovan et al. 2015).

Table D4: Summary Results (HQs) from BERA for the Hero Lands Property Using 95% UCLs as the Exposure Concentrations.

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0216	0.0000452	0.0139	0.0000141	0.0000108	0.0000000415
Barium	0.00528	0.00000493	0.00163	0.0000189	0.0000145	0.00000152
Cadmium	0.0744	0.000035	0.00715	0.0000492	0.0000379	0.000000123
Lead	0.122	0.000139	0.0353	0.0000336	0.0000258	0.000000593
Mercury	0.00131	0.00000167	0.000423	0.00000889	0.00000682	0.00000386
Zinc	0.12	0.000298	0.102	0.000151	0.000116	0.000000217

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.00601	0.0514	0.00000769	0.000508
Barium	0.0000244	0.000696	0.00000117	0.00000645
Cadmium	0.00878	0.166	0.000035	0.000308
Lead	0.00483	0.0473	0.0000531	0.000314
Mercury	0.000518	0.00469	0.000000927	0.0000356
Zinc	0.00964	0.12	0.000087	0.0017

Table D5: Summary Results (HQs) from BERA for the Hero Lands Property Using Maximum Concentrations as the Exposure Concentrations.

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0485	0.000102	0.0314	0.0000316	0.0000243	0.0000000935
Barium	0.023	0.0000215	0.00709	0.0000823	0.0000632	0.00000659
Cadmium	0.150	0.0000707	0.0144	0.0000992	0.0000763	0.000000248
Lead	0.518	0.000592	0.150	0.000143	0.00011	0.00000252
Mercury	0.00200	0.00000254	0.000642	0.0000135	0.0000104	0.00000585
Zinc	0.306	0.000761	0.261	0.000386	0.000297	0.000000552

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.0136	0.116	0.0000173	0.00114
Barium	0.000106	0.00303	0.00000509	0.0000281
Cadmium	0.0177	0.336	0.0000706	0.00062
Lead	0.0206	0.201	0.000226	0.00134
Mercury	0.000786	0.00716	0.00000141	0.0000541
Zinc	0.0246	0.307	0.000222	0.00435

COPEC: 2,3,7,8-TCDD TEQ	
Species	HQ
Avian Receptors	
American Robin	0.00821
Mallard Duck	0.00000441
Spotted Sandpiper	0.00399
Snowy Egret	0.00000233
Great Blue Heron	0.00000179
American Bald Eagle	0.0000000392
Mammalian Receptors	
Swamp Rabbit	0.000929
Least Shrew	0.0116
Red Fox	0.0000174
American Mink	0.0000386

Table D6: Summary Results (HQs) from BERA for the Hero Lands Property Using Average Concentrations as the Exposure Concentrations.

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0199	0.0000416	0.0128	0.0000129	0.00000992	0.0000000382
Barium	0.0032	0.00000298	0.000986	0.0000114	0.00000879	0.000000919
Cadmium	0.0623	0.0000293	0.00599	0.0000413	0.0000317	0.000000103
Lead	0.101	0.000115	0.0293	0.0000280	0.0000215	0.000000492
Mercury	0.000829	0.00000105	0.000266	0.00000559	0.00000429	0.00000243
Zinc	0.107	0.000266	0.0914	0.000135	0.000104	0.000000193

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.00555	0.0473	0.00000708	0.000468
Barium	0.0000147	0.000421	0.000000708	0.0000039
Cadmium	0.00734	0.139	0.0000294	0.000257
Lead	0.004	0.0393	0.0000441	0.000261
Mercury	0.000326	0.00296	0.000000583	0.0000224
Zinc	0.00861	0.107	0.0000776	0.00153

COPEC: 2,3,7,8-TCDD TEQ	
Species	HQ
Avian Receptors	
American Robin	0.00765
Mallard Duck	0.00000417
Spotted Sandpiper	0.00378
Snowy Egret	0.00000203
Great Blue Heron	0.00000157
American Bald Eagle	0.0000000324
Mammalian Receptors	
Swamp Rabbit	0.000854
Least Shrew	0.00951
Red Fox	0.0000155
American Mink	0.0000346

All calculated HQ risk for all receptors is less than the benchmark of 1.0, based on 95%UCL, average, and maximum soil/hydrosoil COPEC concentrations in soils not planned for remediation by ERM. Calculated HQ risk, based on concentrations in all soils/hydrosoils (including those planned for remediation by ERM) are below the benchmark of 1.0 for all receptors except in one instance. A single constituent and receptor species modeled using all site soil concentrations (including those planned for remediation) exceeded the calculated HQ ratio of "1". The constituent is lead and the concentration associated with the HQ>1.0 is the maximum value detected on the property (see Attachment 2). Using more representative concentrations (95% UCL on the mean concentration and average concentration), per LDEQ RECAP guidelines (pg. 112) for this level of ecological risk assessment, result in HQ less than 1.0. Spatial distribution of lead on the Hero Lands Property (see Appendix C of this report) showed that one sample strongly influenced the estimated 95% UCL for the property and this sample was located in a single soil boring (<<1 acre area). The receptor species in this model/calculation is the American robin.

For this conservative/protective analysis, the American robin population in the entire area around the property was assumed to be exposed and limited to the boring (very small) area on the property where the concentration of lead was greater than the 95% UCL. Further, a very protective toxicity reference value (TRV) was also assumed for this calculation. The combination of a single maximum value of lead coupled with a conservative estimate of toxicity for the American robin in this setting produced an HQ of 2.13. This small potential for risk is not confirmed by any other receptor species modeled for the property. The lack of bioavailability of lead in soils and sediment on the property was also clearly discussed in Section 3.4.

10. UNCERTAINTY EVALUATION

As required by the USEPA (1998) guidance, this uncertainty analysis is provided for this BERA for the Hero Lands Property. There are basically four sources of uncertainty inherent in any BERA (USEPA 1997, 1998; Suter 2007): 1) stochasticity (natural variation); 2) lack of information (i.e. data gaps); 3) flawed model assumptions; and 4) human error. Natural variation (stochasticity) is an inherent characteristic of ecological systems and the factors that influence the systems (e.g. weather). Of all of the contributions to uncertainty, stochasticity is the only one that can be acknowledged but sometimes cannot be avoided (Suter 2007). For the Hero Lands Property, sufficient data were available, so lack of detailed information was not an issue. Sufficient soil samples were collected at the site to provide a good spatial coverage of all areas of potential concern. Analytical detection of COPECs was adequate relative to toxicity values. Accordingly, uncertainty in the concentration of COPECs in soil or hydrosoil is judged to be low. This conclusion is supported by the biased sampling effort to include the most potentially impacted areas on the property. Uncertainties associated with estimates of COPECs in food items and soil ingestion are likely moderate due to overestimates based on modeled concentrations. These values are inherently conservative or protective. Selection of toxicity values (e.g. TRVs) is likely also conservative and contributes to overestimation of risks. The BERA necessarily relies on professional judgments (Suter 2007; USEPA 1997, 1998), however, such judgments are limited in this BERA. In addition, to the extent that assumptions may be erroneous, they can contribute to either under- or overestimation of risk. Human error (e.g. flawed assumptions or simple mathematical mistakes) is always a possibility, but with the degree of professional capability, integrity, and quality assurance measures involved, such problems are expected to be minimal or nil.

On balance, most of the uncertainty in this ERA is associated with the degree to which estimates of exposures and toxicities are conservative (or protective). The weight of evidence (WOE) presented herein provides a reasonable level of confidence that the risks are not understated, especially for the more ubiquitous resident and transient receptors.

11. SUMMARY AND CONCLUSIONS

The BERA developed for the Hero Lands Property was conducted in accordance with Louisiana Department of Environmental Quality (LDEQ 2003) and USEPA (USEPA 1997 and 1998) guidance. ERAs evaluate ecological effects caused by human activities or stressors. The term "stressor" is used here to describe any chemical, physical, or biological entity that can induce adverse effects on individuals, populations, communities, or ecosystems. Thus, the ERA process must be flexible while providing a logical and scientific structure to accommodate a broad array of stressors (USEPA, 1992).

USEPA guidance uses a tiered approach (Figure D1) to determine if site constituents of potential ecological concern (COPECs) present an unacceptable risk to ecological receptors. The SLERA focused on potential chemical stressors associated with the Hero Lands Property (i.e. in surface soils and sediments). The SLERA for the Hero Lands Property conservatively estimated potential risks by comparing maximum detected COPEC concentrations to conservatively-derived ecotoxicity screening values. The USEPA guidance provides an opportunity to develop or assemble more site-specific information for more accurate risk assessment. For the Hero Lands Property, this was accomplished by proceeding with Steps 3-8 of the process and production of a BERA that is specific for this site.

Assumptions used in this site-specific BERA were very conservative or protective, assuming each indicator species or receptor spent 30% their lifespan living on and feeding on the soils or hydrosoils that represented the 95 % UCL of the average concentration of the COPEC or analyte measured in the most contaminated areas on the property. For example, a robin generally has a six year life span. So the temporal factor would be an estimate of the time a population of robins would spend on the "spot or area" where the 95% UCL or highest concentrations of analytes were measured and the birds must be feeding on that spot or area (exposed). Based on a temporal factor of 30% and AUF of 1, the robin population is feeding from the spot or area approximately 120 days per year for their entire life (e.g. 6 years). Based on feeding behavior of robins, this is a very conservative estimate of exposure and would be unlikely to actually occur (i.e. exposure would be much less, so the estimate is very protective of a robin population). As demonstrated by the data and analyses presented above, there are no extant or potential ecological risks indicated for the Hero Lands Property.

11.1 Assessment of Plaintiffs' Allegations Regarding "Potential" Ecological Risk and Conclusion Regarding Remediation Alternatives

There are no previous ecological risk assessments or accurate toxicological assessments for the Hero Lands Property. CEI (2019) provided generalities regarding potential exposures to materials, but provided no evidence of a complete exposure pathway or any adverse effect. None of the Plaintiffs' experts have provided evidence that Defendants' oil and gas operations resulted in accumulation of any COPEC on the Hero Lands Property. Dr. W.J. Rogers (2019) provided a screening level analysis that was inconsistent with USEPA protocol and arrived at unsupported opinions regarding potential ecological risks. Similarly, ICON (2019) also provided some unsupported generalities regarding "potential" ecological risks at the site. The opinions in those reports are unreliable in terms of the approaches used as well as the conclusory analyses attempted. So their conclusions regarding potential ecological risks are also unreliable. Consequently, remedial actions based on Rogers' assessment are not supported. Further, the site inspections provided clear evidence of healthy populations and no evidence of harmful impacts from exploration and production activities to populations, habitats, or ecological services provided by the ecosystems on the Hero Lands Property.

On the Hero Lands Property, there is no evidence of population-level stress or toxicity due to salt from exploration or production activities. There were no indications of diagnostic symptoms of stress associated with salts on the Hero Lands Property. Conductivity is a crude and generic estimate of salts

and TDS. As such, conductivity is not a parameter that can be accurately used to assess potential risks at a site (Goodfellow et al. 2002). Further, the composition of salts in terms of ionic strength as well as ion ratios would be needed to accurately determine the potential for risks to susceptible species (Munns 2002, Goodfellow et al. 2002). There is no evidence of salt-impacted species on the Hero Lands Property. Dr. Holloway (2020) found the vegetation on the property to be in good condition with no diagnostic symptoms of salt injury.

There were no indications of oil and grease impacted organisms on the Hero Lands Property. Measurement of oil and grease is a generic parameter as is TPH and these parameters are not accurate indicators of potential risks at a site. There is no indication that an exposure of oil and grease or TPH could achieve a level posing ecological risk for the Hero Lands Property (Suter 1997, Salanitro et al. 1997, Kaputska 2004a, Kaputska 2004b, Efroymsom et al. 2004, Chapman 2004).

Compliant with the regulatory guidance framework, this ERA includes the following lines of evidence:

- Site inspection and characterization.
- Information from investigations conducted in 2020 of the wildlife and vegetation as well as measurements of COPECs in samples of soils and hydrosoils.
- A conservative Screening-Level Ecological Risk Assessment (SLERA).
- A conservative site-specific Baseline Ecological Risk Assessment (BERA).
- Evaluation of previous assessments and associated data for the Hero Lands Property.

The lines of evidence summarized above demonstrate that there are no unacceptable risks to the site ecosystem overall. Extensive remedial action based on ecological risk is not warranted for the Hero Lands Property. Localized strategic remedial action as proposed by ERM (2020) would be acceptable in terms of ecological risks.

12. REFERENCES

Ables, E.D. 1969. Activity studies of red foxes in southern Wisconsin. The Journal of Wildlife Management 33:145-153.

Adair, B. et al. 2003. Mercury Occurrence in Prothonotary Warblers (Protonotaria citrea) Inhabiting a National Priorities List Site and Reference Areas in Southern Alabama Arch. Environ. Contam. Toxicol. 44: 265–271. DOI: 10.1007/s00244-002-2027-0

Agency for Toxic Substances and Disease Registry (ATSDR). 1998. Toxicological Profile for Chlorinated Dibenzo p-Dioxins. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Alberta Environment. 2009. Soil Remediation Guidelines for Barite: Environmental and HumanHealth. ISBN No. 978-0-7785-7691-4 (On-line Edition). http://environment.gov.ab.ca/info/

Aldrich, J.W. and F.C. James. 1991. Ecogeographic variation in the American robin (Turdis migratorius). The Auk 108: 230-249.

Alexander, G. 1977. Food of vertebrate predators on trout waters in north central lower Michigan. Michigan Academician 10: 181-195.

Allen, A.W. 1985. Habitat suitability index models: Swamp rabbit. U.S. Fish and Wildlife Service Biological Report 82 (10.107) 20 pp.

Bailey, A.M. 1919. The Bald Eagle in Louisiana. The Wilson Bulletin 31, No. 2: 52-55.

Basser, J.M., W.E. Brunebaugh, N.E. Kimble, T.W. May and C.G. Ingersoll. 2004. Effects of sediment characteristics on the toxicity of chromium III and chromium VI to the amphipod, *Hyalella azteca*. Environmental Science and Technology 38: 6210-6216.

Basu, N., A.M. Scheuhammer, S.J. Bursian, J. Elliott, K. Rouvinen-Watt and H.M. Chan. 2007. Mink as sentinel species in environmental health. Environmental Research 103 (2007) 130–144.

Battelle. 2007. Sediment toxicity of petroleum hydrocarbon fractions. Prepared for Massachusetts Department of Environmental Protection. Office of Research and Standards, Boston, MA 02108.

Bell, T.L. and M.A. Adams. 2011. Attack on all fronts: functional relationships between aerial and root parasitic plants and their woody hosts and consequences for ecosystems. Tree Physiology 31: 3-15.

Berry, W.J., W.S. Boethman, J.R. Serbst and P.A. Edwards. 2004. Predicting the toxicity of chromium in sediments. Environmental Toxicology and Chemistry 23: 2981-2992.

Bechtel-Jacobs Company. 1998a. Empirical models for the uptake of inorganic chemicals from soil by plants. BJC/OR-133. U.S. Department of Energy, Oak Ridge, TN.

Bechtel-Jacobs Company. 1998b. Biota-sediment accumulation factors for invertebrates: review and recommendations for the Oak Ridge Reservation. BJC/OR-112. Oak Ridge National Laboratory, Oak Ridge, TN.

Beyer, W.N., Pattee, O.H., Sileo, L., Hoffman, D.J., and B.M. Mulhern. 1985. Metal Contamination in Wildlife Living Near Two Zinc Smelters. Environmental Pollution (Series A) 38: 63-86.

Beyer W.N., Connor E.E., Gerould S. 1994. Estimates of soil ingestion by wildlife. *Journal of Wildlife Management* 58(2): 375-382.

Beyer W.N., Fries G.F. 2003. Toxicological significance of soil ingestion by wild and domestic animals. *In:* Handbook of Ecotoxicology Chapter 6, pp 151-166.

Bjørgesæter, A. 2006. Field Based Predicted No Effect Concentrations (F-PNECs) for macro benthos on the Norwegian Continental Shelf. Environmental Risk Management System. Report No. 15.

Blankenship, A., Kaya, D., Zwiernik, M., Holem, R., Newsted, J., Hecker, M., and J. Giesy. 2008. Toxicity reference values for mink exposed to 2,3,7,8-tetrachlodibenzo-p-dioxin (TCDD) equivalents (TEQs). Ecotoxicology and Environmental Safety 69 (2008) 325–349.

Bleavins, M.R. and R.J. Aulerich. 1981. Feed consumption and food passage time in mink (Mustela vison) and European ferrets (Mustela putorius furo). Lab. Anim. Sci. 31: 268-269.

Buehler, 2000.

Bond et al. 2006. Swamp rabbit (*Sylvilagus aquaticus*) demographics, morphometrics, and reproductive characteristics in Mississippi. *Journal of the Mississippi Academy of Sciences* 51(2): 123-128.

Bosworth, W.S., and L.J. Thibodeaux. 1990. Bioturbation: a facilitator of contaminant transport in bed sediment. Environmental Progress. 9(4):211-217.

Bowermann, W.W. et al. 2002. Using bald eagles to indicate the health of the Great Lakes' environment. Lakes and reservoirs: research and Management 7: 183-187.

Boyd, E.M. and M. Abel. 1966. The Acute Toxicity of Barium Sulfate Administered Intragastrically. Canad. Mes. Ass. J. 94.

Bradham, K.D., E.A. Dayton, N.T. Barta, J. Shroder, M. Payton and R.T. Lanno. 2006. Effect of soil properties on lead bioavailability and toxicity to earthworms. Environmental Toxicology and Chemistry 25: 769-775.

Briese, L.A. and M.H. Smith. 1974. Seasonal abundance and movement of nine species of small mammals. Journal of Mammalogy 55: 3: 615-629.

Brookings D.G. 1988. Eh, pH diagram for geochemistry. Berlin, Springer. 1-14.

Brown, M. 2014. Lavin's Radiography for Veterinary Technicians – E-book, 5th Edition. ISBN 978-1-4557-2280-8.

Buchman M.F. 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration. 12 pp.

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 pp.

Buddhawong, S., Kuschk, P., Mattusch, J., Wiessner, A., Stottmeister, U.. 2005. Removal of arsenic and zinc using different laboratory model wetland systems. Eng. Life Sci. 5 (3), 247- 252.

Bursian, S.J., Beckett, K.J., Yamini, B., Martin, P.A., Kannan, K., Shields, K.L., and F.C. Mohr. 2006. Assessment of effects in mink caused by consumption of carp collected from the Saginaw River, Michigan, USA. Arch. Environ. Contam. Toxicol. 50, 614–623.

Burt W.H., Grossenheider R.P. 1998. A Field Guide to the Mammals: North America North of Mexico. Houghton Mifflin Harcourt, New York. p. 15.

Calabrese E.J., Baldwin L.A. 1993. Performing Ecological Risk Assessments. CRC Press, Boca Raton, FL.

Carls, M.G. et al. 1984. Toxic Contributions of Specific Drilling Mud Components to Larval Shrimp and Crabs, Marine Environmental Research 12, 45-62.

Casteel S.W. et al. 1997. Bioavailability of lead to juvenile swine dosed with soil from the Smuggler Mountain NPL site of Aspen, Colorado. Fundamental and Applied Toxicology 36: 177-187.

Casteel S.W. et al. 1996. Bioavailability of lead in soil samples from the New Jersey zinc NPL site from Palmerton, Pennsylvania. Report to USEPA #04800-030-0159. Accessible via: http://www.epa.gov/region8/r8risk/pdf/rba-pb_palmerton.pdf

CCME. 1999. Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Canadian Council of Ministers of the Environment, Report no. CCME EPC-98E. 35 pp.

Chalmers, A.T., Marvin-DiPasquale, M.C., Degnan, J.R., Coles, J.F., Agee, J.L., and D. Luce. 2013. Characterization of Mercury Contamination in the Androscoggin River, Coos County, New Hampshire. USGS and USEPA. 68 pgs.

Chapman, J.A. and G.A. Feldhammer. 1981. Sylvilagus aquaticus. Mammalian Species 151: 1-4.

Chapman, P.M. 2004. Introduction: Ecological Risk Assessments at Petroleum-Contaminated Terrestrial Sites, Human and Ecological Risk Assessment: An International Journal, 10:2, 183-184.

Chapman, P.M., Adams, W.J., Brooks, M.L., Delos, C.G., Luoma, S.N., Maher, W.A., Ohlendorf, H.M., Presser, T.S., Shaw, D.P. 2009. Ecological assessment of selenium in the aquatic environment: Summary of a SETAC Pellston workshop. SETAC Press, Pensacola, FL 35pp.

Chabreck, R H., 1972, Vegetation, water and soil characteristics of the Louisiana coastal region, LSU Agricultural Experiment Station Reports. 147.

Chen and Chen. 1992.

Chen, M.H., Chen, C.Y. 1999. Bioaccumulation of sediment-bound heavy metals in grey mullet, *Liza macrolepis*. Mar. Pollut. Bull. 39: 239-244.

Chibunda, R.T. 2009. Chronic Toxicity of Mercury (HgCl2) to the Benthic Midge Chironomus riparius. Int. J. Environ. Res. 3, No. 3: 455-462.

Chumchal, M.W., R.W. Drenner, D.R. Cross and K. D. Hambright. 2010. Factors influencing mercury accumulation in three species of forage fish from Caddo Lake, Texas, USA. Journal of Environmental Sciences 22: 1158-1163.

Clark, B.K. et al. 1995. Population Ecology of Elliot's Short-Tailed Shrew and Least Shrew in Ungrazed Tallgrass Prairie Manipulated by Experimental Fire. Proceedings of the fourteenth North American prairie conference: prairie biodiversity (D.C. Hartnett, ed.), Kansas State University, Manhattan.

Clench, M.H., Leberman, R.C. 1978. Weights of 151 species of Pennsylvania birds analyzed by month, age, and sex. Bulletin Carnegie Museum of Natural History no. 5, 87 pp.

Cleveland, L., Little, E. E., Buckler, D. R., & Wiedmeyer, R. H. 1993. Toxicity and bioaccumulation of waterborne and dietary selenium in juvenile bluegill (*Lepomis macrochirus*). Aquatic Toxicology, 27(3), 265-279.

Coastal Environments, Inc. (CEI). 2019. Ecological Impacts Associated with Oil and Gas Exploration and Production Activities on Hero Lands Company, L.L.C. Property within Stella Oil and Gas Field, Plaquemines Parish, LA. Coastal Environments, Inc., Baton Rouge, LA. Prepared for Swanson, Huddell and Garrison, LLC, New Orleans, Louisiana (August 12, 2019).

Cooper, T.R., and R.D. Rau. 2012. American woodcock population status, 2012. U.S. Fish and Wildlife Service, Laurel, Maryland. 16 pp.Custer, C.M., S.A. Suarez, and D.A. Olsen. 2004. Feeding

habits of the Great Blue Heron and great egret nesting along the upper Mississippi River, 1995-1998. Waterbirds 27 : 454-468.

Custer, C.M., S.A. Suarez, and D.A. Olsen. 2004. Feeding habits of the Great Blue Heron and great egret nesting along the upper Mississippi River, 1995-1998. Waterbirds 27 454-468.

Custer, T.E. and D.W. Peterson, Jr. 1991. Growth rates of great egret, snowy egret and black-crowned night- heron chicks. Colonial Waterbirds 14: 46-50.

Custer, T. W., and R. G. Osborn. 1978. Feeding habitat use by colonially-breeding herons, egrets, and ibises in North Carolina. Auk 95:733-743.

Czech, H.A. and K.C. Parsons. 2002. Agricultural wetlands and waterbirds: A review. Waterbirds: International Journal of Waterbird Biology 25: 56-65.

Davis, A., C. Sellstone, S. Clough, R. Barrick and B. Yare. 1996. Bioaccumulation of arsenic, chromium and lead in fish: constraints imposed by sediment geochemistry. Applied Geochemistry 11: 409-423.

Delnicki, D. and K.J. Reinecke. 1986. Mid-winter food use and body weights of mallards and wood ducks in Mississippi. The Journal of Wildlife Management 50: 43-51.

Dillon, O. W. (1959) Food habits of wild mallard ducks in three Louisiana parishes. Trans. North Am. Wildl. Nat. Resour. Conf. 24: 374-382.

Dolan, A.J. 1986. Winter Food Habits of Mink in Southern Louisiana. The School of Forestry, Wildlife, and Fisheries, Louisiana State University. Thesis. 84 pgs.

Donovan, S., C. Goldfuss and J. Holdren. 2015. M-16-01. Memorandum or executive departments and agencies. Subject: incorporationg ecosystem services intto federal decision making. Washington, DC. Executive Office of the President of the United States. 5pp.

Dorman, L., Castle, J. W., Rodgers Jr., J. H., 2009. Performance of a pilot-scale constructed wetland system for treating simulated ash basin water. Chemosphere. 75 (7), 939-947.

Dunning, J. B., Jr. (1984) Body weights of 686 species of North American birds. Western Bird Banding Association, Monograph No. 1. Cave Creek, AZ: Eldon Publishing.

Dunning, J.B. 1993. CRC Handbook of Avian Body Masses. CRC Press, Ann Arbor. 371 pp.

Edens, F.W., Garlich, J.D. 1983. Lead induced egg production decrease in leghorn and Japanese quail. Poultry Science 62: 1757-63.

Edwards, D., Andriot, M., Amoruso, M., Tummey, A., Bevan, C., Tviet, A., and L. Hayes. 1997. Development of Fraction Specific Reference Does and Reference Concentrations for Total Petroleum hydrocarbons. The Total Petroleum Hydrocarbons Work Group Series.

Efroymson, R.A., T.M. Carlsen, H.I. Jager, T. Kostova, E.A. Carr, W.W. Hargrove, J. Kercher and T.L. Ashwood. 2004. Toward an ecological framework for assessing risk to vertebrate populations from brine and petroleum spills at exploration and production sites. In: L. Kaputska, H. Galbraith, M. Luxon and G.R. Biddinger, eds. Landscape Ecology and Wildlife Habitat Evaluation: Critical Information for Ecological Risk Assessment, Land-Use Management Activities, and Biodiversity Enhancement Practices, ASTM STP 1458, ASTM International, West Conshocken,PA. pp.1-25.

Efroymson, R.A., B.E. Sample and M.J. Peterson. 2010. Ecotoxicity testing data for total petroleum hydrocarbons in soil: Plants and soil-dwelling invertebrates. Human and Ecological Risk Assessment. 10: 207-231.

Eggert, D.A., Rodgers, Jr., J.H., Huddleston, G.M., Hensman, C.E., 2008. Performance of pilot- scale constructed wetland treatment systems for flue gas desulfurization waters. Environ. Geosci. 15 (3), 115-130.

Egwumah, F.A., Egwumah, P.O., and D. Edet. 2017. Paramount roles of wild birds as bioindicators of contamination. International Journal of Avian & Wildlife Biology 2(6): 194-199.

Elner, R., Beninger, P., Jackson, and D., Potter, T. 2005. Evidence of a new feeding mode in western sandpiper (Calidris mauri) and dunlin (Calidris alpina) based on bill and tongue morphology and ultrastructure. Marine Biology 146: 1223–1234.

Engdahl, A. et al. 2008. Oskarshamm and Forsmark site investigation, Chemical composition of suspended material, sediment and pore water in lakes and sea bays. Swedish Nuclear Fuel and Waste Management Co., P-08-81: 80 pgs.

Environment International Ltd. 2010. Upper Columbia River in-Situ Porewater Assessment Sampling and Quality Assurance Plan, Washington State Attorney General's Office.

Environmental Resources Management (ERM). 2019. East White Lake Ecological Risk Assessment, Section 16 Property, East White Lake Oil and Gas Field, Vermilion Parish, Louisiana. September 16, 2019.

Environmental Resources Management (ERM). 2020. Expert Report of David G. Angle, P.G., CGWP & David Upthegrove, P.G. Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al, Plaquemines Parish, Louisiana

Farner, D.S. 1945. Age groups and longevity in the American robin. The Wilson Bulletin 57: 56-74.

Farner, D.S. 1949. Age Groups and Longevity in the American robin: Comments, Further Discussion, and Certain Revisions. The Wilson Bulletin, Vol. 61, No. 2 (Jun., 1949), pp. 68-81.

Faulk, M. et al. 1973. Acute Toxicity of Petrochemical Drilling Fluids Components and Wastes to Fish, Environment Canada,Technical Report Series.

Finerty, M.W., Madden, J.D., Feagley, and Grodner, R.M. 1990. Tissues of Wild and Pond-raised Crayfish in Southern Louisiana, Effect of Environs and Seasonality on Metal Residues. Arch. Environ. Contam. Toxicol. 19: 94-100.

Fleury, B.E. and T.W. Sherry. 1995. Long-term population trends of colonial wading birds in the southern United States: The impact of crayfish culture on Louisiana populations. The Auk 112: 613-632.

Francesconi, K.A., Kuehneit, D., 2002. Arsenic compounds in the environment. Ch. 3 in Environmental Chemistry of Arsenic. Ed. William T. Frankenberger, Jr., Marcel Dekker, Inc., New York.

Gasparik, J.et al. 2013. Concentration of lead, cadmium, mercury and arsenic in leg skeletal muscles of three species of wild birds. J. Env. Sci and Health: Part A: Toxic/Hazardous Substances and Env Engineering. 45: 818-823.

Gatehouse, R. 2004. Ecological risk assessment of dioxins in Australia. Technical Report No. 11. Department of the Environment and Heritage. ISBN 0 642 55003 4.

Genoways, H.H. and J.R. Choate. 1998. Natural history of the southern short-tail shrew, *Blarina carolinensis*. Mammalogy Papers, University of Nebraska State Museum, Paper 244.

Gibbs, J.P. 1991. Spatial relationships between nesting colonies and foraging areas of great blue herons. Auk 108: 764-770.

Gibbs, J.P. and Kinkel, L.K. 1997. Determinants of the Size and Location of Great Blue Heron Colonies. Colonial Waterbirds 20, No. 1: 1-7.

Gillespie, W.B.J., W.B. Hawkins, J.H. Rodgers Jr., M.L. Cano, and P.B. Dorn. 1999. Transfers and Transformations of Zinc in Flow-Through Wetland Microcosms. Ecotoxicology and Environmental Safety 43:126-132.

Gillespie Jr. W.B., Hawkins, W.B., Rodgers Jr. J.H., Cano, M.L., and Dorn, P.B. 2000. Transfers and transformations of zinc in constructed wetlands: Mitigation of a refinery effluent. Ecological Engineering 14:279-292.

Gilmer et al. 1975. Habitat use and home range of mallards breeding in Minnesota. The Journal of Wildlife Management 39: 781-789.

Goodfellow, W.L., L.W. Ausley, D.T. Burton, D.L. Denton, P.B. Dorn, D.R. Grothe, M.A. Heber, T.J. Norberg-King, and J.H. Rodgers, Jr. 2000. Major ion toxicity in effluents: A review with permitting recommendations. Environ. Toxicol. Chem. 19:175-182.

Goodfellow et al. 2002.

Gould, A.B. 1974. The home range and habitat preferences of swamp rabbits along a shell road in the intermediate marsh of Southwestern Louisiana. Thesis. Louisiana State Univeristy. School of Forestry and Wildlife Management. 82 pp.

Grantham,C.K. and J.P. Sloan. 1975. Toxicity Study Drilling Fluid Chemicals on Aquatic Life. Conf.Proc.on Environ.Aspects of Chemical Use in Well-Drilling Operations, Research Triangle Inst., NC (from ECOTOX). EPA 560/1-75-004.

Gregg, L. 1984. Population ecology of woodcock in Wisconsin. Wisconsin Department of Natural Resources Technical Bulletin No. 144, 51 pp.

Guilday, J.E. 1957. Individual and geographic variation in Blarina brevicaudafrom Pennsylvania. Ann. Carnegie Mus. 35: 41-68.

Halbrook, R.S., Petach, M. 2018. Estimated Mink Home Ranges Using Various Home-Range Estimators. Wildlife Society Bulletin 42, No. 4: 656-666.

Hamilton, M.A., P.W. Rode, M.E. Merchant and J. Sneddon. 2008. Determination and comparison of heavy metals in selected seafood, water, vegetation and sediments by inductively coupled plasma-optical emission spectrometry from an industrialized and pristine waterway in Southwest Louisiana. Microchemical Journal 88: 52-55.

Hamilton S.J., Buhl K.J., Lamothe P.J. 2002. Selenium and other trace elements in water, sediment, aquatic plants, aquatic invertebrates, and fish from streams in southeastern Idaho near phosphate mining operations: June 2000. US Geological Survey, Columbia Environmental Research Center, Yankton, SD. 73 pp.

Hamilton, Jr., W.J. 1944. The biology of the little short-tailed shrew, *Cryptotis parva*. Journal of Mammalogy 25: 1-7.

Han, F.X., Y. Su, B.B. Maruthi-Sridhar and D.L. Monts. 2004. Distribution, transformation and bioavailability of trivalent and hexavalent chromium in contaminated soil. Plant and Soil 265: 243-252.

Hanor, J.S. and L.H. Chan. 1977. Non-conservative behavior of barium during mixing of Mississippi River and Gulf of Mexico waters. Earth Planet. Sci. Lett. 37: 242-250.

Harris, R., C. Pollman, W. Landing, D. Evans, and D. Axelrod. 2012. Mercury in the Gulf of Mexico: Sources to receptors. Environmental Research Publications of the Department of Commerce. Paper 382.

Hays, H. 1972. Polyandry in the spotted sandpiper. Living Bird 11:43-57.

Henke, K.R., Hutchison, A. 2009. Arsenic chemistry. Ch. 2 in Arsenic Environmental Chemistry, Health Threats, and Waste Treatment, Ed. Kevin Henke, Wiley, West Sussex, UK.

Hesse,Jr., T.J. 1994. Effect of Hurricane Andrew on Louisiana's nesting bald eagles. Proc. Ann. Conf. Southeast. Assoc. Fish and Wildlife Agencies 48: 395-400.

Hettiarachchi, G.M. and G.M. Pierzynski. 2004. Soil lead bioavailability and in situ remediation of lead-contaminated Soils: A Review. Environmental Progress 23: 78-93.

Hill, R.A.. P.M. Chapman, G.S. Mann and G.S. Lawrence. 2000. Level of detail in ecological risk assessment. Marine Pollution Bulletin 40: 471-477.

Hockman, G. J., and J. A. Chapman. 1983. Comparative Feeding Habits of red foxes (*Vulpes vulpes*) and gray foxes (*Urocyon cinereoargenteus*) in Maryland.

Hoffmeister, D.F. 1989. *Blarina carolinensis*, Southern short-tailed shrew. In: Mammals of Illinois. University of Illinois Press, Champaign pp 72-74.

Holloway, L. (Holloway Environmental Services, Inc.). 2020. Expert Report and Vegetation Root Study, Hero Lands Company, L.L.C., Property, Plaquemines Parish, Louisiana. 19pp.

Howell. J.C. 1942. Notes on the nesting habits of the American Robin (Turdis migratorius L.). American Midland Naturalist 3: 529-603.

Hrudey, S.E., Chen, W., Rousseaux, C.G. 1996. Bioavailability in Environmental Risk Assessment. CRC Press, New York. 294 pp.

Huner, J.V. et al. 2002. Managing agricultural wetlands for waterbirds in the coastal region of Louisiana, USA. Waterbirds; The International Journal of Waterbird Biology 25: 66-78.

Hutcheson, D., Gray, D.H., Venugopal, B., and T.D. Luckey. 1975. Studies of Nutritional Safety of Some Heavy Metals in Mice, The Journal of Nutrition, Vol 105, no.6.

HSDB. 2013. Hazardous Substance Database. Maintained by the Agency for Toxic Substance and Disease Registry.

ICON. 2019. G.W. Miller and J.S. Sills. Expert Report and Restoration Plan for the Landowners; HeroLands Company v Chevron USA Inc., et al; Docket #64320, Div "A"; 25th JDC; Stella Oil Field, Plaquemines Parish, LA Prepared for Swanson, Huddell and Garrison, LLC, New Orleans, Louisiana (July 12, 2019).

Jager, T. 1998. Mechanistic approach for estimating bioconcentration of organic chemicals in earthworms. Environmental Toxicology and Chemistry 17: 2080-2090.

James, F.C. and H.H. Shugart, Jr. 1974. The phenology of the nesting season of the American robin (Turdis migratorius) in the United States. The Condor 76: 159-168.

Johnson, D. et al. 1960. Tolerance of chickens for barium. Proc. Soc. Exp. Biol. Med. 104: 436- 438.

Johnson, W.P. and F.C. Rohwer. 2000. Foraging behavior of green-wing teal and mallards on tidal mudflats in Louisiana. Wetlands 20: 184-188.

Jones, D. M., and J. B. Theberge. 1982. Summer home range and habitat utilization of red fox (*Vulpes vulpes*) in a tundra habitat, northwest British Columbia, Canada. Can. J. Zool. 60:807-812.

Kadlec, R. H., Wallace, S. D. 2009. Treatment Wetlands. 2nd ed: Boca Raton, FL, CRC Press. 1016 pp.

Kaplan, D. I., Knox, A. S., Myers, J. 2002. Mercury geochemistry in wetlands and its implications for in situ remediation. J. Environ. Eng. 128, 723-732.

Kapustka, L.A. 2004a. Establishing Eco-SSLs for PAHs: Lessons Revealed from a Review of Literature on Exposure and Effects to Terrestrial Receptors, Human and Ecological Risk Assessment: An International Journal, 10:2, 185-205.

Kapustka, L.A. 2004b. Do PAHs Pose Unacceptable Ecological Risks to Terrestrial Receptors at Hazardous Waste Sites? Human and Ecological Risk Assessment: An International Journal, 10:2, 233-243.

Keim, R.F., J.L. Chambers, M.S. Hughes, J.A. Nyman, C.A. Miller, J.B. Amos, W.H. Conner, J.W. Day Jr., S.P. Faulkner, E.S. Gardiner, S.L. King, K.W. McLeod, and G.P. Shaffer. 2006. Ecological consequences of changing hydrological conditions in wetland forests of coastal Louisiana. P. 383-395 in: Coastal Environment and Water Quality, Y.J. Xu and V.P. Singh, eds. Challenges in Coastal Hydrology and Water Quality, Water Resource Publications, Highlands Ranch, Colo. 534 p.

Kelley, James R. Jr.; Williamson, Scot; and Cooper, Thomas R., 2008. "American Woodcock Conservation Plan: A Summary of and Recommendations for Woodcock Conservation in North America". *US Fish & Wildlife Publications.* Paper 430. http://digitalcommons.unl.edu/usfwspubs/430

Khangarot,B.S. 1991. Toxicity of Metals to a Freshwater Tubificid Worm, Tubifex tubifex (Muller), Bull. Environ. Contam. Toxicol.46:906-912 (from ECOTOX).

Khangarot,B.S. and P.K. Ray. 1989. Investigation of Correlation Between Physicochemical Properties of Metals and Their Toxicity to the Water Flea Daphnia magna Straus, Ecotoxicol. Environ. Saf.18(2): 109-121 (from ECOTOX).

Khangarot, B.S. and S. Das. 2009. Acute toxicity of metals and reference toxicants to a freshwater ostracod, Cypris subglobosa Sowerby, 1840 and correlation to EC50 values of other test models, Journal of Hazardous Materials 172, 641–649.

King, D.T. and D. Leblanc. 1995. Foraging behavior of Snowy Egrets (Egretta thuja) and yellow-crowned night herons (Nyctanassa violacea) in south Louisiana. USDA National Wildlife Research Center – Staff Publications (Paper 545).

Kirk, J.G.D. 2004. Biogeochemistry of Submerged Soils. Wiley InterScience, Somerset NJ.

Keithly, J, J.A. Brooker, D.K. DeForest, B.K. Wu and K.V. Brix. 2004. Acute and chronic toxicity of nickel to a cladoceran (*Ceriodaphnia dubia*) and an amphipod (*Hyalella azteca*). Environmental Toxicology and Chemistry 23: 691-696.

Knable, A.E. 1974. Seasonal trends in the utilization of major food groups by the red fox (Vulpes fulva) in Union County, Illinois. Trans. Ill. State Acad. Sci. 66: 113-115.

Kosolapov , D. B., Kuschk, P., Vainshtein, M.B., Vatsourina, A.V., Wiener, A., Kastner, M., Muller, R. A. 2004. Microbial processes of heavy metal removal from carbon-deficient effluents in constructed wetlands. Eng. Life Sci. 4, 403-411.

Kraus, M. 1989. Bioaccumulation of Heavy Metals in Pre-fledgling Tree Swallows, Tachycineta bicolor Bull. Environ. Contam. Toxicol. 43:407-414.

Krementz, D.G. and J.J. Jackson. 2009. Woodcock in the Southeast: Natural history and management for landowners. The University of Georgia College of Agriculture and Environmental Sciences Cooperative Extension Service, 24 pp.

Kubiak, M. and N.A. Forbes. 2012. Short Communications, Fluoroscopic Evaluation of Gastrointestinal Transit Time in African Grey Parrots. 10.1136/vr.100774, Veterinary Record.

Kuperman, R.G., Checkai, R., Simini, M., Phillips, C., Speicher, J., and D. Barclift. 2006. Toxicity Benchmarks for Antimony, Barium, and Beryllium Determin. using Reproduc. Endpoints for Folsomia Candida, Eisenia Fetida, and Enchytraeus Crypticus, Environ. Toxicol. and Chem. 25(3): 754–762.

Kushlan, J.A. 1976. Wading bird predation in a seasonally fluctuating pond. The Auk 93: 464 – 476.

Kushlan, J.A. 1976. Feeding behavior of North American herons. The Auk 93: 86-94.

Lariviere, S., and M. Pasitschniak-Arts. 1996. Vulpes vulpes. Mammalian Species No. 537. American Society of Mammalogists. 11pp.

Leonards, P.E.G., de Vries, T.H., Minnaard, W. et al. 1995. Assessment of experimental data on PCB-induced reproduction inhibition in mink, based on an isomer- and congener139 specific approach using 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalency. Environmental Toxicology and Chemistry, 14 (4): 639-652.

Leung, K.M.Y., Bjørgesæter, A. Gray, J.S., Li, W.K., Lui, G.C.S., Wang, Y., and P.K.S. Lam. 2005. Deriving Sediment Quality Guidelines from Field-Based Species Sensitivity Distributions. Environ. Sci. Technol. 39: 5148-5156.

Levey, D.J. and W. H. Karasov. 1992. Digestive modulation in a seasonal frugivore, the American robin (Turdis migratorius). American J. Physiology 262: 711-718.

Lin, S. and J.W. Morse. 1991. Sulfate reduction and iron sulfide mineral formation in Gulf of Mexico anoxic sediments. Am. J. Science 291: 55-89.

Linscombe, G. 2000. An evaluation of the no.2 victor and 220 conibear traps in coastal Louisiana. Louisiana Wildlife and Fisheries Commission, Baton Rouge, LA 70804 pp.560-568.

Lizama A., K., Fletcher, T. D., Sun, G. 2011. Removal processes for arsenic in constructed wetlands. Chemosphere. 84(8), 1032-1043.

Long, E.R., and D.D. MacDonald. 1998. Recommended uses of empirically derived, sediment quality guidelines for marine and estuarine ecosystems. Human and Ecological Risk Assessment 4(5): 1019-1039.

Longmire, P., M. Dale and K. Granzow. 2013. Chromium geochemistry in a wetland environment. Procedia Earth and Planetary Science 7: 517-520.

Lorber, M., Patterson, D., Howe, J., and H. Kahn. 2009. Evaluation of background exposures of Americans to dioxin-like compounds in the 1990s and the 2000s. Chemosphere 77: 640-651.

Louisiana Department of Environmental Quality (LDEQ). 2001. State-specific Background Arsenic Level in Soil.: First Accessed online August 2011 via: http://thelensnola.org/wp-content/uploads/2010/02/LDEQ_Arsenic-background-level.pdf

Louisiana Department of Environmental Quality (LDEQ). 2011. Memorandum: Arsenic sampling results explained: First Accessed August 2011 via: http://www.deq.state.la.us/portal/portals/0/news/pdf/arsenicexplainedjan10.pdf

Louisiana Department of Environmental Quality (LDEQ) Corrective Action Group. 2003. Risk Evaluation and Corrective Action Program (RECAP). 129 pp. available online at http://www.deq.state.la.us/portal/DIVISIONS/UndergroundStorageTankandRemediation Division/RemediationServices/RECAP/RECAPDocument2003.aspx

Louisiana Department of Environmental Quality (LDEQ). 2019. Louisiana Environmental Assessment Utility (LEAU) database. https://waterdata.deq.louisiana.gov/

Louisiana Department of Natural Resources (LDNR). 2010. Office of Conservation (OC) Off- site Storage, Treatment and/or Disposal of Exploration and Production Waste Generated from Drilling and Production of Oil and Gas Wells of Statewide Order No. 29-B, Title 43; Part XIX. Subpart 1. (Dated June 2010).

Lucas, L. and J.D. Hoffman. 2015. Reproductive notes on shrews (Family Soricidae) in Louisiana. Western North American Naturalist 75: 374-376.

Lui, G.C.S., Li, W.K., Bjørgesæter, A., K.M.Y. Leung. 2014. Deriving field-based sediment quality guidelines from the relationship between species density and contaminant level using a novel nonparametric empirical Bayesian approach. Environ. Sci. Pollut. Res. 21: 177-192.

Luo et al. 2014.

Ma L.Q., Rao G.N. 1997. Chemical fractionation of cadmium, copper, nickel, and zinc in contaminated soils. Journal of Environmental Quality 26(1): 259-264.

Macdonald et al. 1996. Development and evaluation of sediment quality guidelines for Florida coastal waters. Ecotoxicology 5: 253-278.

Macdonald J.M. et al. 1988. Acute toxicities of eleven metals to early life-history stages of the yellow crab Cancer anthonyi, Marine Biology 98, 201-207.

MacDonald et al. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental Contamination and Toxicology 39(1): 20-31.

MacDonald, D.W. and L.A. Harrington. 2003. The American mink: The triumph and tragedy of adaptation out of context, New Zealand Journal of Zoology 30: 421-441.

Martin, R.P. et al. 1991. Habitat usage by small mammals in coastal marshes of southwestern Louisiana. Estuaries 14: 107-110.

Masscheleyn, P.H., J.H. Pardue, K.D. DeLaune, and W.H. Patrick, Jr. 1992. Chromium redox chemistry in a lower Mississippi valley bottomland hardwood wetland. Environmental Science and Technology 26: 1217-1226.

Masscheleyn, P.H. and W.H. Patrick, Jr. 1993. Biogeochemical processes affecting selenium cycling in wetlands. Environmental Toxicology and Chemistry 12: 2235-2243.

Maxson, S.J., Oring, L.W. 1980. Breeding season time and energy budgets of the polyandrous spotted sandpiper. Behaviour 74: 200-263.

McCay T.S. 2001. *Blarina carolinensis*. Mammalian Species, American Society of Mammalogists 673: 1-7.

Mc Ewan, L.C. and D.H. Hirth. 1980. Food Habits of the Bald Eagle in North-Central Florida. The Condor 82, No. 2: 229-231.

McMillen, S.J., R.I Magaw, and R.L. Caravillano. 2001. Developing total petroleum hydrocarbon risk-based screening levels for sites impacted by crude oils and gas condensates. In: Risk-based decision making for assessing petroleum impacts at exploration and production sites; published by the U.S. Department of Energy and the Petroleum Environmental Research Forum. October.

MDEQ. 1998. Part 201 Generic Soil Direct Contact Criteria, Technical Support Document. Michigan Department of Environmental Quality Environmental Response Division. August 31, 1998.

Meador, J.P. et al. 2004. Bioaccumulation of Arsenic in Marine Fish and Invertebrates from Alaska and California. Archives of Environmental Contamination and Toxicology 47, 223-233.

Meador, J.P., Ernest, D.W., Kagley, A.N. 2005. A comparison of the non-essential elements cadmium, mercury, and lead found in fish and sediment from Alaska and California. Science of the Total Environment 339: 189-205.

Meharg, A.A.; Shore, R.F.; French, M.C.; and D. Osborn. 1997. Dioxin and Furan Residues in Wool Mice (Apodemus sylvaticus) Following a Large Scale Polyvinyl Chloride (PVC) Fire. Environmental Pollution. 97(3):213-220.

Menzie, C.A., B. Southworth, G. Stepheson, and N. Feisthauer. 2008. The importance of understanding the chemical form of a metal in the environment: the case of barium sulfate (Barite). Human and Ecological Risk Assessment 14: 974-991.

Moore, K. 2002. "*Actitis macularius*" (On-line), Animal Diversity Web. Accessed September 19, 2016.

Munns, R. 2002. Comparative physiology of salt and water stress. Plant, Cell and Environment 25: 239-250.

Nagy, K.A. 2001. Food requirements of wild animals: predictive equations for free-living mammals, reptiles, and birds. Nutrition Abstracts and Reviews Series B: Livestock Feeds and Feeding. 71(10): 3R-12R.

Nakamora, Y.M. and J. Altansurd. 2014. Speciation and bioavailability of selenium and antimony in non-flooded and wetland soils: a review. Chemosphere 111: 366-371.

National Acid Precipitation Assessment Program. 1987. Diagnosing injury to eastern forest trees. A manual for identifying damage caused by air pollution, pathogens, insects, and abiotic stresses. USDA and Pennsylvania State University (College of Agriculture). 122 pp.

National Research Council. 2003. Bioavailability of Contaminants in Soils and Sediments, Processes, Tools and Applications. Division on Earth and Life Sciences, Water Science and Technology Board, Committee on Bioavailability of Contaminants in Soils and Sediments., Washington, D.C.

Neff, J.M. and T.C. Sauer, Jr. 1995. Barium in produced water: Fate and effects in the marine environment. American Petroleum Institute Publication Number 4633: 66 pp.

Nelson, A.L., Martin, A.C. 1953. Gamebird weights. The Journal of Wildlife Management 17(1): 36- 42.

Newell, A.J., D.W. Johnson, and L.K. Allen. 1987. Niagara River biota contamination project: fish flesh criteria for piscivorous wildlife. Division of Fish and Wildlife, Bureau of Environmental Protection. Technical report 87-3.

Nichols, J.D. et al. 1983. Factors affecting the distribution of mallards wintering in the Mississippi alluvial valley. The Auk 100: 932-946.

Novitzki, R.P., R.D. Smith and J.D. Fretwell. 2014. Wetland Functions, Values and Assessment. USGS United States Geological Survey. USGS Water Supply Paper 2425, National Water Summary on Wetland Resources. Accessed on the internet.

NRCS – Natural Resources Conservation Service. 2008. Wetland Functional Assessments: Rapid Tools Used to Meet the Mandates of the 1985 Food Security Act and NRCS Wetland Protection Policy. Technical Note No. 77; US Department of Agriculture; accessed on the internet.

Ohio Environmental Protection Agency (OEPA). 1991. Fish Tissue Bottom Sediment Surface Water Organic & Metal Chemical Evaluation, Ottawa River, Ten Mile Creek, Toledo, Ohio, Division Of Water Quality Planning And Assessment. US Geological Survey. Pearl, Mississippi.

O'Neil, T. 1949. The muskrat in the Louisiana marshes. LA Wildl. Fish. Commission, New Orleans, LA.

Oremland, R. S. 1994. Biogeochemical transformations of selenium in anoxic environments. In W. T. Frankenberger Jr. & S. Benson (Eds.), Selenium in the environment (pp. 389– 417). New York: Marcel Dekker.

Oring, L.W. and D.B. Lank. 1982. Sexual selection, arrival times, philopatry, and site fidelity in the polyandrous spotted sandpiper. Behavioral Ecology and Sociobiology 10: 185-191.

ORNL 1997a Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. United States Department of Energy, Office of Environmental Management Report #ES/ER/TM-85/R3. Accessible via: http://rais.ornl.gov/documents/tm85r3.pdf

ORNL 1997b Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision. United States Department of Energy, Office of Environmental Management Report #ES/ER/TM- 126/R2. Accessible via: http://rais.ornl.gov/documents/tm126r1.pdf

Paquette, K. Helz, G. 1995. Solubility of cinnabar (red HgS) and implications for mercury speciation in sulfidic waters. Water Air Soil Pol. 80, 1053-1056.

Parish, J.A. 2010. Petroleum product poisoning of cattle. Mississippi State University Extension Service. Publication 2621. 4pp.

Parsons et al. 2000. Snowy Egret Identification, All About Birds, Cornell Lab of Ornithology.

Pattanayek, M. and B. DeShields. 2004. Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons. Publication 4733. American Petroleum Institute. Washington, D.C.

Payne, J.F. et al. 2006. Risks assoc. with drill. fluids at petrol. developm. sites in the offsh.: Eval. of the potent. for an aliph. HC- based drill. fluid to produce sedimen. toxicity and for barite to be acut. toxic to plankton. Can. Tech. Rep. Fish. Aquat. Sci. 2679.

Payne, J. et al. 2011. Produced Water: Overview of Composition, Fates, and Effects, Chapter 21 Risks to Fish Associated with Barium in Drilling Fluids and Produced Water: A Chronic Toxicity Study with Cunner (Tautogolabrus adspersus).

Pezeshki, S.R., M.W. Hester, Q. Lin and J.A. Nyman. 2000. The effects of oil spill and clean-up on dominant US Gulf coast marsh macrophytes: A review. Environmental Pollution 108: 129-139.

Pickett, T., Sonstegard, J., & Bonkoski, B. (2006). Using biology to treat selenium. Power Engineering, 100(11), 140–144.

Pitts, T.D. 1984. Description of American robin territories in northwest Tennessee. Migrant 55:1-6.

Quinney, T. E. (1982) Growth, diet, and mortality of nestling great blue herons. Wilson Bull. 94: 571-577.

Prokop Z et al. 2003 Mobility, bioavailability, and toxic effects of cadmium in soil samples. Environmental Research 91(2): 119-126.

Rahman, M.M., Sengupta, M.K., Chowdhury, U.K., Lodh, D., Das, B., Ahamed, D.S., Mandal, D., Hossain, M.A., Mukherjee, S.C., Pati, S., Saha, K.C., Chakraborti, D. 2006. Arsenic around the world- an overview. Ch. 1 in Managing Arsenic in the Environment. Eds. Ravi Naidu, Euan Smith, Gary Owens, Prosun Bhattacharya and Peter Nadebaum. Csiro Publishing, Collingwood, Victoria, Australia.

Rahman, K. Z., Wiessner, A., Kuschk, P., van Afferden, M., Mattusch, J., Müller, R. A. 2011. Fate and distribution of arsenic in laboratory-scale subsurface horizontal-flow constructed wetlands treating an artificial wastewater. Ecol. Eng. 37 (8), 1214-1224.

Razavi, N.R., Ridal, J.J., De Witt, W., Hickey, M.B.C., Campbell, L.M., and P.V. Hodson. 2013. Ebullition rates and mercury concentrations in St. Lawrence River sediments and a benthic invertebrate. Environmental Toxicology and Chemistry 32, No. 4: 857-865.

Ridal, J.J., Yanch, L.E., Fowlie, A.R., Razavi, N.R., Delongchamp, T.M., Choy, E.S., Fathi, M., Hodson, P.V., Campbell, L.M., Blais, J.M., Hickey, M.B.C., Yumvihoze, E., and D.R.S. Lean. 2010. Potential causes of enhanced transfer of mercury to St. Lawrence River Biota: implications for sediment management strategies at Cornwall, Ontario, Canada. Hydrobiologia 647: 81-98.

Rifkin, E. P. Guinn and E. Bouwer. 2004. Chromium in Sediments. Environmental Science and Technology 38: 267A-271A.

Rogers, W. J. 2019. Toxicological Evaluation and Risk Assessment Associated With Oil and Gas Operations on the Hero Lands, L.L.C. Property Within Stella Oil and Gas Field, Plaquemines Parish, Louisiana. Omega EnviroSolutions, Inc., Canyon, TX. Prepared for Swanson, Huddell and Garrison, LLC, New Orleans, Louisiana (August 26, 2019).

Roumak, V.S.; Leverikova, E.S.; Umnova, N.V.; Popov, V.S.; Turbabina, K.A.; and A.A. Shelepchikov. 2018. The content of dioxins and furans in soils, bottom sediments of water, and tissues of small mammals near the landfill site with municipal solid wastes (Moscow, Russia). Environmental Science and Pollution Research. 2018. 25:29379-29386. https://doi.org/10.1007/s11356-018-2933-y.

Salanitro, J.B., P.B. Dorn, M. H. Huesmann, K.O. Moore, I.A Rhodes, L. M. R. Jackson, T.E. Vipond, M. M. Western, and H.L. Wisnewiski. 1997. Crude oil hydrocarbon bioremediation and soil ecotoxicity assessment. Environ. Sci. Technol. 31: 1769-1776.

Salt, D.E., R.D. Smith and I. Raskin. 1998. Phytoremediation. Annu. Rev. Plant Physiol. Plant Mol. Biol. 49: 643-668.

Sample, B.E., D.M. Opresko, and G.W. Suter, II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, Tennessee. ES/ER/TM- 86/R3.

Sample et al. 1996. Toxicological Benchmarks for Wildlife: 1996 Revisions. Oak Ridge National Laboratory, Oak Ridge, TN.

Sample and Suter. 1994. Estimating Exposure of Terrestrial Wildlife to Contaminants. Oak Ridge National Laboratory, Tennessee, U.S. Department of Energy.

Sample et al. 1998a. Literature-derived bioaccumulation models for earthworms: development and validation. Environmental Toxicology and Chemistry 18(9): 2110-2120.

Sample et al. 1998b Development and validation of bioaccumulation models for small mammals. ES/ER/TM-219. Oak Ridge National Laboratory, Oak Ridge, TN.

Sargeant, A. B. 1972. Red fox spatial characteristics in relation to waterfowl predation. Journal of Wildlife Management. 36:225-236.

Sargeant, A. B. 1978. Red fox prey demands and implications to prairie duck production. Journal of Wildlife Management. 42:520-527.

Sargeant, A. B., S. H. Allen, and R. T. Eberhardt. 1984. Red fox predation on breeding ducks in midcontinent North America. Wildlife Monographs. 89:1-41.

Sasser, C. et al. 2104. Vegetation Types in Coastal Louisiana in 2013, United States Geologic Survey.

Savannah River Site. 1999. Terrestrial toxicity reference values (TRVs) (including exposure dose (ED) and hazard quotient (HQ) calculations. US Department of Energy SRS, Environmental Restoration Division ERD-AG-003.

Scharine, P.D. et al. 2009. Swamp rabbits in flood plain ecosystems: Influence of landscape- and stand-level habitat on relative abundance. Wetlands 29: 615-623.

Scheuhammer, A.M. 1987. The chronic toxicity of aluminium, cadmium, mercury, and lead in birds: a review. Environmental Pollution 46: 263-295.

Schwindaman, J.P., Castle, J.W. and Rodgers, Jr., J.H. 2014. Fate and distribution of arsenic in a processed-designed pilot-scale constructed wetland treatment system. Ecol. Engineering 68: 251-259.

Seaman, D., Guglielmo, C., Williams, T. 2005. Effects of physiological state, mass change and diet on plasma metabolite profiles in the western sandpiper Calidris mauri. Journal of Experimental Biology 208, 761-769.

Seston, R.M. et al. 2009. Utilizing the Great Blue Heron (*Ardea herodias*) in ecological risk assessments of bioaccumulative contaminants. Environ Monitoring Assess 157: 199-210.

Seston, R.M. 2010. AN Ecological Risk Assessment of Fish-Eating Birds Exposed to Polychlorinated Dibenzofurans and Dibenzo-p-dioxins Withing the Tittabawassee River Floodplain, MI, USA. A Dissertation Submitted to Michigan State University.

Sharma, V.K., Sohn, M. 2009. Aquatic arsenic: toxicity, speciation, transformations, and remediation. Environ. Int. 35, 743-759.

Siddique, T., Arocena, J. M., Thring, R. W., and Zhang, Y. 2007. Bacterial reduction of selenium in coal mine tailings pond sediment. Journal of Environmental Quality, 36, 621–627.

Siddique, T., Okeke, B. C., Zhang, Y., Arshad, M., Han, S. K., and Frankenberger, W. T. 2005. Bacterial diversity in selenium reduction of agricultural drainage water amended with rice straw. Journal of Environmental Quality, 34, 217–226.

Silverman, S. and L.A. Tell. 2010. Radiology of Birds: An Atlas of Normal Anatomy and Positioning. First Edition.

Singhakant, C., Koottatep, T., Satayavivad, J., 2009. Enhanced arsenic removals through plant interactions in subsurface-flow constructed wetlands. J. Environ. Sci. Heal. A. 44 (2), 163- 169.

Smith, D.B., Cannon, W.F., Woodruff, L.G., Solano, Federico, Kilburn, J.E., and D.L. Fey. 2013. Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, 19 p., http://pubs.usgs.gov/ds/801/.

Smith, J.P. 1997. Nesting Season Food Habits of 4 Species of Herons and Egrets at Lake Okeechobee, Florida. Colonial Waterbirds 20: 198-220.

Smith, N.R. 2014. History, Nesting Population, Migration, Home Range and Habitats Used by Louisiana Bald Eagles. Thesis, Louisiana State University, School of Renewable Natural Resources.122 pp.

Smith, N.R. et al. 2016. History and nesting population of bald eagles in Louisiana. Southeastern Naturalist 15: 12-25.

Smith, W.P. and P.A. Zollner. 2001. Seasonal habitat and distribution of swamp rabbits, white-tailed deer, and small mammals in old growth and managed bottomland hardwood forests. U.S. Forest Service General Technical Publication SRS-42.

Spacil, M.M., Rodgers, Jr., J.H., Castle, J.W., Chao, W.Y. 2011. Performance of a pilot-scale constructed wetland treatment system for selenium, arsenic, and low-molecular-weight organics in simulated fresh produced water. Environ. Geosci. 18 (3), 145-156.

Sparling, D.W., G. Linder, and C.A. Bishop. 2000. Ecotoxicology of Amphibians and Reptiles. Society of Environmental Toxicology and Chemistry (SETAC). SETAC Press, Pensacola, Florida.

Sprague, J. et al. 1979. Separate and Joint Toxicity to Rainbow Trout of Substances Used in Drilling Fluids for Oil Exploration, Environ. Pollut. 0013-9327.

Spencer, R.K. and J.A. Chapman. 1986. Seasonal feeding habits of New England and eastern cottontails. Proc. Penn. Acad. Sci. 60: 157-160.

Stein, ED et al. 2009. Diagnosing wetland health with rapid assessment methods. Society of Wetland Scientists Research Brief. (No. 2006-0018). Accessed on the internet.

Stevenson, Jr., H.M. 1944. Southeastern limits of the spotted sandpiper's breeding range. The Auk 61: 247-251.

Storm et al. 1976 Morphology, reproduction, dispersal, and mortality of midwestern red fox populations. Wildlife Monographs No. 49: 82 pp.

Storm, G. L., R. D. Andrews, P. L. Phillips, R. A. Bishop, D. B. Siniff, and J. R. Tester. 1976. Morphology, reproduction, dispersal, and mortality of Midwestern red fox populations. Wildlife Monograph No. 49. 82pp.

Stribling, H.L., Doerr, P.D. 1985. Nocturnal use of fields by American woodcock. The Journal of Wildlife Management 49: 485-491.

Strong, A.M., Bancroft, G.T., Jewell, S.D. 1997. Hydrological constraints on tricolored heron and snowy egret resource use. Condor 99: 894-905.

Stumm, W. & Morgan, J.J. 1996. Aquatic chemistry: Chemical equilibria and rates in natural waters. In 3rd (Ed.), Scope of aquatic chemistry 1996; 1-15. John Wiley & Sons: New York, NY.

Su, T., S. Shu, H, Shi, J. Wang, C. Adams and E.C.Witt. 2008. Distribution of toxic trace elements in soil/sediment in post-Katrina New Orleans and the Louisiana Delta. Environmental Pollution 156: 944-950.

Suntornvongsagul, K, D.J. Burke, E.P. Hamerlunck, and D. Hahn. 2007. Fate and effects of heavy metals in salt marsh sediments. Environmental Pollution 149: 79-91.

Suter, G.W. 1997. A framework for assessing ecological risks of petroleum-derived materials in soil. ORNL/TM -13408. ORNL, USDOE. 59 pp.

Suter, G.W., II. (editor). 2007. Ecological Risk Assessment. Lewis Publishers, Boca Raton, Florida. 2nd ed.

Swanson, G. A.; Meyer, M. I.; and V.A. Adomaitis. 1985. Foods consumed by breeding mallards on wetlands of south-central North Dakota. J. Wildl. Manage. 49: 197-203.

Swarzenski, C.M., Mize, S.V., Thompson, B.A., and Peterson, G.W. 2004. Fish and aquatic invertebrate communities in waterways, and contaminants in fish, at the Barataria Preserve of Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000: U.S. Geological Survey Scientific Investigations Report 2004-5065, 35 p.

Svihla, A. 1931. Habits of the Louisiana Mink (Mustela vulgivagus) Journal of Mammalogy12: 366-368.

Tamisier, A. 1976. Diurnal activities of the green-wing teal and pintail wintering in Louisiana. Wildfowl 27: 19-32.

Tannebaum, L.V. 2005. A critical assessment of the ecological risk assessment process: a review of misapplied concepts. Integrated Environmental Assessment and Management 1: 66-72.

Taylor, G.W. 1972. A Telemetric Study of the Red Fox in Agricultural Areas of Southeast Louisiana. The School of Forestry and Wildlife Management, Louisiana State University. Thesis. 115 pgs.

Tazelaar, D.; Fredricks, T.; Seston, R.; Coefield, S.; Bradley, P.; Roark, S.; Kay, D.; Newsted, J.; Giesy, J.; Bursian, S.; Zwiernik, M. 2013. Multiple lines of evidence risk assessment of American robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry. Volume 32, Issue 6.

Teal, J.M., R. Best, J. Caffrey, C.S. Hopkinson, K.L. McKee, J.T. Morris, S. Newman and B. Orem. 2012. Mississippi River Freshwater Diversions in Southern Louisiana: Effects on Wetland Vegetation, Soils, and Elevation. Edited by A.J. Lewitus, M. Croom, T. Davison, D.M. Kidwell, B.A. Kleiss, J.W. Pahl, and C.M. Swarzenski. Final Report to the State of Louisiana and the U.S. Army Corps of Engineers through the Louisiana Coastal Area Science & Technology Program; coordinated by the National Oceanic and Atmospheric Administration. 49 pages.

Teck American, Inc. 2010. Upper Columbia River Screening - Level Ecological Risk Assessment (SLERA) Teck American, Inc., Spokane, WA.

Thom, M.D. et al. 2004. Why are American mink sexually dimorphic? A role for niche separation. Oikos 105: 525-535.

Thompson, J.A.J. and D.W. Patton. 1975. Chemical delineation of a submerged mine tailings plume in Rupert and Holberg inlets. BC Fish Mar Serv Tech Rept No. 506.

Tillitt D.E., Gale, R.W., Meadows, J.C., Zajicek, J.L., Peterman, P.H., Heaton, S.N., Jones, P.D., Bursian, S.J., Kubiank, T.J., Giesy, J.P., and R.J. Aulerich. 1996. Dietary exposure of mink to carp from Saginaw Bay. 3. Characterization of dietary exposure to planar halogenated hydrocarbons, dioxin equivalents and biomagnificationí. Environmental Science and Technology 30:283-291.

Todd, C.S., Young, L.S., Owen, R.B., Jr. et al. 1982. Food habits of bald eagles in Maine. J. Wildl. Manage. 46: 636-645.

Toll, J.E., Baskett, T.S., Conaway, C.H. 1960. Home range, reproduction, and foods of the swamp rabbit in Missouri. American Midland Naturalist 63: 398-412.

Trahan, L. 2000, Soil survey of Plaquemines Parish, Louisiana, United States Department of Agriculture, Natural Resources Conservation Service ; in cooperation with Louisiana Agricultural Experiment Station and Louisiana Soil and Water Conservation Committee.

Trewhella, W.J. et al. 1988. Dispersal distance, home-range size and population density in the red fox (Vulpes vulpes): A quantitative analysis. Journal of Applied Ecology 25: 423-434.

USACE. 2007. Biota-Sediment Accumulation Factor Database. United States Army Corps of Engineers. Accessed 2/28/12 from: http://el.erdc.usace.army.mil/bsafnew/

USEPA. 1985. Health Assessment Document for Polychlorinated Dibenzo-p-Dioxin.Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. EPA 600/8-84-014F.

USEPA. 1989. Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual ("RAGS II") (EPA/540/1-89/001).

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

USEPA. 1993. Wildlife Exposure Factors Handbook. Volumes I and II. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. EPA/600/R-93/187a, b.

USEPA. 1996. Soil Screening Guidance: User's Guide. Office of Solid Waste and Emergency Response. 9355.4-23. 2nd Ed.

USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Washington, D.C. OSWER 540-R-97-006.

USEPA. 1997. Health Effects Assessment Summary Tables. FY 1997 Update. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH.

USEPA. 1997. Uncertainty Factor Protocol for Ecological Risk Assessment Toxicological Extrapolations to Wildlife Receptors. Region VIII, Ecosystems Protection and Remediation Division, Denver, CO.

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

USEPA. 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Originally published November 1995. Website version last updated November 30, 2001:http://www.epa.gov/region4/superfund/programs/riskassess/ecolbul.html.

USEPA. 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Review of Background Concentrations for Metals (Attachment 4-1). OSWER Directive 92857-55.

USEPA. 2005(a). Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER Directive 92.857-55 and Attachment 1-2 (Assessment of whether to develop ecological soil screening levels for microbes and microbial processes).

USEPA. 2005(b). Ecological Soil Screening Levels for Arsenic Interim Final OSWER Directive 9285.7-62 Office of Solid Waste and Emergency Response 1200 Pennsylvania Avenue, N.W. Washington, DC 20460 March 2005.

USEPA. 2005(c). Ecological Soil Screening Levels for Barium Interim Final, OSWER Directive 9285.7-63U.S. Office of Solid Waste and Emergency Response 1200 Pennsylvania Avenue, N.W. Washington, DC 20460, February, 2005.

USEPA. 2005(d). Ecological Soil Screening Levels for Cadmium Interim Final OSWER Directive 9285.7-65 U.S. Office of Solid Waste and Emergency Response 1200 Pennsylvania Avenue, N.W. Washington, DC 20460, March, 2005.

USEPA. 2005(e). Ecological Soil Screening Levels for Lead Interim Final OSWER Directive 9285.7-70 U.S. Office of Solid Waste and Emergency Response 1200 Pennsylvania Avenue, N.W. Washington, DC 20460, March 2005.

USEPA. 2007(c). Ecological Soil Screening Levels for Zinc Interim Final OSWER Directive 9285.7-73 U.S Office of Solid Waste and Emergency Response1200 Pennsylvania Avenue, N.W. Washington, DC 20460, June 2007.

USEPA. 2008. Ecological Soil Screening Levels for Chromium Interim Final OSWER Directive 9285.7- 66 Office of Solid Waste and Emergency Response 1200 Pennsylvania Avenue, N.W. Washington, DC 20460, March 2005, Revised April 2008.

USEPA. 2008. Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment. EPA 10/R-0/00. http://www.epa.gov/raf/teffframework/pdfs/tefs-draft-052808.pdf

USEPA. 2010. Bioavailability of Dioxins and Dioxin-Like Compounds in Soil http://epa.gov/superfund/health/contaminants/dioxin/pdfs/Final_dioxin_RBA_Report_12_20_10.pdf

USEPA. 2010. Explanation of PAH benchmark calculations using EPA PAH ESB approach orginally developed by Dave Mount, ORD, Duluth. @ explanation-of-pah-benchmark-caalculations-20100622.doc. 6/23/2010.

USEPA. 2015. Determination of the Biologically Relevant Sampling Depth for Terrestrial and Aquatic Ecological Risk Assessments (Final Report). U.S. Environmental Protection Agency, Ecological Risk Assessment Support Center, Cincinnati, OH, EPA/600/R-15/176, 2015.

USEPA. 2015. ProUCL Version 5.1 Technical Guide. EPA/600/R-07/041.

USFWS. 1994. Accumulation of Mercury in Sediments, Prey, and Shorebirds of Lavaca Bay, Texas, Phase II Report.

USFWS. 2015.

USGS. 2002. Vertical Distribution of Trace-Element Concentrations and Occurrence of Metallurgical Slag Particles in Accumulated Bed Sediments of Lake Roosevelt, Washington. Scientific Investigations Report 2004-5090.

Van den Berg, M.; Bimbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waem, F; Zacharewski, T. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for human and wildlife. Environ Health Perspect. 106(12):775-792.

Van den Berg, M; Birnbaum, LS; Denison, M; DeVitto, M; Farland, W; Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci. 93:223-241.

Vasenev, V.; Stoorvogel, J.; and I. Vasenev. 2013. Urban soil organic carbon and its spatial heterogeneity in comparison with natural and agricultural areas in the Moscow region. Catena. 107:96-102.

Verheijen, F.; Bellamy, P.; Kibblewhite, M.; and K. Gaunt. 2005. Organic carbon ranges in arable soils of England and Wales Soil Use and Management. 21:2-9.

Vermeer, K. and J.A.J. Thompson. 1992. Arsenic and Copper Residues in Waterbirds and Their Food Down Inlet from the Island Copper Mill. Bulletin of Environmental Contamination and Toxicology 48:733-378.

Waldichuk, M. and R.J. Buchanan. 1980. Significance of environmental changes due to mine waste disposal into Rupert Inlet. Fisheries and Oceans, Vancouver, British Columbia.

Wang, J.J., C.W. Kennedy, H.P. Viator, A.E. Arceneaux and A.J. Guidry. 2005. Zinc fertilization of sugar cane in acid and calcareous soils. Journal American Society Sugar Cane Technologists. 25: 49-61.

Watts et al. 2008.

Wheelwright, N.T. 1986. The diet of American robins: an analysis of U.S. Biological Survey records. Auk 103: 710-725.

Whitaker, J.O. 2006. Food of the southern short-tailed shrew (*Blarina carolinensis*) on Cumberland Island, Georgia. Southeastern Naturalist 5(2): 361-366.

Whitaker, J. O., Jr. and M.G. Ferraro. 1963. Summer food of 220 short-tailed shrews from Ithaca, New York. J. Mammal. 44: 419.

Whitaker, J.O., and C. Ruckdeschel. Food of the Southern Short-tailed Shrew (Blarina carolinensis) on Cumberland Island, Georgia. Southeastern Naturalist 5, No 2. 361-366.

White, D. et al. 1985. Bird Use and Heavy Metal Accumulation in Waterbirds at Dredge Disposal Impoundments, Corpus Christi, Texas. Bull. Environ. Contam. Toxicol. 34: 295-300 9.

White, P.C.L. and S. Harris. 1994. Encounters between red foxes (Vulpes vulpes): Implications for territory maintenance, social cohesion and dispersion. Journal of Animal Ecology 63: 315-327.

Witmer, C.M., R. Harris and S.I. Shupack. 1991. Oral bioavailability of chromium from a specific site. Environmental Health Perspectives 92: 105-110.

Wittsiepe, J; Erlenkamper, B; Welge, P; Hack, A; and M. Wilhelm. 2007. Bioavailability of PCDD/F from contaminated soil in young Goettingen minipigs. Chemosphere. 67(2007) S355-S364.

Wood, T.S. and M.L. Shelley. 1999. A dynamic model of metals in constructed wetland sediments. Ecological Engineering 12: 231-252.

Xu, X., Bryan, A.L., Mills, G.L., and A.M. Korotasz. 2019. Mercury speciation, bioavailability, and biomagnification in contaminated streams on the Savannah River Site (SC, USA). Science of the Total Environment 668: 261-270.

Ye, Z.H., S.N. Whiting, Z-Q Lin, C.M. Lytle, J.H. Qian and N. Terry. 2001. Removal and distribution of iron, manganese, cobalt and nickel within a Pennsylvania constructed wetland treating coal combustion by-product leachate. Journal of Environmental Quality 30: 1464-1473.

Ye, Z. H., Lin, Z. -Q., Whiting, S. N., De Souza, M. P., Terry, N. 2003. Possible use of constructed wetland to remove selenocyanate, arsenic, and boron from electric utility wastewater. Chemosphere. 52 (9), 1571-1579.

Zhang, Y., and Frankenberger, W. T., Jr. 2005. Removal of selenium from river water by a microbial community enhanced with *Enterobacter taylorae* in organic carbon coated sand columns. The Science of the Total Environment, 346, 280–285.

Zhang, Y., and Moore, J. N. 1996. Selenium fractionation and speciation in a wetland system. Environmental Science & Technology, 30, 2613–2619.

Zhang, Y., Okeke, B. C., and Frankenberger, W. T., Jr. 2008. Bacterial reduction of selenate to elemental selenium utilizing molasses as a carbon source. Bioresource Technology, 99, 1267–1273.

Zimmerman, A.J. 2010. Speciation of Heavy Metals in Disturbed and Undisturbed Sediments from Atchafalaya Bay, Houma Navigation Canal, and Southwest Pass; Louisiana. Masters Thesis, Department of Geology and Geophysics, Louisiana State University. December.

Zollner, Patrick A., Smith, Winston P., Brennan, Leonard A. 1999. Home range use by swamp rabbits (*Sylvilagus aquaticus*) in a frequently inundated bottomland forest. American Midland Naturalist 143(1): 64-69.

Zollner, P.A. et al. 2000. Microhabitat characteristics of sites used by swamp rabbits. Wildlife Society Bulletin 28: 1003-1011.

TABLES

Table D7: Species Factors for Ecological Risk Assessment

Parameter	Description	Units	American Robin	Source	Spotted Sandpiper	Source	Mallard Duck	Source
BW	Body weight of receptor	Kg	0.0773	USEPA (1993; Page 2-197); [source: Clench & Leberman (1978)]; Sample & Suter (1994; Page 21; Table 4.9); [source: Dunning 1984])	0.0425	USEPA (1993; Page 2-152) [Source: Maxson & Oring (1980)][a]	1.134	USEPA (1993; Page 2-43); [Source: Nelson & Martin (1953)][b]
Food IR	Ingestion rate of food	Kg/Kg BW/d	0.132	Nagy (2001)	0.196	Nagy (2001), Seaman (2005), Elner (2005)	0.05	Nagy (2001)
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.02	Sample and Suter (1994; Page 22; Table 4.9); [Source: Beyer et al. (1994)]	0.17	Beyer et al. (1994)[c]	0.033	Beyer et al. (1994)
Fd (plants)	Fraction of diet consisting of plants		0.41	USEPA (1993; Page 2-198); [Source: Wheelwright (1986)]	0		0.5	USEPA (1993; Pages 2-44 and 2-45); [Source: Dillon (1959); Swanson et al. (1985)][d]
Fd (inverts)	Fraction of diet consisting of soil invertebrates		0.59	USEPA (1993; Page 2-198); [Source: Wheelwright (1986)]	0		0	
Fd (mammals)	Fraction of diet consisting of mammals		0		0		0	
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0		1	USEPA (1993; Page 2-152); [Source: Maxson & Oring (1980)]	0.5	USEPA (1993; Pages 2-44 and 2-45); [Source: Dillon (1959); Swanson et al. (1985)][d]
Fd (fish)	Fraction of diet consisting of fish		0		0		0	
Fd (birds)	Fraction of diet consisting of birds		0		0		0	

Notes:

[a]Spotted Sandpiper body weight: mean body weight of adult male (37.9 g) and female (47.1 g).

[b]Mallard body weight: Mean body weight of adult male (1,225 g) and adult female (1,043 g).

[c]Stilt sandpiper is used as model for spotted sandpiper, I think this note should be included

[d]Mallard diet: Dillon (1959) reports 92% of mallard diet consists of plants, Swanson et al. (1985) reports dietary consumption of invertebrates ranges from (67.8% to 89.4% [wet volume % esophagus contents]); a conservative dietary estimate of 0.5 (50%) plants and 0.5 (50%) invertebrates was used.

Table D7: Species Factors for Ecological Risk Assessment (Cont'd)

Parameter	Description	Units	Snowy Egret	Source	Great Blue Heron	Source	American Bald Eagle	Source
BW	Body weight of receptor	Kg	0.371	Parsons et al. (2000)	2.229	USEPA (1993; Section 2-8); [Source: Quinney, 1982]	4.6	USEPA (1995; Table 2-8)
Food IR	Ingestion rate of food	Kg/Kg BW/d	0.116	Nagy (2001)	0.103	Nagy 2001	0.09	USFWS (2015); [Source: Buehler, 2000]
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.005	Sample and Suter (1994 ; Section 4.13; Page 27)[a]	0.005	Sample and Suter (1994; Section 4.13; Page 27)	0[c]	Sample and Suter (1994; Section 4.15)
Fd (plants)	Fraction of diet consisting of plants		0		0		0	
Fd (inverts)	Fraction of diet consisting of soil invertebrates		0		0		0	
Fd (mammals)	Fraction of diet consisting of mammals		0		0		0.068[c]	USEPA (1993; Section 2-97); [Source: Todd et al., 1982]
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0.1	Smith (1997)[b]	0.1	USEPA (1993; Section 2-9); [Source: Alexander 1977]	0	
Fd (fish)	Fraction of diet consisting of fish		0.9	Smith (1997)[b]	0.9	USEPA (1993; Section 2-9); [Source: Alexander 1977]	0.767[d]	USEPA (1993; Section 2-97); [Source: Todd et al., 1982]
Fd (birds)	Fraction of diet consisting of birds		0		0		0.165[d]	USEPA (1993; Section 2-97); [Source: Todd et al., 1982]

Notes:

[a]Surrogate value based on great blue heron.

[b]Snowy egret diet (based on % biomass stomach contents): fish (91.4%), crayfish (6-7%); frogs (1%); invertebrates (1%; [insects, grass shrimp]).

[c]Surrogate value based on red-tailed hawk.

[d]Estimated using collection of animal carcasses near bald eagle nests in Maine.

Table D7: Species Factors for Ecological Risk Assessment (Cont'd)

Parameter	Description	Units	Swamp Rabbit	Source	Least Shrew	Source
BW	Body weight of receptor	Kg	2.118	Bond et al. (2006)[a]	0.017	USEPA (1993; Page 2-213); [source: Guilday, 1957][d]
Food IR	Ingestion rate of food	Kg/Kg BW/d	0.13	Sample and Suter (1994; Section 4.5, Page 16)[b]	0.096	Nagy (2001)[e]
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.063	Sample and Suter (1994; Section 4.5, Page 17)[b]	0.13	Sample and Suter (1994; Section 4.5, Page 17)[d]
Fd (plants)	Fraction of diet consisting of plants		1	USEPA (1993; Page 2-356); [Source: Spencer & Chapman (1986)][c]	0	
Fd (inverts)	Fraction of diet consisting of soil invertebrates		0		1	USEPA (1993; Page 2-214); [Source: Whitaker & Ferraro (1963)]; Whitaker & Ruckdeschel (2006)[d]
Fd (mammals)	Fraction of diet consisting of mammals		0		0	
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0		0	
Fd (fish)	Fraction of diet consisting of fish		0		0	
Fd (birds)	Fraction of diet consisting of birds		0		0	

Notes:

[a]Swamp rabbit body weight: arithmetic mean of adult males and females (Bond et al. (2006)).

[b]Swamp rabbit diet (based on black-tailed jackrabbit) is converted to dry weight assuming 45% moisture in food (Sample and Suter, 1994).

[c]Eastern cottontail is used to represent swamp rabbit.

[d]Short-tailed shrew is used to represent the least shrew. Body weight is the arithmetic mean of adult male and female body weights.

[e]Ingestion rate is based on the ingestion rate of the shrew-tenrec (*Microgale dobsoni*).

Table D7: Species Factors for Ecological Risk Assessment (Cont'd)

Parameter	Description	Units	Red Fox	Source	American Mink	Source
BW	Body weight of receptor	Kg	4.53	USEPA (1993; Page 2-224); [Source: Storm et al. (1976)][a]	1.0	Sample and Suter (1994; Page 18; Table 4.6); [Source: Newell et al. (1987)]
Food IR	Ingestion rate of food	Kg/Kg BW/d	0.16	USEPA (1993; Page 2-224); [Source: Sargeant, (1978)]	0.137	Sample and Suter (1994; Page 18; Table 4.6); [Source: Bleavins and Aulerich (1981)]
Soil / Sediment Ingestion	Ingestion Proportion of soil or sediment	Fraction of Total Diet	0.028	Beyer et al. (1994)	0.005	Sample and Suter (1994; Page 18; Table 4.6)
Fd (plants)	Fraction of diet consisting of plants		0.07	USEPA (1993; Page 2-225); [Source: Knable (1974); Hockman and Chapman, (1983)]	0	
Fd (inverts)	Fraction of diet consisting of soil invertebrates		0.03	USEPA (1993; Page 2-225); [Source: Knable (1974); Hockman and Chapman, (1983)]	0	
Fd (mammals)	Fraction of diet consisting of mammals		0.9	USEPA (1993; Page 2-225); [Source: Knable (1974); Hockman and Chapman, (1983)]	0.22	Dolan (1986)
Fd (benthic inverts)	Fraction of diet consisting of benthic invertebrates		0		0.64	Dolan (1986)
Fd (fish)	Fraction of diet consisting of fish		0		0.14	Dolan (1986)
Fd (birds)	Fraction of diet consisting of birds		0		0	

Note:
[a]Red fox body weight: arithmetic mean of adult male and female during spring and fall (Storm et al. 1976).

Table D8: Exposure Modifying Factors (EMFs) for Receptors in Ecological Risk Assessment

Parameter	Description	American Robin	Spotted Sandpiper	Mallard Duck	Snowy Egret	Great Blue Heron	American Bald Eagle	Swamp Rabbit	Least Shrew	Red Fox	American Mink	Citations
Home Range	Home Range of receptor (acres)	0.61[a]	8[b]	405[c]	490[d]	560	124,109[e]	7.9[f]	0.98[g]	2419[h]	216[i]	USEPA 1993 [source: Pitts (1984); Howell (1942); Maxson & Oring (1980); Gilmer (1975); Gibbs (1991, 1997); Custer & Osborn (1978)]; Gould (1974); Clark (1995); Taylor (1972); Halbrook (2018)
Home Range Factor (area use factor)	Fraction of home range that may be contaminated	1.0	0.50	0.0099	0.0082	0.0071	0.000032	0.51	1.0	0.0017	0.019	Calculated based on estimated size of affected area (4 acres).
Time (Temporal) Factor	Fraction of time spent in presumed contaminated area	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	Based on the amount of time the animal spends in the affected area

Notes:

[a] USEPA (1993) [Source: Pitts (1984); Howell (1942)]; Average of mean territory sizes.

[b] USEPA (1993) [Source: Maxson and Oring, L. et al. (1980)]

[c] USEPA (1993) [Source: Gilmer. et al. (1975)]; average of male and female home ranges.

[d] USEPA (1993) [Source: Custer & Osborn (1978)].

[e] USEPA (1993) [Source: Smith et al. (2017)]; average of all eagle ranges - summer and winter.

[f] Gould, A. (1974); Average of adult male (10.6 acres) and female (5.14 acres) home ranges.

[g] Clark et al. (1995); Average of male (.56 ha) and female (.23 ha) home ranges.

[h] Taylor (1972); Average home range of males and females.

[i] Halbrook (2018); Based on maximum home range of males and females.

Table D9: Toxicity Reference Values (TRVs) for Baseline Ecological Risk Assessment

Element or Constituent	TRV (mg/kg/d)					
	Avian (Robin, Mallard, Sandpiper, Egret, and Heron)		Avian (American Bald Eagle)		Mammal (Rabbit, Shrew, Fox, and Mink)	
	mg/kg/day	Source	mg/kg/day	Source	mg/kg/day	Source
Arsenic	2.24	USEPA (2005)	2.24	USEPA (2005)	1.04	USEPA (2005)
Barium	600[a]	Brown et al. (2014); Silverman and Tell (2010); Kubiak (2012)	20.8[c]	Johnson et al., 1960: Sample et al., 1996	5433[e]	Boyd and Abel (1966)
Cadmium	1.47	USEPA (2005)	1.47	USEPA (2005)	0.77	USEPA (2005)
Lead	1.63	USEPA (2005)	1.63	USEPA (2005)	4.7	USEPA (2005)
Mercury	3.25[b]	USEPA (1999; Table E-8)	0.077-0.346[d]	USEPA (1997)	1.01[f]	USEPA (1999; Table E-7)
Zinc	66.1	USEPA (2007)	66.1	USEPA (2007)	75.4	USEPA (2007)

Notes:
a - Barium sulfate; Recommended x-ray imaging dose for birds of 6,000 to 15,000 mg/kg bw. Low range value of 6,000 mg/kg bw used as proxy NOAEL; uncertainty factor of 10 for acute to chronic endpoint applied.
b - Mercuric chloride; Acute (5 day) LOAEL (mortality) for quail of 325 mg/kg/d; uncertainty factor of 0.01 applied to estimate from an acute to chronic endpoint (produces a very conservative TRV estimate.)
c - Only a single paper (Johnson et al. 1960) with data on the toxicity of barium hydroxide to one avian species (chicken) was identified by USEPA (2005). Johnson et al. (1960) reports a subchronic NOAEL of 208.26 mg/kg/d. The NOAEL was multiplied by an uncertainty factor of 0.1 to derive a very conservative TRV of 20.8 mg/kg/d.
d - This is a calculated TRV, specific to bald eagles, that is based on toxicity factors for reproduction, and estimates of bioaccumulation and biomagnification.
e - Barium sulfate; Acute (14 day) NOAEL (mortality) for rat of 163,000 mg/kg bw; uncertainty factor of 10 for species variability and 3 for acute to chronic endpoint.
f - Mercuric chloride; Chronic (6 month) NOAEL (reproduction) for mink of 1.01 mg/kg/d.

Note: See Attachment 1 (Supporting Calculations) for TRVs for Dioxins/Furans.

Table D10: Bioconcentration Factors (BCFs) for Food Items

COPEC	Soil- Plant BCF	Citation	Soil-Earthworm BCF	Citation	Soil-Mammal BCF	Citation
Arsenic	0.0375	Bechtel-Jacobs (1998; Table 6)	0.224	Sample et al. (1998a; Table 11)	0.0025	Sample et al. (1998b; Table 7)
Barium	0.0046	Nelson et al. (1984); Lamb et al. (2013)	0.0910	Sample et al. (1998a; Table C.1)	0.0566	Sample et al. (1998b; Table 7)
Cadmium	0.586	Bechtel-Jacobs (1998; Table 6)	7.708	Sample et al. (1998a; Table 11)	0.333	Sample et al. (1998b; Table 7)
Lead	0.0389	Bechtel-Jacobs (1998; Table 6)	0.266	Sample et al. (1998a; Table 11)	0.1504	Sample et al. (1998b; Table 7)
Mercury	0.270	Fernández-Martínez (2015); Rodriguez (2007); Hamilton (2008)	1.693	Sample et al. (1998a; Table 11)	0.0534	Sample et al. (1998b; Table 7)
Zinc	0.366	Bechtel-Jacobs (1998; Table 6)	3.201	Sample et al. (1998a; Table 11)	0.7717	Sample et al. (1998b; Table 7)

COPEC	Soil-Bird BCF	Citation	Soil/Sediment - Benthic Invertebrate BCF	Citation	Sediment - Fish BCF	Citation
Arsenic	0.075	Vermeer and Thompson (1992); Thompson and Patton (1975); Waldichuk and Buchanan (1980)	0.127	Bechtel Jacobs (1998; Table 2)	0.00065	Davis et al. (1996; p.420)
Barium	0.718	Egwumah et al. (2017); Kraus (1989)	0.023	Finerty et al. (1990); ERM (2019)	0.028	Ohio EPA (1991); Teck American, Inc. (2010); ERM (2019)
Cadmium	0.113	Beyer et al. (1985)	0.614	Bechtel Jacobs (1998; Table 2)	0.42	Chen and Chen (1992; Table 2)
Lead	0.191	Beyer et al. (1985)	0.066	Bechtel Jacobs (1998; Table 2)	0.0000018	Davis et al. (1996; p.420)
Mercury	0.184	White et al. (1985); Adair et al. (2003)	0.48	Razavi (2013); USFWS (1994); Ridal et al. (2010); ERM (2019)	1.1	LDEQ LEAU database (2019); ERM (2019)
Zinc	0.0645	Beyer et al. (1985)	2.33	Bechtel Jacobs (1998; Table 2)	0.138	Chen and Chen (1992; Table 2)

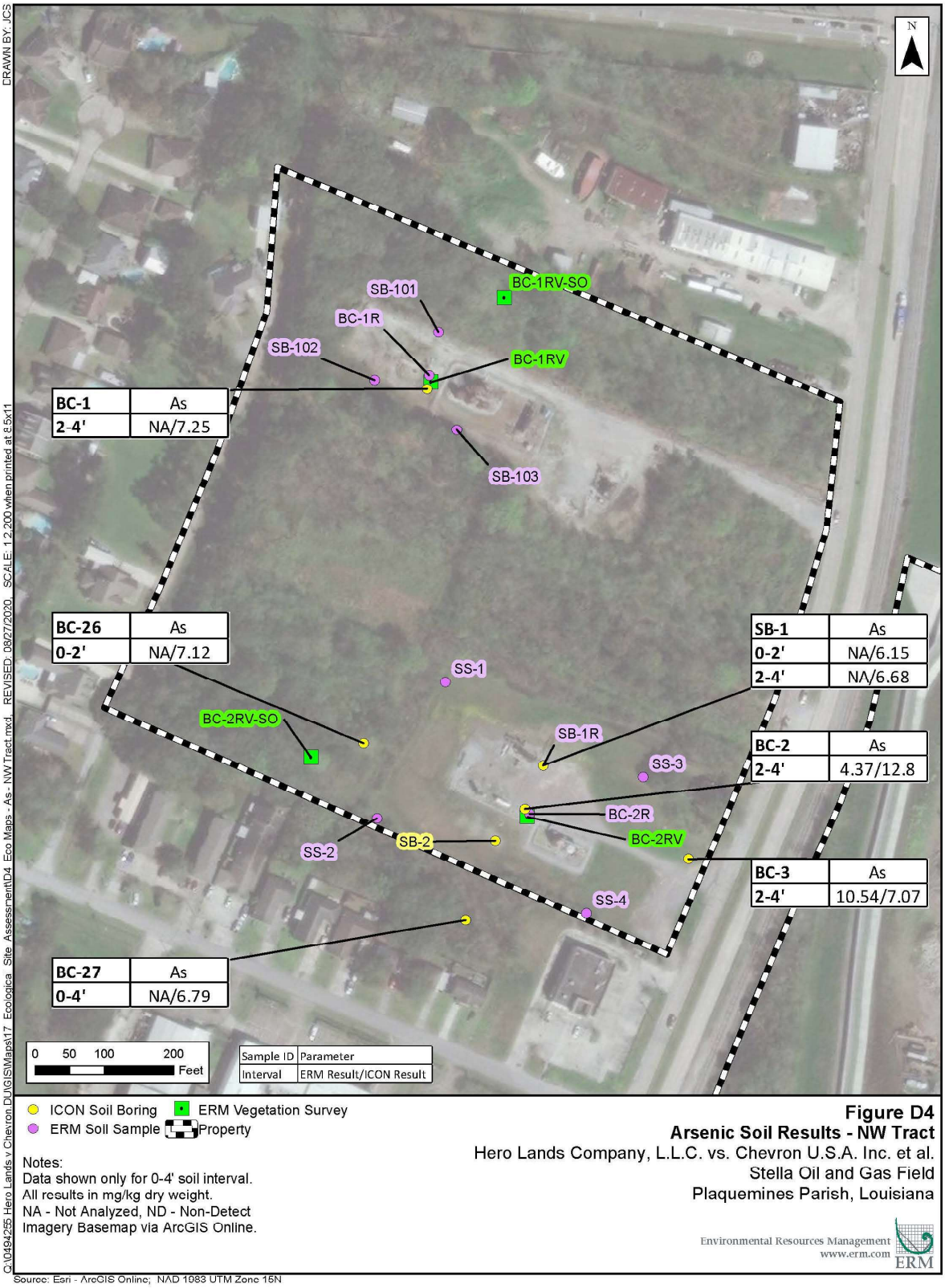
Note: See Attachment 1 (Supporting Calculations) for Dioxin/Furan BCFs, Barium and Mercury BCFs, and Soil-Bird BCFs

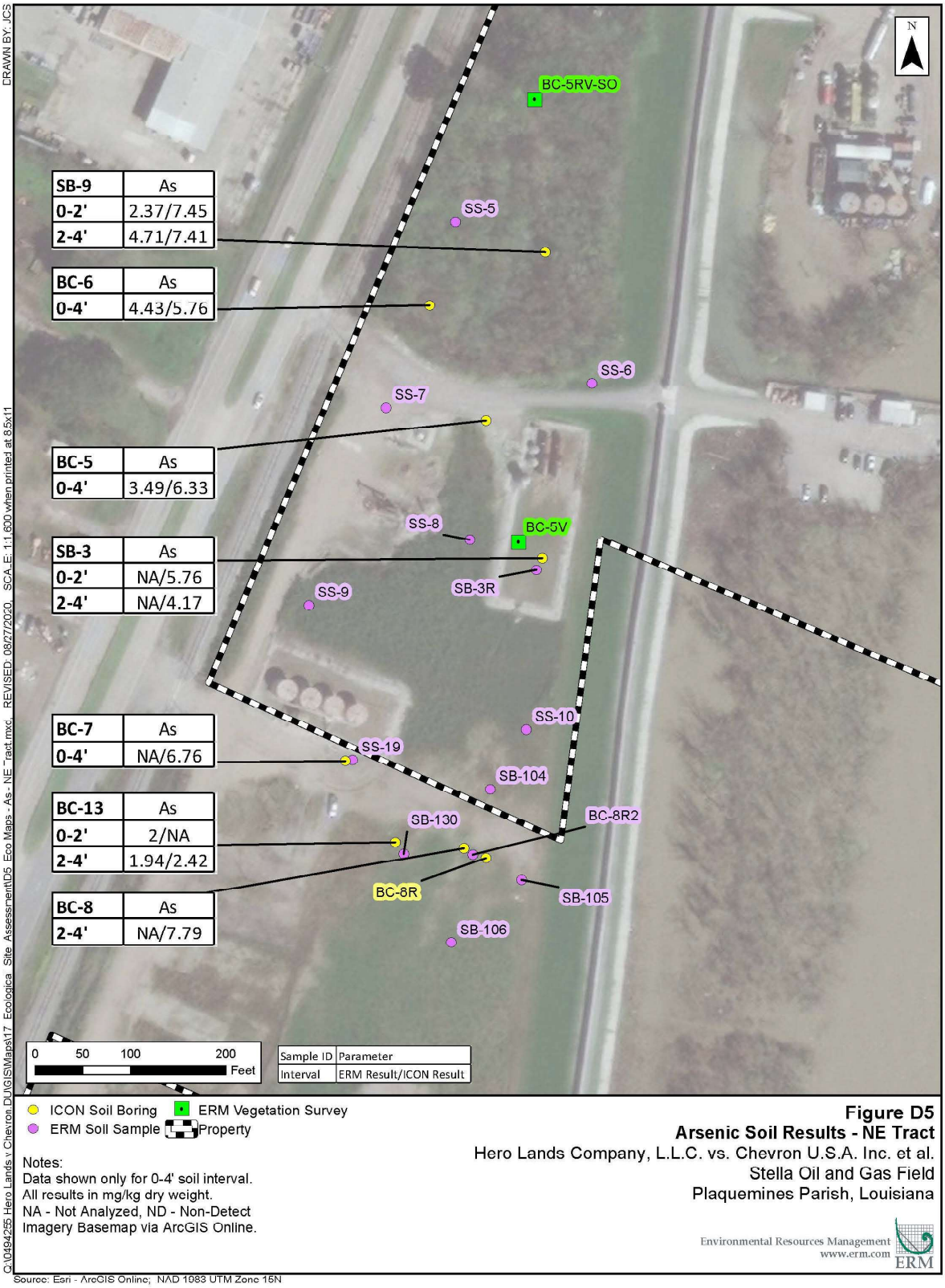
Table D11: Soil Bioavailability Estimates for the Hero Lands Property

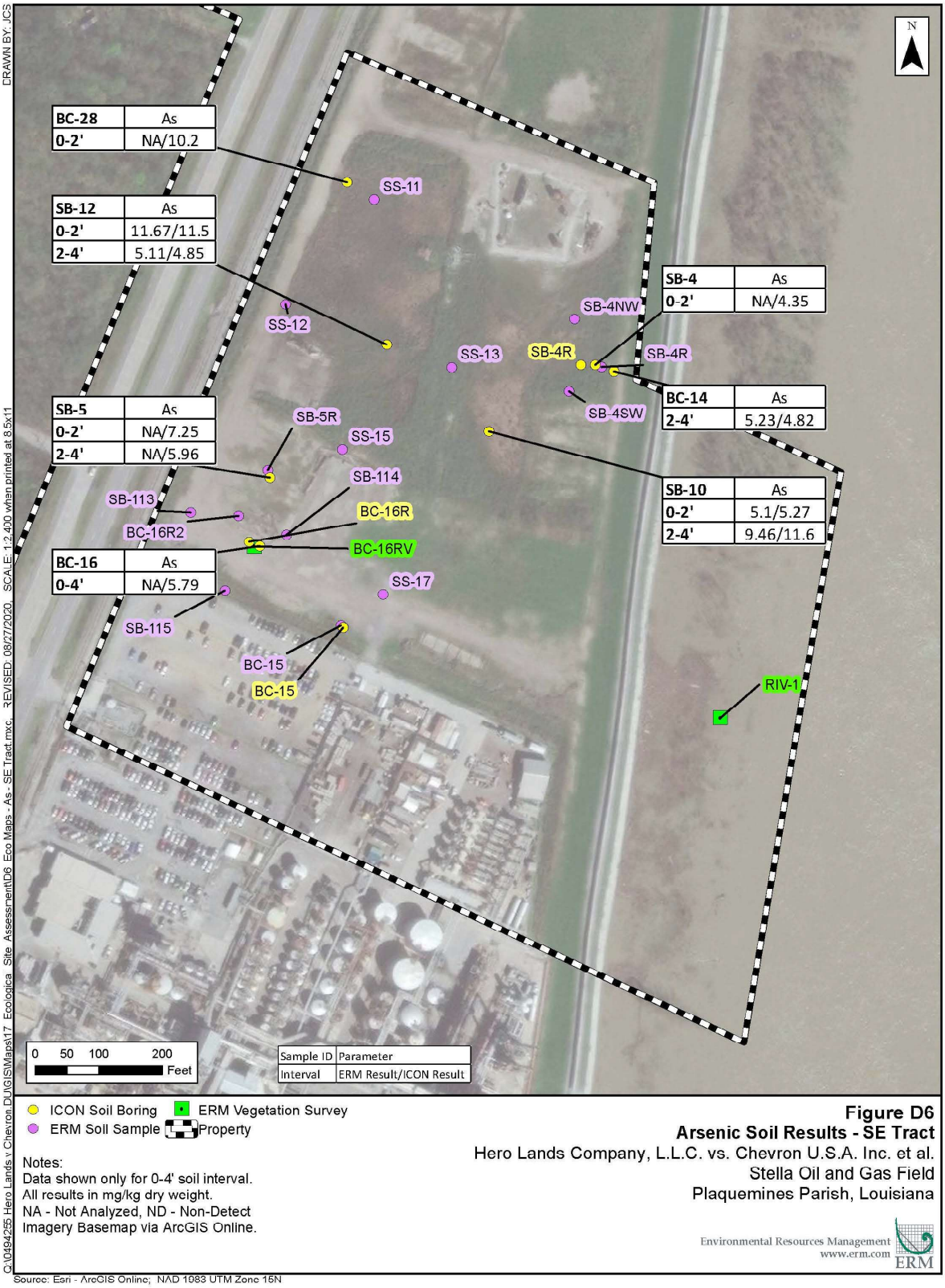
COPEC	Soil Bioavailability Factor	Citation
Arsenic	0.01	USEPA (2005); Watts et al. (2008)
Barium	0.0002	Engdahl et al. (2008); Cappuyns (2018); Environment International Ltd. (2010); USGS (2002)
Cadmium	0.036	Prokop et al. (2003)
Lead	0.01	Hettiarachchi and Pierzynski (2004); Luo et al. (2014)
Mercury	0.00031	Xu et al. (2019); Chibunda et al. (2009); Chalmers et al. (2013)
Zinc	0.01 - 0.1	USEPA (2005); Wang et al. (2005)

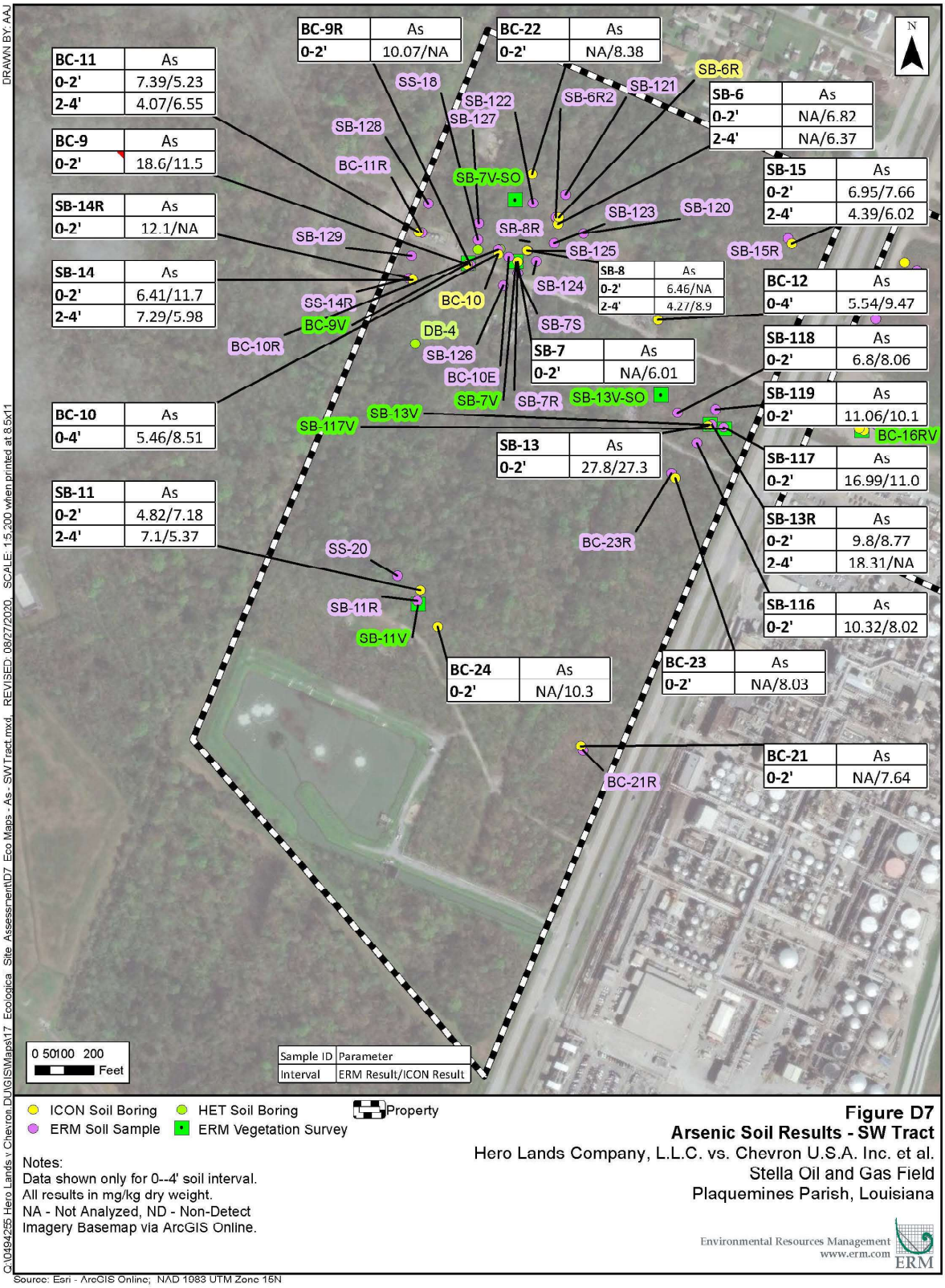
Note: See Attachment 1 (Supporting Calculations) for Soil Bioavailability Factors for Barium, Mercury, and Dioxins/Furans.

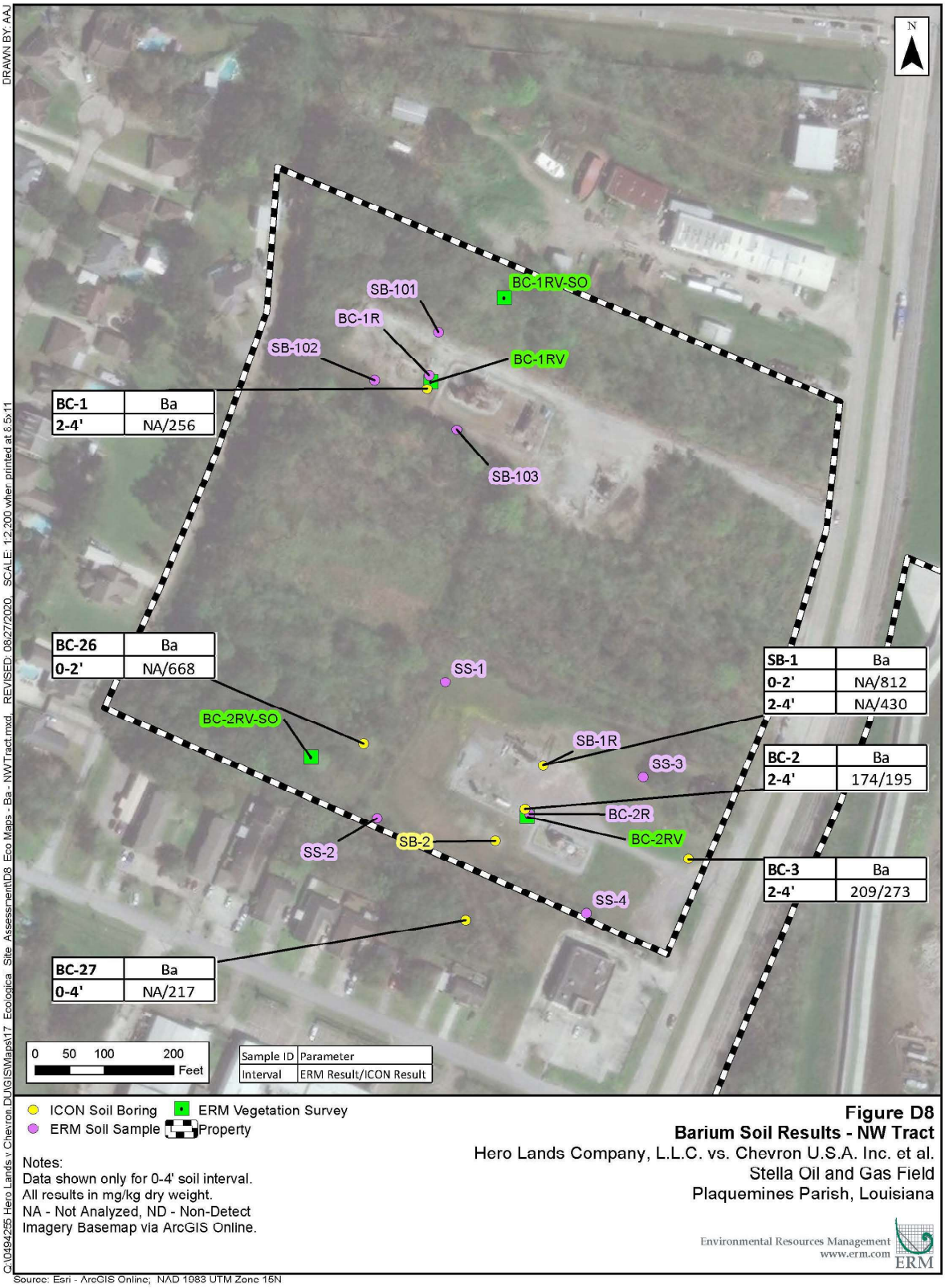
FIGURES

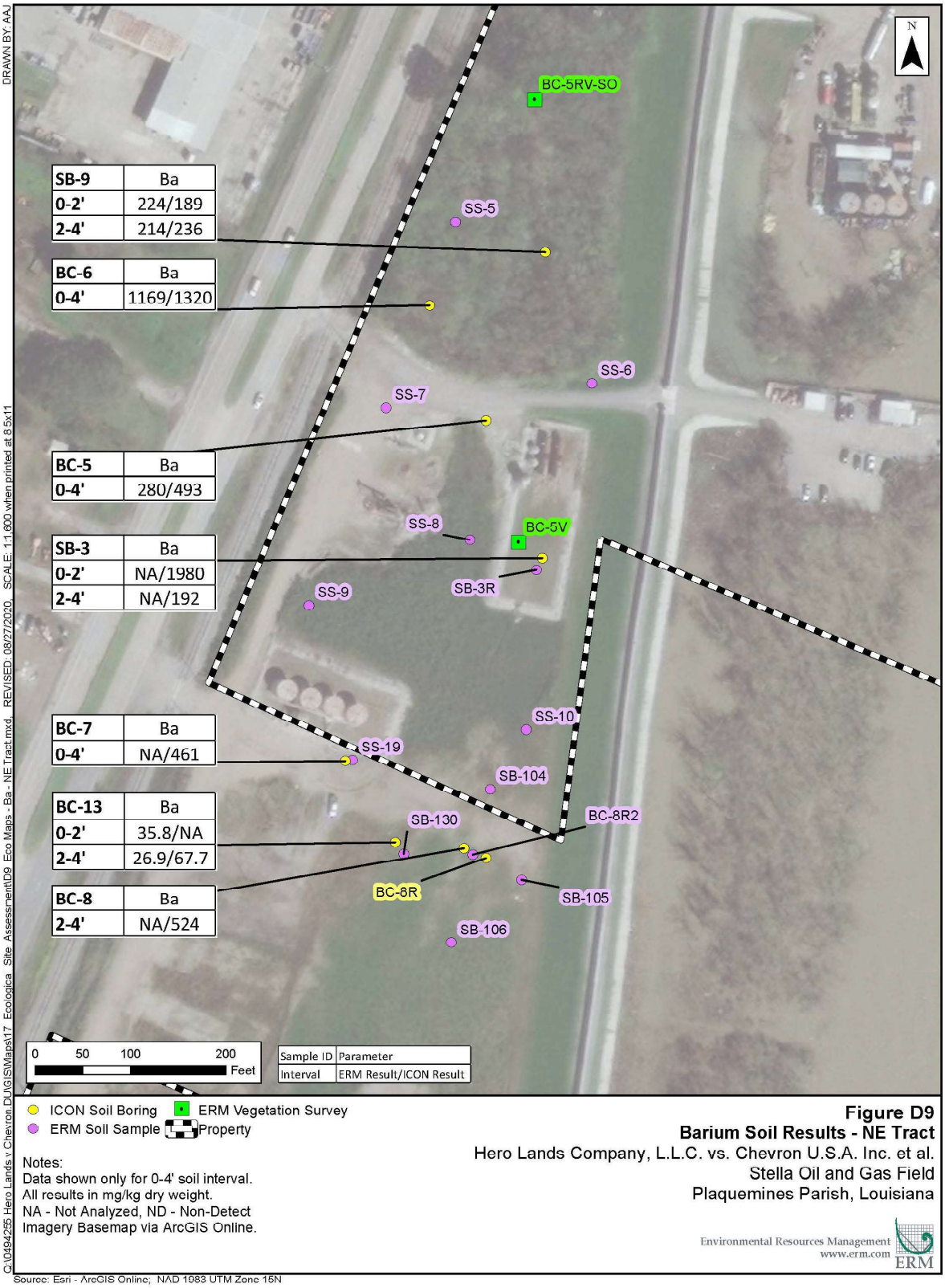

CRAWN BY: JCS
SCALE: 1:2,200 when printed at 8.5x11
REVISED: 08/27/2020
C:\0494255 Hero Lands v Chevron DL\GIS\Maps\17 Ecologica Site Assessment\D4 Eco Maps - As - NW Tract.mxd
N
SB-101
BC-1RV-SO
BC-1R
SB-102
BC-1RV
SB-103
BC-1 | As
2-4' | NA/7.25
BC-26 | As
0-2' | NA/7.12
SS-1
BC-2RV-SO
SB-1R
SS-3
SB-1 | As
0-2' | NA/6.15
2-4' | NA/6.68
BC-2 | As
2-4' | 4.37/12.8
BC-2R
BC-2RV
SS-2
SB-2
SS-4
BC-3 | As
2-4' | 10.54/7.07
BC-27 | As
0-4' | NA/6.79
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Vegetation Survey
ERM Soil Sample
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D4
Arsenic Soil Results - NW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

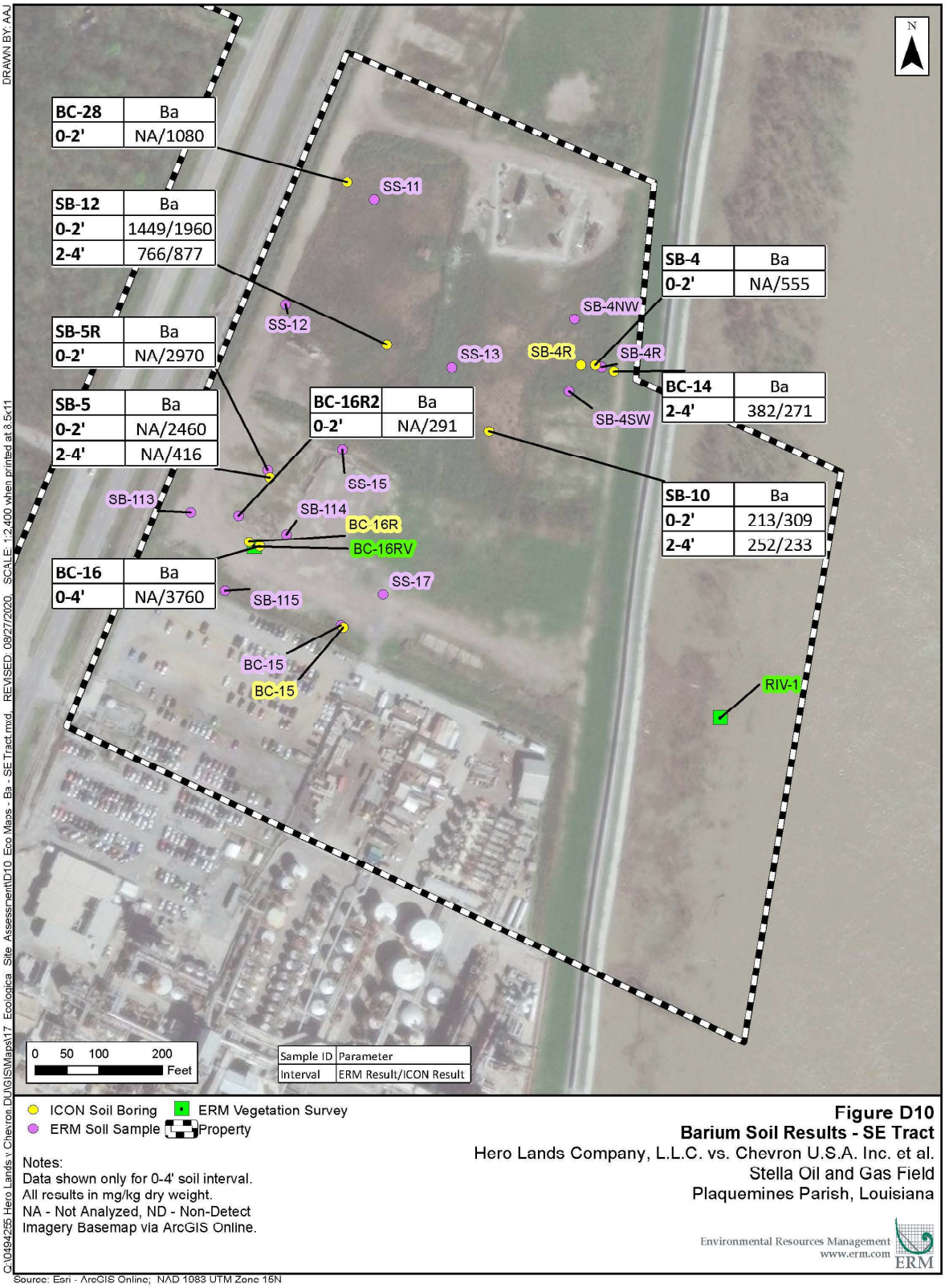

DRAWN BY: JCS
REVISED: 08/27/2020 SCA_E: 1:1,600 when printed at 8.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D5 Eco Maps - As - NE Tract.mxd
N
BC-5RV-SO
SS-5
SS-6
SS-7
SS-8
BC-5V
SB-3R
SS-9
SS-10
SS-19
SB-104
SB-130
BC-8R2
BC-8R
SB-105
SB-106
SB-9 | As
0-2' | 2.37/7.45
2-4' | 4.71/7.41
BC-6 | As
0-4' | 4.43/5.76
BC-5 | As
0-4' | 3.49/6.33
SB-3 | As
0-2' | NA/5.76
2-4' | NA/4.17
BC-7 | As
0-4' | NA/6.76
BC-13 | As
0-2' | 2/NA
2-4' | 1.94/2.42
BC-8 | As
2-4' | NA/7.79
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D5
Arsenic Soil Results - NE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

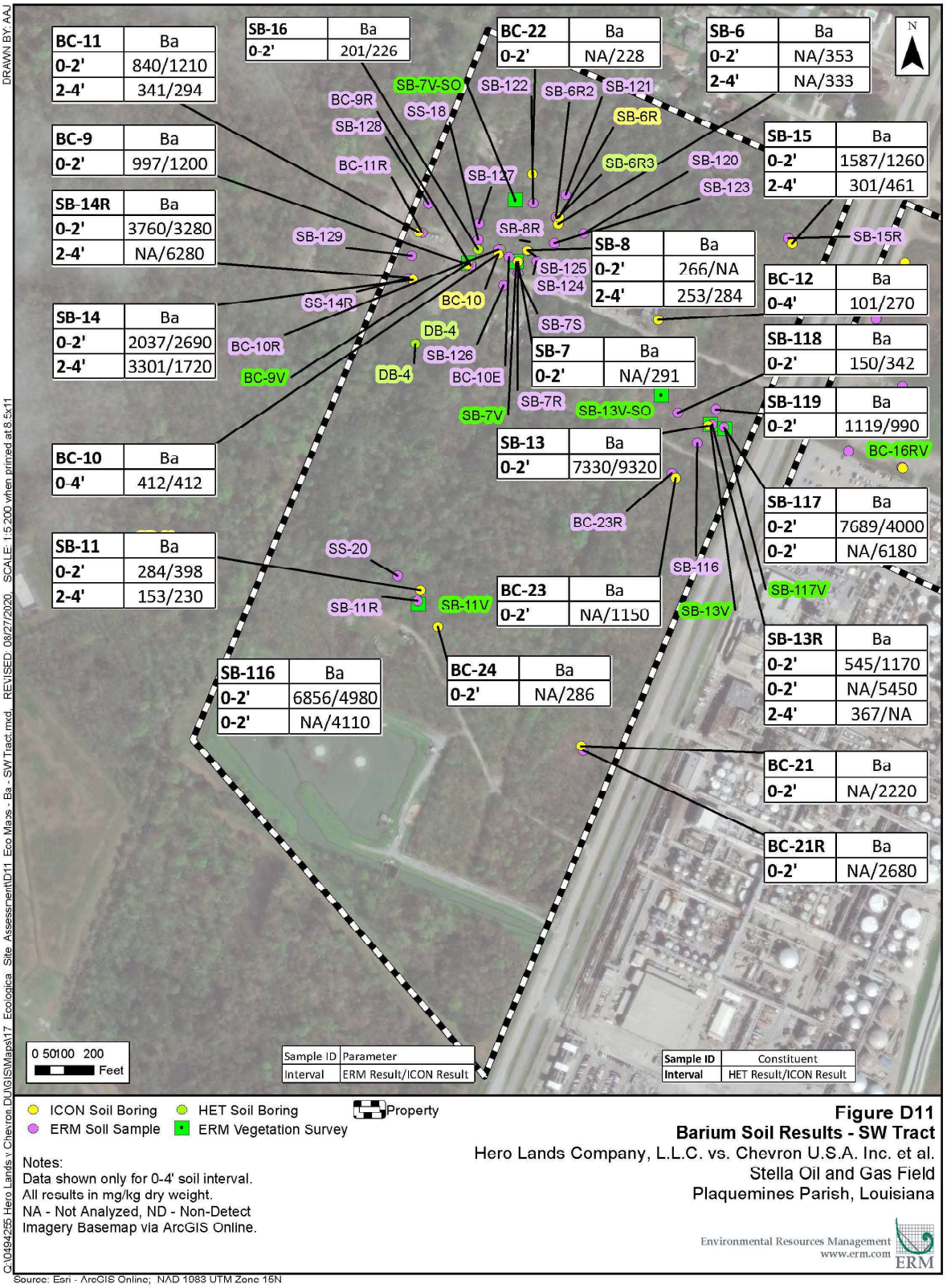

DRAWN BY: JCS
SCALE: 1:2,400 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D6 Eco Maps - As - SE Tract.mxd
N
BC-28 | As
0-2' | NA/10.2
SB-12 | As
0-2' | 11.67/11.5
2-4' | 5.11/4.85
SB-5 | As
0-2' | NA/7.25
2-4' | NA/5.96
BC-16 | As
0-4' | NA/5.79
SB-4 | As
0-2' | NA/4.35
BC-14 | As
2-4' | 5.23/4.82
SB-10 | As
0-2' | 5.1/5.27
2-4' | 9.46/11.6
SS-11
SS-12
SS-13
SB-4NW
SB-4R
SB-4R
SB-4SW
SB-5R
SS-15
SB-114
SB-113
BC-16R
BC-16R2
BC-16RV
SS-17
SB-115
BC-15
BC-15
RIV-1
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D6
Arsenic Soil Results - SE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

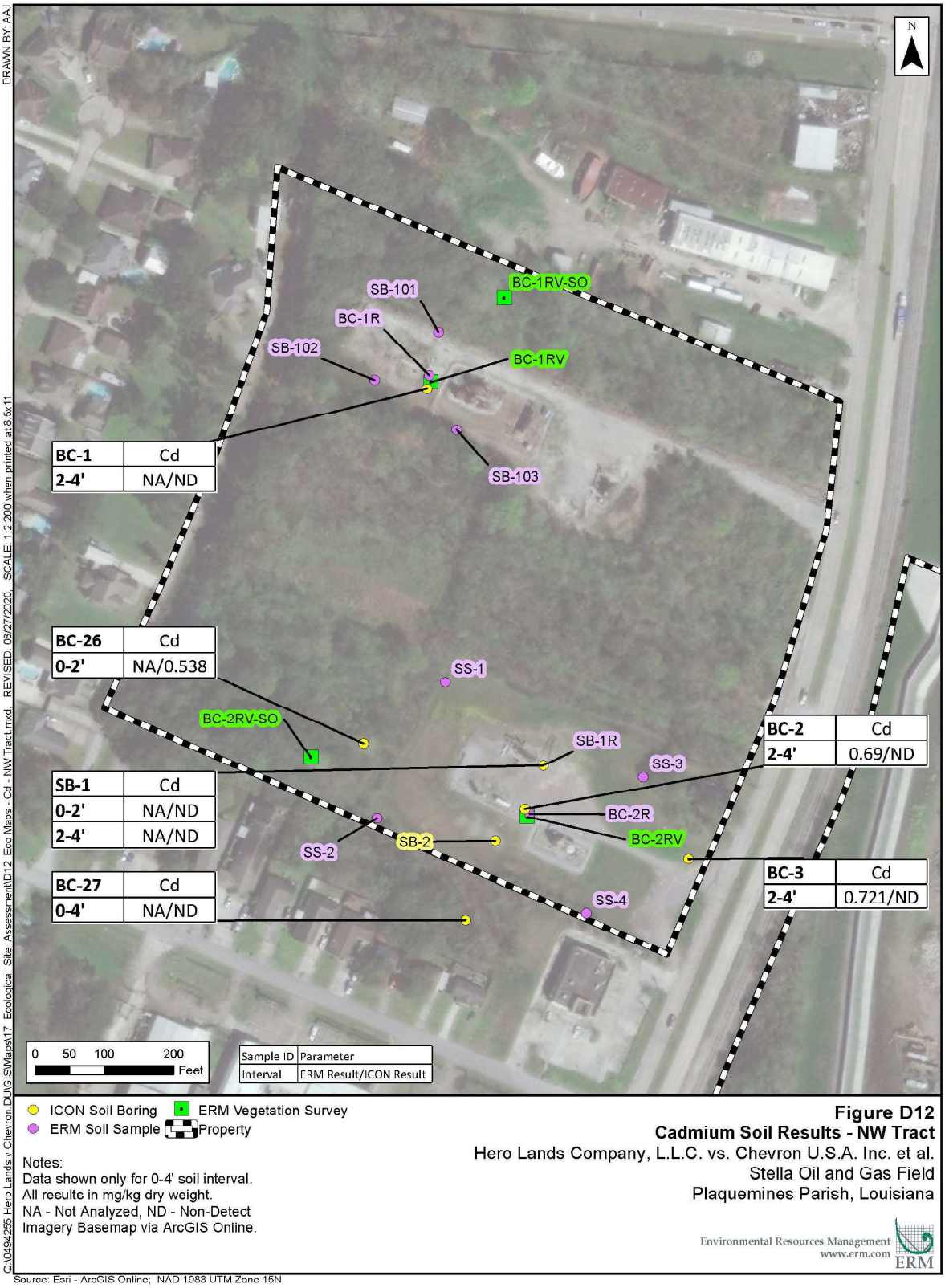

DRAWN BY: AAJ
Q:\0494255 Hero Lands v Chevron DUG\GIS\Maps\17 Ecologica Site Assessment\D7 Eco Maps - As - SWTract.mxd REVISED: 08/27/2020 SCALE: 1:5,200 when printed at 8.5x11
BC-9R | As | 0-2' | 10.07/NA
BC-22 | As | 0-2' | NA/8.38
BC-11 | As | 0-2' | 7.39/5.23 | 2-4' | 4.07/6.55
BC-9 | As | 0-2' | 18.6/11.5
SB-14R | As | 0-2' | 12.1/NA
SB-14 | As | 0-2' | 6.41/11.7 | 2-4' | 7.29/5.98
BC-10 | As | 0-4' | 5.46/8.51
SB-11 | As | 0-2' | 4.82/7.18 | 2-4' | 7.1/5.37
SB-13 | As | 0-2' | 27.8/27.3
SB-7 | As | 0-2' | NA/6.01
SB-8 | As | 0-2' | 6.46/NA | 2-4' | 4.27/8.9
SB-6 | As | 0-2' | NA/6.82 | 2-4' | NA/6.37
SB-15 | As | 0-2' | 6.95/7.66 | 2-4' | 4.39/6.02
BC-12 | As | 0-4' | 5.54/9.47
SB-118 | As | 0-2' | 6.8/8.06
SB-119 | As | 0-2' | 11.06/10.1
SB-117 | As | 0-2' | 16.99/11.0
SB-13R | As | 0-2' | 9.8/8.77 | 2-4' | 18.31/NA
SB-116 | As | 0-2' | 10.32/8.02
BC-24 | As | 0-2' | NA/10.3
BC-23 | As | 0-2' | NA/8.03
BC-21 | As | 0-2' | NA/7.64
SS-18
SB-122
SB-127
SB-128
BC-11R
SB-7V-SO
SB-8R
SB-129
SB-14R
BC-9V
BC-10R
BC-10
DB-4
SB-126
BC-10E
SB-7V
SB-7R
SB-7S
SB-124
SB-6R2
SB-121
SB-6R
SB-123
SB-120
SB-125
SB-15R
SB-13V
SB-117V
SB-13V-SO
BC-16RV
BC-23R
SS-20
SB-11R
SB-11V
BC-21R
N
0 50100 200
Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
HET Soil Boring
Property
ERM Soil Sample
ERM Vegetation Survey
Notes:
Data shown only for 0--4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D7
Arsenic Soil Results - SW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

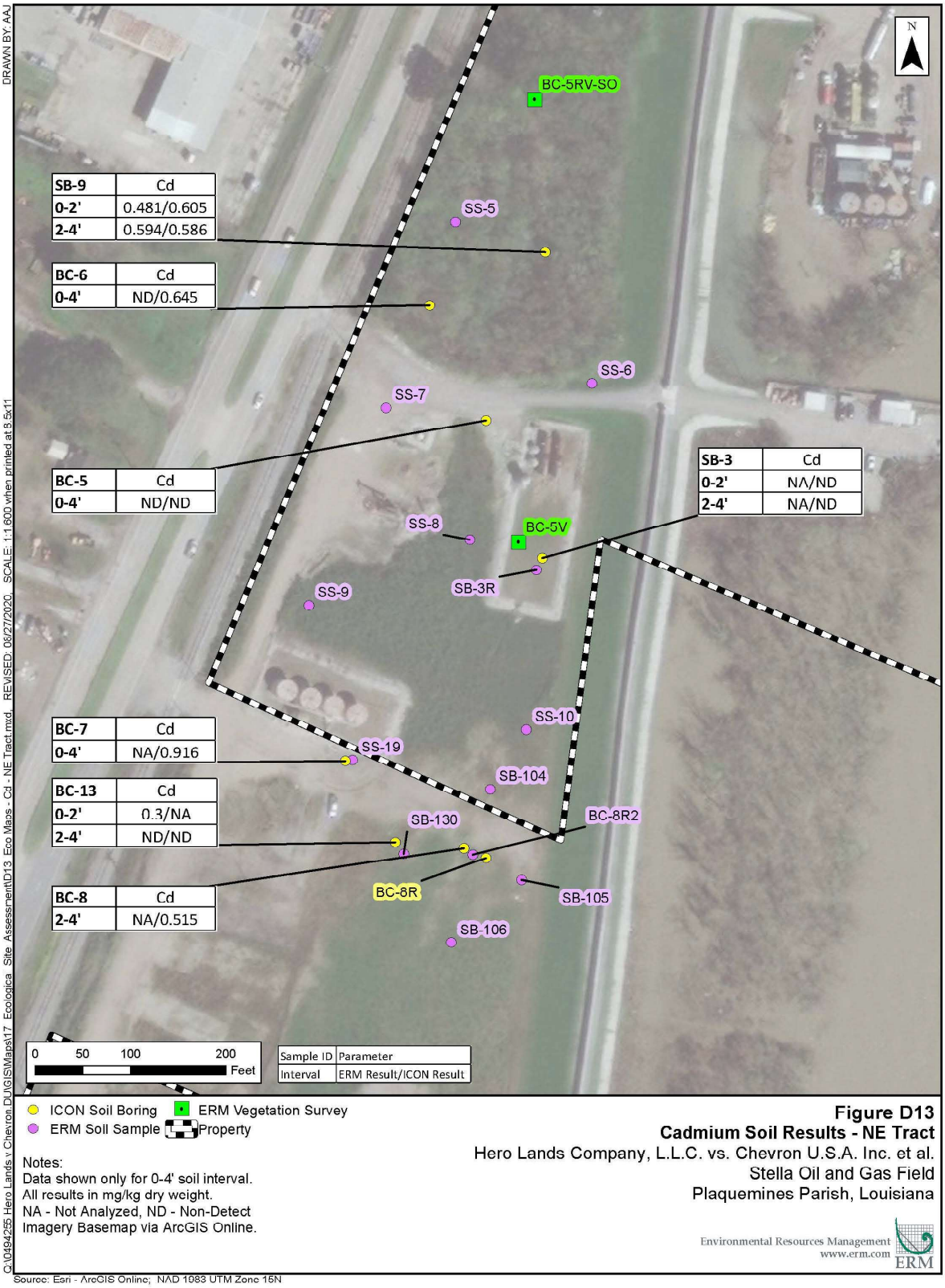

DRAWN BY: AAJ
SCALE: 1:2,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DLI\GIS\Maps\17 Ecologica Site Assessment\D8 Eco Maps - Ba - NWTract.mxd
N
SB-101
BC-1RV-SO
BC-1R
SB-102
BC-1RV
SB-103
BC-1 | Ba
2-4' | NA/256
BC-26 | Ba
0-2' | NA/668
SS-1
BC-2RV-SO
SB-1R
SS-3
SB-1 | Ba
0-2' | NA/812
2-4' | NA/430
BC-2 | Ba
2-4' | 174/195
BC-2R
BC-2RV
SB-2
SS-2
SS-4
BC-3 | Ba
2-4' | 209/273
BC-27 | Ba
0-4' | NA/217
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Vegetation Survey
ERM Soil Sample
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Figure D8
Barium Soil Results - NW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N

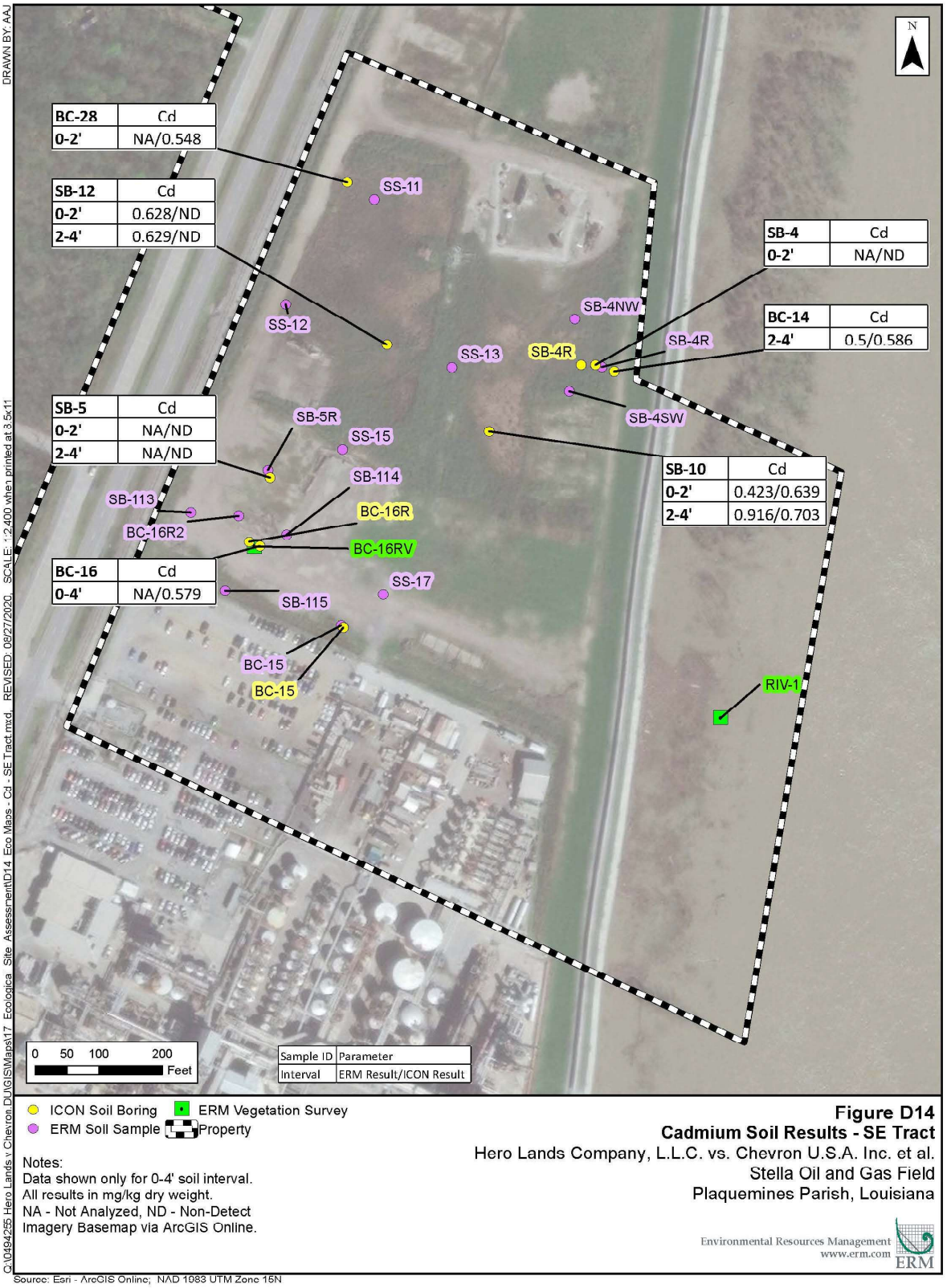

DRAWN BY: AAJ
REVISED: 08/27/2020 SCALE: 1:1,800 when printed at 8.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D9 Eco Maps - Ba - NE Tract.mxd
N
BC-5RV-SO
SS-5
SS-6
SS-7
SS-8
BC-5V
SB-3R
SS-9
SS-10
SS-19
SB-104
SB-130
BC-8R2
BC-8R
SB-105
SB-106
SB-9 | Ba
0-2' | 224/189
2-4' | 214/236
BC-6 | Ba
0-4' | 1169/1320
BC-5 | Ba
0-4' | 280/493
SB-3 | Ba
0-2' | NA/1980
2-4' | NA/192
BC-7 | Ba
0-4' | NA/461
BC-13 | Ba
0-2' | 35.8/NA
2-4' | 26.9/67.7
BC-8 | Ba
2-4' | NA/524
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D9
Barium Soil Results - NE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

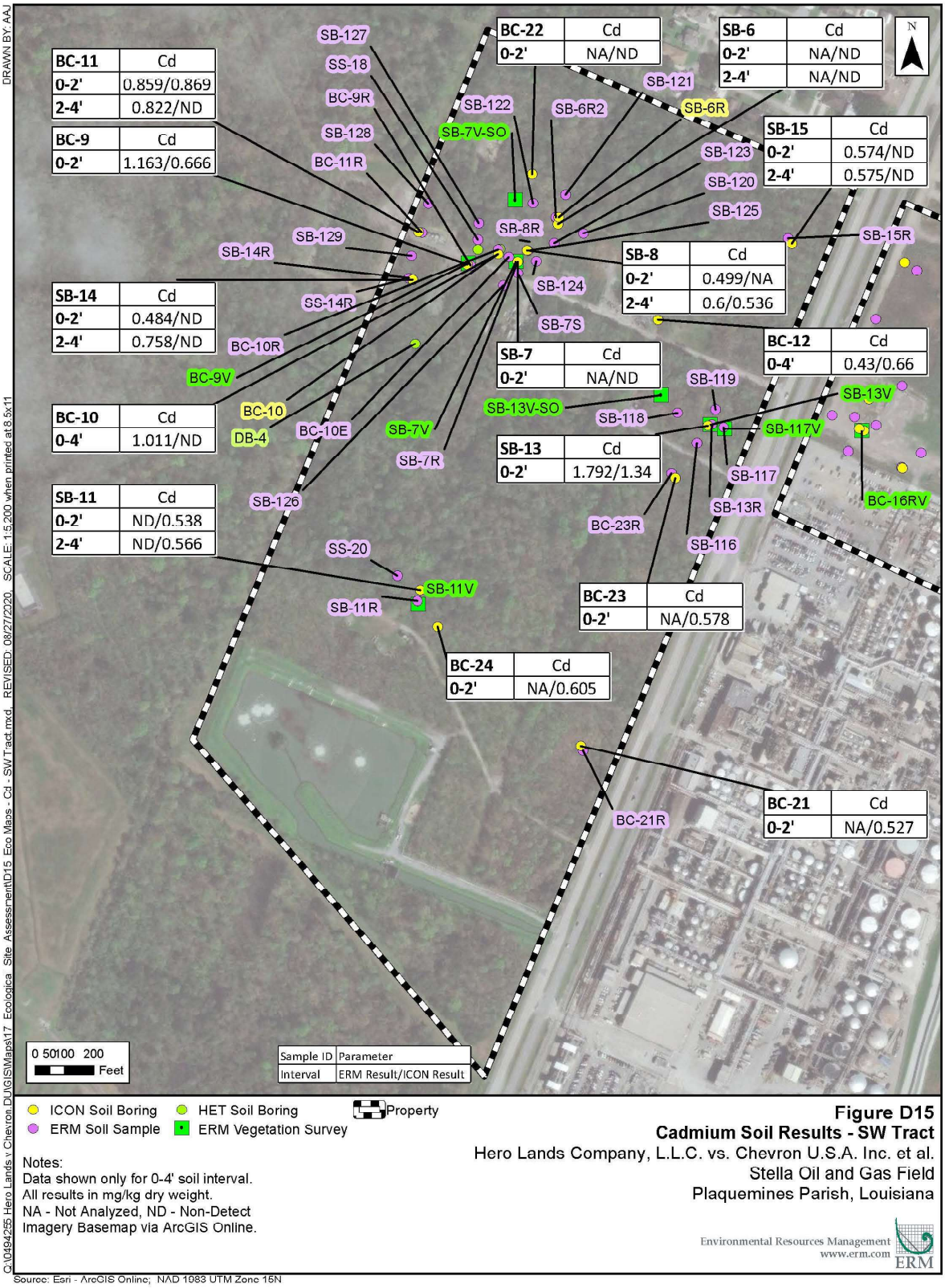

DRAWN BY: AAJ
SCALE: 1:2,400 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D10 Eco Maps - Ba - SE Tract.mxd
N
BC-28 | Ba
0-2' | NA/1080
SB-12 | Ba
0-2' | 1449/1960
2-4' | 766/877
SB-5R | Ba
0-2' | NA/2970
SB-5 | Ba
0-2' | NA/2460
2-4' | NA/416
BC-16 | Ba
0-4' | NA/3760
BC-16R2 | Ba
0-2' | NA/291
SB-4 | Ba
0-2' | NA/555
BC-14 | Ba
2-4' | 382/271
SB-10 | Ba
0-2' | 213/309
2-4' | 252/233
SS-11
SS-12
SS-13
SS-15
SS-17
SB-4NW
SB-4R
SB-4R
SB-4SW
SB-113
SB-114
BC-16R
BC-16RV
SB-115
BC-15
BC-15
RIV-1
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D10
Barium Soil Results - SE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

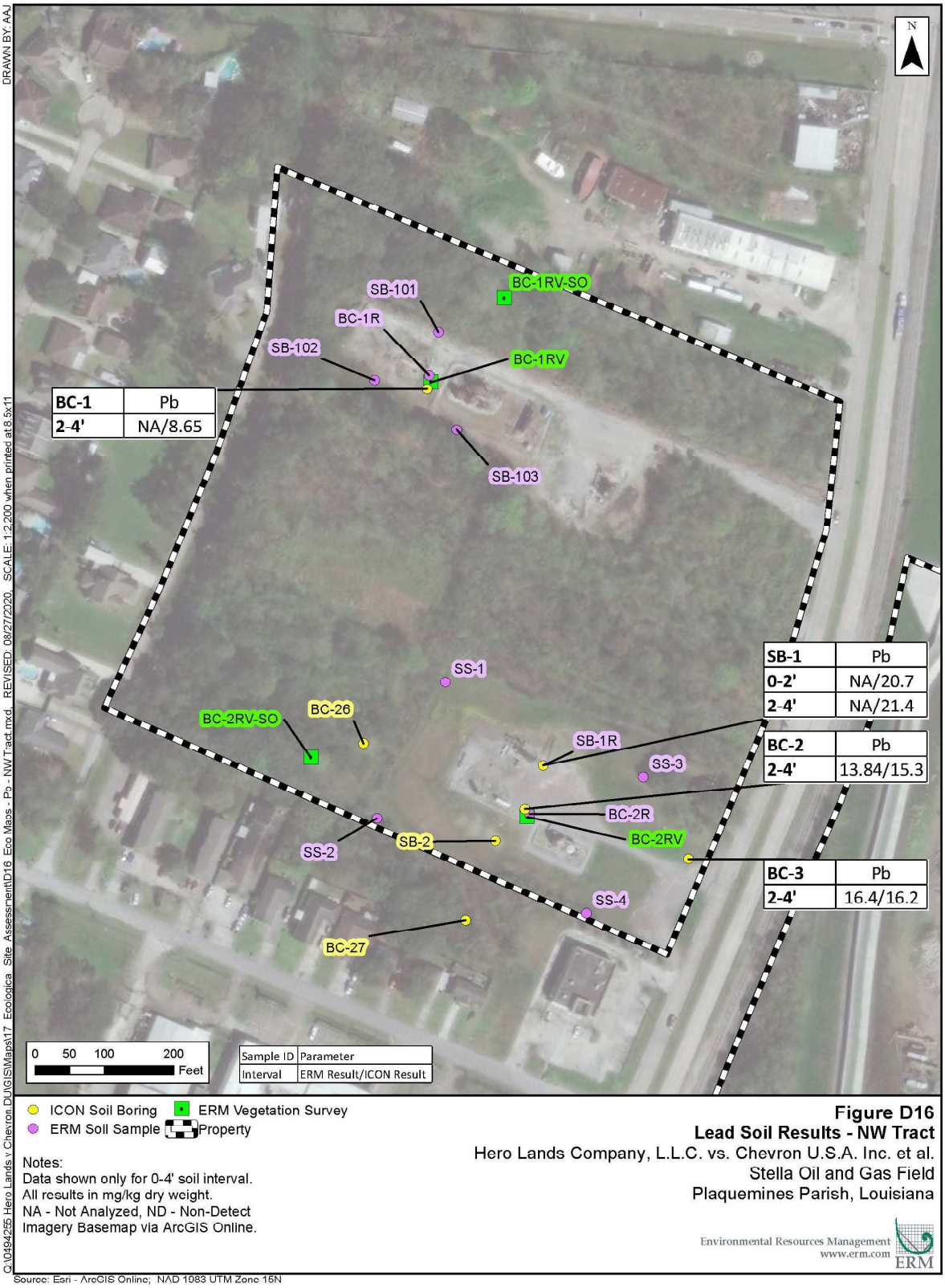

DRAWN BY: AAJ
SCALE: 1:5,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DJ\GIS\Maps\17 Ecologica Site Assessment\D11 Eco Maps - Ba - SW Tract.mxd
N
BC-11 Ba
0-2' 840/1210
2-4' 341/294
SB-16 Ba
0-2' 201/226
BC-22 Ba
0-2' NA/228
SB-6 Ba
0-2' NA/353
2-4' NA/333
BC-9 Ba
0-2' 997/1200
SB-14R Ba
0-2' 3760/3280
2-4' NA/6280
SB-14 Ba
0-2' 2037/2690
2-4' 3301/1720
BC-10 Ba
0-4' 412/412
SB-11 Ba
0-2' 284/398
2-4' 153/230
SB-15 Ba
0-2' 1587/1260
2-4' 301/461
SB-8 Ba
0-2' 266/NA
2-4' 253/284
BC-12 Ba
0-4' 101/270
SB-7 Ba
0-2' NA/291
SB-118 Ba
0-2' 150/342
SB-119 Ba
0-2' 1119/990
SB-13 Ba
0-2' 7330/9320
SB-117 Ba
0-2' 7689/4000
0-2' NA/6180
BC-23 Ba
0-2' NA/1150
SB-13R Ba
0-2' 545/1170
0-2' NA/5450
2-4' 367/NA
SB-116 Ba
0-2' 6856/4980
0-2' NA/4110
BC-24 Ba
0-2' NA/286
BC-21 Ba
0-2' NA/2220
BC-21R Ba
0-2' NA/2680
SB-7V-SO
SB-122
SB-6R2
SB-121
SB-6R
BC-9R
SS-18
SB-128
BC-11R
SB-127
SB-6R3
SB-120
SB-123
SB-8R
SB-129
SB-15R
SB-125
SB-124
SS-14R
BC-10
SB-7S
DB-4
BC-10R
SB-126
BC-9V
DB-4
BC-10E
SB-7R
SB-13V-SO
SB-7V
BC-16RV
BC-23R
SS-20
SB-116
SB-11R
SB-11V
SB-13V
SB-117V
0 50100 200
Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
Sample ID | Constituent
Interval | HET Result/ICON Result
ICON Soil Boring
HET Soil Boring
Property
ERM Soil Sample
ERM Vegetation Survey
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D11
Barium Soil Results - SW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

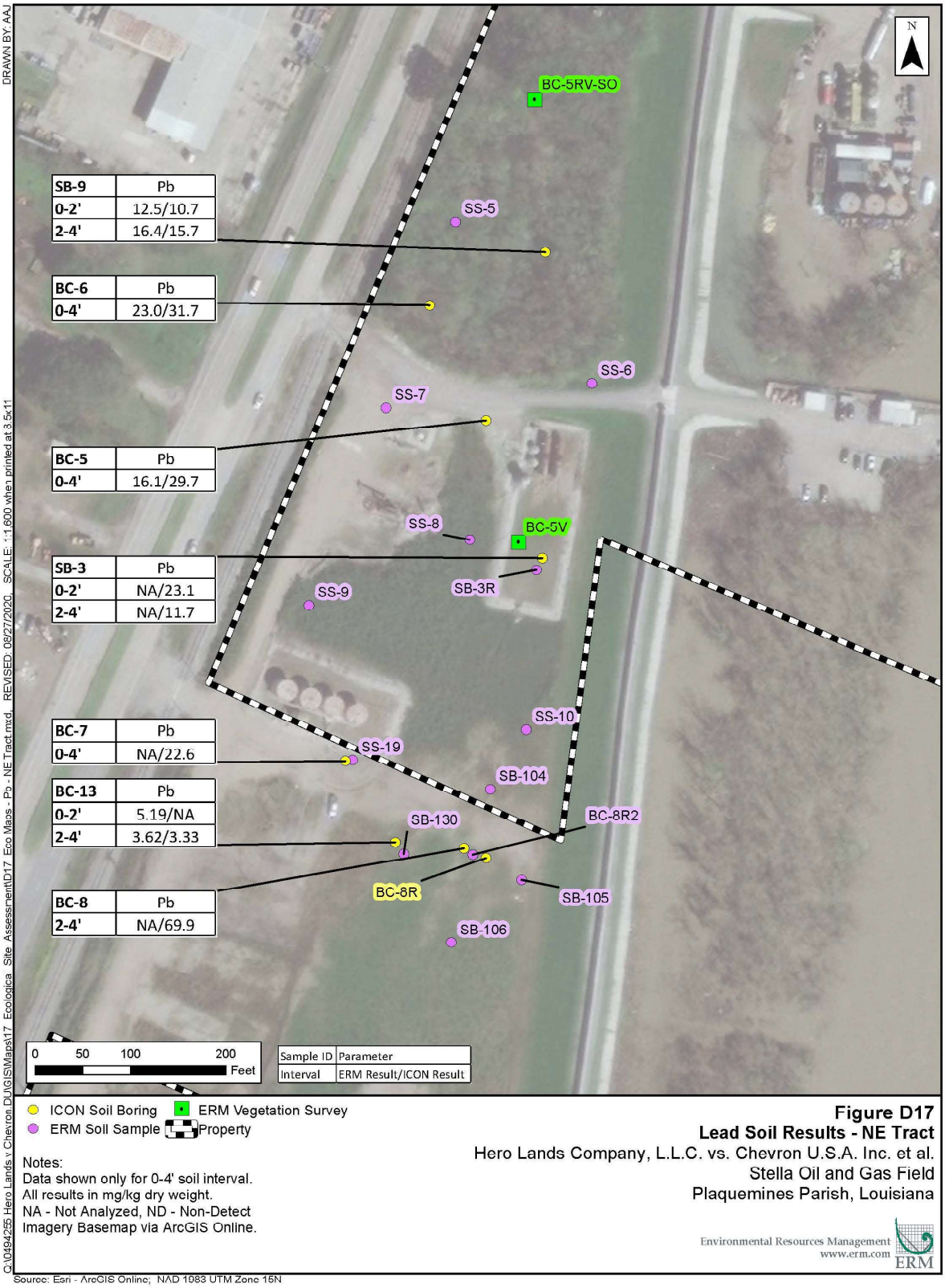

DRAWN BY: AAJ
REVISED: 03/27/2020 SCALE: 1:2,200 when printed at 8.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D12 Eco Maps - Cd - NW Tract.mxd
N
SB-101
BC-1RV-SO
BC-1R
SB-102
BC-1RV
SB-103
BC-1 | Cd
2-4' | NA/ND
BC-26 | Cd
0-2' | NA/0.538
SS-1
BC-2RV-SO
SB-1R
SS-3
BC-2 | Cd
2-4' | 0.69/ND
SB-1 | Cd
0-2' | NA/ND
2-4' | NA/ND
BC-2R
BC-2RV
SS-2
SB-2
BC-3 | Cd
2-4' | 0.721/ND
BC-27 | Cd
0-4' | NA/ND
SS-4
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D12
Cadmium Soil Results - NW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

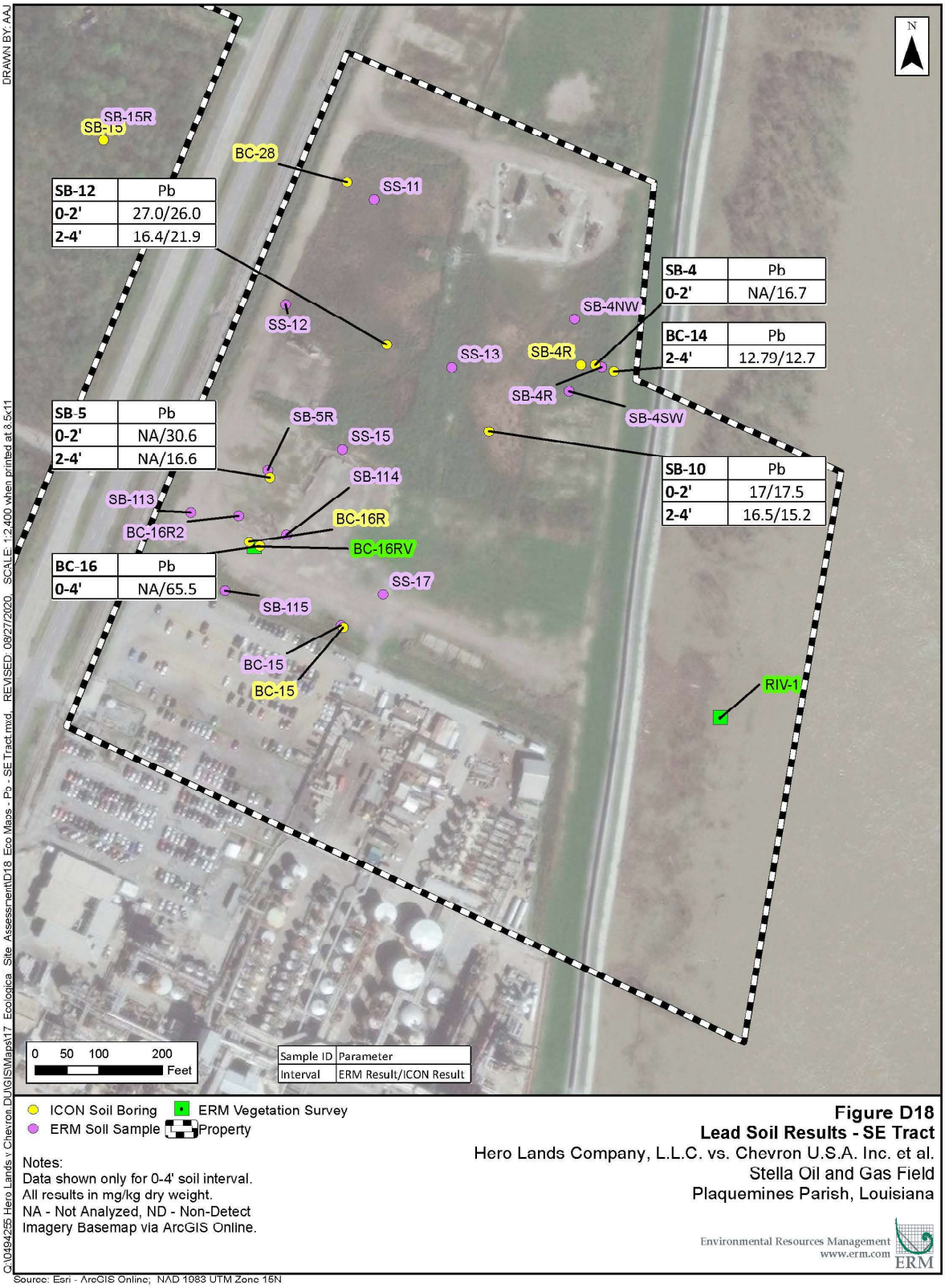

DRAWN BY: AAJ
REVISED: 06/27/2020 SCALE: 1:1,600 when printed at 8.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D13 Eco Maps - Cd - NE Tract.mxd
N
BC-5RV-SO
SB-9 | Cd
0-2' | 0.481/0.605
2-4' | 0.594/0.586
SS-5
BC-6 | Cd
0-4' | ND/0.645
SS-6
SS-7
BC-5 | Cd
0-4' | ND/ND
SB-3 | Cd
0-2' | NA/ND
2-4' | NA/ND
SS-8
BC-5V
SB-3R
SS-9
SS-10
BC-7 | Cd
0-4' | NA/0.916
SS-19
SB-104
BC-13 | Cd
0-2' | 0.3/NA
2-4' | ND/ND
SB-130
BC-8R2
BC-8 | Cd
2-4' | NA/0.515
BC-8R
SB-105
SB-106
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Vegetation Survey
ERM Soil Sample
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D13
Cadmium Soil Results - NE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

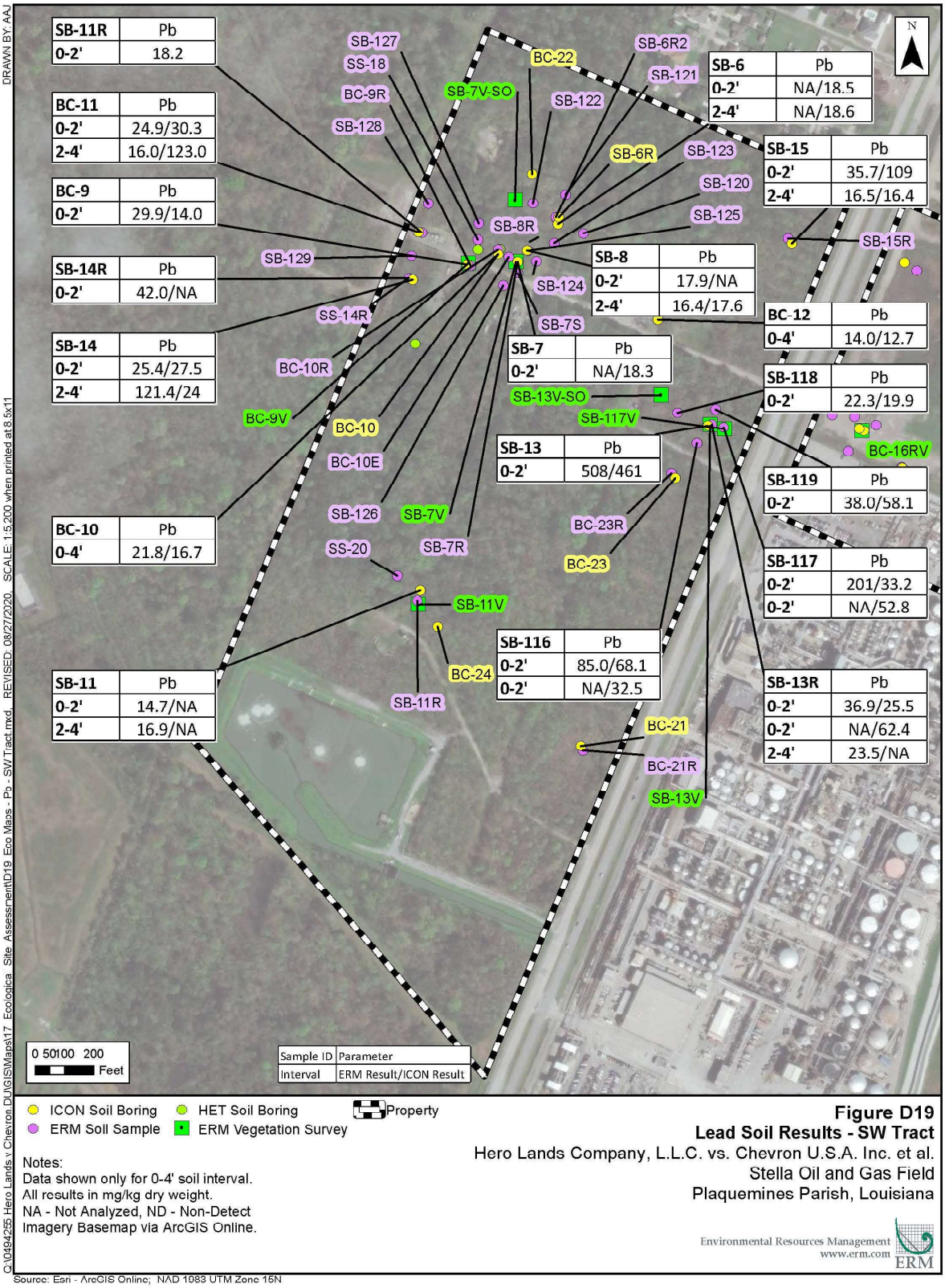

DRAWN BY: AAJ
SCALE: 1:2,400 when printed at 3.5x11
REVISED: 09/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D14 Eco Maps - Cd - SE Tract.mxd
N
BC-28 | Cd
0-2' | NA/0.548
SB-12 | Cd
0-2' | 0.628/ND
2-4' | 0.629/ND
SB-4 | Cd
0-2' | NA/ND
BC-14 | Cd
2-4' | 0.5/0.586
SB-5 | Cd
0-2' | NA/ND
2-4' | NA/ND
SB-10 | Cd
0-2' | 0.423/0.639
2-4' | 0.916/0.703
BC-16 | Cd
0-4' | NA/0.579
SS-11
SS-12
SS-13
SS-15
SS-17
SB-4NW
SB-4R
SB-4SW
SB-5R
SB-114
SB-113
SB-115
BC-16R
BC-16R2
BC-16RV
BC-15
BC-15
RIV-1
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D14
Cadmium Soil Results - SE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

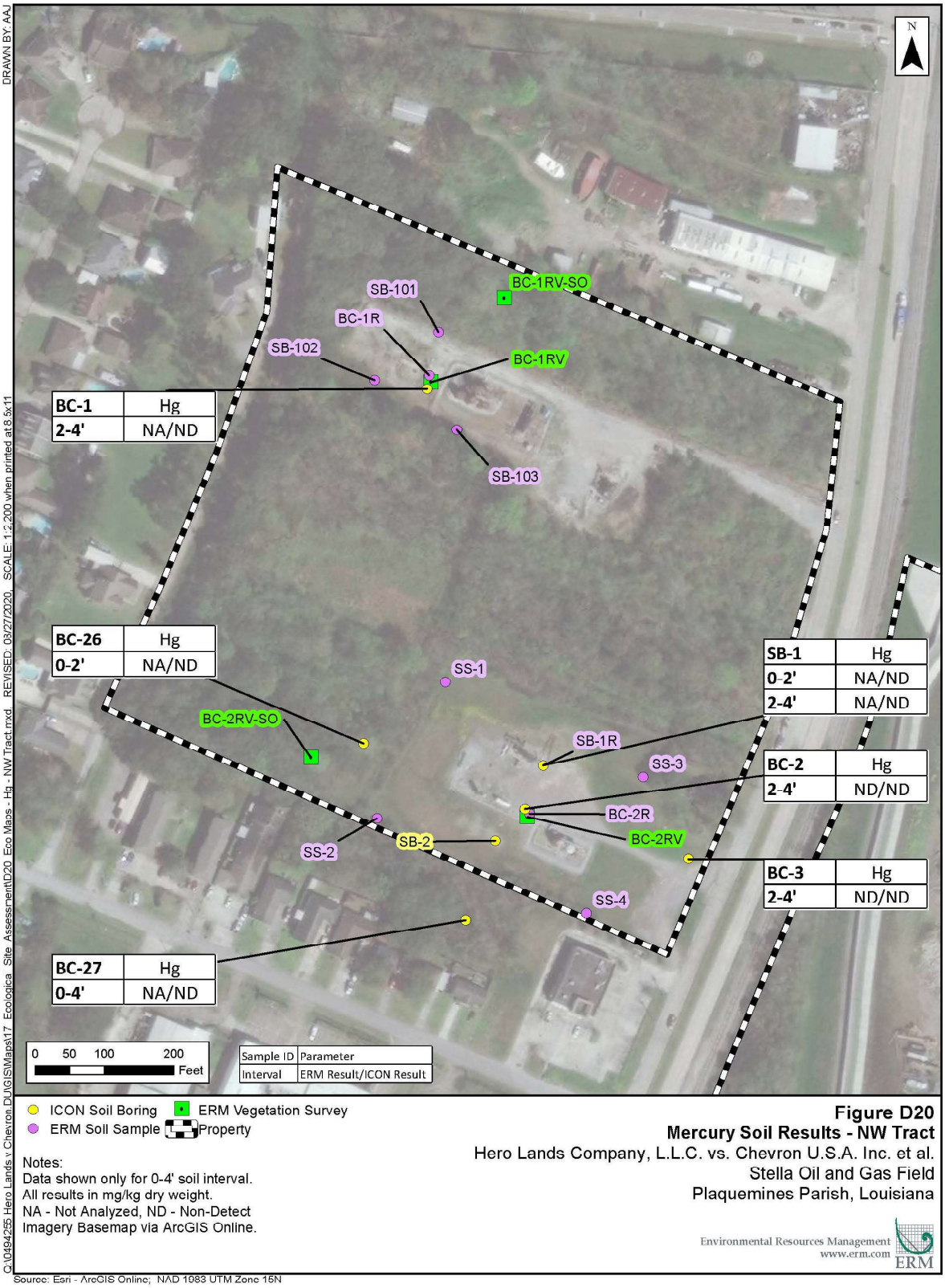

DRAWN BY: AAJ
SCALE: 1:5,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D15 Eco Maps - Cd - SW Tract.mxd
N
BC-11 | Cd
0-2' | 0.859/0.869
2-4' | 0.822/ND
BC-9 | Cd
0-2' | 1.163/0.666
SB-14 | Cd
0-2' | 0.484/ND
2-4' | 0.758/ND
BC-10 | Cd
0-4' | 1.011/ND
SB-11 | Cd
0-2' | ND/0.538
2-4' | ND/0.566
BC-22 | Cd
0-2' | NA/ND
SB-6 | Cd
0-2' | NA/ND
2-4' | NA/ND
SB-15 | Cd
0-2' | 0.574/ND
2-4' | 0.575/ND
SB-8 | Cd
0-2' | 0.499/NA
2-4' | 0.6/0.536
BC-12 | Cd
0-4' | 0.43/0.66
SB-7 | Cd
0-2' | NA/ND
SB-13 | Cd
0-2' | 1.792/1.34
BC-23 | Cd
0-2' | NA/0.578
BC-24 | Cd
0-2' | NA/0.605
BC-21 | Cd
0-2' | NA/0.527
SB-127
SS-18
BC-9R
SB-128
BC-11R
SB-129
SB-14R
SS-14R
BC-10R
BC-9V
BC-10
DB-4
BC-10E
SB-126
SS-20
SB-11V
SB-11R
SB-122
SB-7V-SO
SB-6R2
SB-121
SB-6R
SB-123
SB-120
SB-125
SB-8R
SB-124
SB-7S
SB-7V
SB-7R
SB-15R
SB-13V-SO
SB-118
SB-119
SB-13V
SB-117V
SB-117
SB-13R
SB-116
BC-23R
BC-16RV
BC-21R
0 50100 200
Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
HET Soil Boring
Property
ERM Soil Sample
ERM Vegetation Survey
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D15
Cadmium Soil Results - SW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

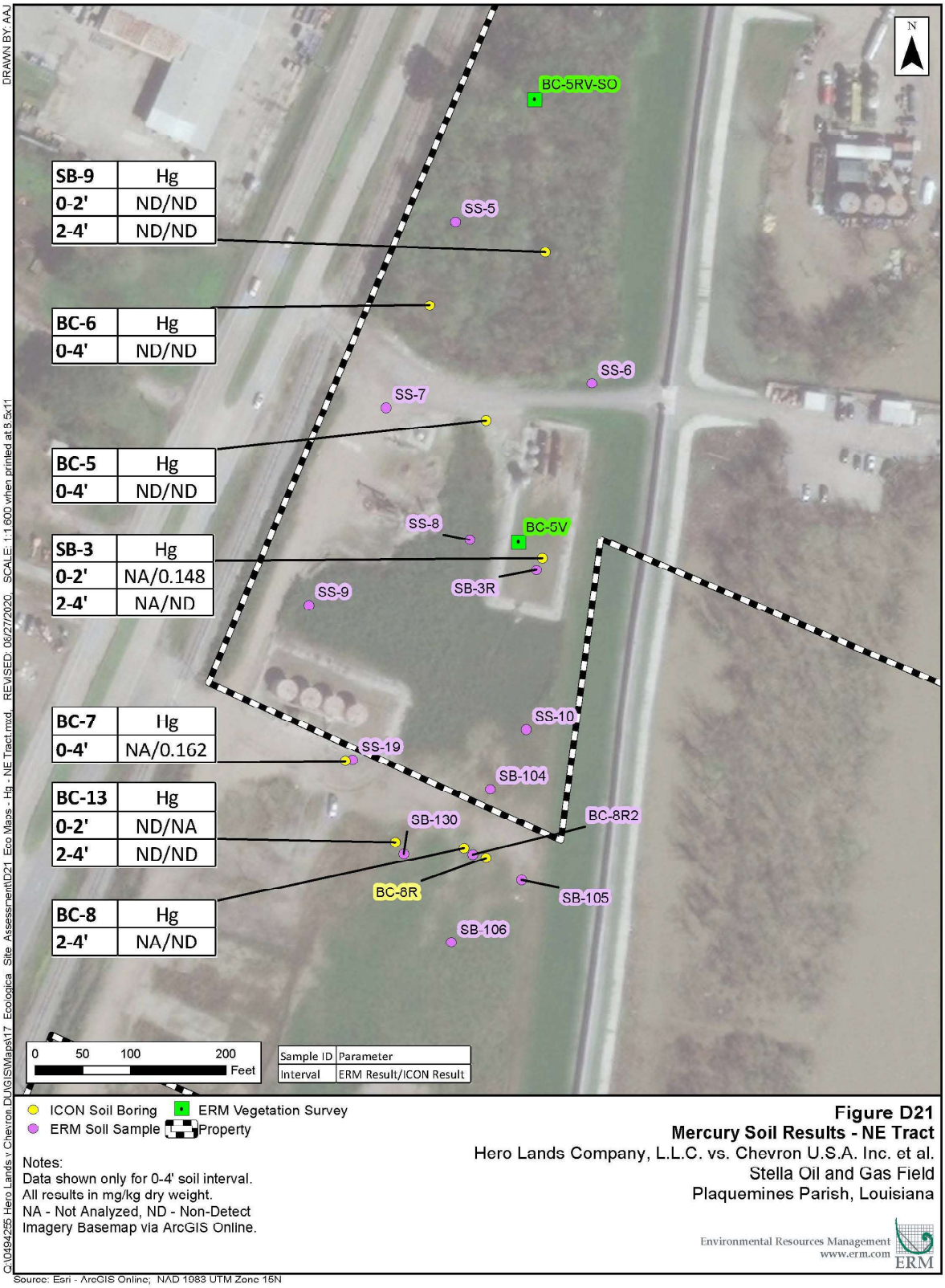

DRAWN BY: AAJ
SCALE: 1:2,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D16 Eco Maps - Pb - NW Tract.mxd
N
SB-101
BC-1RV-SO
BC-1R
SB-102
BC-1RV
BC-1 | Pb
2-4' | NA/8.65
SB-103
SS-1
BC-26
BC-2RV-SO
SB-1R
SS-3
BC-2R
BC-2RV
SB-2
SS-2
SS-4
BC-27
SB-1 | Pb
0-2' | NA/20.7
2-4' | NA/21.4
BC-2 | Pb
2-4' | 13.84/15.3
BC-3 | Pb
2-4' | 16.4/16.2
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D16
Lead Soil Results - NW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

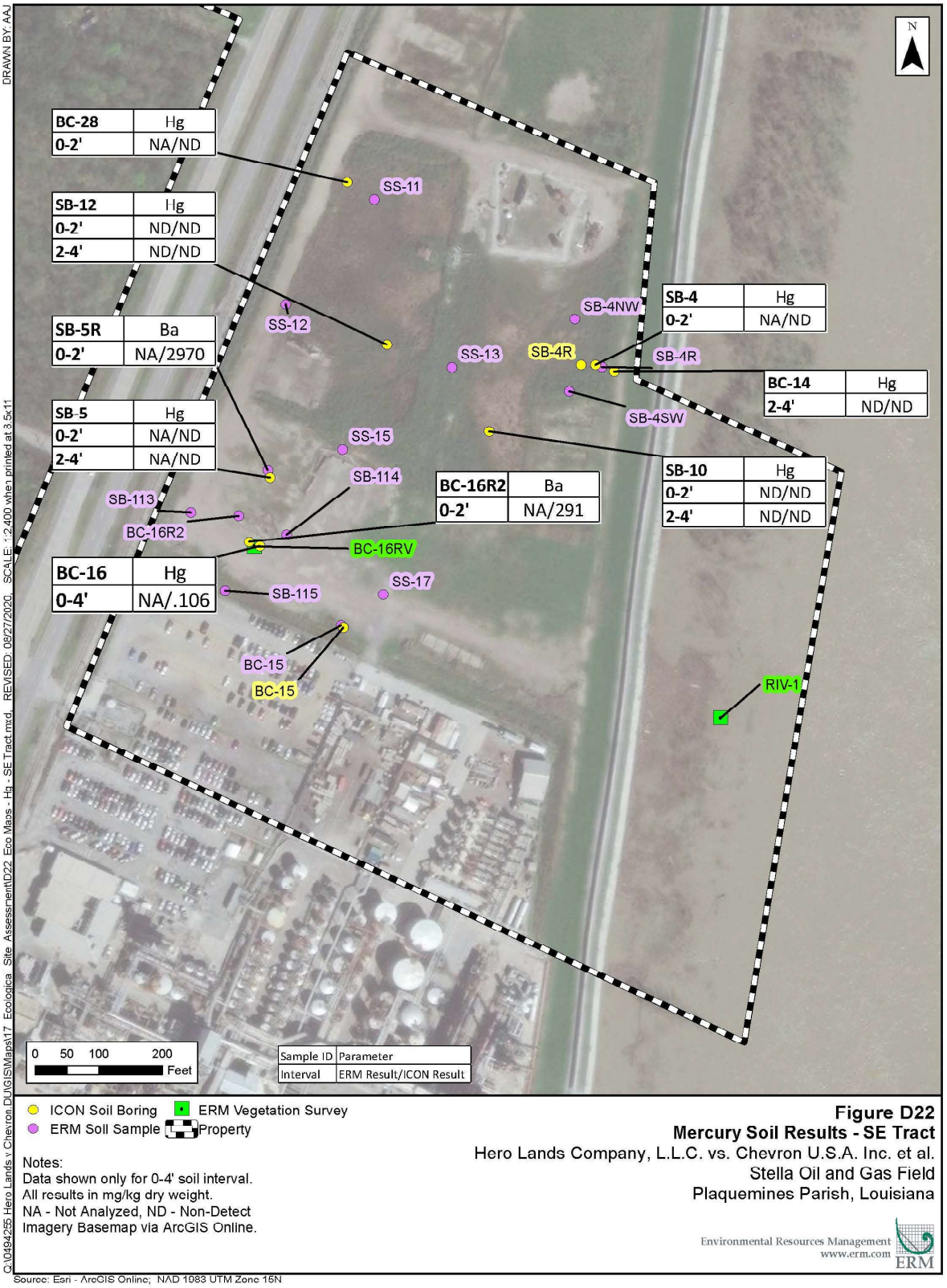

DRAWN BY: AAJ
REVISED: 08/27/2020 SCALE: 1:1,600 when printed at 3.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D17 Eco Maps - Pb - NE Tract.mxd
N
BC-5RV-SO
SS-5
SS-6
SS-7
SS-8
BC-5V
SB-3R
SS-9
SS-10
SS-19
SB-104
SB-130
BC-8R2
BC-8R
SB-105
SB-106
SB-9 | Pb
0-2' | 12.5/10.7
2-4' | 16.4/15.7
BC-6 | Pb
0-4' | 23.0/31.7
BC-5 | Pb
0-4' | 16.1/29.7
SB-3 | Pb
0-2' | NA/23.1
2-4' | NA/11.7
BC-7 | Pb
0-4' | NA/22.6
BC-13 | Pb
0-2' | 5.19/NA
2-4' | 3.62/3.33
BC-8 | Pb
2-4' | NA/69.9
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D17
Lead Soil Results - NE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

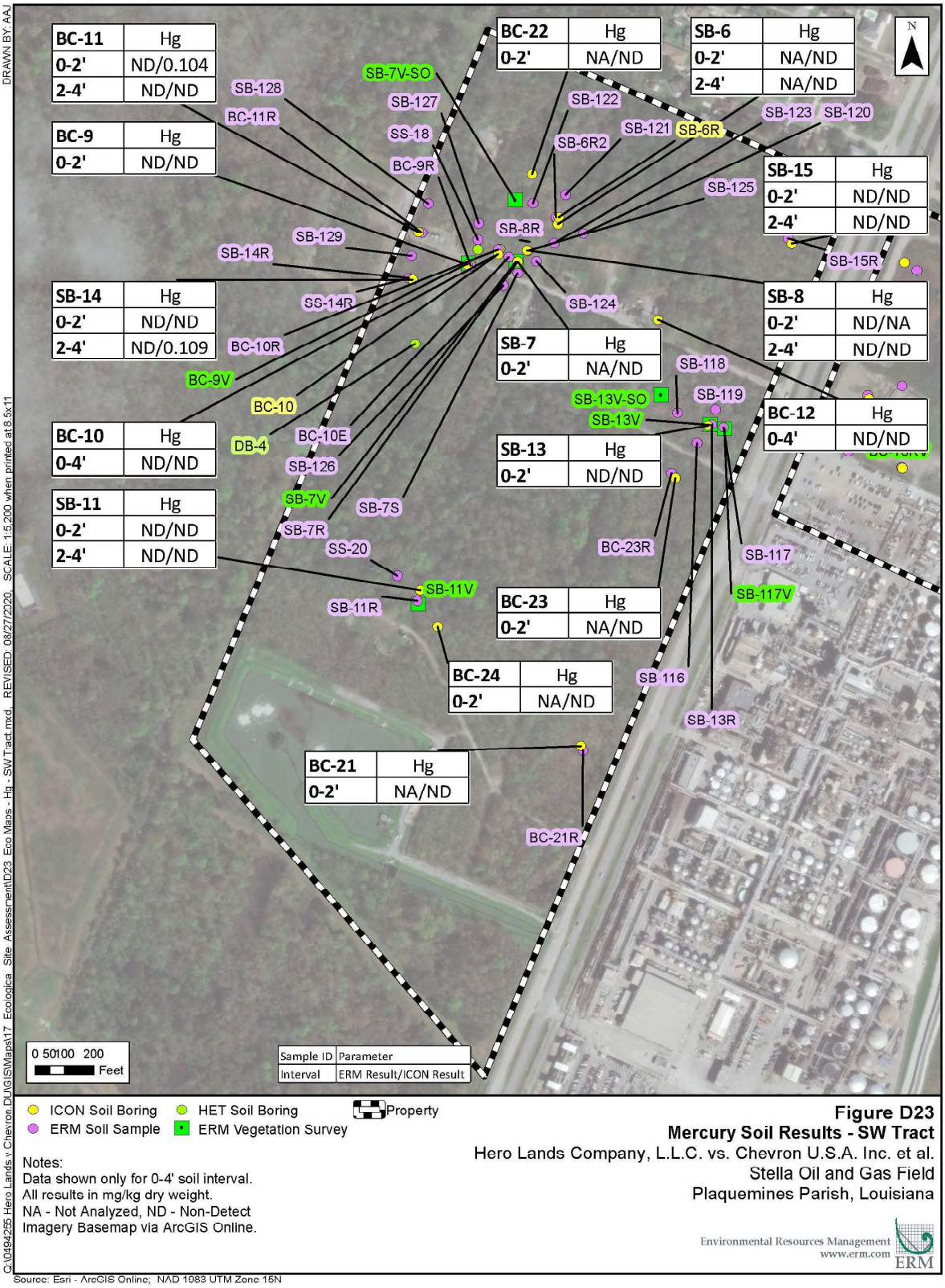

DRAWN BY: AAJ
SCALE: 1:2,400 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D18 Eco Maps - Pb - SE Tract.mxd
N
SB-15R
SB-15
BC-28
SS-11
SB-12 | Pb
0-2' | 27.0/26.0
2-4' | 16.4/21.9
SS-12
SB-4 | Pb
0-2' | NA/16.7
SB-4NW
BC-14 | Pb
2-4' | 12.79/12.7
SS-13
SB-4R
SB-4R
SB-4SW
SB-5 | Pb
0-2' | NA/30.6
2-4' | NA/16.6
SB-5R
SS-15
SB-10 | Pb
0-2' | 17/17.5
2-4' | 16.5/15.2
SB-114
SB-113
BC-16R
BC-16R2
BC-16RV
BC-16 | Pb
0-4' | NA/65.5
SS-17
SB-115
BC-15
BC-15
RIV-1
0 50 100 200
Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D18
Lead Soil Results - SE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

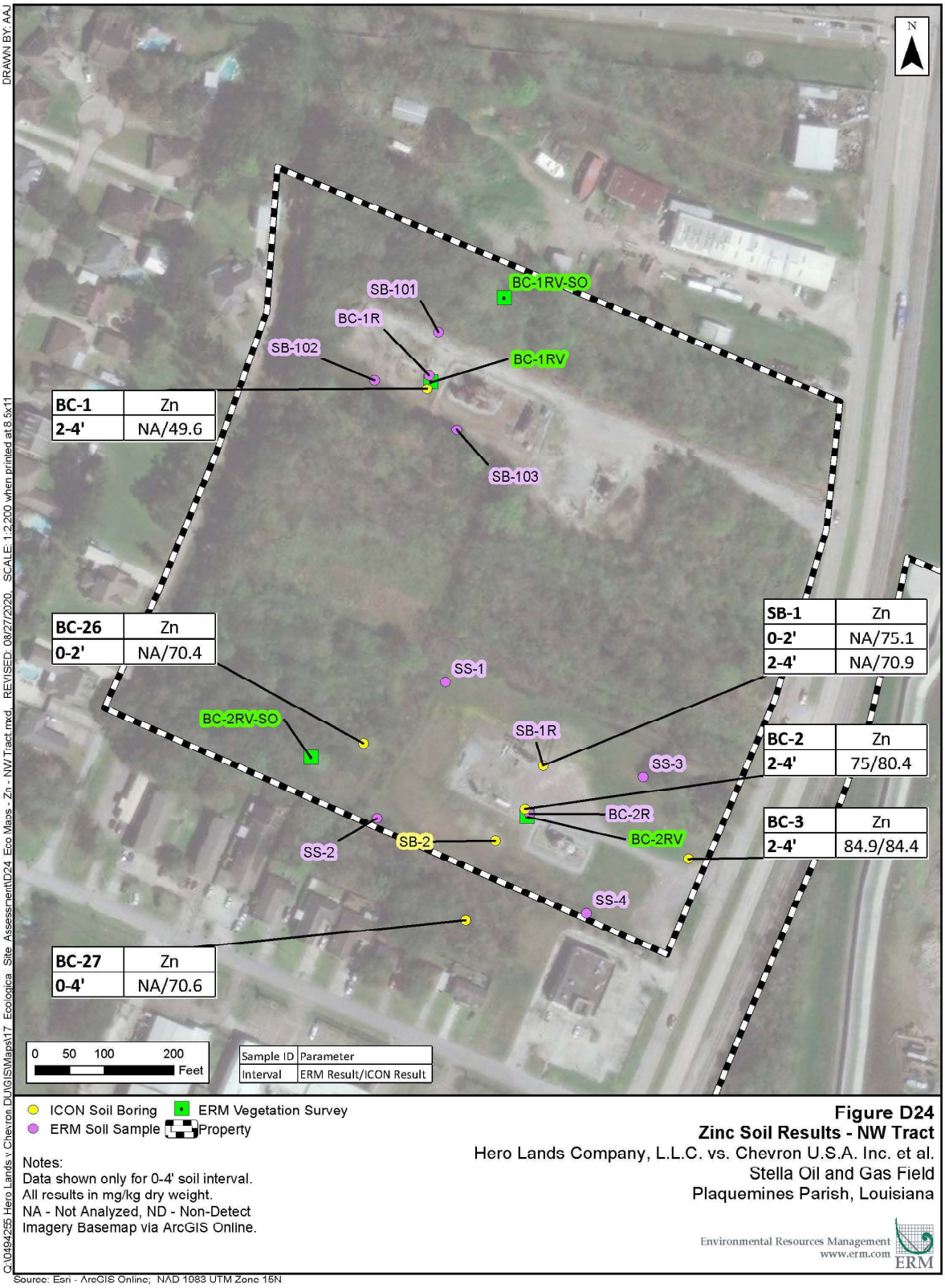

DRAWN BY: AAJ
SCALE: 1:5,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DUG\GIS\Maps\17 Ecologica Site Assessment\D19 Eco Maps - Pb - SW Tract.mxd
N
SB-11R | Pb
0-2' | 18.2
BC-11 | Pb
0-2' | 24.9/30.3
2-4' | 16.0/123.0
BC-9 | Pb
0-2' | 29.9/14.0
SB-14R | Pb
0-2' | 42.0/NA
SB-14 | Pb
0-2' | 25.4/27.5
2-4' | 121.4/24
BC-10 | Pb
0-4' | 21.8/16.7
SB-11 | Pb
0-2' | 14.7/NA
2-4' | 16.9/NA
SB-6 | Pb
0-2' | NA/18.5
2-4' | NA/18.6
SB-15 | Pb
0-2' | 35.7/109
2-4' | 16.5/16.4
SB-8 | Pb
0-2' | 17.9/NA
2-4' | 16.4/17.6
SB-7 | Pb
0-2' | NA/18.3
SB-13 | Pb
0-2' | 508/461
SB-116 | Pb
0-2' | 85.0/68.1
0-2' | NA/32.5
BC-12 | Pb
0-4' | 14.0/12.7
SB-118 | Pb
0-2' | 22.3/19.9
SB-119 | Pb
0-2' | 38.0/58.1
SB-117 | Pb
0-2' | 201/33.2
0-2' | NA/52.8
SB-13R | Pb
0-2' | 36.9/25.5
0-2' | NA/62.4
2-4' | 23.5/NA
SB-127
SS-18
BC-9R
SB-128
SB-129
SS-14R
BC-10R
BC-9V
BC-10
BC-10E
SB-126
SS-20
SB-11V
SB-11R
BC-24
SB-7V-SO
BC-22
SB-6R2
SB-121
SB-122
SB-6R
SB-123
SB-120
SB-125
SB-8R
SB-124
SB-7S
SB-13V-SO
SB-117V
SB-7V
SB-7R
BC-23R
BC-23
BC-21
BC-21R
SB-13V
SB-15R
BC-16RV
0 50100 200
Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
HET Soil Boring
Property
ERM Soil Sample
ERM Vegetation Survey
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D19
Lead Soil Results - SW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

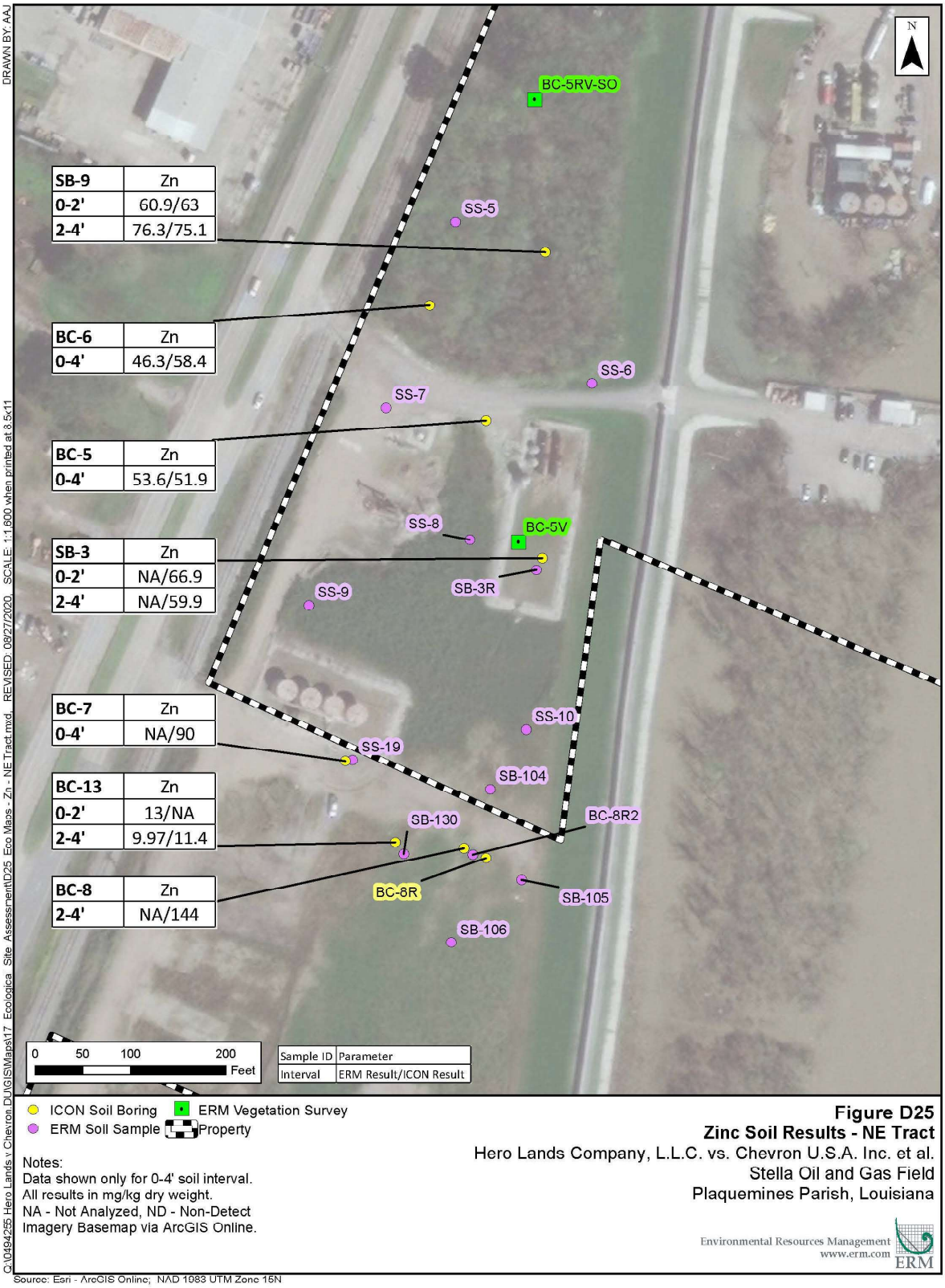

DRAWN BY: AAJ
REVISED: 03/27/2020 SCALE: 1:2,200 when printed at 8.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D20 Eco Maps - Hg - NW Tract.mxd
N
SB-101
BC-1RV-SO
BC-1R
SB-102
BC-1RV
SB-103
BC-1 | Hg
2-4' | NA/ND
BC-26 | Hg
0-2' | NA/ND
SS-1
BC-2RV-SO
SB-1R
SS-3
SB-2R
BC-2RV
SS-2
SB-2
SS-4
BC-27 | Hg
0-4' | NA/ND
SB-1 | Hg
0-2' | NA/ND
2-4' | NA/ND
BC-2 | Hg
2-4' | ND/ND
BC-3 | Hg
2-4' | ND/ND
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D20
Mercury Soil Results - NW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

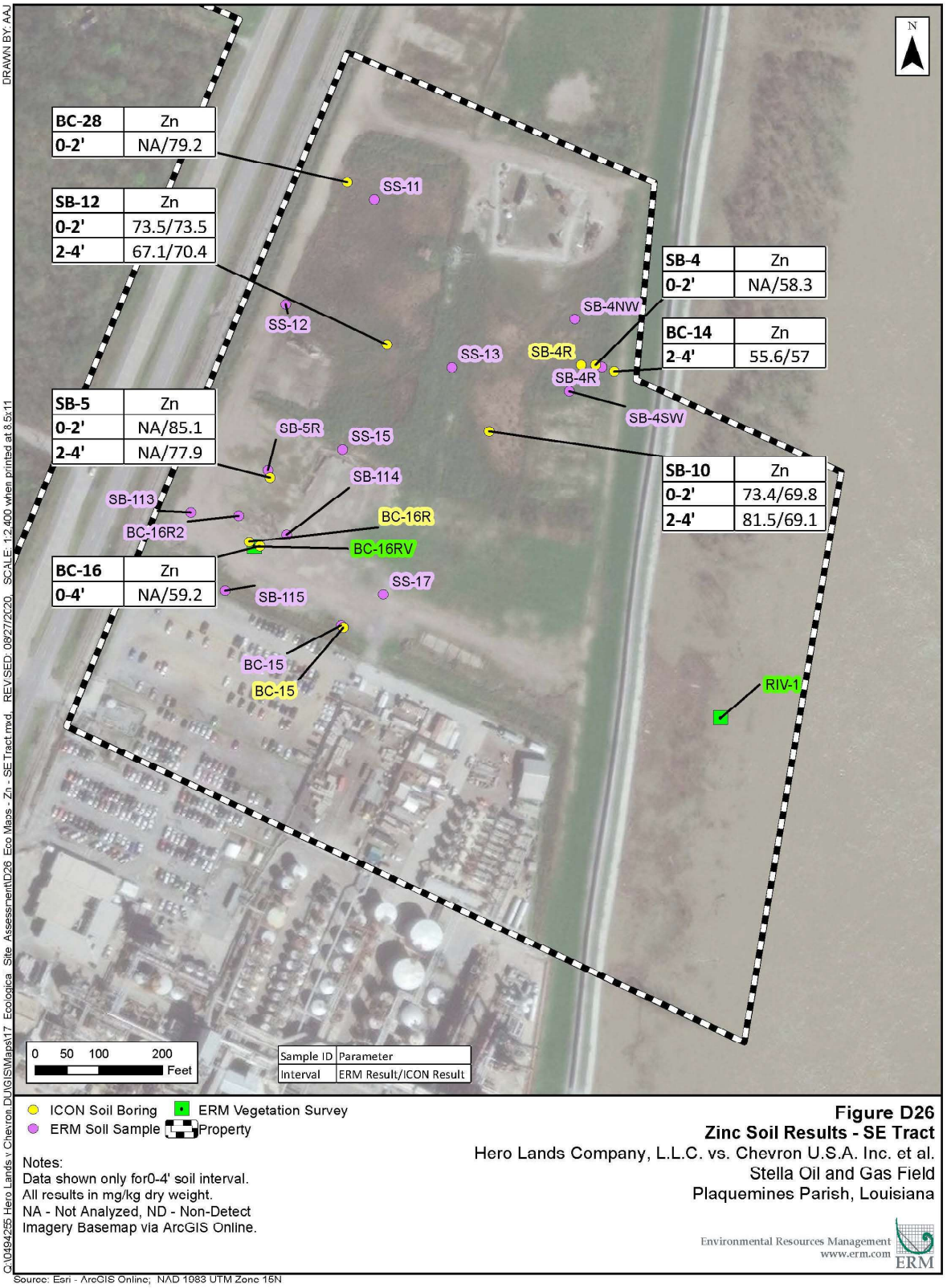

DRAWN BY: AAJ
REVISED: 06/27/2020 SCALE: 1:1,600 when printed at 8.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D21 Eco Maps - Hg - NE Tract.mxd
N
BC-5RV-SO
SS-5
SS-6
SS-7
SS-8
BC-5V
SB-3R
SS-9
SS-10
SS-19
SB-104
BC-8R2
SB-130
BC-8R
SB-105
SB-106
SB-9 | Hg
0-2' | ND/ND
2-4' | ND/ND
BC-6 | Hg
0-4' | ND/ND
BC-5 | Hg
0-4' | ND/ND
SB-3 | Hg
0-2' | NA/0.148
2-4' | NA/ND
BC-7 | Hg
0-4' | NA/0.162
BC-13 | Hg
0-2' | ND/NA
2-4' | ND/ND
BC-8 | Hg
2-4' | NA/ND
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D21
Mercury Soil Results - NE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

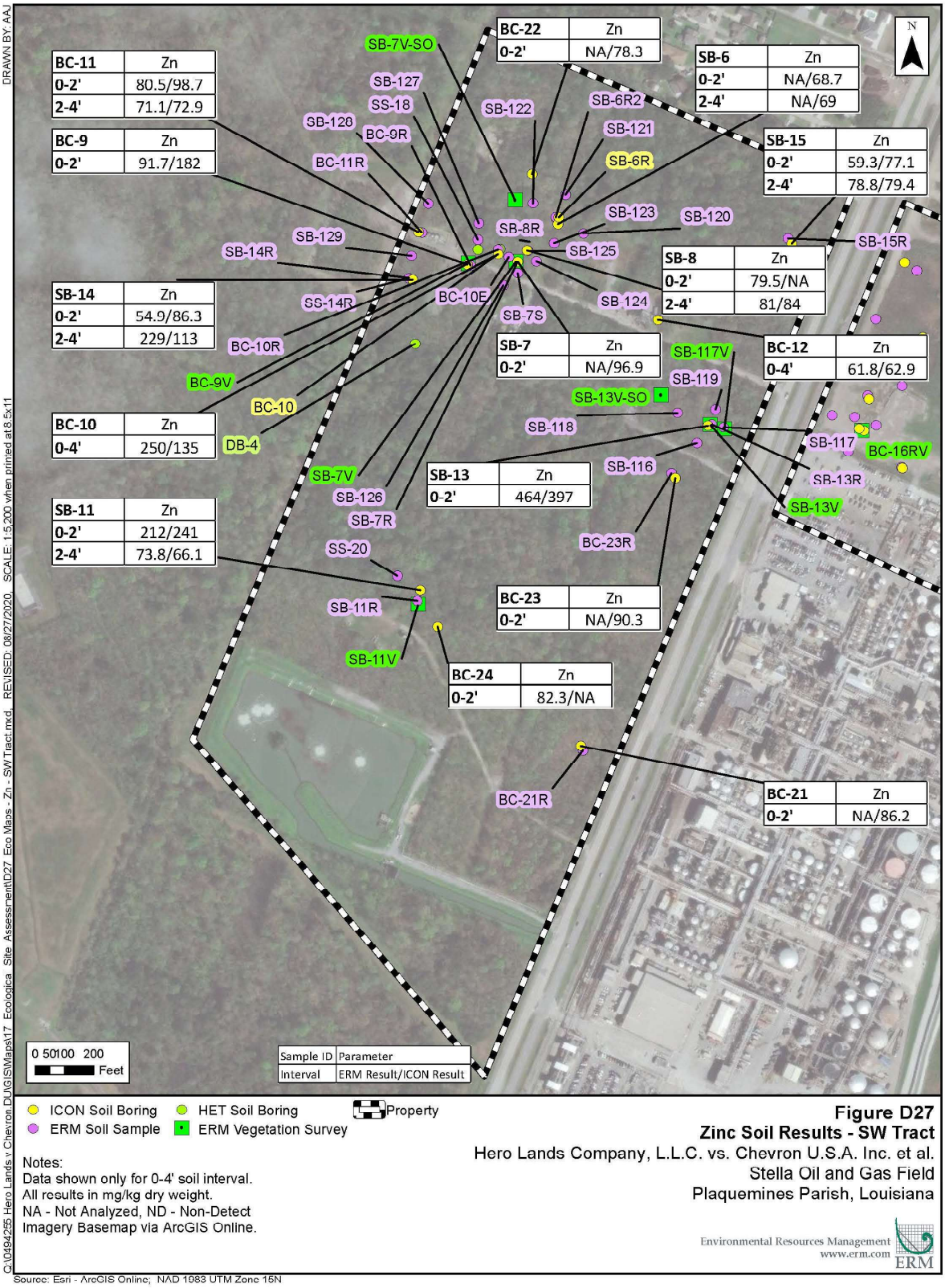

DRAWN BY: AAJ
SCALE: 1:2,400 when printed at 3.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D22 Eco Maps - Hg - SE Tract.mxd
N
BC-28 | Hg
0-2' | NA/ND
SB-12 | Hg
0-2' | ND/ND
2-4' | ND/ND
SB-5R | Ba
0-2' | NA/2970
SB-5 | Hg
0-2' | NA/ND
2-4' | NA/ND
BC-16 | Hg
0-4' | NA/.106
SB-4 | Hg
0-2' | NA/ND
BC-14 | Hg
2-4' | ND/ND
SB-10 | Hg
0-2' | ND/ND
2-4' | ND/ND
BC-16R2 | Ba
0-2' | NA/291
SS-11
SS-12
SS-13
SS-15
SS-17
SB-4NW
SB-4R
SB-4SW
SB-114
SB-113
BC-16R2
BC-16RV
SB-115
BC-15
BC-15
RIV-1
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D22
Mercury Soil Results - SE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

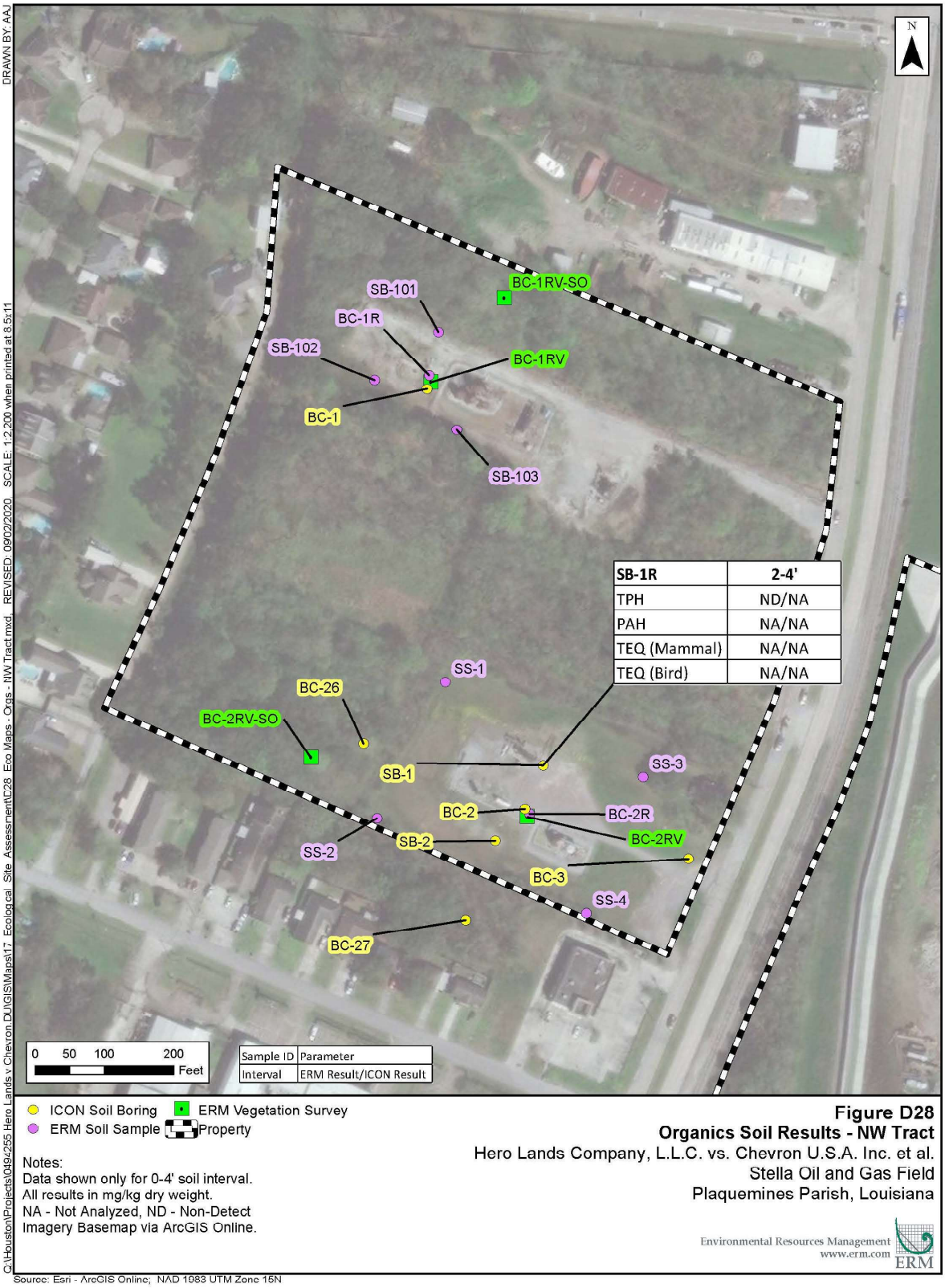

DRAWN BY: AAJ
SCALE: 1:5,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DJ\GIS\Maps\17 Ecologica Site Assessment\D23 Eco Maps - Hg - SW Tract.mxd
BC-11 Hg
0-2' ND/0.104
2-4' ND/ND
BC-9 Hg
0-2' ND/ND
SB-14 Hg
0-2' ND/ND
2-4' ND/0.109
BC-10 Hg
0-4' ND/ND
SB-11 Hg
0-2' ND/ND
2-4' ND/ND
BC-22 Hg
0-2' NA/ND
SB-6 Hg
0-2' NA/ND
2-4' NA/ND
SB-15 Hg
0-2' ND/ND
2-4' ND/ND
SB-8 Hg
0-2' ND/NA
2-4' ND/ND
SB-7 Hg
0-2' NA/ND
SB-13 Hg
0-2' ND/ND
BC-12 Hg
0-4' ND/ND
BC-23 Hg
0-2' NA/ND
BC-24 Hg
0-2' NA/ND
BC-21 Hg
0-2' NA/ND
SB-7V-SO
SB-128
SB-127
RC-11R
SS-18
BC-9R
SB-122
SB-121
SB-6R
SB-6R2
SB-123
SB-120
SB-125
SB-8R
SB-129
SB-14R
SB-15R
SS-14R
SB-124
BC-10R
BC-9V
SB-118
SB-13V-SO
SB-119
SB-13V
BC-10
BC-10E
DB-4
SB-126
SB-7V
SB-7S
SB-7R
SS-20
BC-23R
SB-117
SB-11V
SB-117V
SB-11R
SB 116
SB-13R
BC-21R
N
0 50100 200
Feet
Sample ID
Interval
Parameter
ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
HET Soil Boring
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D23
Mercury Soil Results - SW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

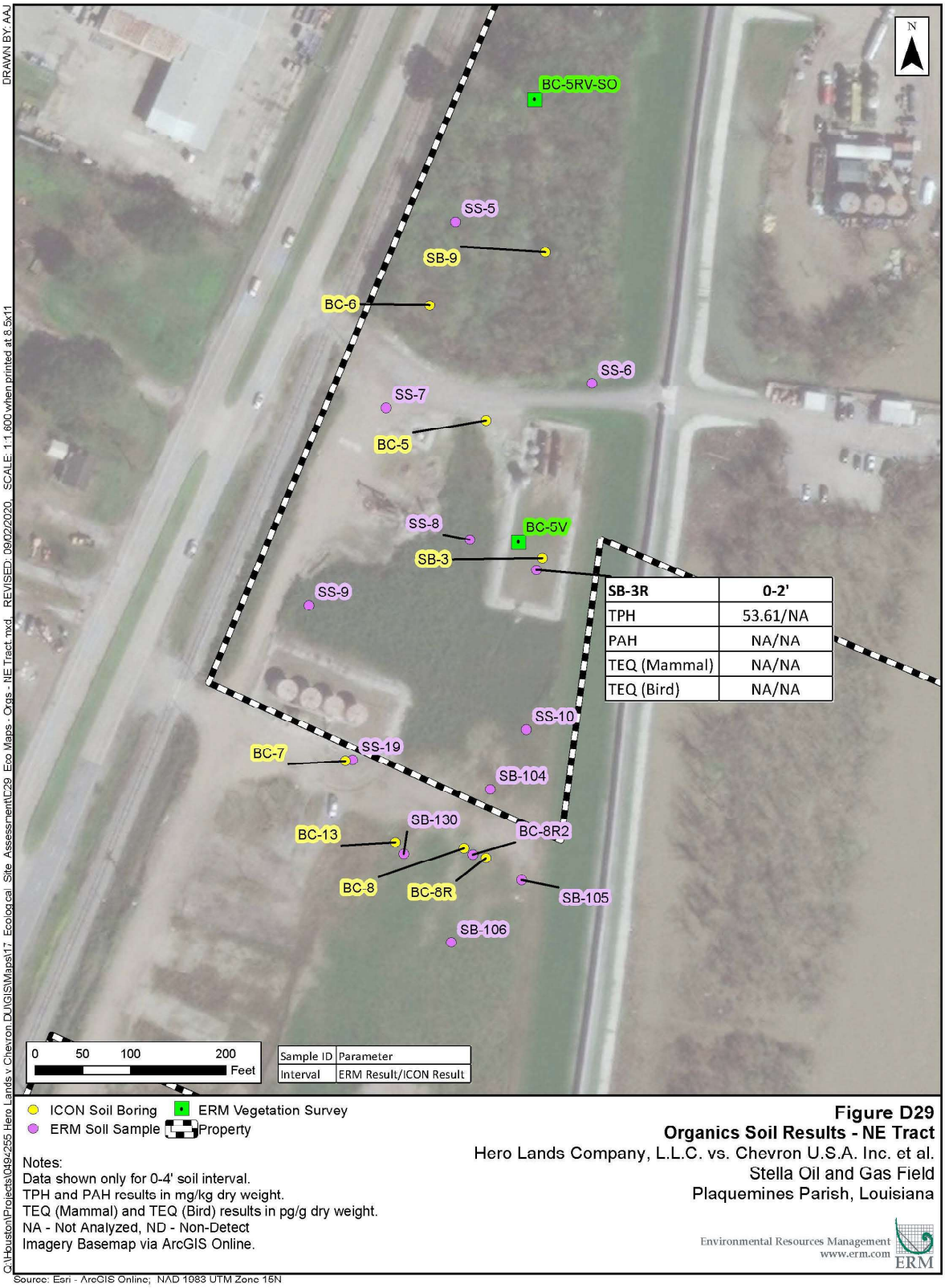

DRAWN BY: AAJ
SCALE: 1:2,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DLI\GIS\Maps\17 Ecologica Site Assessment\D24 Eco Maps - Zn - NW Tract.mxd
N
SB-101
BC-1RV-SO
BC-1R
SB-102
BC-1RV
BC-1 | Zn
2-4' | NA/49.6
SB-103
BC-26 | Zn
0-2' | NA/70.4
SB-1 | Zn
0-2' | NA/75.1
2-4' | NA/70.9
SS-1
BC-2RV-SO
SB-1R
BC-2 | Zn
2-4' | 75/80.4
SS-3
BC-2R
BC-2RV
BC-3 | Zn
2-4' | 84.9/84.4
SS-2
SB-2
SS-4
BC-27 | Zn
0-4' | NA/70.6
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D24
Zinc Soil Results - NW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

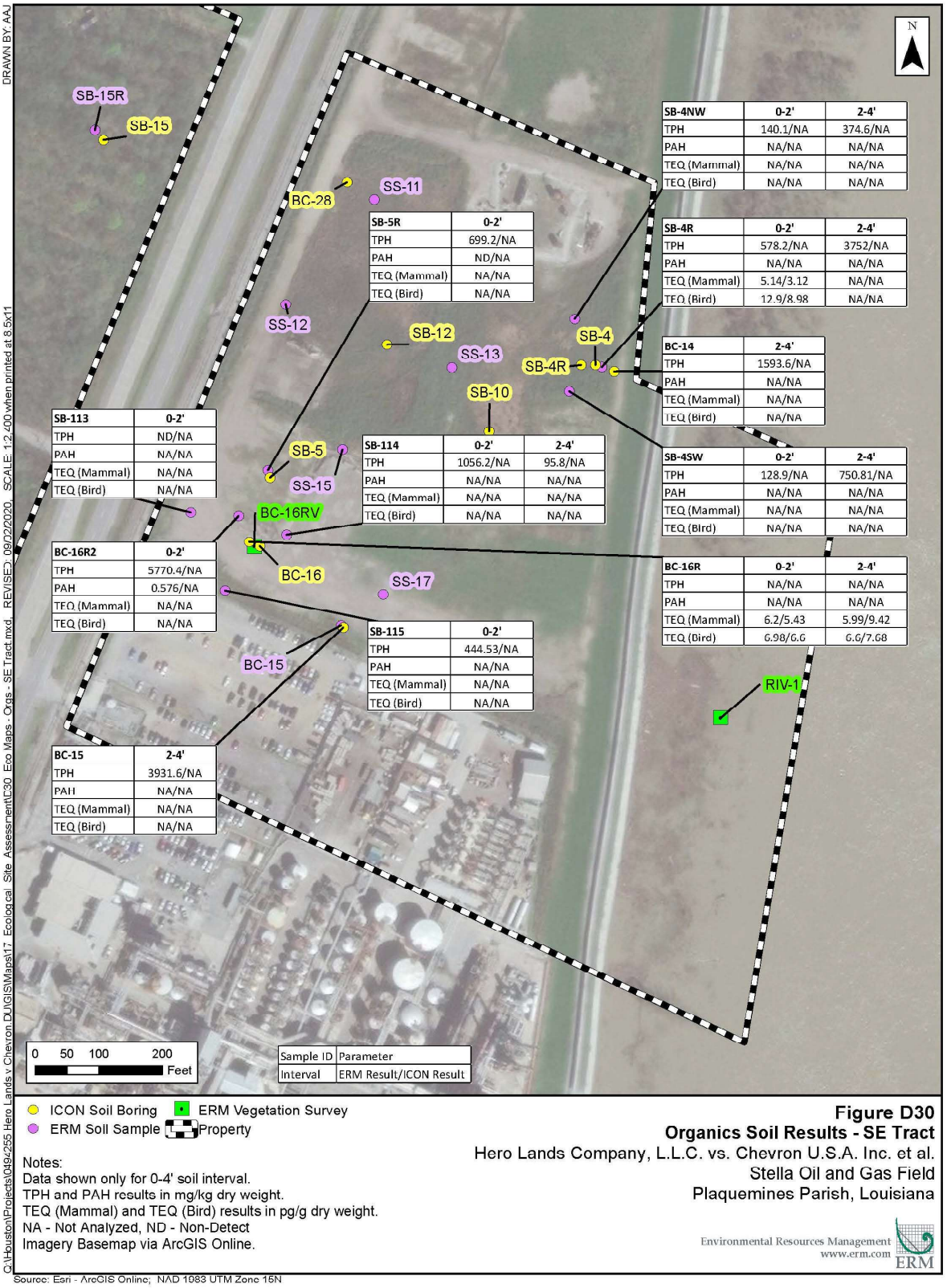

DRAWN BY: AAJ
REVISED: 08/27/2020 SCALE: 1:1,600 when printed at 8.5x11
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D25 Eco Maps - Zn - NE Tract.mxd
N
BC-5RV-SO
SS-5
SS-6
SS-7
SS-8
BC-5V
SB-3R
SS-9
SS-10
SS-19
SB-104
SB-130
BC-8R2
BC-8R
SB-105
SB-106
SB-9 | Zn
0-2' | 60.9/63
2-4' | 76.3/75.1
BC-6 | Zn
0-4' | 46.3/58.4
BC-5 | Zn
0-4' | 53.6/51.9
SB-3 | Zn
0-2' | NA/66.9
2-4' | NA/59.9
BC-7 | Zn
0-4' | NA/90
BC-13 | Zn
0-2' | 13/NA
2-4' | 9.97/11.4
BC-8 | Zn
2-4' | NA/144
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D25
Zinc Soil Results - NE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM

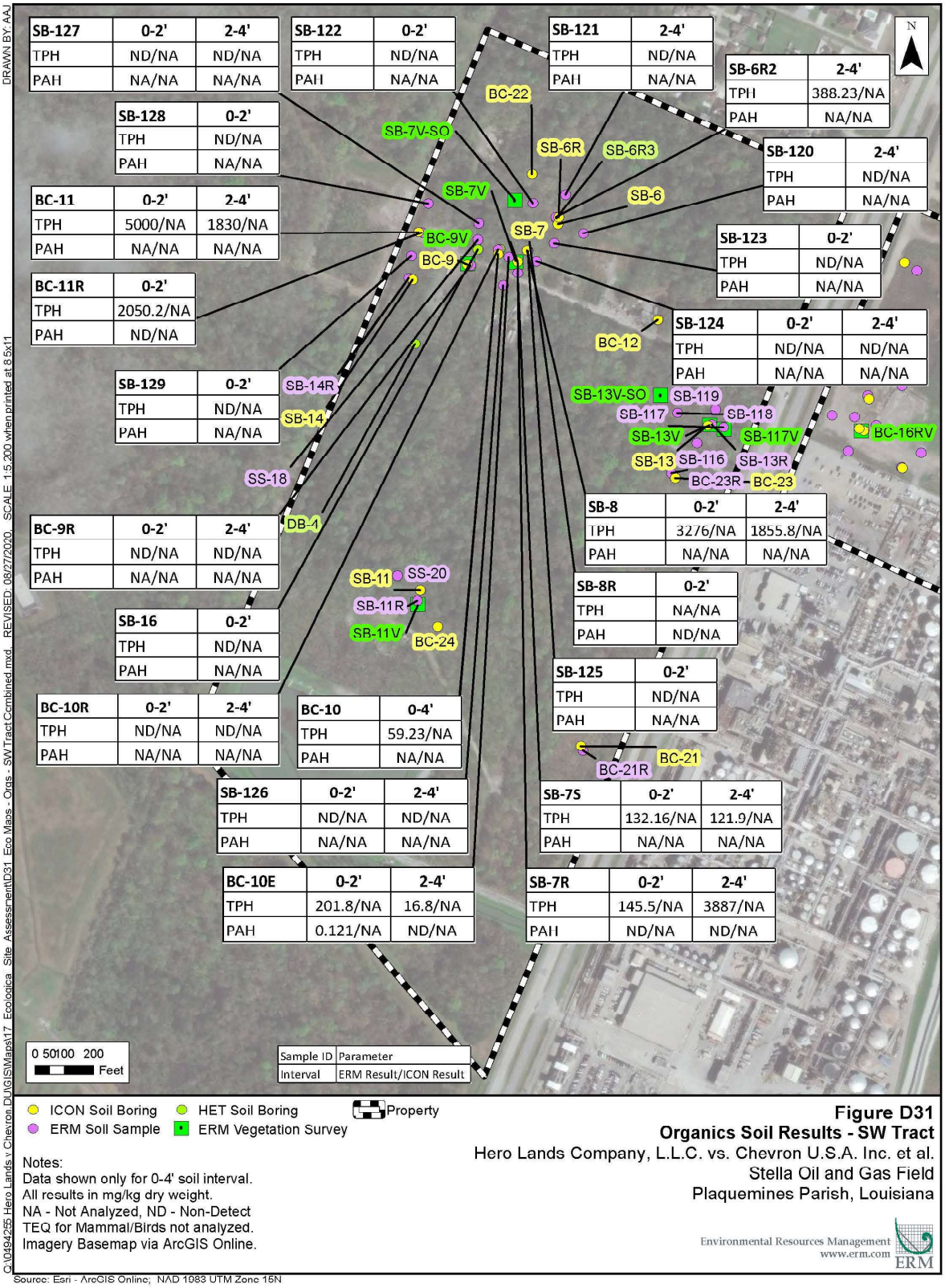

DRAWN BY: AAJ
SCALE: 1:2,400 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecologica Site Assessment\D26 Eco Maps - Zn - SE Tract.mxd
N
BC-28 | Zn
0-2' | NA/79.2
SB-12 | Zn
0-2' | 73.5/73.5
2-4' | 67.1/70.4
SB-5 | Zn
0-2' | NA/85.1
2-4' | NA/77.9
BC-16 | Zn
0-4' | NA/59.2
SB-4 | Zn
0-2' | NA/58.3
BC-14 | Zn
2-4' | 55.6/57
SB-10 | Zn
0-2' | 73.4/69.8
2-4' | 81.5/69.1
SS-11
SS-12
SS-13
SS-15
SS-17
SB-4NW
SB-4R
SB-4R
SB-4SW
SB-5R
SB-114
SB-113
BC-16R
BC-16R2
BC-16RV
SB-115
BC-15
BC-15
RIV-1
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D26
Zinc Soil Results - SE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM


DRAWN BY: AAJ
SCALE: 1:5,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DJ\GIS\Maps\17 Ecologica Site Assessment\D27 Eco Maps - Zn - SW Tract.mxd
N
BC-11 | Zn
0-2' | 80.5/98.7
2-4' | 71.1/72.9
BC-9 | Zn
0-2' | 91.7/182
SB-14 | Zn
0-2' | 54.9/86.3
2-4' | 229/113
BC-10 | Zn
0-4' | 250/135
SB-11 | Zn
0-2' | 212/241
2-4' | 73.8/66.1
BC-22 | Zn
0-2' | NA/78.3
SB-6 | Zn
0-2' | NA/68.7
2-4' | NA/69
SB-15 | Zn
0-2' | 59.3/77.1
2-4' | 78.8/79.4
SB-8 | Zn
0-2' | 79.5/NA
2-4' | 81/84
SB-7 | Zn
0-2' | NA/96.9
BC-12 | Zn
0-4' | 61.8/62.9
SB-13 | Zn
0-2' | 464/397
BC-23 | Zn
0-2' | NA/90.3
BC-24 | Zn
0-2' | 82.3/NA
BC-21 | Zn
0-2' | NA/86.2
SB-7V-SO
SB-127
SS-18
SB-120
BC-9R
BC-11R
SB-122
SB-6R2
SB-121
SB-6R
SB-123
SB-120
SB-8R
SB-125
SB-15R
SB-129
SB-14R
SS-14R
BC-10E
SB-7S
SB-124
BC-10R
BC-9V
BC-10
DB-4
SB-7V
SB-126
SB-7R
SS-20
SB-11R
SB-11V
SB-117V
SB-119
SB-13V-SO
SB-118
SB-116
SB-117
BC-16RV
SB-13R
SB-13V
BC-23R
BC-21R
0 50100 200
Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
HET Soil Boring
Property
ERM Soil Sample
ERM Vegetation Survey
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D27
Zinc Soil Results - SW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM


DRAWN BY: AAJ
SCALE: 1:2,200 when printed at 8.5x11
REVISED: 09/02/2020
C:\Houston\Projects\0494-255 Hero Lands v Chevron DJ\GIS\Maps\17 Ecological Site Assessment\C28 Eco Maps - Orgs - NW Tract.mxd
N
SB-101
BC-1RV-SO
BC-1R
SB-102
BC-1RV
BC-1
SB-103
SB-1R | 2-4'
TPH | ND/NA
PAH | NA/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
SS-1
BC-26
BC-2RV-SO
SB-1
SS-3
BC-2
BC-2R
BC-2RV
SB-2
SS-2
BC-3
SS-4
BC-27
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Vegetation Survey
ERM Soil Sample
Property
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 15N
Figure D28
Organics Soil Results - NW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM


DRAWN BY: AAJ
SCALE: 1:1,600 when printed at 8.5x11
REVISED: 09/02/2020
C:\Houston\Projects\0494255 Hero Lands v Chevron DJ\GIS\Maps\17 Ecological Site Assessment\C29 Eco Maps - Orgs - NE Tract.mxd
N
BC-5RV-SO
SS-5
SB-9
BC-6
SS-6
SS-7
BC-5
SS-8
BC-5V
SB-3
SS-9
SS-10
BC-7
SS-19
SB-104
SB-130
BC-13
BC-8R2
BC-8
BC-8R
SB-105
SB-106
SB-3R | 0-2'
TPH | 53.61/NA
PAH | NA/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
TPH and PAH results in mg/kg dry weight.
TEQ (Mammal) and TEQ (Bird) results in pg/g dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D29
Organics Soil Results - NE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM


DRAWN BY: AAJ
SCALE: 1:2,400 when printed at 8.5x11
REVISED: 09/22/2020
C:\Houston\Projects\0494255 Hero Lands v Chevron DJ\GIS\Maps\17 Ecological Site Assessment\D30 Eco Maps - Orgs - SE Tract.mxd
N
SB-15R
SB-15
BC-28
SS-11
SS-12
SB-12
SS-13
SB-4
SB-4R
SB-10
SB-5
SS-15
BC-16RV
BC-16
SS-17
BC-15
RIV-1
SB-5R | 0-2'
TPH | 699.2/NA
PAH | ND/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
SB-4NW | 0-2' | 2-4'
TPH | 140.1/NA | 374.6/NA
PAH | NA/NA | NA/NA
TEQ (Mammal) | NA/NA | NA/NA
TEQ (Bird) | NA/NA | NA/NA
SB-4R | 0-2' | 2-4'
TPH | 578.2/NA | 3752/NA
PAH | NA/NA | NA/NA
TEQ (Mammal) | 5.14/3.12 | NA/NA
TEQ (Bird) | 12.9/8.98 | NA/NA
BC-14 | 2-4'
TPH | 1593.6/NA
PAH | NA/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
SB-113 | 0-2'
TPH | ND/NA
PAH | NA/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
SB-114 | 0-2' | 2-4'
TPH | 1056.2/NA | 95.8/NA
PAH | NA/NA | NA/NA
TEQ (Mammal) | NA/NA | NA/NA
TEQ (Bird) | NA/NA | NA/NA
SB-4SW | 0-2' | 2-4'
TPH | 128.9/NA | 750.81/NA
PAH | NA/NA | NA/NA
TEQ (Mammal) | NA/NA | NA/NA
TEQ (Bird) | NA/NA | NA/NA
BC-16R2 | 0-2'
TPH | 5770.4/NA
PAH | 0.576/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
BC-16R | 0-2' | 2-4'
TPH | NA/NA | NA/NA
PAH | NA/NA | NA/NA
TEQ (Mammal) | 6.2/5.43 | 5.99/9.42
TEQ (Bird) | 6.98/6.6 | 6.6/7.68
SB-115 | 0-2'
TPH | 444.53/NA
PAH | NA/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
BC-15 | 2-4'
TPH | 3931.6/NA
PAH | NA/NA
TEQ (Mammal) | NA/NA
TEQ (Bird) | NA/NA
0 50 100 200 Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
ERM Soil Sample
ERM Vegetation Survey
Property
Notes:
Data shown only for 0-4' soil interval.
TPH and PAH results in mg/kg dry weight.
TEQ (Mammal) and TEQ (Bird) results in pg/g dry weight.
NA - Not Analyzed, ND - Non-Detect
Imagery Basemap via ArcGIS Online.
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N
Figure D30
Organics Soil Results - SE Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM


DRAWN BY: AAJ
SCALE 1:5,200 when printed at 8.5x11
REVISED: 08/27/2020
Q:\0494255 Hero Lands v Chevron DU\GIS\Maps\17 Ecological Site Assessment\D31 Eco Maps - Orgs - SW Tract Combined.mxd
N
SB-127 | 0-2' | 2-4'
TPH | ND/NA | ND/NA
PAH | NA/NA | NA/NA
SB-122 | 0-2'
TPH | ND/NA
PAH | NA/NA
SB-121 | 2-4'
TPH | ND/NA
PAH | NA/NA
SB-6R2 | 2-4'
TPH | 388.23/NA
PAH | NA/NA
SB-128 | 0-2'
TPH | ND/NA
PAH | NA/NA
SB-120 | 2-4'
TPH | ND/NA
PAH | NA/NA
BC-11 | 0-2' | 2-4'
TPH | 5000/NA | 1830/NA
PAH | NA/NA | NA/NA
SB-123 | 0-2'
TPH | ND/NA
PAH | NA/NA
BC-11R | 0-2'
TPH | 2050.2/NA
PAH | ND/NA
SB-124 | 0-2' | 2-4'
TPH | ND/NA | ND/NA
PAH | NA/NA | NA/NA
SB-129 | 0-2'
TPH | ND/NA
PAH | NA/NA
SB-8 | 0-2' | 2-4'
TPH | 3276/NA | 1855.8/NA
PAH | NA/NA | NA/NA
BC-9R | 0-2' | 2-4'
TPH | ND/NA | ND/NA
PAH | NA/NA | NA/NA
SB-8R | 0-2'
TPH | NA/NA
PAH | ND/NA
SB-16 | 0-2'
TPH | ND/NA
PAH | NA/NA
SB-125 | 0-2'
TPH | ND/NA
PAH | NA/NA
BC-10R | 0-2' | 2-4'
TPH | ND/NA | ND/NA
PAH | NA/NA | NA/NA
BC-10 | 0-4'
TPH | 59.23/NA
PAH | NA/NA
SB-126 | 0-2' | 2-4'
TPH | ND/NA | ND/NA
PAH | NA/NA | NA/NA
SB-7S | 0-2' | 2-4'
TPH | 132.16/NA | 121.9/NA
PAH | NA/NA | NA/NA
BC-10E | 0-2' | 2-4'
TPH | 201.8/NA | 16.8/NA
PAH | 0.121/NA | ND/NA
SB-7R | 0-2' | 2-4'
TPH | 145.5/NA | 3887/NA
PAH | ND/NA | ND/NA
BC-22
SB-7V-SO
SB-6R
SB-6R3
SB-7V
SB-6
SB-7
BC-9V
BC-9
BC-12
SB-14R
SB-14
SB-13V-SO
SB-119
SB-117
SB-118
SB-13V
SB-117V
BC-16RV
SB-13
SB-116
SB-13R
BC-23R
BC-23
SS-18
DB-1
SB-11
SS-20
SB-11R
SB-11V
BC-24
BC-21
BC-21R
0 50100 200
Feet
Sample ID | Parameter
Interval | ERM Result/ICON Result
ICON Soil Boring
HET Soil Boring
Property
ERM Soil Sample
ERM Vegetation Survey
Notes:
Data shown only for 0-4' soil interval.
All results in mg/kg dry weight.
NA - Not Analyzed, ND - Non-Detect
TEQ for Mammal/Birds not analyzed.
Imagery Basemap via ArcGIS Online.
Figure D31
Organics Soil Results - SW Tract
Hero Lands Company, L.L.C. vs. Chevron U.S.A. Inc. et al.
Stella Oil and Gas Field
Plaquemines Parish, Louisiana
Environmental Resources Management
www.erm.com
ERM
Source: Esri - ArcGIS Online; NAD 1983 UTM Zone 16N

ATTACHMENT 1 SUPPORTING CALCULATIONS

BCF CALCULATIONS - METALS

Summary: Barium Sediment to Benthic Invertebrate Bioconcentration Factors

Location	Barium Geometric Mean Sediment to Benthic Invertebrate BCF	Reference
South Louisiana (Abdominal)	0.0013	Finerty et al., 1990
South Louisiana (Hepatopancreas)	0.012	Finerty et al., 1990
EWL, LA (Site)	0.091	ERM, 2019
EWL, LA (Reference)	0.21	ERM, 2019
Total Means: Barium Sediment to Benthic Invertebrate BCF	0.023	

Notes:
BCF=Bioconcentration Factor
EWL, LA=East White Lake, Louisiana

References:
Finerty, M.W., Madden, J.D., Feagley, and Grodner, R.M. 1990. Tissues of Wild and Pond-raised Crayfish in Southern Louisiana, Effect of Environs and Seasonality on Metal Residues. Arch. Environ. Contam. Toxicol. 19: 94-100.

ERM. 2019. East White Lake Ecological Risk Assessment.

Barium in Sediments and Invertebrates and Bioconcentration Factor Calculations (Finerty et al., 1990)

Sample ID	Crawfish Mean Abdominal Barium (mg/kg)	Crawfish Mean Hepatopancreas Barium (mg/kg)	Mean Sediment Barium (mg/kg)	Abdominal BCF (conc. in crawfish ÷ conc. in sed.)	Hepatopancreas BCF (conc. in crawfish ÷ conc. in sed.)
VER	0.782	8.223	333.5	0.0023	0.025
AP	-	4.84	556.4	-	0.0087
CRS	0.532	6.869	519.3	0.0010	0.013
LB	1.288	6.177	297.6	0.0043	0.021
STM	0.043	2.193	945.9	0.000045	0.0023
UB	2.383	6.558	282.2	0.0084	0.023
Geometric Mean Barium Sediment to Benthic Invertebrate BCF				0.0013	0.012

Notes:
Outlier removed: Barium soil outlier significantly below background (13.39 mg/kg).
BCF=Bioconcentration Factor

Reference:
Finerty, M.W., Madden, J.D., Feagley, and Grodner, R.M. 1990. Tissues of Wild and Pond-raised Crayfish in Southern Louisiana, Effect of Environs and Seasonality on Metal Residues. Arch. Environ. Contam. Toxicol. 19: 94-100.

Barium in Sediments and Crabs at EWL and Bioconcentration Factor Calculations (ERM, 2019)

Area	Sample ID	Barium Concentration in Crab Tissue	Barium Concentration in Sediment	Barium Sediment to Crab BCF (conc. in crab tissue ÷ conc. in sediment)
Site	EWL-T-01A-C	13.1		
Site	EWL-T-01-C	22.6		
Site	EWL-T-02-C	16.5		
Site	EWL-T-03-C	34.1		
Site	EWL-T-04-C	20.7		
Site	EWL-T-05-C	19.5		
Site	EWL-T-06-C	22.9		
Site	EWL-T-07-C	20.4		
Site	EWL-T-08-C	23.5		
Site	EWL-T-09-C	16.1		
Site	EWL-T-10-C	37.7		
Site	EWL-T-11-C	24.3		
Site	EWL-T-12-C	24.9		
Site Geometric Mean		**21.9**	**241**	**0.091**
Reference	EWL-TR-01-C	16.8		
Reference	EWL-TR-02-C	20.8		
Reference	EWL-TR-03A-C	25.8		
Reference	EWL-TR-03-C	20.4		
Reference	EWL-TR-04-C	22.4		
Reference	EWL-TR-05-C	21.1		
Reference	EWL-TR-06-C	29.3		
Reference	EWL-TR-07-C	14.3		
Reference	EWL-TR-08-C	21.8		
Reference	EWL-TR-09-C	23.6		
Reference Geometric Mean		**21.3**	**101**	**0.21**

Notes:
Concentrations are in mg/kg wet weight.
Concentrations for crab are for tissue.
Crab sampling was performed in December 2010/January 2011. Sediment data are from 0-2 feet and collected in 2010 at EWL.
BCF=Bioconcentration Factor
EWL=East White Lake

Reference:
ERM. 2019. East White Lake Ecological Risk Assessment.

Summary: Bariumn Sediment to Fish Bioconcentration Factors

Location	Geometric Mean Barium Sediment to Fish BCF	Reference
Ottawa River, Ten Mile Creek, Ohio	0.012	Ohio EPA, 1991
Upper Columbia River, Washington	0.0068	Teck American, Inc. 2010
EWL, LA (Site)	0.071	ERM, 2019
EWL, LA (Reference)	0.11	ERM, 2019
Barium Sediment to Fish BCF	**0.028**	

Notes:
BCF=Bioconcentration Factor
EWL, LA= East White Lake, Louisiana

References:
Ohio EPA. 1991. Fish Tissue Bottom Sediment Surface Water Organic & Metal Chemical Evaluation, Ottawa River, Ten Mile Creek, Toledo, Ohio, Division Of Water Quality Planning And Assessment. US Geological Survey. Pearl, Mississippi.

Teck American, Inc. 2010. Upper Columbia River Screening-Level Ecological Risk Assessment (SLERA) Teck American, Inc., Spokane, WA.

ERM. 2019. East White Lake Ecological Risk Assessment.

Barium in Fish and Sediments in Rivers in Ohio and Washington and Bioconcentration Factor Calculations (Ohio EPA, 1991; Teck American, Inc., 2010)

Ottawa River/Ten Mile Creek[a]	Site Location	Detroit Ave	Adj. Dura Landfill	Suder Ave	Dst Summit St	Sylvania Ave	Highland Meadows Golf	
Whole body common carp conc.	mg/kg	1.94	0.843	0.79	1.38	1.22	1.34	
Sediment composite conc.	mg/kg	96.9	126	143	175	55	72.6	
BCF	fish conc.÷sed. conc	0.020	0.0067	0.0055	0.0079	0.022	0.018	
				Geometric Mean Barium Sediment to Fish BCF			**0.012**	

Upper Columbia River[b]	Reach #	6b	6a	5	4a	3	2	1
Mean fish tissue conc. in reach	mg/kg-dry	10.6	10.6	10.4	9.2	8.0	6.7	7.6
Avg. sediment conc. by location	mg/kg-dry	1517	798	1067	1190	1382	1543	2008
BCF	fish conc.÷sed. conc	0.0070	0.013	0.010	0.0077	0.0058	0.0043	0.0038
					Geometric Mean Barium Sediment to Fish BCF			**0.0068**

Note:
BCF=Bioconcentration Factor

References:
[a]Ohio EPA. 1991. Fish Tissue Bottom Sediment Surface Water Organic & Metal Chemical Evaluation, Ottawa River, Ten Mile Creek, Toledo, Ohio, Division Of Water Quality Planning And Assessment. US Geological Survey. Pearl, Mississippi.

[b]Teck American, Inc. 2010. Upper Columbia River Screening-Level Ecological Risk Assessment (SLERA) Teck American, Inc., Spokane, WA.

Barium in EWL Fish and Sediments and Bioconcentration Factor Calculations (ERM, 2019)

Area	Sample ID	Barium Concentration in Fish Tissue	Barium Concentration in Sediment	Barium Sediment to Fish BCF Conc. in Fish Tissue ÷ Conc. in Sediment
Site	EWL-T-01A-F	NA		
Site	EWL-T-01-F	16.4		
Site	EWL-T-02-F	17.0		
Site	EWL-T-03-F	15.9		
Site	EWL-T-04-F	17.1		
Site	EWL-T-05-F	19.1		
Site	EWL-T-06-F	16.4		
Site	EWL-T-07-F	17.0		
Site	EWL-T-08-F	17.1		
Site	EWL-T-09-F	16.7		
Site	EWL-T-10-F	20.1		
Site	EWL-T-11-F	18.0		
Site	EWL-T-12-F	14.7		
Site Geometric Mean		**17.1**	**241**	**0.071**
Reference	EWL-TR-01-F	NA		
Reference	EWL-TR-02-F	9.1		
Reference	EWL-TR-03A-F	NA		
Reference	EWL-TR-03-F	9.5		
Reference	EWL-TR-04-F	13.4		
Reference	EWL-TR-05-F	13.0		
Reference	EWL-TR-06-F	10.8		
Reference	EWL-TR-07-F	11.5		
Reference	EWL-TR-08-F	11.9		
Reference	EWL-TR-09-F	12.1		
Reference Geometric Mean		**11.3**	**101**	**0.11**

Notes:
Concentrations are in mg/kg wet weight.
Concentrations for shad fish are for tissue.
Fish sampling was performed in December 2010/January 2011. Sediment data are from 0-2 feet and collected in 2010 at EWL.
BCF=Bioconcentration Factor
EWL=East White Lake

Reference:
ERM. 2019. East White Lake Ecological Risk Assessment.

Summary: Barium Soil/Sediment to Plant Bioconcentration Factors

Plant	Geometric Mean Soil/Sediment to Plant Bioconcentration Factor conc. in plant ÷ conc. in sediment	Reference
Swiss Chard	0.0041	Nelson et al., 1984
Rye Grass	0.0043	Nelson et al., 1984
Plant Shoots	0.0056	Lamb et al., 2013
Geometric Mean Ba Soil/Sediment to Plant BCF	0.0046	

Notes:
Ba=Barium
BCF=Bioconcentration Factor

References:
Environmental Quality, Vol. 13, No. 4.

Environ. Sci. Technol. 47: 4670 - 4676.

Barium in Soils and Plants and Bioconcentration Factor Calculations (Nelson et al., 1984)

Treatment	Barium in Swiss Chard (mg/kg)	Barium in Soil (mg/kg)	Soil to Plant BCF (Ba in Swiss Chard ÷Total Ba in Soil)
Control	206	350	0.59
BM1	196	101000	0.0019
BM2	226	252000	0.00090
NS2	165	215000	0.00077
MX1	464	91000	0.0051
MX2	262	227000	0.0012
Geometric Mean Ba Plant BCF			0.0041

Treatment	Barium in Rye Grass (mg/kg)	Barium in Soil (mg/kg)	Soil to Plant BCF (Ba in Rye Grass÷Total Ba in Soil)
Control	188	350	0.54
BM1	172	101000	0.0017
BM2	275	252000	0.0011
NS2	-	215000	NA
MX1	142	91000	0.0016
MX2	216	227000	0.0010
Geometric Mean Barium Soil to Plant BCF			0.0043

Notes:
The controls are not included in BCF calculations, because they represent the Ba in plants at background.
Ba=Barium
BCF=Bioconcentration Factor

Reference:
Nelson et al. 1984. Extractability and Plant Uptake of Trace Elements from Drilling Fluids. Journal of Environmental Quality, Vol. 13, No. 4.

Barium in Soils and Plants and Bioconcentration Factor Calculations (Lamb et al., 2013)

Total Barium[a] Soil (mg/kg)	Barium Shoot Concentration (mg/kg)	Barium Soil to Plant BCF
mg/kg	mg/kg	(conc. in plant ÷ conc. in soil)
700	18	0.026
1300	122	0.094
5300	87	0.016
7700	79	0.010
5700	65	0.011
10100	79	0.0078
10100	133	0.013
6700	132	0.020
269000	92	0.00034
292000	68	0.00023
265000	65	0.00025
Geometric Mean Barium Soil to Plant BCF		0.0056

Notes:
BCF=Bioconcentration Factor
[a]Analyzed by XRF (X-ray diffraction analysis)

Reference:
Lamb, D. et al. 2013. Bioavailability of Barium to Plants and Invertebrates in Soils Contaminated by Barite. Environ. Sci. Technol. 47: 4670 - 4676.

Summary: Soil/Sediment Barium Bioavailability Factors

Geometric Mean Barium Soil/Sediment Bioavailability Factor	Reference
0.00072	Engdahl, A. et al., 2008
0.00013	Environment International Ltd, 2010
0.000086	USGS, 2002
0.00020	**Geometric Mean Barium Soil Bioavailability Factor**

Note:
Soil bioavailability factors in each study are based on mean soil and porewater concentrations.

References:

Engdahl, A. et al. 2008. Oskarshamm and Forsmark site investigation, Chemical composition of suspended material, sediment and pore water in lakes and sea bays. Swedish Nuclear Fuel and Waste Management Co., P-08-81: 80 pgs.

Environment International Ltd. 2010. Upper Columbia River in-Situ Porewater Assessment Sampling and Quality Assurance Plan, Washington State Attorney General's Office.

USGS. 2002. Vertical Distribution of Trace-Element Concentrations and Occurrence of Metallurgical Slag Particles in Accumulated Bed Sediments of Lake Roosevelt, Washington. Scientific Investigations Report 2004-5090.

Barium in Soils/Sediments/Porewaters and Soil Bioavailability Calculations (Engdahl et al., 2008)

Barium Sediment Concentration								
	Sample ID	Eck	Eck	Lab	Lab	Bol	Bol	Geometric Mean Ba Sediment Concentration
Sample Depth	*cm*	0-5	25-30	0-5	25-30	0-5	25-30	
Concentration	mg/kg-dry	40	46	59	59	220	280	86
Barium Porewater Concentration								
	Sample ID	Eck	Eck	Lab	Lab	Bol	Bol	Geometric Mean Ba Porewater Concentration
Sample Depth	*cm*	0-5	25-30	0-5	25-30	0-5	25-30	
Concentration	mg/L	0.03	0.06	0.06	0.08	0.04	0.17	0.062
Barium Soil Bioavailability								
	Sample ID	Eck	Eck	Lab	Lab	Bol	Bol	**Geometric Mean Barium Soil/Sed. Bioavailability Factor**
Porewater conc. ÷ Sediment conc.	unitless	0.0008	0.0013	0.0009	0.0013	0.0002	0.0006	**0.00072**

Note:
Ba=Barium

Reference:
Engdahl, A. et al. 2008. Oskarshamm and Forsmark site investigation, Chemical composition of suspended material, sediment and pore water in lakes and sea bays. Swedish Nuclear Fuel and Waste Management Co., P-08-81: 80 pgs.

Barium in Soils/Sediments/Porewaters and Soil Bioavailability Calculations (Environment International Ltd, 2010)

	Barium Soil Concentrations							
	(mg/kg)							
Sample ID	UDE 2 SED	BSB 2 SED	BSB 1 SED	DE 2 SED	DE 1 SED	MSB 1 SED	MSB 2 SED	UDE 1 SED
	347	1010	1250	845	415	268	468	678
	Barium Porewater Concentrations							
	(mg/L)							
Collected AM	0.109	0.058	0.154	0.129	0.115	0.040	0.047	0.029
Collected PM	0.129	0.055	0.146	0.173	0.117	0.039	0.044	0.029
Mean of AM and PM	0.119	0.057	0.150	0.151	0.116	0.0392	0.046	0.029
	Barium Soil/Sediment Bioavailability Factor							
porewater conc.÷ soil conc.	0.00034	0.000056	0.00012	0.00018	0.00028	0.00015	0.00010	0.000042
							Geometric Mean Soil/Sediment Barium Bioavailability Factor	**0.00013**

Reference:

Environment International Ltd. 2010. Upper Columbia River in-Situ Porewater Assessment Sampling and Quality Assurance Plan, Washington State Attorney General's Office.

Barium in Lake Roosevelt in Soils/Sediments/Porewaters and Soil Bioavailability Calculations (USGS, 2002)

Sample ID	Depth	Barium Porewater	Barium Sediment	Barium Soil/Sediment Bioavailability Factor
	cm	mg/L	mg/kg	(porewater conc. ÷ sediment conc.)
1	1-2	0.091	1100	0.000083
	9-11	0.14	1100	0.00013
2	1-2	0.11	1200	0.000092
	9-11	0.18	1500	0.00012
3	1-2	0.068	1200	0.000057
	9-11	0.08	1300	0.000062
Geometric Mean Barium Soil/Sediment Bioavailability Factor				**0.000086**

Reference:

USGS. 2002. Vertical Distribution of Trace-Element Concentrations and Occurrence of Metallurgical Slag Particles in Accumulated Bed Sediments of Lake Roosevelt, Washington. Scientific Investigations Report 2004-5090.

Summary: Total Mercury Sediment to Fish Bioconcentration Factors

Location	Geometric Mean Total Mercury Sediment to Fish BCF	Reference
White Lake at Abbeville, LA	3.9	LDEQ LEAU database, 2019
Upper Prong Schooner Bayou, LA	3.9	LDEQ LEAU database, 2019
EWL, LA. Site	0.20	ERM, 2019
EWL, LA. Reference	0.51	ERM, 2019
Total Mercury Sediment to Fish BCF	1.1	

References:

LDEQ. 2019. Data taken from the LDEQ's Louisiana Environmental Assessment Utility (LEAU) database. https://waterdata.deq.louisiana.gov/

ERM. 2019. East White Lake Ecological Risk Assessment.

Total Mercury in Fish and Sediments in EWL Area as Collected by LDEQ

	LDEQ Site 310: White Lake at Abbeville, LA				LDEQ Site 756: Upper Prong Schooner Bayou			
	4/2/1998	7/23/2003	7/12/2004	7/10/2008	8/31/1998	9/30/2002	8/4/2004	6/22/2009
Fish Tissue Concentration	0.15	0.41	0.06	0.1978	0.08	0.72	0.51	0.0661
	0.05	0.15	0.22	0.6438	0.24	0.21	0.06	0.0577
	0.02	0.4	0.28	0.2286	0.19	0.41	0.2	0.0572
	0.04	0.37	0.3	0.3809	0.35	0.2	0.27	0.0948
	0.03	0.24	0.72	0.2693		0.61	0.08	0.0688
	0.03	0.41	0.04	0.2242		0.5	0.11	0.0543
	0.0001	0.27	0.28	0.2079		0.62	0.24	0.0785
	0.05	0.17	0.47	0.2628		0.27	0.12	0.1467
	0.07	0.58	0.23	0.1911		0.24	0.44	
	0.33	0.29	0.44	0.573		0.21	0.09	
	0.02	0.13	0.21	0.2966			0.4	
	0.05	0.17	0.69	0.2683			0.06	
	0.14	0.3		0.2659				
	0.18	0.17		0.2729				
				0.1996				
				0.1778				
				0.2325				
				0.2288				
Geometric Mean Fish Tissue Concentration	0.038	0.264	0.251	0.266	0.189	0.355	0.165	0.074
Sediment Concentration	0.01	0.05895	0.0849	0.0575	0.13	0.05466	0.02558	NA
Geometric Mean Sediment to Fish BCF (Fish Tissue Concentration ÷ Sediment Concentration)	3.85	4.47	2.95	4.62	1.45	6.50	6.44	NA
Geometric Mean Sediment to Fish BCF for LDEQ Site	3.9				3.9			

Notes:
Concentrations are in mg/kg.
Data from LDEQ's Louisiana Environmental Assessment Utility (LEAU) database. https://waterdata.deq.louisiana.gov/

Total Mercury in EWL Fish and Sediments and Bioconcentration Factor Calculations (ERM, 2019)

Area	Sample ID	Total Mercury Concentration in Fish Tissue	Total Mercury Concentration in Sediment	Total Mercury Sediment to Fish BCF Conc. in Fish Tissue ÷ Conc. in Sediment
Site	EWL-T-01A-F	NA		
Site	EWL-T-01-F	0.0119		
Site	EWL-T-02-F	0.0105		
Site	EWL-T-03-F	0.0098		
Site	EWL-T-04-F	0.0131		
Site	EWL-T-05-F	0.0117		
Site	EWL-T-06-F	0.0109		
Site	EWL-T-07-F	0.0102		
Site	EWL-T-08-F	0.0097		
Site	EWL-T-09-F	0.0104		
Site	EWL-T-10-F	0.0125		
Site	EWL-T-11-F	0.0114		
Site	EWL-T-12-F	0.0106		
Site Geometric Mean		**0.0110**	**0.0555**	**0.20**
Reference	EWL-TR-01-F	NA		
Reference	EWL-TR-02-F	0.0120		
Reference	EWL-TR-03A-F	NA		
Reference	EWL-TR-03-F	0.0098		
Reference	EWL-TR-04-F	0.0116		
Reference	EWL-TR-05-F	0.0104		
Reference	EWL-TR-06-F	0.0101		
Reference	EWL-TR-07-F	0.0098		
Reference	EWL-TR-08-F	0.0101		
Reference	EWL-TR-09-F	0.0101		
Reference Geometric Mean		**0.0105**	**0.0205**	**0.51**

Notes:
Concentrations are in mg/kg wet weight.
Concentrations for shad fish are for tissue.
Fish sampling was performed in December 2010/January 2011. Sediment data are from 0-2 feet and collected in 2010 at EWL.

Reference:
ERM. 2019. East White Lake Ecological Risk Assessment.

Summary: Total Mercury Soil to Plant Bioconcentration Factors

Reference	Geometric Means	
Fernández-Martínez et al., 2015	Geometric Mean Total Mercury Plant BCF	0.02
Rodriguez et al., 2007	Geometric Mean Total Mercury Plant BCF	0.95
Hamilton et al., 2008	Geometric Mean Total Mercury Plant BCF	1.02
	Total Geometric Mean Total Mercury Plant BCF	0.27

Note:
BCF=Bioconcentration Factor

References:
Fernández-Martínez, R. et al. 2015. Mercury accumulation and speciation in plants and soils from abandoned cinnabar mines. Geoderma 253–254, 30–38.

Rodriguez, L. et al. 2007. Capability of Selected Crop Plants for Shoot Mercury Accumulation from Polluted Soils: Phytoremediation Perspectives. Journal of Phytoremediation, 9:1–13, 2007.

Hamilton, M. et al. 2008. Determination and comparison of heavy metals in selected seafood, water, vegetation and sediments by inductively coupled plasma-optical emission spectrometry from an industrialized and pristine waterway in Southwest Louisiana. Microchemical Journal 88 (2008) 52–55.

Total Mercury in Soils and Plants near Cinnabar Mines and Bioconcentration Factor Calculations (Fernández-Martínez et. al., 2015)

Mining area	Sampling Location	Plant species	Soil to Plant BCF
La Soterraña	P1-E1	*Crupina vulgaris*	0.029
	P3-E4	*Typha latifolia*	0.014
	P3-E5	*Phyllitis scolopendrium*	0.013
	P3-H6	*Dryopteris filix-mas*	0.186
Los Rueldos	P8-E7	*Calluna vulgaris*	0.010
	P8-H7	*Dryopteris affinis*	0.017
		Geometric Mean Total Hg Plant BCF	0.02

Reference:

Fernández-Martínez, R. et al. 2015. Mercury accumulation and speciation in plants and soils from abandoned cinnabar mines. Geoderma 253–254, 30–38.

Total Mercury in Soils and Plants and Bioconcentration Factor Calculations (Rodriguez et. al., 2007)

Media: Soil and Vegetation	Total Mercury mg/kg	BCF
Soil	33.56	
Lupine	30.65	0.91
Lentil	33.25	0.99
Chickpea	31	0.92
Barley	32.53	0.97
Geometric Mean Total Hg Plant BCF		0.95

Reference:

Rodriguez, L. et al. 2007. Capability of Selected Crop Plants for Shoot Mercury Accumulation from Polluted Soils: Phytoremediation Perspectives. Journal of Phytoremediation, 9:1–13, 2007.

Total Mercury in Southwest Louisiana Soils and Plants and Bioconcentration Factor Calculations (Hamilton et. al., 2008)

Sample Location	Total Hg mg/kg	Sample Location	Total Hg mg/kg
Vegetation 63–64, Site 1	6.41	Sediments 75, 78, Site 1	6.2
Vegetation 65–66, Site 2	6.69	Sediments 76, 79, Site 2	6.22
Vegetation 67–68, Site 3	6.36		
Vegetation 69–70, Site 4	6.25		
Vegetation 71–72, Site 5	6.25		
Vegetation 73–74, Site 6	6.14		
Geometric Veg. Mean	6.35	Geometric Sed. Mean	6.21
		Geometric Mean Hg Plant BCF (conc. in veg/conc. in sed.)	1.02

Reference:

Hamilton, M. et al. 2008. Determination and comparison of heavy metals in selected seafood, water, vegetation and sediments by inductively coupled plasma-optical emission spectrometry from an industrialized and pristine waterway in Southwest Louisiana. Microchemical Journal 88 (2008) 52–55.

Summary: Total Mercury Sediment to Benthic Invertebrate Bioconcentration Factors

Location	Geometric Mean Total Mercury Sed. to Invert. BCF	Reference
St. Lawrence, Canada	0.035	Razavi, 2013
Lavaca, TX	1.1	USFW, 1994
EWL, LA (Site)	0.90	ERM, 2019
EWL, LA (Reference)	2.2	ERM, 2019
St. Lawrence, Cornwall Zooplankton	0.40	Ridal et. al., 2010
St.Lawrence, Cornwall Benthos	0.40	Ridal et al., 2010
Total Mercury Sediment to Invertebrate BCF	0.48	

Note:
BCF=Bioconcentration Factor

References:
Razavi, R. 2013. Ebullition Rates And Mercury Concentrations In St. Lawrence River Sediments And a Benthic Invertebrate. Environmental Toxicology and Chemistry, Vol. 32, No. 4, pp. 857–865.

U.S. Fish And Wildlife Service. 1994. Accumulation Of Mercury In Sediments, Prey, And Shorebirds of Lavaca Bay, Texas, Phase II Report.

ERM. 2019. East White Lake Ecological Risk Assessment.

Ridal, J. et al. 2010. Potential causes of enhanced transfer of mercuryto St. Lawrence River Biota: implications for sedimentmanagement strategies at Cornwall, Ontario, Canada. Hydrobiologia 647:81–98.

Total Mercury in St. Lawrence Sediments and Benthic Invertebrates and Bioconcentration Factor Calculations (Razavi, 2013)

Media: Invertebrates and Sediments	Mean Total Mercury (ng/g dw)	Bioconcentration Factor (BCF) Total Mercury Sediment to Invertebrates (amphipod total Hg conc. ÷ sediment total Hg conc.)
Amphipods	173	**0.035**
Sediments	5000	

Reference:
Razavi, R. 2013. Ebullition Rates And Mercury Concentrations In St. Lawrence River Sediments And a Benthic Invertebrate. Environmental Toxicology and Chemistry, Vol. 32, No. 4, pp. 857–865.

Total Mercury in Lavaca Bay, TX. Sediments and Benthic Invertebrates and Bioconcentration Factor Calculations (USFW, 1994)

	Mean Total Mercury mg/kg dw	Bioconcentration Factor (BCF) Total Mercury Sediment to Invertebrates (invertebrate total mercury conc.÷ total mercury sediment conc.)
Sediment	0.26	
Mussel	0.27	1.0
Oyster	0.26	1.0
Polychaete	0.20	0.77
Xanthid crab	0.18	0.69
Fiddler crab	0.83	3.2
Geometric Mean Total Mercury Invertebrate BCF		1.1

Reference:
U.S. Fish And Wildlife Service. 1994. Accumulation Of Mercury In Sediments, Prey, And Shorebirds of Lavaca Bay, Texas, Phase II Report.

Total Mercury in EWL Sediments and Crabs and Bioconcentration Factor Calculations (ERM, 2019)

Area	Sample ID	Total Mercury Concentration in Crab Tissue	Total Mercury Concentration in Sediment	Total Mercury Sediment to Crab BCF (Conc. in Crab Tissue ÷ Conc. in Sediment)
Site	EWL-T-01A-C	0.055		
Site	EWL-T-01-C	0.055		
Site	EWL-T-02-C	0.047		
Site	EWL-T-03-C	0.063		
Site	EWL-T-04-C	0.043		
Site	EWL-T-05-C	0.050		
Site	EWL-T-06-C	0.055		
Site	EWL-T-07-C	0.046		
Site	EWL-T-08-C	0.049		
Site	EWL-T-09-C	0.046		
Site	EWL-T-10-C	0.058		
Site	EWL-T-11-C	0.047		
Site	EWL-T-12-C	0.042		
Site Geometric Mean		**0.050**	**0.055**	**0.90**
Reference	EWL-TR-01-C	0.045		
Reference	EWL-TR-02-C	0.036		
Reference	EWL-TR-03A-C	0.063		
Reference	EWL-TR-03-C	0.043		
Reference	EWL-TR-04-C	0.057		
Reference	EWL-TR-05-C	0.035		
Reference	EWL-TR-06-C	0.072		
Reference	EWL-TR-07-C	0.038		
Reference	EWL-TR-08-C	0.035		
Reference	EWL-TR-09-C	0.046		
Reference Geometric Mean		**0.046**	**0.020**	**2.2**

Notes:
Concentrations are in mg/kg wet weight.
Concentrations for crab are for tissue.
Crab sampling was performed in December 2010/January 2011. Sediment data are from 0-2 feet and collected in 2010 at EWL.
BCF=Bioconcentration Factor

Reference:
ERM. 2019. East White Lake Ecological Risk Assessment.

Total Mercury in St. Lawrence River Sediments and Benthic Invertebrates and Bioconcentration Factor Calculations (Ridal et al., 2010)

Sample Location	1	2	3	4	**Bioconcentration Factors (conc. in invert. ÷ conc. in sed.)**
Zooplankton (ng/g dw)	502	608	245	111	
Sediment (ng/g dw) Top 10 cm	774	2238	1744	104	**Geometric Mean Total Mercury Zooplankton BCF**
Total Hg BCF Zooplankton	0.65	0.27	0.14	1.1	0.40
Benthos (ng/g dw)	338	300	666	118	
Sediment (ng/g dw) Top 10 cm	774	2238	1744	104	**Geometric Mean Total Mercury Benthos BCF**
Total Hg BCF Benthos	0.44	0.13	0.38	1.1	0.40

Note:
BCF=Bioconcentration Factor

Reference:
Ridal, J. et al. 2010. Potential causes of enhanced transfer of mercury to St. Lawrence River Biota: implications for sediment management strategies at Cornwall, Ontario, Canada. Hydrobiologia 647:81–98.

Summary: Total Mercury Soil/Sediment Bioavailability Factors

Location	Geometric Mean Total Mercury Soil/Sed. Bioavailability Factors (conc. in porewater ÷ conc. in sed.)	Reference
Savannah River	0.00009	Xu et al., 2019
Spiked Sediment	0.018	Chibunda et al., 2009
Chloralkalai Plant	0.00002	Chalmers et al., 2013
Mean	**0.00031**	

References:

Xu, X. et al. 2019. Mercury speciation, bioavailability, and biomagnification in contaminated streams on the Savannah River Site (SC, USA), Science of The Total Environment. 668, 261-270.

Chibunda, R. T. et al. 2009. Chronic Toxicity of Mercury (HgCl2) to the Benthic Midge *Chironomus riparius*. Int. J. Environ. Res., 3(3):455-462

Chalmers, A. et al. 2013. Characterization of Mercury Contamination in the Androscoggin River, Coos County, New Hampshire, USGS, USEPA, USDOI

Total Mercury In Savannah River Soil/Sediment/Porewaters and Bioavailabilty Calculations (Xu et al., 2019)

	Soil Total Mercury	Soil Methylmercury	%MeHg	Total Mercury in Porewater	Total Mercury Soil/Sed. Bioavailability
units	ng/kg dw	ng/g dw		ng/L	(Total Hg porewater conc.÷Total Hg sediment conc.)
MB-a	50000	0.9	1.8	6.9	0.00014
MB-b	51000	0.6	1.1	4	0.00008
MB-c	52000	0.6	1.1	4	0.00008
FMC-a	77000	1.2	1.5	7.2	0.00009
FMC-b	76000	1	1.3	4.5	0.00006
FMC-c	58000	1.4	2.5	8.4	0.00014
Geometric Mean Total Mercury Soil/Sediment Bioavailability Factor					0.00009

Reference:

Xu, X. et al. 2019. Mercury speciation, bioavailability, and biomagnification in contaminated streams on the Savannah River Site (SC, USA), Science of The Total Environment. 668, 261-270.

Total Mercury in Spiked Soil/Sediment/Porewater and Bioavailability Calculations (Chibunda et al., 2009)

Conc. in Sediment	Conc. in Porewater	Total Mercury Soil/Sed. Bioavailability Factor
mg /Kg dry weight	mg/L	(conc. in porewater ÷ conc. in sediment)
0.59	0.00001	0.00002
0.93	0.09	0.09
2.42	0.14	0.06
3.84	0.32	0.08
7.20	0.51	0.07
12.68	0.80	0.06
Geometric Mean Total Mercury Soil/Sed. Bioavailability Factor		0.018

Reference:
Chibunda, R. T. et al. 2009. Chronic Toxicity of Mercury (HgCl2) to the Benthic Midge *Chironomus riparius*. Int. J. Environ. Res., 3(3):455-462.

Total Mercury In Soil/Sediment/Porewater near a Chloralkali Plant and Bioavailabilty Calculations (Chalmers et al., 2013)

	Sed. Reference 1 Location	Porewater Concentration	Soil/Sediment Bioavailability Factor
	mg/kg	mg/L	
Total Mercury	0.03	7.00E-07	0.00002
	Sed. Downstream	Porewater Concentration	Soil/Sediment Bioavailability Factor
	mg/kg	mg/L	
Total Mercury	0.114	1.72E-06	0.00002
	Sed. Reference 2 Location	Porewater Concentration	Soil/Sediment Bioavailability Factor
	mg/kg	mg/L	
Total Mercury	0.026	7.00E-07	0.00003
	Sed. Nearstream Reach	Porewater Concentration	Soil/Sediment Bioavailability Factor
	mg/kg	mg/L	
Total Mercury	0.117	1.32E-06	0.00001
	Sed. Farstream	Porewater Concentration	Soil/Sediment Bioavailability Factor
	mg/kg	mg/L	
Total Mercury	0.111	1.72E-06	0.00002
Total Geometric Mean Total Mercury Soil/Sed. Bioavailability Factor			0.00002

Note:
Sediment and porewater are median concentrations.

Reference:
Chalmers, A. et al. 2013. Characterization of Mercury Contamination in the Androscoggin River, Coos County, New Hampshire, USGS, USEPA, USDOI.

Calculation of Arsenic Soil-to-Bird Bioconcentration Factor

Matrix[a]	Year	Number of Birds	Arsenic (mg/kg wet)	Arsenic Soil-to-bird BCF
Sediment			5	
Bird Liver Concentration				
Western Grebe	1976	6	1.11	0.222
Western Grebe	1981-1982	6	0.08	0.016
Glaucous-winged Gull	1976	6	1.63	0.326
Glaucous-winged Gull	1981-1982	6	0.14	0.028
Marbled Murrelet	1976	6	3.23	0.646
Marbled Murrelet	1981-1982	25	0.78	0.156
American Wigeon	1981-1982	14	0.09	0.018
Mallard	1981-1982	17	0.14	0.028
Bufflehead	1981-1982	20	0.22	0.044
Soil-to-bird BCF				0.075

Notes:
a) Sediment and bird liver concentrations are averages.

References:

Vermeer, K. and J.A.J. Thompson. 1992. Arsenic and Copper Residues in Waterbirds and Their Food Down Inlet from the Island Copper Mill. Bulletin of Environmental Contamination and Toxicology 48:733-378.

Thompson, J.A.J. and D.W. Patton. 1975. Chemical delineation of a submerged mine tailings plume in Rupert and Holberg inlets. BC Fish Mar Serv Tech Rept No.

Waldichuk, M. and R.J. Buchanan. 1980. Significance of environmental changes due to mine waste disposal into Rupert Inlet. Fisheries and Oceans, Vancouver, British Columbia.

Calculation of Mercury Soil-to-Bird Bioconcentration Factor

Matrix[a]	Mercury (mg/kg wet weight)	Soil-to-Bird BCF	Reference
Sediment	0.5		White et al., 1985
Liver	0.1	0.200	
Matrix[b]	Mercury (mg/kg)	Soil-to-Bird BCF	Reference
Soil	2		Adair et al., 2003.
Kidney	0.22	0.110	
Soil-to-Bird BCF (Geometric Mean)		0.148	

Notes:
a) Livers: 10 samples American advocet and 10 samples Black-necked stilt. Sediment: 3 samples, range (0.4 - 0.7 mg/kg), geomean = 0.5 mg/kg
b) Soil concentration is the minimum site geometric mean of four samples at a location. Kidney concentration is the maximum site geometric mean of kidneys at a nesting location. Minimum soil and maximum kidney are used as a conservative approach.

References:
White, D. et al. 1985. Bird Use and Heavy Metal Accumulation in Waterbirds at Dredge Disposal Impoundments, Corpus Christi, Texas. Bull. Environ. Contam. Toxicol. 34: 295-300 9.
Adair, B. et al. 2003. Mercury Occurrence in Prothonotary Warblers (Protonotaria citrea) Inhabiting a National Priorities List Site and Reference Areas in Southern Alabama Arch. Environ. Contam. Toxicol. 44: 265–271. DOI: 10.1007/s00244-002-2027-0

Calculation of Cadmium, Lead, and Zinc Soil-to-Bird Bioconcentration Factor

Matrix[a]	Cadmium (mg/kg dry)		Lead (mg/kg dry)		Zinc (mg/kg dry)	
Location:	Bake Oven Knob	Palmerton	Bake Oven Knob	Palmerton	Bake Oven Knob	Palmerton
Soil horizon						
01	5.8	250	99	1200	460	9900
02	13	710	490	2700	960	24000
A1	2.7	35	150	41	230	2900
A2	0.83	3	17	17	83	480
Average Soil Concentration	3.61	66	105	218	433	9320
Songbird Carcass (average)	1.2	2.5	15	56	120	140
Soil-to-bird BCF	0.333	0.0380	0.1422	0.2569	0.277	0.0150
Soil-to-bird BCF (Geometric Mean)	0.113		0.191		0.0645	

Notes:
a) Each soil sample is a pool of 10 samples.
Bake Oven Knob birds: catbird, wood thrush, black-and-white warbler, warbler, ovenbird, orchard oriole, common grackle, scarlet
Palmerton birds: Carolina chickadee, catbird, brown thrasher, robin, wood thrush, black-and-white warbler, yellow-throated warbler, common grackle, rufous-sided towhee, and field sparrow.

Reference:
Beyer, W.N., Pattee, O.H., Sileo, L., Hoffman, D.J., and B.M. Mulhern. 1985. Metal Contamination in Wildlife Living Near Two Zinc Smelters. Environmental Pollution (Series A) 38: 63-86.

BARIUM SULFATE TOXICITY LITERATURE REVIEW

Barium Sulfate Toxicity Studies

Endpoint	Result	Units	Exposure	Duration	Media	Salinity	Organism Scientific Name	Common Name	Life Stage	Effect	Reference
AQUATIC STUDIES											
Freshwater											
EC50	32	mg/L	direct contact	48 hrs	water	freshwater	*Daphnia magna Straus*	water flea	not reported	immobility	1. Khangarot,B.S., and P.K. Ray, 1989
EC50	33.65	mg/L	direct contact	48 hrs	water	freshwater	*Tubifex tubifex*	Tubificid Worm	not reported	immobility	2. Khangarot,B.S., 1991
EC50	33.65	mg/L	direct contact	96 hrs	water	freshwater	*Tubifex tubifex*	Tubificid Worm	not reported	immobility	2. Khangarot,B.S., 1991
EC50	44.98	mg/L	direct contact	24 hrs	water	freshwater	*Tubifex tubifex*	Tubificid Worm	not reported	immobility	2. Khangarot,B.S., 1991
EC50	52.82	mg/L	direct contact	24 hrs	water	freshwater	*Daphnia magna Straus*	water flea	not reported	immobility	1. Khangarot,B.S., and P.K. Ray, 1989
EC50	634-798	mg/L	direct contact	48 hr	water	freshwater	*C. subglobosa Sowerby*	freshwater ostracod	various	immobility	3. Khangarot, B.S. and Das, S., 2009
LC50	> 7500	mg/L	direct contact	96 hrs	water	freshwater	*Salmo gairdneri* Richardson	rainbow trout	2.5 - 4.0 cm	mortality	4. Faulk, M. et al., 1973
LC50	76000	mg/L	direct contact	96 hrs	water	freshwater	*Oncorhynchus mykiss*	rainbow trout	1 gram weight	mortality	5. Sprague, J. et al., 1979
LC0	100000	mg/L	direct contact	96 hrs	water	freshwater	*Poecilia sp.*	Mollies	not reported	mortality	6. Grantham,C.K., and J.P. Sloan, 1975
Saltwater											
NOAEL	10	mg/L	direct contact	7 days	water	34 ppt salinity	*Cancer anthonyi*	yellow crab	embryo	mortality/reproduct.	7. Macdonald J.M. et al., 1988
NOAEL	200	mg/L	direct contact	24 hours	water	marine	*Mallotus villosus*	capelin	larvae	survival	8. Payne, J.F. et al., 2006
LC50	1000	mg/L	direct contact	7 days	water	34 ppt salinity	*Cancer anthonyi*	yellow crab	embryo	mortality	7. Macdonald J.M. et al., 1988
NOAEL	1000	mg/L	direct contact	24 hours	water	marine	*Chionoecetes opilio*	snow crab	larvae	survival	8. Payne, J.F. et al., 2006
NOAEL	1000	mg/L	direct contact	24 hours	water	marine	jellyfish	jellyfish	planktonic	survival	8. Payne, J.F. et al., 2006
NOAEL	1000	mg	ingestion	4x/one month	water	marine	*Pseudopleuronectes americanus*	winter flounder	300 gram weight	survival	8. Payne, J.F. et al., 2006
EC50	16200	mg/L	direct contact	96 hour	water	28-31 ppt salinity	*Pandalus danae*	dock shrimp	larvae	swimming	9. Carls, M.G. et al., 1984
EC50	71400	mg/L	direct contact	96 hour	water	28-31 ppt salinity	*Metacarcinus magister*	dungeness crab	larvae	swimming	9. Carls, M.G. et al., 1984
NOAEL	200000	mg/L	direct contact	10 month	water	seawater	*Tautogolabrus adspersus*	cunner	70.7 +/-20.8 gms	growth	10. Payne, J. et al., 2011
TERRESTRIAL STUDIES											
Mammals											
NOAEL	8	mg/kg	ingestion	apprx 60 days [a]	diet	NA	CF-1 mice	mice	weanling	growth/repro/mortal	11. Hutcheson, D., 1975
LD50	364000	mg/kg	intragastric	28 -52 hours	dosed	NA	CBL-Wistar Albino Rats	rat	130-160 gm wght	mortality	12. Boyd, M.D. and Abel, M., 1966
LD0	163000	mg/kg	intragastric	14 days	dosed	NA	CBL-Wistar Albino Rats	rat	130-160 gm wght	mortality	12. Boyd, M.D. and Abel, M., 1966
Terrestrial Invertebrates											
NOAEL	10000	mg/kg	direct contact		sandy loam soil	NA	*Folsomia Candida*	soil arthropod	adult	mortality	13. Kuperman, R.G. et al., 2006
NOAEL	10000	mg/kg	direct contact		sandy loam soil	NA	*Eisenia Fetida*	earth worm	adult	mortality	13. Kuperman, R.G. et al., 2006
NOAEL	10000	mg/kg	direct contact		sandy loam soil	NA	*Enchytraeus Crypticus*	white worm	adult	mortality	13. Kuperman, R.G. et al., 2006
NOAEL	1000000	mg/kg	direct contact	14 days	clayey soil	NA	*Onychiurus folsomi*	springtail insect	not reported	mortality	14. Menzie et al., 2008
NOAEL	300000	mg/kg	direct contact	14 days	loamy soil	NA	*Eisenia andrei*	worm	not reported	mortality	14. Menzie et al., 2008

Notes

a) Three generations of mice

References

1. Khangarot,B.S., and P.K. Ray, 1989, Investigation of Correlation Between Physicochemical Properties of Metals and Their Toxicity to the Water Flea Daphnia magna Straus, Ecotoxicol. Environ. Saf.18(2): 109-121 (from ECOTOX)
2. Khangarot,B.S., 1991, Toxicity of Metals to a Freshwater Tubificid Worm, Tubifex tubifex (Muller), Bull. Environ. Contam. Toxicol.46:906-912 (from ECOTOX)
3. Khangarot, B.S. and Das, S., 2009, Acute toxicity of metals and reference toxicants to a freshwater ostracod, Cypris subglobosa Sowerby, 1840 and correlation to EC50 values of other test models, Journal of Hazardous Materials 172, 641–649
4. Faulk, M. et al., Acute Toxicity of Petrochemical Drilling Fluids Components and Wastes to Fish, 1973, Environment Canada,Technical Report Series
5. Sprague, J. et al., 1979, Separate and Joint Toxicity to Rainbow Trout of Substances Used in Drilling Fluids for Oil Exploration, Environ. Pollut. 0013-9327
6. Grantham,C.K., and J.P. Sloan, 1975, EPA 560/1-75-004, 1975, Toxicity Study Drilling Fluid Chemicals on Aquatic LifeConf.Proc.on Environ.Aspects of Chemical Use in Well-Drilling Operations, Research Triangle Inst., NC (from ECOTOX)
7. Macdonald J.M. et al., 1988, Acute toxicities of eleven metals to early life-history stages of the yellow crab Cancer anthonyi, Marine Biology 98, 201-207
8. Payne, J.F. et al., 2006. Risks assoc. with drill. fluids at petrol. developm. sites in the offsh.: Eval. of the potent. for an aliph. HC- based drill. fluid to produce sedimen. toxicity and for barite to be acut. toxic to plankton. Can. Tech. Rep. Fish. Aquat. Sci. 2679
9. Carls, M.G. et al., 1984, Toxic Contributions of Specific Drilling Mud Components to Larval Shrimp and Crabs, Marine Environmental Research 12, 45-62.
10. Payne, J. et al., 2011, Produced Water: Overview of Composition, Fates, and Effects, Chapter 21 Risks to Fish Associated with Barium in Drilling Fluids and Produced Water: A Chronic Toxicity Study with Cunner (Tautogolabrus adspersus)
11. Hutcheson, D. et al., 1975, Studies of Nutritional Safety of Some Heavy Metals in Mice, The Journal of Nutrition, Vol 105, no.6.
12. Boyd, M.D. and Abel, M., 1966, The Acute Toxicity of Barium Sulfate Administered Intragastrically, Canad. Med. Ass. J.
13. Kuperman, R.G. et al., 2006, Toxicity Benchmarks for Antimony, Barium, and Beryllium Determin. using Reproduc. Endpoints for Folsomia Candida, Eisenia Fetida, and Enchytraeus Crypticus, Environ. Toxicol. and Chem., Vol. 25, No. 3, pp. 754–762
14. Menzie, C. et al., 2008, The Importance of Understanding the Chemical Form of a Metal in the Environment: The Case of Barium Sulfate, Human and Ecological Risk Assessment, 14: 974–991

Barium in Sediment: Literature Review of Toxicity in Sediment

Endpoint	Derivation of Endpoint	Description of Endpoint/Organisms Protected	Result *mg/kg-dry*	Species	Media	Reference
HC5	Median HC5 (hazardous conc. 5%) for 343 different sensitive species	Conc. at which 5% of sensitive species exhibit reduction in abundance	130	sensitive benthic invertebrates	marine sediment	1
HC28	Median HC28 for 343 different sensitive species	Community HC5, protects 95% of community, concentrations below which harmful effects unlikely	2218	sensitive benthic invertebrates	marine sediment	1
HC56	Median HC56 for 343 different sensitive species	Community HC10, protects 90% of community, concentrations below which harmful effects are unlikely	4876	sensitive benthic invertebrates	marine sediment	1
F-PNEC$_{13}$	Median F-PNEC for 191 most common species (lowest value at which abundance effects are observed in 13% of species)	F-PNEC below which harmful effects for 95% of the macro benthos (> 1 mm) community are unlikely	1718	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$	Median F-PNEC for 2206 species (lowest value at which abundance effects are observed in 13% of species)	F-PNEC in mud sediment below which harmful effects for 95% of the community are unlikely	2645	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$	Median F-PNEC for 2206 species (lowest value at which abundance effects are observed in 10% of species)	F-PNEC in mud-fine sand sediment below which harmful effects for 95% of the community are unlikely	2263	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{9}$	Median F-PNEC for 2206 species (lowest value at which abundance effects are observed in 9% of species)	F-PNEC in fine sand-sand sediment below which harmful effects for 95% of the community are unlikely	1951	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{mean}$	Mean of grain sized based median F-PNECs for 2206 species	F-PNEC in sediments below which harmful effects for 95% of the community are unlikely	2286	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$	Median F-PNEC at 5% protection level for 191 most common species using bootstrapping method	Median F-PNEC for 191 most common species (lowest value at which abundance effects are observed in 5% of species)	1718	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-low	Confidence Interval (95%-low) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% lower confidence limit F-PNEC$_{5}$	1644	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-high	Confidence Interval (95%-high) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% upper confidence limit F-PNEC$_{5}$	2020	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$	Median F-PNEC adjusted for non-sensitive species for 191 most common species using bootstrapping method	Median F-PNEC$_{13}$ (Adjusted protection value from PNEC$_{5}$ to PNEC$_{13}$ to account for non-sensitive species)	2283	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$95%-low	Confidence Interval (95%-low) F-PNEC at 13% protection level for 191 most common species using bootstrapping method	95% lower confidence limit F-PNEC$_{13}$	1938	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$95%-high	Confidence Interval (95%-high) F-PNEC at 13% protection level for 191 most common species using bootstrapping method	95% upper confidence limit F-PNEC$_{13}$	2522	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$	F-PNEC at 5% protection level for 191 most common species using logistic function	Median F-PNEC for 191 most common species (lowest value at which abundance effects are observed in 5% of species)	1148	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$	F-PNEC adjusted for non-sensitive species for 191 most common species using logisitic function	Median F-PNEC for the adjusted 5% protection level (5% adjusted to 13% to account for non-sensitive species)	1793	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$-mud	Median F-PNEC at 5% protection level in mud substrate for 191 most common species using bootstrapping method	Median F-PNEC for 191 most common species (lowest value at which abundance effects are observed in 5% of species)	1977	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-low-mud	Confidence Interval (95%-low) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% lower confidence limit for F-PNEC$_{5}$95%-low-mud	1808	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-high-mud	Confidence Interval (95%-high) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% upper confidence limit for F-PNEC$_{5}$95%-high-mud	2275	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$-mud	Median F-PNEC adjusted for non-sensitive species in mud substrate for 191 most common species using bootstrapping method	Median F-PNEC for the adjusted 5% protection level in mud substrate (5% adjusted to 13% to account for non-sensitive species)	2645	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$95%-low-mud	Confidence Interval (95%-low) F-PNEC in mud substrate for 191 most common species using bootstrapping method	95% lower confidence limit for F-PNEC$_{13}$95%-low-mud	2409	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$95%-high-mud	Confidence Interval (95%-high) F-PNEC in mud substrate for 191 most common species using bootstrapping method	95% upper confidence limit for F-PNEC$_{13}$95%-high-mud	3181	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$-mud-fine-sand	Median F-PNEC at 5% protection level in mud-fine sand substrate for 191 most common species using bootstrapping method	Median F-PNEC for 191 most common species (lowest value at which abundance effects are observed in 5% of species)	1720	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-low-mud-fine sand	Confidence Interval (95%-low) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% lower confidence limit for F-PNEC$_{5}$95%-low-mud-fine sand	1372	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-high-mud-fine sand	Confidence Interval (95%-high) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% upper confidence limit for F-PNEC$_{5}$95%-high-mud-fine sand	2200	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$-mud-fine sand	Median F-PNEC adjusted for non-sensitive species for 191 most common species using bootstrapping method	Median F-PNEC for the adjusted 5% protection level (5% adjusted to 10% to account for non-sensitive species)	2263	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$95%-low-mud-fine sand	Confidence Interval (95%-low) F-PNEC in mud-fine sand substrate for 191 most common species using bootstrapping method	95% lower confidence limit for F-PNEC$_{10}$95%-low-mud-fine sand	2141	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$95%-high-mud-fine sand	Confidence Interval (95%-high) F-PNEC in mud-fine sand substrate for 191 most common species using bootstrapping method	95% upper confidence limit for F-PNEC$_{10}$95%-high-mud-fine sand	2490	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$-fine sand-sand	Median F-PNEC at 5% protection level in fine sand-sand substrate for 191 most common species using bootstrapping method	Median F-PNEC for 191 most common species (lowest value at which abundance effects are observed in 5% of species)	1711	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-low-fine sand-sand	Confidence Interval (95%-low) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% lower confidence limit for F-PNEC$_{5}$95%-low-mud-fine sand	1498	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{5}$95%-high-fine sand-sand	Confidence Interval (95%-high) F-PNEC at 5% protection level for 191 most common species using bootstrapping method	95% upper confidence limit for F-PNEC$_{5}$95%-high-mud-fine sand	1929	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$-fine sand-sand	Median F-PNEC adjusted for non-sensitive species for 191 most common species using bootstrapping method	Median F-PNEC for the adjusted 5% protection level (5% adjusted to 9% to account for non-sensitive species)	1951	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$95%-fine sand-sand	Confidence Interval (95%-low) F-PNEC in fine sand-sand substrate for 191 most common species using bootstrapping method	95% lower confidence limit for F-PNEC$_{9}$95%-low-mud-fine sand	1816	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$95%-fine sand-sand	Confidence Interval (95%-high) F-PNEC in fine sand-sand substrate for 191 most common species using bootstrapping method	95% upper confidence limit for F-PNEC$_{9}$95%-high-mud-fine sand	2254	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{13}$-mud	Probable no effects concentration derived using logistic function (5% is adjusted to 13% to account for non-sensitive species)	Actual conc. level below which harmful effects on the benthic community are unlikley to be observed in 95% of the community	2200	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{10}$-mud-fine sand	Probable no effects concentration derived using logistic function (5% is adjusted to 10% to account for non-sensitive species)	Actual conc. level below which harmful effects on the benthic community are unlikley to be observed in 95% of the community	1931	macro benthos (> 1 mm)	marine sediment	2
F-PNEC$_{9}$-fine sand-sand	Probable no effects concentration derived using logistic function (5% is adjusted to 9% to account for non-sensitive species)	Actual conc. level below which harmful effects on the benthic community are unlikley to be observed in 95% of the community	1942	macro benthos (> 1 mm)	marine sediment	2
HC$_{5}$-median	Median hazardous concentration causing effects in 5% of the invertebrate sediment population	Median concentration causing reduction in density of 5% of a marine benthic organism population	765	benthic sediment species	marine sediment	3
HC$_{10}$-median	Median hazardous concentration causing effects in 10% of the invertebrate sediment population	Median concentration causing reduction in density of 10% of a marine benthic organism population	3424	benthic sediment species	marine sediment	3
HC$_{5}$-mode	The mode hazardous concentration causing effects in 5% of the invertebrate sediment population	Mode concentration causing reduction in density of 5% of a marine benthic organism population	401	benthic sediment species	marine sediment	3
HC$_{10}$-mode	The mode hazardous concentration causing effects in 10% of the invertebrate sediment population	Mode concentration causing reduction in density of 10% of a marine benthic organism population	1085	benthic sediment species	marine sediment	3

Reference:

1. Leung, K.M.Y., et al. 2005. Deriving Sediment Quality Guidelines from Field-Based Species Sensitivity Distributions. Environ. Sci. Technol. 39: 5148-5156.

2. Bjørgesæter, A. 2006. Field Based Predicted No Effect Concentrations (F-PNECs) for macro benthos on the Norwegian Continental Shelf. Environmental Risk Management System. Report No. 15.

3. Lui et al. 2014. Deriving field-based sediment quality guidelines from the relationship between species density and contaminant level using a novel nonparametric empirical Bayesian approach. Environ. Sci. Pollut. Res. 21:177-192.

HAZARD QUOTIENT CALCULATIONS - METALS - 95% UCL CONCENTRATIONS

COPEC concentrations used for estimating potential risk (HQs) in the BERA for Hero Lands Property using 95% UCL concentrations in soil samples (Site-Wide).

Constituent	95% UCL Concentration (mg/kg dry)
Arsenic	8.25
Barium	1444
Cadmium	0.577
Lead	28.9
Mercury	0.0974
Zinc	98.1

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): American Robin

American Robin			
Parameter	**Value**	**Symbol**	**Calculations based on 95% UCL values**
Body weight (kg)	0.0773	BW	
Soil ingestion proportion	0.02	Ps	
Food ingestion Rate (kg/kgBW/d)	0.132	FIR	
Proportion of diet, plants	0.41	Pp	
Proportion of diet, soil inverts	0.59	Pi	
Area use factor	1	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	8.25	2.24	0.01	0.0375	0.224	0.000218	0.0167	0.144	0.0216
Barium	1444	600	0.0002	0.0046	0.091	0.000762	0.359	10.2	0.00528
Cadmium	0.577	1.47	0.036	0.586	7.708	0.0000548	0.0183	0.346	0.0744
Lead	28.9	1.63	0.01	0.0389	0.266	0.000763	0.0608	0.599	0.122
Mercury	0.0974	3.25	0.00031	0.27	1.693	7.97E-08	0.00142	0.0128	0.00131
Zinc	98.1	66.1	0.1	0.366	3.201	0.0259	1.94	24.5	0.12

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): Mallard Duck

Mallard Duck			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	1.134	BW	
Soil ingestion proportion	0.033	Ps	
Food ingestion Rate (kg/kgBW/d)	0.05	FIR	
Proportion of diet, plants	0.5	Pp	
Proportion of diet, benthic inverts	0.5	Pbi	
Area use factor	0.0099	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	8.25	2.24	0.01	0.0375	0.127	0.000136	0.00773	0.0262	0.0000452
Barium	1444	600	0.0002	0.0046	0.023	0.000477	0.166	0.83	0.00000493
Cadmium	0.577	1.47	0.036	0.586	0.614	0.0000343	0.00845	0.00886	0.000035
Lead	28.9	1.63	0.01	0.0389	0.066	0.000477	0.0281	0.0477	0.000139
Mercury	0.0974	3.25	0.00031	0.27	0.48	4.98E-08	0.000657	0.00117	0.00000167
Zinc	98.1	66.1	0.1	0.366	2.33	0.0162	0.898	5.71	0.000298

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0425	BW	
Soil ingestion proportion	0.17	Ps	
Food ingestion Rate (kg/kgBW/d)	0.196	FIR	
Proportion of diet, benthic inverts	1	Pbi	
Area use factor	0.5	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	8.25	2.24	0.01	0.127	0.00275	0.205	0.0139
Barium	1444	600	0.0002	0.023	0.00962	6.51	0.00163
Cadmium	0.577	1.47	0.036	0.614	0.000692	0.0694	0.00715
Lead	28.9	1.63	0.01	0.066	0.00963	0.374	0.0353
Mercury	0.0974	3.25	0.00031	0.48	0.00000101	0.00916	0.000423
Zinc	98.1	66.1	0.1	2.33	0.327	44.8	0.102

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): Snowy Egret

Snowy Egret			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.371	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.116	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0082	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	8.25	2.24	0.01	0.127	0.00065	0.0000479	0.0122	0.00056	0.0000141
Barium	1444	600	0.0002	0.023	0.028	0.000168	0.385	4.22	0.0000189
Cadmium	0.577	1.47	0.036	0.614	0.42	0.000012	0.00411	0.0253	0.0000492
Lead	28.9	1.63	0.01	0.066	0.0000018	0.000168	0.0221	5.43E-06	0.0000336
Mercury	0.0974	3.25	0.00031	0.48	1.1	1.75E-08	0.000542	0.0112	0.00000889
Zinc	98.1	66.1	0.1	2.33	0.138	0.00569	2.65	1.41	0.000151

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	8.25	2.24	0.01	0.127	0.00065	0.0000425	0.0108	0.000497	0.0000108
Barium	1444	600	0.0002	0.023	0.028	0.000149	0.342	3.75	0.0000145
Cadmium	0.577	1.47	0.036	0.614	0.42	0.0000107	0.00365	0.0225	0.0000379
Lead	28.9	1.63	0.01	0.066	0.0000018	0.000149	0.0196	4.82E-06	0.0000258
Mercury	0.0974	3.25	0.00031	0.48	1.1	1.55E-08	0.000482	0.00993	0.00000682
Zinc	98.1	66.1	0.1	2.33	0.138	0.00505	2.35	1.25	0.000116

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): American Bald Eagle

American Bald Eagle		
Parameter	**Value**	**Symbol**
Body weight (kg)	4.6	BW
Soil ingestion proportion	0	Ps
Food ingestion Rate (kg/kgBW/d)	0.09	FIR
Proportion of diet, mammals	0.068	Pm
Proportion of diet, birds	0.165	Pb
Proportion of diet, fish	0.767	Pf
Area use factor	0.000032	AUF
Time (temporal) factor	0.3	TF

Calculations based on 95% UCL values

			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	8.25	2.24	-	0.0025	0.075	0.00065	-	0.000126	0.00919	0.00037	0.0000000415
Barium	1444	20.8	-	0.0566	0.00001	0.028	-	0.5	0.000214	2.79	0.00000152
Cadmium	0.577	1.47	-	0.3333	0.113	0.42	-	0.00118	0.000968	0.0167	0.000000123
Lead	28.9	1.63	-	0.1054	0.191	0.0000018	-	0.0186	0.082	3.59E-06	0.000000593
Mercury	0.0974	0.019	-	0.0534	0.148	1.1	-	0.0000318	0.000214	0.0074	0.00000386
Zinc	98.1	66.1	-	0.7717	0.0645	0.138	-	0.463	0.094	0.935	0.000000217

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.118	BW	
Soil ingestion proportion	0.063	Ps	
Food ingestion Rate (kg/kgBW/d)	0.13	FIR	
Proportion of diet, plants	1	Pp	
Area use factor	0.51	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	8.25	1.04	0.01	0.0375	0.000676	0.0402	0.00601
Barium	1444	5433	0.0002	0.0046	0.00237	0.864	0.0000244
Cadmium	0.577	0.77	0.036	0.586	0.00017	0.044	0.00878
Lead	28.9	4.7	0.01	0.0389	0.00237	0.146	0.00483
Mercury	0.0974	1.01	0.00031	0.27	2.47E-07	0.00342	0.000518
Zinc	98.1	75.4	0.1	0.366	0.0803	4.67	0.00964

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): Least Shrew

Least Shrew			Calculations based on 95% UCL values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	0.017	BW					
Soil ingestion proportion	0.13	Ps					
Food ingestion Rate (kg/kgBW/d)	0.096	FIR					
Proportion of diet, soil inverts	1	Pi					
Area use factor	1	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	8.25	1.04	0.01	0.224	0.00103	0.177	0.0514
Barium	1444	5433	0.0002	0.091	0.0036	12.6	0.000696
Cadmium	0.577	0.77	0.036	7.708	0.000259	0.427	0.166
Lead	28.9	4.7	0.01	0.266	0.00361	0.738	0.0473
Mercury	0.0974	1.01	0.00031	1.693	3.77E-07	0.0158	0.00469
Zinc	98.1	75.4	0.1	3.201	0.122	30.1	0.12

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): Red Fox

Red Fox			Calculations based on 95% UCL values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	4.53	BW									
Soil ingestion proportion	0.028	Ps									
Food ingestion Rate (kg/kgBW/d)	0.16	FIR									
Proportion of diet, plants	0.07	Pp									
Proportion of diet, soil inverts	0.03	Pi									
Proportion of diet, mammals	0.9	Pm									
Area use factor	0.0017	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	8.25	1.04	0.01	0.0375	0.224	0.0025	0.00037	0.00347	0.00887	0.00297	0.00000769
Barium	1444	5433	0.0002	0.0046	0.091	0.0566	0.00129	0.0744	0.631	11.8	0.00000117
Cadmium	0.577	0.77	0.036	0.586	7.708	0.3333	0.0000931	0.00379	0.0213	0.0277	0.000035
Lead	28.9	4.7	0.01	0.0389	0.266	0.1054	0.00129	0.0126	0.0369	0.439	0.0000531
Mercury	0.0974	1.01	0.00031	0.27	1.693	0.0534	1.35E-07	0.000295	0.000792	0.000749	0.000000927
Zinc	98.1	75.4	0.1	0.366	3.201	0.7717	0.0439	0.402	1.51	10.9	0.000087

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): Site-Wide (0-4'): American Mink

American Mink			Calculations based on 95% UCL values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	8.25	1.04	0.01	0.0025	0.127	0.00065	0.0000565	0.000622	0.0919	0.000103	0.000508
Barium	1444	5433	0.0002	0.0566	0.023	0.028	0.000198	2.46	2.91	0.775	0.00000645
Cadmium	0.577	0.77	0.036	0.3333	0.614	0.42	0.0000142	0.0058	0.0311	0.00465	0.000308
Lead	28.9	4.7	0.01	0.1054	0.066	0.0000018	0.000198	0.0918	0.167	9.98E-07	0.000314
Mercury	0.0974	1.01	0.00031	0.0534	0.48	1.1	2.07E-08	0.000157	0.0041	0.00205	0.0000356
Zinc	98.1	75.4	0.1	0.7717	2.33	0.138	0.00672	2.28	20	0.26	0.0017

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT CALCULATIONS - METALS - MAXIMUM CONCENTRATIONS

COPEC concentrations used for estimating potential risk (HQs) in the BERA for Hero Lands Property using maximum detected values in soil samples (Site-Wide).

Constituent	Maximum Concentration (mg/kg dry)
Arsenic	18.6
Barium	6280
Cadmium	1.16
Lead	123
Mercury	0.148
Zinc	250

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): American Robin

American Robin			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0773	BW	
Soil ingestion proportion	0.02	Ps	
Food ingestion Rate (kg/kgBW/d)	0.132	FIR	
Proportion of diet, plants	0.41	Pp	
Proportion of diet, soil inverts	0.59	Pi	
Area use factor	1	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	18.6	2.24	0.01	0.0375	0.224	0.000491	0.0377	0.324	0.0485
Barium	6280	600	0.0002	0.0046	0.091	0.00332	1.56	44.5	0.023
Cadmium	1.163	1.47	0.036	0.586	7.708	0.000111	0.0369	0.698	0.15
Lead	123	1.63	0.01	0.0389	0.266	0.00325	0.259	2.55	0.518
Mercury	0.148	3.25	0.00031	0.27	1.693	1.21E-07	0.00216	0.0195	0.002
Zinc	250	66.1	0.1	0.366	3.201	0.066	4.95	62.3	0.306

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): Mallard Duck

Mallard Duck			Calculations based on maximum values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	1.134	BW							
Soil ingestion proportion	0.033	Ps							
Food ingestion Rate (kg/kgBW/d)	0.05	FIR							
Proportion of diet, plants	0.5	Pp							
Proportion of diet, benthic inverts	0.5	Pbi							
Area use factor	0.0099	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	18.6	2.24	0.01	0.0375	0.127	0.000307	0.0174	0.0591	0.000102
Barium	6280	600	0.0002	0.0046	0.023	0.00207	0.722	3.61	0.0000215
Cadmium	1.163	1.47	0.036	0.586	0.614	0.0000691	0.017	0.0179	0.0000707
Lead	123	1.63	0.01	0.0389	0.066	0.00203	0.12	0.203	0.000592
Mercury	0.148	3.25	0.00031	0.27	0.48	7.57E-08	0.000999	0.00178	0.00000254
Zinc	250	66.1	0.1	0.366	2.33	0.0413	2.29	14.6	0.000761

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0425	BW	
Soil ingestion proportion	0.17	Ps	
Food ingestion Rate (kg/kgBW/d)	0.196	FIR	
Proportion of diet, benthic inverts	1	Pbi	
Area use factor	0.5	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	18.6	2.24	0.01	0.127	0.0062	0.463	0.0314
Barium	6280	600	0.0002	0.023	0.0418	28.3	0.00709
Cadmium	1.163	1.47	0.036	0.614	0.0014	0.14	0.0144
Lead	123	1.63	0.01	0.066	0.041	1.59	0.15
Mercury	0.148	3.25	0.00031	0.48	0.00000153	0.0139	0.000642
Zinc	250	66.1	0.1	2.33	0.833	114	0.261

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): Snowy Egret

Snowy Egret			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.371	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.116	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0082	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	18.6	2.24	0.01	0.127	0.00065	0.000108	0.0274	0.00126	0.0000316
Barium	6280	600	0.0002	0.023	0.028	0.000728	1.68	18.4	0.0000823
Cadmium	1.163	1.47	0.036	0.614	0.42	0.0000243	0.00828	0.051	0.0000992
Lead	123	1.63	0.01	0.066	0.0000018	0.000713	0.0942	0.0000231	0.000143
Mercury	0.148	3.25	0.00031	0.48	1.1	2.66E-08	0.000824	0.017	0.0000135
Zinc	250	66.1	0.1	2.33	0.138	0.0145	6.76	3.6	0.000386

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	18.6	2.24	0.01	0.127	0.00065	0.0000958	0.0243	0.00112	0.0000243
Barium	6280	600	0.0002	0.023	0.028	0.000647	1.49	16.3	0.0000632
Cadmium	1.163	1.47	0.036	0.614	0.42	0.0000216	0.00736	0.0453	0.0000763
Lead	123	1.63	0.01	0.066	0.0000018	0.000633	0.0836	0.0000205	0.00011
Mercury	0.148	3.25	0.00031	0.48	1.1	2.36E-08	0.000732	0.0151	0.0000104
Zinc	250	66.1	0.1	2.33	0.138	0.0129	6	3.2	0.000297

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): American Bald Eagle

American Bald Eagle			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.6	BW	
Soil ingestion proportion	0	Ps	
Food ingestion Rate (kg/kgBW/d)	0.09	FIR	
Proportion of diet, mammals	0.068	Pm	
Proportion of diet, birds	0.165	Pb	
Proportion of diet, fish	0.767	Pf	
Area use factor	0.000032	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	18.6	2.24	-	0.0025	0.075	0.00065	-	0.000285	0.0207	0.000835	9.35E-08
Barium	6280	20.8	-	0.0566	0.00001	0.028	-	2.18	0.000933	12.1	0.00000659
Cadmium	1.163	1.47	-	0.3333	0.113	0.42	-	0.00237	0.00195	0.0337	0.000000248
Lead	123	1.63	-	0.1054	0.191	0.0000018	-	0.0793	0.349	0.0000153	0.00000252
Mercury	0.148	0.019	-	0.0534	0.148	1.1	-	0.0000484	0.000325	0.0112	0.00000585
Zinc	250	66.1	-	0.7717	0.0645	0.138	-	1.18	0.239	2.38	0.000000552

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on maximum values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	2.118	BW					
Soil ingestion proportion	0.063	Ps					
Food ingestion Rate (kg/kgBW/d)	0.13	FIR					
Proportion of diet, plants	1	Pp					
Area use factor	0.51	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	18.6	1.04	0.01	0.0375	0.00152	0.0907	0.0136
Barium	6280	5433	0.0002	0.0046	0.0103	3.76	0.000106
Cadmium	1.163	0.77	0.036	0.586	0.000343	0.0886	0.0177
Lead	123	4.7	0.01	0.0389	0.0101	0.622	0.0206
Mercury	0.148	1.01	0.00031	0.27	3.76E-07	0.00519	0.000786
Zinc	250	75.4	0.1	0.366	0.205	11.9	0.0246

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): Least Shrew

Least Shrew			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.017	BW	
Soil ingestion proportion	0.13	Ps	
Food ingestion Rate (kg/kgBW/d)	0.096	FIR	
Proportion of diet, soil inverts	1	Pi	
Area use factor	1	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	18.6	1.04	0.01	0.224	0.00232	0.4	0.116
Barium	6280	5433	0.0002	0.091	0.0157	54.9	0.00303
Cadmium	1.163	0.77	0.036	7.708	0.000523	0.861	0.336
Lead	123	4.7	0.01	0.266	0.0154	3.14	0.201
Mercury	0.148	1.01	0.00031	1.693	5.73E-07	0.0241	0.00716
Zinc	250	75.4	0.1	3.201	0.312	76.8	0.307

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): Red Fox

Red Fox			Calculations based on maximum values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	4.53	BW									
Soil ingestion proportion	0.028	Ps									
Food ingestion Rate (kg/kgBW/d)	0.16	FIR									
Proportion of diet, plants	0.07	Pp									
Proportion of diet, soil inverts	0.03	Pi									
Proportion of diet, mammals	0.9	Pm									
Area use factor	0.0017	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	18.6	1.04	0.01	0.0375	0.224	0.0025	0.000833	0.00781	0.02	0.0067	0.0000173
Barium	6280	5433	0.0002	0.0046	0.091	0.0566	0.00563	0.324	2.74	51.2	0.00000509
Cadmium	1.163	0.77	0.036	0.586	7.708	0.3333	0.000188	0.00763	0.043	0.0558	0.0000706
Lead	123	4.7	0.01	0.0389	0.266	0.1054	0.00551	0.0536	0.157	1.87	0.000226
Mercury	0.148	1.01	0.00031	0.27	1.693	0.0534	2.06E-07	0.000448	0.0012	0.00114	0.00000141
Zinc	250	75.4	0.1	0.366	3.201	0.7717	0.112	1.02	3.84	27.8	0.000222

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): Site-Wide (0-4'): American Mink

American Mink			Calculations based on maximum values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	18.6	1.04	0.01	0.0025	0.127	0.00065	0.000127	0.0014	0.207	0.000232	0.00114
Barium	6280	5433	0.0002	0.0566	0.023	0.028	0.00086	10.7	12.7	3.37	0.0000281
Cadmium	1.163	0.77	0.036	0.3333	0.614	0.42	0.0000287	0.0117	0.0626	0.00937	0.00062
Lead	123	4.7	0.01	0.1054	0.066	0.0000018	0.000843	0.391	0.712	4.25E-06	0.00134
Mercury	0.148	1.01	0.00031	0.0534	0.48	1.1	3.14E-08	0.000238	0.00623	0.00312	0.0000541
Zinc	250	75.4	0.1	0.7717	2.33	0.138	0.0171	5.81	51.1	0.662	0.00435

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT CALCULATIONS - METALS - AVERAGE CONCENTRATIONS

COPEC concentrations used for estimating potential risk (HQs) in the BERA for Hero Lands Property using average detected values in soil samples.

Constituent	Average Concentration (mg/kg dry)
Arsenic	7.60
Barium	873
Cadmium	0.483
Lead	24.0
Mercury	0.0613
Zinc	87.6

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): American Robin

American Robin			Calculations based on average values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	0.0773	BW							
Soil ingestion proportion	0.02	Ps							
Food ingestion Rate (kg/kgBW/d)	0.132	FIR							
Proportion of diet, plants	0.41	Pp							
Proportion of diet, soil inverts	0.59	Pi							
Area use factor	1	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	7.6	2.24	0.01	0.0375	0.224	0.000201	0.0154	0.133	0.0199
Barium	873	600	0.0002	0.0046	0.091	0.000461	0.217	6.19	0.0032
Cadmium	0.483	1.47	0.036	0.586	7.708	0.0000459	0.0153	0.29	0.0623
Lead	24	1.63	0.01	0.0389	0.266	0.000634	0.0505	0.497	0.101
Mercury	0.0613	3.25	0.00031	0.27	1.693	5.02E-08	0.000896	0.00808	0.000829
Zinc	87.6	66.1	0.1	0.366	3.201	0.0231	1.74	21.8	0.107

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): Mallard Duck

Mallard Duck			Calculations based on average values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	1.134	BW							
Soil ingestion proportion	0.033	Ps							
Food ingestion Rate (kg/kgBW/d)	0.05	FIR							
Proportion of diet, plants	0.5	Pp							
Proportion of diet, benthic inverts	0.5	Pbi							
Area use factor	0.0099	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	7.6	2.24	0.01	0.0375	0.127	0.000125	0.00713	0.0241	0.0000416
Barium	873	600	0.0002	0.0046	0.023	0.000288	0.1	0.502	0.00000298
Cadmium	0.483	1.47	0.036	0.586	0.614	0.0000287	0.00708	0.00741	0.0000293
Lead	24	1.63	0.01	0.0389	0.066	0.000396	0.0233	0.0396	0.000115
Mercury	0.0613	3.25	0.00031	0.27	0.48	3.14E-08	0.000414	0.000736	0.00000105
Zinc	87.6	66.1	0.1	0.366	2.33	0.0145	0.802	5.1	0.000266

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	0.0425	BW					
Soil ingestion proportion	0.17	Ps					
Food ingestion Rate (kg/kgBW/d)	0.196	FIR					
Proportion of diet, benthic inverts	1	Pbi					
Area use factor	0.5	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	7.6	2.24	0.01	0.127	0.00253	0.189	0.0128
Barium	873	600	0.0002	0.023	0.00582	3.94	0.000986
Cadmium	0.483	1.47	0.036	0.614	0.000579	0.0581	0.00599
Lead	24	1.63	0.01	0.066	0.008	0.31	0.0293
Mercury	0.0613	3.25	0.00031	0.48	6.33E-07	0.00577	0.000266
Zinc	87.6	66.1	0.1	2.33	0.292	40	0.0914

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}\;]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): Snowy Egret

Snowy Egret		
Parameter	**Value**	**Symbol**
Body weight (kg)	0.371	BW
Soil ingestion proportion	0.005	Ps
Food ingestion Rate (kg/kgBW/d)	0.116	FIR
Proportion of diet, benthic inverts	0.1	Pbi
Proportion of diet, fish	0.9	Pf
Area use factor	0.0082	AUF
Time (temporal) factor	0.3	TF

Calculations based on average values

			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	7.6	2.24	0.01	0.127	0.00065	0.0000441	0.0112	0.000516	0.0000129
Barium	873	600	0.0002	0.023	0.028	0.000101	0.233	2.55	0.0000114
Cadmium	0.483	1.47	0.036	0.614	0.42	0.0000101	0.00344	0.0212	0.0000413
Lead	24	1.63	0.01	0.066	0.0000018	0.000139	0.0184	4.51E-06	0.000028
Mercury	0.0613	3.25	0.00031	0.48	1.1	1.1E-08	0.000341	0.00704	0.00000559
Zinc	87.6	66.1	0.1	2.33	0.138	0.00508	2.37	1.26	0.000135

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	7.6	2.24	0.01	0.127	0.00065	0.0000391	0.00994	0.000458	0.00000992
Barium	873	600	0.0002	0.023	0.028	0.0000899	0.207	2.27	0.00000879
Cadmium	0.483	1.47	0.036	0.614	0.42	0.00000895	0.00305	0.0188	0.0000317
Lead	24	1.63	0.01	0.066	0.0000018	0.000124	0.0163	0.000004	0.0000215
Mercury	0.0613	3.25	0.00031	0.48	1.1	9.79E-09	0.000303	0.00625	0.00000429
Zinc	87.6	66.1	0.1	2.33	0.138	0.00451	2.1	1.12	0.000104

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): American Bald Eagle

American Bald Eagle			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.6	BW	
Soil ingestion proportion	0	Ps	
Food ingestion Rate (kg/kgBW/d)	0.09	FIR	
Proportion of diet, mammals	0.068	Pm	
Proportion of diet, birds	0.165	Pb	
Proportion of diet, fish	0.767	Pf	
Area use factor	0.000032	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	7.6	2.24	-	0.0025	0.075	0.00065	-	0.000116	0.00846	0.000341	0.0000000382
Barium	873	20.8	-	0.0566	0.00001	0.028	-	0.302	0.00013	1.69	0.000000919
Cadmium	0.483	1.47	-	0.3333	0.113	0.42	-	0.000985	0.00081	0.014	0.000000103
Lead	24	1.63	-	0.1054	0.191	0.0000018	-	0.0155	0.0681	2.98E-06	0.000000492
Mercury	0.0613	0.019	-	0.0534	0.148	1.1	-	0.00002	0.000135	0.00465	0.00000243
Zinc	87.6	66.1	-	0.7717	0.0645	0.138	-	0.414	0.0839	0.834	0.000000193

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	2.118	BW					
Soil ingestion proportion	0.063	Ps					
Food ingestion Rate (kg/kgBW/d)	0.13	FIR					
Proportion of diet, plants	1	Pp					
Area use factor	0.51	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	7.6	1.04	0.01	0.0375	0.000622	0.0371	0.00555
Barium	873	5433	0.0002	0.0046	0.00143	0.522	0.0000147
Cadmium	0.483	0.77	0.036	0.586	0.000142	0.0368	0.00734
Lead	24	4.7	0.01	0.0389	0.00197	0.121	0.004
Mercury	0.0613	1.01	0.00031	0.27	0.000000156	0.00215	0.000326
Zinc	87.6	75.4	0.1	0.366	0.0717	4.17	0.00861

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): Least Shrew

Least Shrew			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	0.017	BW					
Soil ingestion proportion	0.13	Ps					
Food ingestion Rate (kg/kgBW/d)	0.096	FIR					
Proportion of diet, soil inverts	1	Pi					
Area use factor	1	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	7.6	1.04	0.01	0.224	0.000948	0.163	0.0473
Barium	873	5433	0.0002	0.091	0.00218	7.63	0.000421
Cadmium	0.483	0.77	0.036	7.708	0.000217	0.357	0.139
Lead	24	4.7	0.01	0.266	0.003	0.613	0.0393
Mercury	0.0613	1.01	0.00031	1.693	2.37E-07	0.00996	0.00296
Zinc	87.6	75.4	0.1	3.201	0.109	26.9	0.107

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}\;]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): Red Fox

Red Fox			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.53	BW	
Soil ingestion proportion	0.028	Ps	
Food ingestion Rate (kg/kgBW/d)	0.16	FIR	
Proportion of diet, plants	0.07	Pp	
Proportion of diet, soil inverts	0.03	Pi	
Proportion of diet, mammals	0.9	Pm	
Area use factor	0.0017	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	7.6	1.04	0.01	0.0375	0.224	0.0025	0.00034	0.00319	0.00817	0.00274	0.00000708
Barium	873	5433	0.0002	0.0046	0.091	0.0566	0.000782	0.045	0.381	7.12	0.000000708
Cadmium	0.483	0.77	0.036	0.586	7.708	0.3333	0.0000779	0.00317	0.0179	0.0232	0.0000294
Lead	24	4.7	0.01	0.0389	0.266	0.1054	0.00108	0.0105	0.0306	0.364	0.0000441
Mercury	0.0613	1.01	0.00031	0.27	1.693	0.0534	8.51E-08	0.000185	0.000498	0.000471	0.000000583
Zinc	87.6	75.4	0.1	0.366	3.201	0.7717	0.0392	0.359	1.35	9.73	0.0000776

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): Site-Wide (0-4'): American Mink

American Mink			Calculations based on average values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	7.6	1.04	0.01	0.0025	0.127	0.00065	0.0000521	0.000573	0.0846	0.0000947	0.000468
Barium	873	5433	0.0002	0.0566	0.023	0.028	0.00012	1.49	1.76	0.469	0.0000039
Cadmium	0.483	0.77	0.036	0.3333	0.614	0.42	0.0000119	0.00485	0.026	0.00389	0.000257
Lead	24	4.7	0.01	0.1054	0.066	0.0000018	0.000164	0.0762	0.139	8.29E-07	0.000261
Mercury	0.0613	1.01	0.00031	0.0534	0.48	1.1	1.3E-08	0.0000987	0.00258	0.00129	0.0000224
Zinc	87.6	75.4	0.1	0.7717	2.33	0.138	0.006	2.04	17.9	0.232	0.00153

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT INPUT FACTORS AND CALCULATIONS - DIOXINS/FURANS

SOIL 2,3,7,8-TCDD TEQ CALCULATIONS

Calculation of 2,3,7,8-TCDD TEQ for Site-Wide Soil 0-4': Bird

		Reported Data		Calculated Average Congener Concentration 0-4' On Site	WHO 1998 TEF Bird	Calculated Toxicity Equivalent Concentration Predicted for Birds		Calculated Average Toxic Equivalent Concentration Predicted for Bird 0-4' On Site
Location ID		BC-16R	BC-16R			BC-16R	BC-16R	
Depth Interval		2-4'	2-4'			2-4'	2-4'	
Sample Date		6/24/2019	6/24/2019			6/24/2019	6/24/2019	
Reported Parameter	*Sampler*	ICON	ERM			ICON	ERM	
2,3,7,8-TCDD	pg/g-dry	0.549	<0.705	0.27	1	0.549	0	0.270
1,2,3,7,8-PeCDD	pg/g-dry	1.2	1.34	1.27	1	1.2	1.34	1.27
1,2,3,4,7,8-HxCDD	pg/g-dry	<0.431	1.38	0.69	0.05	0	0.069	0.0345
1,2,3,6,7,8-HxCDD	pg/g-dry	6.14	3.79	4.97	0.01	0.0614	0.0379	0.0497
1,2,3,7,8,9-HxCDD	pg/g-dry	4.09	3.03	3.56	0.1	0.409	0.303	0.356
1,2,3,4,6,7,8-HpCDD	pg/g-dry	343	160	251.5	<0.001	0	0	0
1,2,3,4,6,7,8,9-OCDD	pg/g-dry	5860	2870	4365	0.0001	0.586	0.287	0.437
2,3,7,8-TCDF	pg/g-dry	2.12	**2.08**, 2.67	2.1	1	2.12	2.08	2.10
1,2,3,7,8-PeCDF	pg/g-dry	1.56 K	1.58 K	0	0.1	0	0	0
2,3,4,7,8-PeCDF	pg/g-dry	2.16	1.9	2.03	1	2.16	1.9	2.03
1,2,3,4,7,8-HxCDF	pg/g-dry	2.68	2.03	2.36	0.1	0.268	0.203	0.236
1,2,3,6,7,8-HxCDF	pg/g-dry	1.61	1.43	1.52	0.1	0.161	0.143	0.152
2,3,4,6,7,8-HxCDF	pg/g-dry	1.59	1.36	1.48	0.1	0.159	0.136	0.148
1,2,3,7,8,9-HxCDF	pg/g-dry	<0.762	<0.745	0	0.1	0	0	0
1,2,3,4,6,7,8-HpCDF	pg/g-dry	12 K	10.4	5.2	0.01	0	0.104	0.0520
1,2,3,4,7,8,9-HpCDF	pg/g-dry	<4.56	1.02 K	0	0.01	0	0	0
1,2,3,4,6,7,8,9-OCDF	pg/g-dry	38.9	19.2	29.05	0.0001	0.00389	0.00192	0.00291
				Calculated 2,3,7,8-TCDD TEQ (bird)		7.68	6.60	7.14

Notes:

WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

K-flagged values were reported by the laboratory as estimated maximum probable concentrations (EMPC).

Non-detect and K-flagged values were assumed a value of 0 for average and TEQ calculations.

For ERM samples, the laboratory reported two 2,3,7,8-TCDF results: one from the original analysis run and one from subsequent dual column confirmation. Bolded 2,3,7,8-TCDF values were used in average and TEQ calculations, and were reported from the original analysis run, except for sample SB-4R 0-2'. 2,3,7,8-TCDF in the original run for sample SB-4R was a K-flagged result. Therefore the non-flagged result from the dual column confirmation run was used to represent 2,3,7,8-TCDF concentration in sample SB-4R 0-2'.

Calculation of 2,3,7,8-TCDD TEQ for Site-Wide Soil 0-4': Mammal

		Reported Data		Calculated Average Congener Concentration 0-4' On Site	WHO 2005 TEF Mammal	Calculated Toxicity Equivalent Concentration Predicted for Mammals		Calculated Average Toxic Equivalent Concentration Predicted for Mammal 0-4' On Site
Location ID		BC-16R	BC-16R			BC-16R	BC-16R	
Depth Interval		2-4'	2-4'			2-4'	2-4'	
Sample Date		6/24/2019	6/24/2019			6/24/2019	6/24/2019	
Reported Parameter	*Sampler*	ICON	ERM			ICON	ERM	
2,3,7,8-TCDD	pg/g-dry	0.549	<0.705	0.27	1	0.549	0	0.27
1,2,3,7,8-PeCDD	pg/g-dry	1.2	1.34	1.27	1	1.2	1.34	1.27
1,2,3,4,7,8-HxCDD	pg/g-dry	<0.431	1.38	0.69	0.1	0	0.138	0.069
1,2,3,6,7,8-HxCDD	pg/g-dry	6.14	3.79	4.97	0.1	0.614	0.379	0.497
1,2,3,7,8,9-HxCDD	pg/g-dry	4.09	3.03	3.56	0.1	0.409	0.303	0.356
1,2,3,4,6,7,8-HpCDD	pg/g-dry	343	160	251.5	0.01	3.43	1.6	2.52
1,2,3,4,6,7,8,9-OCDD	pg/g-dry	5860	2870	4365	0.0003	1.758	0.861	1.310
2,3,7,8-TCDF	pg/g-dry	2.12	**2.08**, 2.67	2.1	0.1	0.212	0.208	0.21
1,2,3,7,8-PeCDF	pg/g-dry	1.56 K	1.58 K	0	0.03	0	0	0
2,3,4,7,8-PeCDF	pg/g-dry	2.16	1.9	2.03	0.3	0.648	0.57	0.609
1,2,3,4,7,8-HxCDF	pg/g-dry	2.68	2.03	2.36	0.1	0.268	0.203	0.236
1,2,3,6,7,8-HxCDF	pg/g-dry	1.61	1.43	1.52	0.1	0.161	0.143	0.152
2,3,4,6,7,8-HxCDF	pg/g-dry	1.59	1.36	1.48	0.1	0.159	0.136	0.148
1,2,3,7,8,9-HxCDF	pg/g-dry	<0.762	<0.745	0	0.1	0	0	0
1,2,3,4,6,7,8-HpCDF	pg/g-dry	12 K	10.4	5.2	0.01	0	0.104	0.052
1,2,3,4,7,8,9-HpCDF	pg/g-dry	<4.56	1.02 K	0	0.01	0	0	0
1,2,3,4,6,7,8,9-OCDF	pg/g-dry	38.9	19.2	29.05	0.0003	0.01167	0.00576	0.00872
				Calculated 2,3,7,8-TCDD TEQ (mammal)		9.42	5.99	7.70

Notes:

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.
K-flagged values were reported by the laboratory as estimated maximum probable concentrations (EMPC).
Non-detect and K-flagged values were assumed a value of 0 for average and TEQ calculations.

For ERM samples, the laboratory reported two 2,3,7,8-TCDF results: one from the original analysis run and one from subsequent dual column confirmation. Bolded 2,3,7,8-TCDF values were used in average and TEQ calculations, and were reported from the original analysis run, except for sample SB-4R 0-2'. 2,3,7,8-TCDF in the original run for sample SB-4R was a K-flagged result. Therefore the non-flagged result from the dual column confirmation run was used to represent 2,3,7,8-TCDF concentration in sample SB-4R 0-2'.

TRVS FOR 2,3,7,8-TCDD TEQ

Toxicity Reference Values (TRVs) for 2,3,7,8-TCDD TEQ

Element or Constituent	TRV (mg/kg/d)					
	Avian (Robin, Mallard, Sandpiper, Egret, and Heron)		Avian (American Bald Eagle)		Mammal (Rabbit, Shrew, Fox, and Mink)	
	mg/kg/day	Source	mg/kg/day	Source	mg/kg/day	Source
2,3,7,8-TCDD TEQ	0.0000028	USEPA (2014)[a]	0.0000028	USEPA (2014)[a]	0.0000036	Gatehouse (2004); [Source: Leonards et al. (2004); Tillitt et al. (1996); Bursian et al. (2006); Blankenship et al. (2008)][b]

Notes:

a - 2,3,7,8-TCDD TEQ; Bounded LOAEL equivalent to 140 pg/g-day; Reproduction and Mortality; An uncertainty factor of 50 was applied (10 for LOAEL to NOAEL; 5 for interspecies variability due to pheasant not being the most sensitive avian receptor).

b - 2,3,7,8-TCDD TEQ; Bounded LOAEL based on reproduction in mink with carp diet.

DIOXINS/FURANS SOIL BIOAVAILABILITY AND BCF CALCULATIONS

Calculation of Dioxin/Furan Soil Bioavailability Factor

Dioxin/Furan Congener	Mean Bioavailability from Soil			Mean Bioavailability from Solvent			Mean Relative Bioavailability		
	Liver	Adipose tissue	Total	Liver	Adipose Tissue	Total	Liver	Adipose tissue	Total
2378-TetraCDD	0.75	n.d.	0.75	9.3	31.2	38.2	8.1	–	2
12378-PentaCDD	2.3	4.3	6.6	9.3	11.5	20.8	24.5	37.5	31.7
123478-HexaCDD	7.2	6.9	14.1	24.9	34.9	59.8	28.8	19.9	23.6
123678-HexaCDD	3	4.8	7.8	10	27	37	29.6	17.9	21.1
123789-HexaCDD	1.7	1.7	2.5	6.8	6	12.8	24.8	28.1	19.7
1234678-HeptaCDD	5.9	2.2	8.1	21.5	11.8	33.4	27.6	18.2	24.3
OctaCDD	11.9	2.9	14	28.4	6.8	35.3	41.8	42	39.8
2378-TetraCDF	0.3	0.64	0.86	1.5	2.1	3.6	20.5	30.1	24.1
12378-PentaCDF	0.14	0.49	0.64	0.56	2.2	2.8	25.8	22.1	22.8
23478-PentaCDF	10.4	2.3	12.8	23.6	13.5	37.1	44.2	17.3	34.4
123478-HexaCDF	16.5	5.4	21.9	33.6	20	53.6	49.1	27.1	40.9
123678-HexaCDF	13.8	4	17.9	41.4	15.3	56.8	33.4	26.2	31.5
234678-HexaCDF	12.6	2	14.6	30.5	6.5	36.9	41.2	31.1	39.4
123789-HexaCDF	1.5	0.92	2.2	4.9	2.8	7.7	31	32.6	28.6
1234678-HeptaCDF	10.7	1.9	12.7	33	11.3	44.4	32.5	17	28.5
1234789-HeptaCDF	10.5	1.3	11.8	34.4	7.7	42.1	30.5	17	28

Notes:
Mean soil bioavailability, mean solvent bioavailability, and mean soil relative bioavailability for liver tissue, adipose tissue, and total tissue taken from Wittsiepe et al. 2007.

Reference:
Wittsiepe, J., Erlenkamper, B., Welge, P., Hack, A., and M. Wilhelm. 2007. Bioavailability of PCDD/F from contaminated soil in young Goettingen minipigs. Chemosphere 67 (2007) S355–S364.

Calculation of Dioxin/Furan Soil-to-Mammal BCF

Dioxin/Furan Congener	Site 1[a,b,c]							Site 2[a,b,c]						
	Concentration				BCF			Concentration				BCF		
	Soil	Ural field mouse	Bank vole	Shrew	Soil-to-Field mouse	Soil-to-Bank vole	Soil-to-Shrew	Soil	Ural field mouse	Bank vole	Shrew	Soil-to-Field mouse	Soil-to-Bank vole	Soil-to-Shrew
	pg/g	pg/g	pg/g	pg/g	unitless	unitless	unitless	pg/g	pg/g	pg/g	pg/g	unitless	unitless	unitless
2,3,7,8-TCDD	0.09	0.49	1	1.7	0.180	0.367	0.623	0.1	0.18	0.46	0.89	0.059	0.152	0.294
1,2,3,7,8-PeCDD	0.17	1.3	2.4	5.9	0.252	0.466	1.145	0.1	0.15	1.3	3.9	0.050	0.429	1.287
1,2,3,4,7,8-HxCDD	0.18	0.93	0.91	4.7	0.171	0.167	0.862	0.2	0.27	0.61	2.4	0.045	0.101	0.396
1,2,3,6,7,8-HxCDD	0.33	1.2	1.5	4.7	0.120	0.150	0.470	0.36	0.18	1.1	2.4	0.017	0.101	0.220
1,2,3,7,8,9-HxCDD	0.33	0.4	0.66	0.9	0.040	0.066	0.090	0.35	0.12	0.39	0.55	0.011	0.037	0.052
1,2,3,4,6,7,8-HpCDD	2.6	2.1	1.6	7.6	0.027	0.020	0.096	2.82	1.04	1.5	4.5	0.012	0.018	0.053
OCDD	14	4.9	4.3	10	0.012	0.010	0.024	16.01	3.6	3.4	8.5	0.007	0.007	0.018
2,3,7,8-TCDF	1.5	0.91	3.1	13	0.020	0.068	0.286	1.35	0.6	1.7	5.6	0.015	0.042	0.137
1,2,3,7,8-PeCDF	0.76	0.23	0.73	2.7	0.010	0.032	0.117	0.81	0.16	0.42	1.3	0.007	0.017	0.053
2,3,4,7,8-PeCDF	0.88	17	8.5	177	0.638	0.319	6.638	1.04	4	5.2	55	0.127	0.165	1.745
1,2,3,4,7,8-HxCDF	0.85	8.3	4.1	30	0.322	0.159	1.165	0.96	2.4	3.1	11	0.083	0.107	0.378
1,2,3,6,7,8-HxCDF	0.67	6.4	3.1	41	0.315	0.153	2.019	0.74	2.2	3	17	0.098	0.134	0.758
2,3,4,6,7,8-HxCDF	0.72	14.5	3.5	29	0.665	0.160	1.329	0.81	4.2	3.6	12	0.171	0.147	0.489
1,2,3,7,8,9-HxCDF	0	0	0	0	-	-	-	0	0	0	0	-	-	-
1,2,3,4,6,7,8-HpCDF	3.7	5.4	2.2	10.3	0.048	0.020	0.092	3.74	3.1	3.6	5.9	0.027	0.032	0.052
1,2,3,4,7,8,9-HpCDF	0.32	0.9	0.51	2.1	0.093	0.053	0.217	0.32	0.2	0.73	1.2	0.021	0.075	0.124
OCDF	2.1	1	0.78	2	0.016	0.012	0.031	2.67	0.53	1.7	1.6	0.007	0.021	0.020

PCDD/PCDF Congener	Contaminated area[d,e,f]					Control area[d,e,f]			Geometric Mean Soil-to-Mammal BCF
	Concentration				BCF	Concentration		BCF	
	Litter on black plastic	Litter on khaki plastic	Average litter	Wood mouse liver	Soil-to-wood mouse	Reference site soil	Wood mouse liver	Soil-to-wood mouse	
	ng/kg dry	ng/kg dry	ng/kg dry	ng/kg wet	unitless	ng/kg dry	ng/kg wet	unitless	unitless
2,3,7,8-TCDD	4.5	0.43	2.465	2.8	1.033	1.3	0	0	0.180
1,2,3,7,8-PeCDD	10.6	2.9	6.75	10.5	1.414	4.6	0	0	0.291
1,2,3,4,7,8-HxCDD	24.3	15.3	19.8	21.5	0.987	10.4	0.97	0.085	0.209
1,2,3,6,8,9-HxCDD[g]	11	1.5	6.25	14.8	2.153	5.3	0.2	0.034	0.121
1,2,3,7,8,9-HxCDD	17.3	6.8	12.05	1.2	0.091	8.1	0.47	0.053	0.0472
1,2,3,4,6,7,8-HpCDD	156	173	164.5	66	0.365	74	66	0.811	0.0603
OCDD	780	1600	1190	816	0.623	410	433	0.960	0.0333
2,3,7,8-TCDF	20.7	5.7	13.2	4.7	0.324	9.9	0	0	0.0566
1,2,3,7,8-PeCDF	26	8.9	17.45	6.9	0.359	10	0	0	0.0307
2,3,4,7,8-PeCDF	33.3	10.6	21.95	31	1.284	12.7	7.3	0.523	0.653
1,2,3,4,7,8-HxCDF	39.3	14.7	27	108	3.636	16.7	4	0.218	0.335
1,2,3,6,7,8-HxCDF	38.4	15.3	26.85	92	3.115	14.3	4.4	0.280	0.413
2,3,4,6,7,8-HxCDF	32	14.3	23.15	43	1.689	12.7	5.1	0.365	0.425
1,2,3,7,8,9-HxCDF	12	2.6	7.3	1.2	0.149	5.9	0.15	0.023	0.0588
1,2,3,4,6,7,8-HpCDF	220	350	285	153	0.488	82	9.8	0.109	0.0616
1,2,3,4,7,8,9-HpCDF	17.3	6.8	12.05	13.3	1.003	10.1	0.62	0.056	0.102
OCDF	147	247	197	320	1.477	85	146	1.561	0.0498

Notes:
BCF = (Mammal Concentration ÷ Fraction Lipid) ÷ (Soil Concentration ÷ Fraction Organic Carbon)
For geometric mean BCF calculations, a BCF of 0 was treated as 0.01 for calculation purposes. For reference, the lowest non-zero BCF was 0.03.
[a]Data from Roumak et al., 2018.
[b]Sediment fraction of organic carbon of 3.3% was assumed for Roumak (2018) sediment data based on Vasenev et al. 2013.
[c]Roumak et al. (2018) reported lipid-normalized mammal concentrations.
[d]Data from Meharg et al., 1997.
[e]Sediment fraction of organic carbon of 3% was assumed for Meharg (1997) sediment data based on Verheijen et al. 2005.
[f]Meharg et al. (1997) reported 3.3% lipid in wood mouse.
[g]BCF for 1,2,3,6,8,9-HxCDD was not used for geometric mean calculation as this congener was not analyzed in soil samples at Hero Lands.
References:
Roumak, V.S., Levenkova, E.S., Umnova, N.V., Popov, V.S., Turbabina, K.A. and A.A. Shelepchikov. 2018. The content of dioxins and furans in soils, bottom sediments of water bodies, and tissues of small mammals near the landfill site with municipal solid wastes (Moscow, Russia). Environmental Science and Pollution Research (2018) 25:29379–29386. https://doi.org/10.1007/s11356-018-2933-y.
Meharg, A.A., Shore, R.F., French, M.C., and D. Osborn. 1997. Dioxin and Furan Residues in Wood Mice (Apodemus sylvaticus) Following a Large Scale Polyvinyl Chloride (PVC) Fire. Environmental Pollution 97(3): 213-220.
Vasenev, V., Stoorvogel, J., and I. Vasenev. 2013. Urban soil organic carbon and its spatial heterogeneity in comparison with natural and agricultural areas in the Moscow region. Catena 107, 96–102.
Verheijen, F., Bellamy, P., Kibblewhite, M., and J. Gaunt. 2005. Organic carbon ranges in arable soils of England and Wales Soil Use and Management. 21, 2–9.

Calculation of Dioxin/Furan Soil-to-Bird BCF

I. Calculation of BCF

Dioxin/Furan Congener	UTR Sediment	Great Blue Heron	Soil-to-bird BCF
	ng/kg wet	ng/kg wet	unitless
2378-TCDD	2	25.68	0.128
12378-PeCDD	110	21.59	0.00196
123478-HxCDD	1.3	3.02	0.0233
123678-HxCDD	10	19.19	0.0192
123789-HxCDD	3.2	2.36	0.00738
1234678-HpCDD	200	5.24	0.000262
1234678-OCDD	1900	6.28	0.0000330
2378-TCDF	260	38.60	0.00148
12378-PeCDF	110	8.03	0.000730
23478-PeCDF	87	40.42	0.00465
123478-HxCDF	87	5.21	0.000599
123678-HxCDF	16	6.72	0.00420
234678-HxCDF	6.9	2.44	0.00354
123789-HxCDF	1.9	0.00	0
1234678-HpCDF	210	3.30	0.000157
1234789-HpCDF	17	0.00	0
12346789-OCDF	730	0.38	0.00000522

II. Calculation of Great Blue Heron Average Tissue Concentration (ng/kg wet)

Dioxin/Furan Congener	FRE Rookery				SNWR Rookery				CAS Rookery				Average Great Blue Heron Tissue
	Muscle	Liver	Adipose	Sum Tissue	Muscle	Liver	Adipose	Sum Tissue	Muscle	Liver	Adipose	Sum Tissue	
2378-TCDD	0.77	0.77	28	29.54	1.5	13	16	30.50	0.515	0.48	16	17.00	25.68
12378-PeCDD	0.54	0.65	21	22.19	1.1	11	12	24.10	0.475	0.515	17.5	18.49	21.59
123478-HxCDD	ND	ND	3.2	3.20	ND	1.50	1.47	2.97	ND	ND	2.9	2.90	3.02
123678-HxCDD	0.39	0.66	18	19.05	0.92	9	9.2	19.12	0.425	0.485	18.5	19.41	19.19
123789-HxCDD	ND	ND	2.2	2.20	ND	1.17	1.07	2.23	ND	ND	2.65	2.65	2.36
1234678-HpCDD	ND	0.3	5.3	5.60	0.48	2.6	1.9	4.98	ND	0.335	4.8	5.14	5.24
1234678-OCDD	0.66	1.3	3.3	5.26	2.2	2.7	2.6	7.50	ND	2.42	3.65	6.07	6.28
2378-TCDF	1.1	0.74	30	31.84	2.1	47	20	69.10	0.395	0.455	14	14.85	38.60
12378-PeCDF	0.41	0.2	6.7	7.31	0.28	10.44	2.2	12.92	ND	ND	3.85	3.85	8.03
23478-PeCDF	0.83	1.3	33	35.13	2.9	36	21	59.90	0.67	1.065	24.5	26.24	40.42
123478-HxCDF	ND	0.24	4.7	4.94	ND	4.9	1.8	6.70	ND	ND	4	4.00	5.21
123678-HxCDF	0.22	0.18	6.7	7.10	0.5	4.1	2.9	7.50	0.42	NA	5.15	5.57	6.72
234678-HxCDF	ND	ND	2.3	2.30	ND	1.22	1.2	2.42	ND	ND	2.6	2.60	2.44
123789-HxCDF	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	0
1234678-HpCDF	ND	ND	2.8	2.80	0.10	1.85	1.4	3.36	ND	ND	3.75	3.75	3.30
1234789-HpCDF	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	0
12346789-OCDF	ND	ND	0.57	0.57	0.21	ND	0.37	0.57	ND	ND	ND	0	0.38

Notes:
BCF = (Lipid-normalized Bird Concentration) ÷ (Soil Concentration ÷ Fraction Organic Carbon)
Sediment fraction of organic carbon of 1% was assumed based on Taylor, A. and McCabe, J. 2002. Baseline Chemical Characterization of Saginaw Bay Watershed Sediments, A Report to the Office of the Great Lakes Michigan Department of Environmental Quality, Appendix H.
Great blue heron tissue concentration was reported a lipid-normalized basis in Seston, 2010.
Reference:
Seston, R.M. 2010. An Ecological Risk Assessment of Fish-Eating Birds Exposed to Polychlorinated Dibenzofurans and Dibenzo-p-dioxins Within the Tittabawassee River Floodplain, MI, USA. A Dissertation Submitted to Michigan State University.

Calculation of Dioxin/Furan Sediment-to-Benthic Invertebrate BCF

Dioxin/Furan Congener	RA			UTR			LTR			SR			Geometric Mean Sediment-to-Benthic Invertebrate BCF
	Crayfish	Sediment	Sediment to Crayfish BCF	Crayfish	Sediment	Sediment to Crayfish BCF	Crayfish	Sediment	Sediment to Crayfish BCF	Crayfish	Sediment	Sediment to Crayfish BCF	
	ng/kg	ng/kg wet	unitless	ng/kg	ng/kg wet	unitless	ng/kg	ng/kg wet	unitless	ng/kg	ng/kg wet	unitless	unitless
2378-TCDD	0.16	0.26	6.00E-03	0.89	2	4.45E-03	1.3	1.5	8.67E-03	0.68	6.9	9.89E-04	0.00389
12378-PeCDD	0.14	0.28	4.93E-03	0.49	110	4.45E-05	0.86	1.3	6.62E-03	0.25	9.7	2.53E-04	0.000778
123478-HxCDD	0	0.35	0.00E+00	0.06	1.3	4.62E-04	0.13	0.85	1.53E-03	0	3.2	0.00E+00	0.0000917
123678-HxCDD	0	0.82	0.00E+00	0.34	10	3.37E-04	1.1	4.4	2.39E-03	0.05	26	1.73E-05	0.000109
123789-HxCDD	0	0.6	0.00E+00	0.11	3.2	3.35E-04	0.22	1.9	1.18E-03	0	11	0.00E+00	0.0000792
1234678-HpCDD	0.42	6.8	6.18E-04	5.0	200	2.50E-04	15	64	2.34E-03	1.4	140	1.00E-04	0.000436
1234678-OCDD	2.8	64	4.38E-04	44	1900	2.32E-04	140	630	2.22E-03	10	1300	7.69E-05	0.000363
2378-TCDF	0.55	0.8	6.88E-03	60	260	2.31E-03	140	630	2.22E-03	25	290	8.62E-04	0.00235
12378-PeCDF	0.10	0.56	1.72E-03	14	110	1.25E-03	44	350	1.26E-03	4.4	180	2.44E-04	0.000901
23478-PeCDF	0.22	0.43	5.21E-03	12	87	1.38E-03	35	250	1.40E-03	3.7	130	2.85E-04	0.00130
123478-HxCDF	0.34	1.3	2.58E-03	5.2	87	5.98E-04	19	260	7.31E-04	1.3	150	8.67E-05	0.000559
123678-HxCDF	0.086	0.7	1.23E-03	0.97	16	6.06E-04	3.9	58	6.72E-04	0.19	53	3.54E-05	0.000365
234678-HxCDF	0.04	0.51	7.76E-04	0.25	6.9	3.56E-04	1.5	22	6.76E-04	0	23	0.00E+00	0.000208
123789-HxCDF	0	0	0.00E+00	0.03	1.9	1.38E-04	0.18	5.2	3.46E-04	0	21	0.00E+00	0.0000468
1234678-HpCDF	0.28	4.3	6.56E-04	7.8	210	3.71E-04	26	120	2.17E-03	2.8	370	7.57E-05	0.000447
1234789-HpCDF	0	0.62	0.00E+00	0.41	17	2.39E-04	1.1	19	5.59E-04	0	38	0.00E+00	0.0000604
12346789-OCDF	0.29	9.2	3.13E-04	13	730	1.78E-04	31	230	1.35E-03	2.7	520	5.19E-05	0.000250

Notes:
BCF = (Lipid-normalized Benthic Invertebrate Concentration) ÷ (Soil Concentration ÷ Fraction Organic Carbon)
Crayfish and sediment concentrations are average concentrations, with individual crayfish and sediment ND results assumed to be 0.
For geometric mean BCF calculations, a BCF of 0 for the RA, UTR, LTR, or SR was treated as 0.00001 for calculation purposes. For reference, the lowest non-zero BCF for the RA, UTR, LTR, or SR was 0.00002.
Sediment fraction of organic carbon of 1% was assumed based on Taylor, A. and McCabe, J. 2002. Baseline Chemical Characterization of Saginaw Bay Watershed Sediments, A Report to the Office of the Great Lakes Michigan Department of Environmental Quality, Appendix H.
Crayfish concentration was reported a lipid-normalized basis in Seston, 2010.
RA: Reference Area
UTR: Upper Tittabawassee River
LTR: Lower Tittabawassee River
SR: Saginaw River
Reference:
Seston, R.M. 2010. An Ecological Risk Assessment of Fish-Eating Birds Exposed to Polychlorinated Dibenzofurans and Dibenzo-p-dioxins Within the Tittabawassee River Floodplain, MI, USA. A Dissertation Submitted to Michigan State University.

Calculation of Dioxin/Furan Sediment-to-Fish BCF

Dioxin/Furan Congener	RA			UTR			LTR			SR			Geometric Mean Sediment-to-Fish BCF
	Forage Fish	Sediment	Sediment to Forage Fish BCF	Forage Fish	Sediment	Sediment to Forage Fish BCF	Forage Fish	Sediment	Sediment to Forage Fish BCF	Forage Fish	Sediment	Sediment to Forage Fish BCF	
	ng/kg	ng/kg wet	unitless	ng/kg	ng/kg wet	unitless	ng/kg	ng/kg wet	unitless	ng/kg	ng/kg wet	unitless	unitless
2378-TCDD	0.22	0.26	8.27E-03	5.4	2	2.68E-02	4.6	1.5	3.07E-02	1.7	6.9	2.46E-03	0.0114
12378-PeCDD	0.11	0.28	4.02E-03	1.4	110	1.27E-04	1.2	1.3	9.23E-03	0.52	9.7	5.36E-04	0.00126
123478-HxCDD	0	0.35	0.00E+00	0.76	1.3	5.85E-03	0.72	0.85	8.47E-03	0.01	3.2	3.13E-05	0.000265
123678-HxCDD	0	0.82	0.00E+00	1.2	10	1.19E-03	0.80	4.4	1.82E-03	0.55	26	2.12E-04	0.000260
123789-HxCDD	0	0.6	0.00E+00	0.31	3.2	9.53E-04	0.066	1.9	3.47E-04	0.23	11	2.05E-04	0.0000759
1234678-HpCDD	0.34	6.8	4.93E-04	3.9	200	1.93E-04	5	64	7.81E-04	1.9	140	1.36E-04	0.000317
1234678-OCDD	2.6	64	3.98E-04	24	1900	1.26E-04	31	630	4.92E-04	13	1300	1.00E-04	0.000223
2378-TCDF	0.48	0.8	6.00E-03	120	260	4.60E-03	170	630	2.70E-03	27	290	9.31E-04	0.00289
12378-PeCDF	0	0.56	0.00E+00	14	110	1.27E-03	31	350	8.86E-04	4.0	180	2.22E-04	0.000224
23478-PeCDF	0.068	0.43	1.57E-03	21	87	2.36E-03	35	250	1.40E-03	4.5	130	3.46E-04	0.00116
123478-HxCDF	0	1.3	0.00E+00	4.15	87	4.77E-04	19	260	7.31E-04	2.0	150	1.33E-04	0.000147
123678-HxCDF	0.028	0.7	3.93E-04	1.5	16	9.38E-04	4.5	58	7.76E-04	0.55	53	1.04E-04	0.000415
234678-HxCDF	0	0.51	0.00E+00	0.87	6.9	1.25E-03	2.3	22	1.05E-03	0.14	23	5.87E-05	0.000107
123789-HxCDF	0	ND	0.00E+00	0	1.9	0.00E+00	0.21	5.2	3.96E-04	0	21	0.00E+00	0.0000251
1234678-HpCDF	0.082	4.3	1.91E-04	5.3	210	2.52E-04	8.2	120	6.83E-04	3.7	370	1.00E-04	0.000239
1234789-HpCDF	0	0.62	0.00E+00	0.52	17	3.06E-04	1.0	19	5.47E-04	0.14	38	3.75E-05	0.0000640
12346789-OCDF	0.32	9.2	3.48E-04	8.8	730	1.20E-04	12	230	5.22E-04	4.5	520	8.65E-05	0.000208

Notes:
BCF = (Lipid-normalized Fish Concentration) ÷ (Soil Concentration ÷ Fraction Organic Carbon)
Forage fish and sediment concentrations are average concentrations, with individual crayfish and sediment ND results assumed to be 0.
For geometric mean BCF calculations, a BCF of 0 for the RA, UTR, LTR, or SR was treated as 0.00001 for calculation purposes. For reference, the lowest non-zero BCF for the RA, UTR, LTR, or SR was 0.00009.
Sediment fraction of organic carbon of 1% was assumed based on Taylor, A. and McCabe, J. 2002. Baseline Chemical Characterization of Saginaw Bay Watershed Sediments, A Report to the Office of the Great Lakes Michigan Department of Environmental Quality, Appendix H.
Forage fish concentration was reported a lipid-normalized basis in Seston, 2010.
RA: Reference Area
UTR: Upper Tittabawassee River
LTR: Lower Tittabawassee River
SR: Saginaw River
Reference:
Seston, R.M. 2010. An Ecological Risk Assessment of Fish-Eating Birds Exposed to Polychlorinated Dibenzofurans and Dibenzo-p-dioxins Within the Tittabawassee River Floodplain, MI, USA. A Dissertation Submitted to Michigan State University.

DIET 2,3,7,8-TCDD TEQ CALCULATIONS USING MAXIMUM SOIL CONCENTRATIONS

Summary of 2,3,7,8-TCDD TEQ Concentration by Food Item and Taxa Based on Maximum Soil Concentration (Site-Wide)

	Bird		Mammal	
	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ
Diet Item	pg/g	mg/kg	pg/g	mg/kg
Soil	2.20	0.0000022	2.64	0.00000264
Plants	0.0154	0.0000000154	0.0020	0.0000000020
Soil invertebrates	0.899	0.00000090	1.10	0.00000110
Mammals	1.12	0.00000112	0.734	0.00000073
Birds	0.251	0.0000002510	0.256	0.000000256
Benthic Invertebrates	0.0057	0.0000000057	0.00344	0.00000000344
Fish	0.0125	0.0000000125	0.00819	0.00000000819

Note:
Concentrations based on Dioxins/Furans reported for maximum on site 0-4' soil (BC-16R 2-4' for mammal and bird).

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Maximum Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Mean Relative Bioavailability	Available Concentration in Soil	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFmammal		Bioavailable Soil Conc x TEFbird
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	2	0.011	1	0.011	1	0.011
1,2,3,7,8-PeCDD	1.2	31.7	0.38	1	0.38	1	0.38
1,2,3,4,7,8-HxCDD	<0.431	23.6	0	0.1	0	0.05	0
1,2,3,6,7,8-HxCDD	6.14	21.1	1.3	0.1	0.13	0.01	0.013
1,2,3,7,8,9-HxCDD	4.09	19.7	0.806	0.1	0.0806	0.1	0.0806
1,2,3,4,6,7,8-HpCDD	343	24.3	83.3	0.01	0.833	<0.001	0
1,2,3,4,6,7,8,9-OCDD	5860	39.8	2330	0.0003	0.699	0.0001	0.233
2,3,7,8-TCDF	2.12	24.1	0.511	0.1	0.0511	1	0.511
1,2,3,7,8-PeCDF	1.56 K	22.8	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.16	34.4	0.743	0.3	0.223	1	0.743
1,2,3,4,7,8-HxCDF	2.68	40.9	1.1	0.1	0.11	0.1	0.11
1,2,3,6,7,8-HxCDF	1.61	31.5	0.507	0.1	0.0507	0.1	0.0507
2,3,4,6,7,8-HxCDF	1.59	39.4	0.626	0.1	0.0626	0.1	0.0626
1,2,3,7,8,9-HxCDF	<0.762	28.6	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	28.5	0	0.01	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	28	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	42.2	16.4	0.0003	0.00492	0.0001	0.00164
2,3,7,8-TCDD TEQ (pg/g)					**2.64**		**2.20**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Maximum Soil Concentration, Site-Wide)

Receptor	Maximum 2,3,7,8-TCDD TEQ 0-4' On Site BC-16R 2-4' (pg/g)	Sample ID	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Bird	7.68	BC-16R 2-4'	0.002	0.0154	0.117	0.899
Mammal	9.42	BC-16R 2-4'	0.002	0.0188	0.117	1.10

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' on site soil.
TEQ for bird uses WHO 1998 TEF-bird applied to site concentration.
TEQ for mammal uses WHO 2005 TEF-mammal applied to site concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Maximum Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.0114	0.00469	1	0.00469	1	0.00469
1,2,3,7,8-PeCDD	1.2	0.00126	0.00113	1	0.00113	1	0.00113
1,2,3,4,7,8-HxCDD	<0.431	0.000265	0	0.1	0	0.05	0
1,2,3,6,7,8-HxCDD	6.14	0.00026	0.0012	0.1	0.00012	0.01	0.000012
1,2,3,7,8,9-HxCDD	4.09	0.0000759	0.000233	0.1	0.0000233	0.1	0.0000233
1,2,3,4,6,7,8-HpCDD	343	0.000317	0.0815	0.01	0.000815	<0.001	0
1,2,3,4,6,7,8,9-OCDD	5860	0.000223	0.98	0.0003	0.000294	0.0001	0.000098
2,3,7,8-TCDF	2.12	0.00289	0.0046	0.1	0.00046	1	0.0046
1,2,3,7,8-PeCDF	1.56 K	0.000224	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.16	0.00116	0.00188	0.3	0.000564	1	0.00188
1,2,3,4,7,8-HxCDF	2.68	0.000147	0.000295	0.1	0.0000295	0.1	0.0000295
1,2,3,6,7,8-HxCDF	1.61	0.000415	0.000501	0.1	0.0000501	0.1	0.0000501
2,3,4,6,7,8-HxCDF	1.59	0.000107	0.000128	0.1	0.0000128	0.1	0.0000128
1,2,3,7,8,9-HxCDF	<0.762	0.0000251	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.000239	0	0.01	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0.000064	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.000208	0.00607	0.0003	0.00000182	0.0001	0.000000607
2,3,7,8-TCDD TEQ (pg/g)					**0.00819**		**0.0125**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Maximum Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.00389	0.00107	1	0.00107	1	0.00107
1,2,3,7,8-PeCDD	1.2	0.000778	0.000467	1	0.000467	1	0.000467
1,2,3,4,7,8-HxCDD	<0.431	0.0000917	0	0.1	0	0.05	0
1,2,3,6,7,8-HxCDD	6.14	0.000109	0.000335	0.1	0.0000335	0.01	0.00000335
1,2,3,7,8,9-HxCDD	4.09	0.0000792	0.000162	0.1	0.0000162	0.1	0.0000162
1,2,3,4,6,7,8-HpCDD	343	0.000436	0.0748	0.01	0.000748	<0.001	0
1,2,3,4,6,7,8,9-OCDD	5860	0.000363	1.06	0.0003	0.000318	0.0001	0.000106
2,3,7,8-TCDF	2.12	0.00235	0.00249	0.1	0.000249	1	0.00249
1,2,3,7,8-PeCDF	1.56 K	0.000901	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.16	0.0013	0.0014	0.3	0.00042	1	0.0014
1,2,3,4,7,8-HxCDF	2.68	0.000559	0.000749	0.1	0.0000749	0.1	0.0000749
1,2,3,6,7,8-HxCDF	1.61	0.000365	0.000294	0.1	0.0000294	0.1	0.0000294
2,3,4,6,7,8-HxCDF	1.59	0.000208	0.000165	0.1	0.0000165	0.1	0.0000165
1,2,3,7,8,9-HxCDF	<0.762	0.0000468	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.000447	0	0.01	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0.0000604	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.00025	0.00486	0.0003	0.00000146	0.0001	0.0000004860
2,3,7,8-TCDD TEQ (pg/g)					**0.00344**		**0.00567**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Maximum Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.128	0.193	1	0.193	1	0.193
1,2,3,7,8-PeCDD	1.2	0.00196	0.00647	1	0.00647	1	0.00647
1,2,3,4,7,8-HxCDD	<0.431	0.0233	0	0.1	0	0.05	0
1,2,3,6,7,8-HxCDD	6.14	0.0192	0.324	0.1	0.0324	0.01	0.00324
1,2,3,7,8,9-HxCDD	4.09	0.00738	0.083	0.1	0.0083	0.1	0.0083
1,2,3,4,6,7,8-HpCDD	343	0.000262	0.247	0.01	0.00247	<0.001	0
1,2,3,4,6,7,8,9-OCDD	5860	0.000033	0.532	0.0003	0.00016	0.0001	0.0000532
2,3,7,8-TCDF	2.12	0.00148	0.00863	0.1	0.000863	1	0.00863
1,2,3,7,8-PeCDF	1.56 K	0.00073	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.16	0.00465	0.0276	0.3	0.00828	1	0.0276
1,2,3,4,7,8-HxCDF	2.68	0.000599	0.00441	0.1	0.000441	0.1	0.000441
1,2,3,6,7,8-HxCDF	1.61	0.0042	0.0186	0.1	0.00186	0.1	0.00186
2,3,4,6,7,8-HxCDF	1.59	0.00354	0.0155	0.1	0.00155	0.1	0.00155
1,2,3,7,8,9-HxCDF	<0.762	0	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.000157	0	0.01	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.00000522	0.000558	0.0003	0.000000167	0.0001	0.0000000558
2,3,7,8-TCDD TEQ (pg/g)					**0.256**		**0.251**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Maximum Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.18	0.0494	1	0.0494	1	0.0494
1,2,3,7,8-PeCDD	1.2	0.291	0.175	1	0.175	1	0.175
1,2,3,4,7,8-HxCDD	<0.431	0.209	0	0.1	0	0.05	0
1,2,3,6,7,8-HxCDD	6.14	0.121	0.371	0.1	0.0371	0.01	0.00371
1,2,3,7,8,9-HxCDD	4.09	0.0472	0.0965	0.1	0.00965	0.1	0.00965
1,2,3,4,6,7,8-HpCDD	343	0.0603	10.3	0.01	0.103	<0.001	0
1,2,3,4,6,7,8,9-OCDD	5860	0.0333	97.6	0.0003	0.0293	0.0001	0.00976
2,3,7,8-TCDF	2.12	0.0566	0.06	0.1	0.006	1	0.06
1,2,3,7,8-PeCDF	1.56 K	0.0307	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.16	0.653	0.705	0.3	0.212	1	0.705
1,2,3,4,7,8-HxCDF	2.68	0.335	0.449	0.1	0.0449	0.1	0.0449
1,2,3,6,7,8-HxCDF	1.61	0.413	0.332	0.1	0.0332	0.1	0.0332
2,3,4,6,7,8-HxCDF	1.59	0.425	0.338	0.1	0.0338	0.1	0.0338
1,2,3,7,8,9-HxCDF	<0.762	0.0588	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.0616	0	0.01	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0.102	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.0499	0.971	0.0003	0.000291	0.0001	0.0000971
2,3,7,8-TCDD TEQ (pg/g)					**0.734**		**1.12**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

2,3,7,8-TCDD TEQ HQ CALCULATIONS USING MAXIMUM SOIL CONCENTRATIONS

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): American Robin

American Robin			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0773		BW
Soil ingestion proportion	0.02		Ps
Food ingestion Rate (kg/kgBW/d)	0.132		FIR
Proportion of diet, plants	0.41		Pp
Proportion of diet, soil inverts	0.59		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.20E-06	Soil	5.81E-09
2,3,7,8-TCDD TEQ	1.54E-08	Plants	8.31E-10
2,3,7,8-TCDD TEQ	8.99E-07	Soil invertebrates	7.00E-08
		Daily Intake	2.30E-08
		HQ	0.00821

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): Mallard Duck

Mallard Duck			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	1.134		BW
Soil ingestion proportion	0.033		Ps
Food ingestion Rate (kg/kgBW/d)	0.05		FIR
Proportion of diet, plants	0.5		Pp
Proportion of diet, benthic inverts	0.5		Pbi
Area use factor	0.0099		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.20E-06	Soil	3.63E-09
2,3,7,8-TCDD TEQ	1.54E-08	Plants	3.84E-10
2,3,7,8-TCDD TEQ	5.67E-09	Benthic Invertebrates	1.42E-10
		Daily Intake	1.23E-11
		HQ	0.00000441

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): Spotted Sandpiper

Spotted Sandpiper			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0425		BW
Soil ingestion proportion	0.17		Ps
Food ingestion Rate (kg/kgBW/d)	0.196		FIR
Proportion of diet, benthic inverts	1		Pbi
Area use factor	0.5		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.20E-06	Soil	7.33E-08
2,3,7,8-TCDD TEQ	5.67E-09	Benthic Invertebrates	1.11E-09
		Daily Intake	1.12E-08
		HQ	0.00399

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): Snowy Egret

Snowy Egret			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.371		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.116		FIR
Proportion of diet, benthic inverts	0.1		Pbi
Proportion of diet, fish	0.9		Pf
Area use factor	0.0082		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.20E-06	Soil	1.28E-09
2,3,7,8-TCDD TEQ	5.67E-09	Benthic Invertebrates	6.58E-11
2,3,7,8-TCDD TEQ	1.25E-08	Fish	1.31E-09
		Daily Intake	6.53E-12
		HQ	0.00000233

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): Great Blue Heron

Great Blue Heron			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.229		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.103		FIR
Proportion of diet, benthic inverts	0.1		Pbi
Proportion of diet, fish	0.9		Pf
Area use factor	0.0071		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.20E-06	Soil	1.13E-09
2,3,7,8-TCDD TEQ	5.67E-09	Benthic Invertebrates	5.84E-11
2,3,7,8-TCDD TEQ	1.25E-08	Fish	1.16E-09
		Daily Intake	5.00E-12
		HQ	0.00000179

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): American Bald Eagle

American Bald Eagle			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.6		BW
Soil ingestion proportion	0		Ps
Food ingestion Rate (kg/kgBW/d)	0.09		FIR
Proportion of diet, mammals	0.068		Pm
Proportion of diet, birds	0.165		Pb
Proportion of diet, fish	0.767		Pf
Area use factor	0.000032		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.20E-06	Soil	-
2,3,7,8-TCDD TEQ	1.12E-06	Mammals	6.85E-09
2,3,7,8-TCDD TEQ	2.51E-07	Birds	3.73E-09
2,3,7,8-TCDD TEQ	1.25E-08	Fish	8.63E-10
		Daily Intake	1.10E-13
		HQ	0.0000000392

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): Swamp Rabbit

Swamp Rabbit			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.118		BW
Soil ingestion proportion	0.063		Ps
Food ingestion Rate (kg/kgBW/d)	0.13		FIR
Proportion of diet, plants	1		Pp
Area use factor	0.51		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	2.16E-08
2,3,7,8-TCDD TEQ	2.00E-09	Plants	2.60E-10
		Daily Intake	3.34E-09
		HQ	0.000929

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): Least Shrew

Least Shrew			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.017		BW
Soil ingestion proportion	0.13		Ps
Food ingestion Rate (kg/kgBW/d)	0.096		FIR
Proportion of diet, soil inverts	1		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	3.29E-08
2,3,7,8-TCDD TEQ	1.10E-06	Soil invertebrates	1.06E-07
		Daily Intake	4.17E-08
		HQ	0.0116

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): Red Fox

Red Fox			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.53		BW
Soil ingestion proportion	0.028		Ps
Food ingestion Rate (kg/kgBW/d)	0.16		FIR
Proportion of diet, plants	0.07		Pp
Proportion of diet, soil inverts	0.03		Pi
Proportion of diet, mammals	0.9		Pm
Area use factor	0.0017		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	1.18E-08
2,3,7,8-TCDD TEQ	2.00E-09	Plants	2.24E-11
2,3,7,8-TCDD TEQ	1.10E-06	Soil invertebrates	5.29E-09
2,3,7,8-TCDD TEQ	7.34E-07	Mammals	1.06E-07
		Daily Intake	6.28E-11
		HQ	0.0000174

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): Site-Wide (0-4'): American Mink

American Mink			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	1		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.137		FIR
Proportion of diet, mammals	0.22		Pm
Proportion of diet, benthic inverts	0.64		Pbi
Proportion of diet, fish	0.14		Pf
Area use factor	0.019		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	1.81E-09
2,3,7,8-TCDD TEQ	7.34E-07	Mammals	2.21E-08
2,3,7,8-TCDD TEQ	3.44E-09	Benthic Invertebrates	3.02E-10
2,3,7,8-TCDD TEQ	8.19E-09	Fish	1.57E-10
		Daily Intake	1.39E-10
		HQ	0.0000386

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

DIET 2,3,7,8-TCDD TEQ CALCULATIONS USING AVERAGE SOIL CONCENTRATIONS

Summary of 2,3,7,8-TCDD TEQ Concentration by Food Item and Taxa Based on Average Soil Concentration (Site-Wide)

	Bird		Mammal	
	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ
Diet Item	pg/g	mg/kg	pg/g	mg/kg
Soil	2.09	0.00000209	2.21	0.00000221
Plants	0.0143	0.0000000143	0.0154	0.0000000154
Soil invertebrates	0.835	0.00000084	0.901	0.00000090
Mammals	1.06	0.00000106	0.662	0.00000066
Birds	0.152	0.0000001520	0.154	0.000000154
Benthic Invertebrates	0.00503	0.0000000050	0.00261	0.00000000261
Fish	0.0100	0.0000000100	0.00554	0.00000000554

Note:
Diet 2,3,7,8-TCDD TEQ concentrations are calculated using average soil 2,3,7,8-TCDD TEQ or congener concentrations for 0-4' on site samples.

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Average Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Mean Relative Bioavailability	Available Concentration in Soil	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFmammal		Bioavailable Soil Conc x TEFbird
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.27	2	0.0054	1	0.0054	1	0.0054
1,2,3,7,8-PeCDD	1.27	31.7	0.403	1	0.403	1	0.403
1,2,3,4,7,8-HxCDD	0.69	23.6	0.163	0.1	0.0163	0.05	0.00815
1,2,3,6,7,8-HxCDD	4.97	21.1	1.05	0.1	0.105	0.01	0.0105
1,2,3,7,8,9-HxCDD	3.56	19.7	0.701	0.1	0.0701	0.1	0.0701
1,2,3,4,6,7,8-HpCDD	251.5	24.3	61.1	0.01	0.611	<0.001	0
1,2,3,4,6,7,8,9-OCDD	4365	39.8	1740	0.0003	0.522	0.0001	0.174
2,3,7,8-TCDF	2.1	24.1	0.506	0.1	0.0506	1	0.506
1,2,3,7,8-PeCDF	0	22.8	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.03	34.4	0.698	0.3	0.209	1	0.698
1,2,3,4,7,8-HxCDF	2.36	40.9	0.965	0.1	0.0965	0.1	0.0965
1,2,3,6,7,8-HxCDF	1.52	31.5	0.479	0.1	0.0479	0.1	0.0479
2,3,4,6,7,8-HxCDF	1.48	39.4	0.583	0.1	0.0583	0.1	0.0583
1,2,3,7,8,9-HxCDF	0	28.6	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	5.2	28.5	1.48	0.01	0.0148	0.01	0.0148
1,2,3,4,7,8,9-HpCDF	0	28	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	29.05	42.2	12.3	0.0003	0.00369	0.0001	0.00123
2,3,7,8-TCDD TEQ (pg/g)					**2.21**		**2.09**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Average Soil Concentration, Site-Wide)

Receptor	Average 2,3,7,8-TCDD TEQ 0-4' On Site All Samples (pg/g)	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Bird	7.14	0.002	0.0143	0.117	0.835
Mammal	7.70	0.002	0.0154	0.117	0.901

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
Average 2,3,7,8-TCDD TEQ concentrations were calculated by multiplying the congener average concentration for 0-4' on site soil by the TEF.
TEQ for bird uses WHO 1998 TEF-bird applied to site average concentration.
TEQ for mammal uses WHO 2005 TEF-mammal applied to site average concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Average Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.27	0.0114	0.00231	1	0.00231	1	0.00231
1,2,3,7,8-PeCDD	1.27	0.00126	0.0012	1	0.0012	1	0.0012
1,2,3,4,7,8-HxCDD	0.69	0.000265	0.000137	0.1	0.0000137	0.05	0.00000685
1,2,3,6,7,8-HxCDD	4.97	0.00026	0.000969	0.1	0.0000969	0.01	0.00000969
1,2,3,7,8,9-HxCDD	3.56	0.0000759	0.000203	0.1	0.0000203	0.1	0.0000203
1,2,3,4,6,7,8-HpCDD	251.5	0.000317	0.0598	0.01	0.000598	<0.001	0
1,2,3,4,6,7,8,9-OCDD	4365	0.000223	0.73	0.0003	0.000219	0.0001	0.000073
2,3,7,8-TCDF	2.1	0.00289	0.00455	0.1	0.000455	1	0.00455
1,2,3,7,8-PeCDF	0	0.000224	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.03	0.00116	0.00177	0.3	0.000531	1	0.00177
1,2,3,4,7,8-HxCDF	2.36	0.000147	0.00026	0.1	0.000026	0.1	0.000026
1,2,3,6,7,8-HxCDF	1.52	0.000415	0.000473	0.1	0.0000473	0.1	0.0000473
2,3,4,6,7,8-HxCDF	1.48	0.000107	0.000119	0.1	0.0000119	0.1	0.0000119
1,2,3,7,8,9-HxCDF	0	0.0000251	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	5.2	0.000239	0.000932	0.01	0.00000932	0.01	0.00000932
1,2,3,4,7,8,9-HpCDF	0	0.000064	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	29.05	0.000208	0.00453	0.0003	0.00000136	0.0001	0.000000453
2,3,7,8-TCDD TEQ (pg/g)					**0.00554**		**0.0100**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Average Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.27	0.00389	0.000525	1	0.000525	1	0.000525
1,2,3,7,8-PeCDD	1.27	0.000778	0.000494	1	0.000494	1	0.000494
1,2,3,4,7,8-HxCDD	0.69	0.0000917	0.0000316	0.1	0.00000316	0.05	0.00000158
1,2,3,6,7,8-HxCDD	4.97	0.000109	0.000271	0.1	0.0000271	0.01	0.00000271
1,2,3,7,8,9-HxCDD	3.56	0.0000792	0.000141	0.1	0.0000141	0.1	0.0000141
1,2,3,4,6,7,8-HpCDD	251.5	0.000436	0.0548	0.01	0.000548	<0.001	0
1,2,3,4,6,7,8,9-OCDD	4365	0.000363	0.792	0.0003	0.000238	0.0001	0.0000792
2,3,7,8-TCDF	2.1	0.00235	0.00247	0.1	0.000247	1	0.00247
1,2,3,7,8-PeCDF	0	0.000901	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.03	0.0013	0.00132	0.3	0.000396	1	0.00132
1,2,3,4,7,8-HxCDF	2.36	0.000559	0.00066	0.1	0.000066	0.1	0.000066
1,2,3,6,7,8-HxCDF	1.52	0.000365	0.000277	0.1	0.0000277	0.1	0.0000277
2,3,4,6,7,8-HxCDF	1.48	0.000208	0.000154	0.1	0.0000154	0.1	0.0000154
1,2,3,7,8,9-HxCDF	0	0.0000468	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	5.2	0.000447	0.00116	0.01	0.0000116	0.01	0.0000116
1,2,3,4,7,8,9-HpCDF	0	0.0000604	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	29.05	0.00025	0.00363	0.0003	0.00000109	0.0001	0.000000363
2,3,7,8-TCDD TEQ (pg/g)					**0.00261**		**0.00503**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Average Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.27	0.128	0.095	1	0.095	1	0.095
1,2,3,7,8-PeCDD	1.27	0.00196	0.00685	1	0.00685	1	0.00685
1,2,3,4,7,8-HxCDD	0.69	0.0233	0.0442	0.1	0.00442	0.05	0.00221
1,2,3,6,7,8-HxCDD	4.97	0.0192	0.262	0.1	0.0262	0.01	0.00262
1,2,3,7,8,9-HxCDD	3.56	0.00738	0.0723	0.1	0.00723	0.1	0.00723
1,2,3,4,6,7,8-HpCDD	251.5	0.000262	0.181	0.01	0.00181	<0.001	0
1,2,3,4,6,7,8,9-OCDD	4365	0.000033	0.396	0.0003	0.000119	0.0001	0.0000396
2,3,7,8-TCDF	2.1	0.00148	0.00855	0.1	0.000855	1	0.00855
1,2,3,7,8-PeCDF	0	0.00073	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.03	0.00465	0.026	0.3	0.0078	1	0.026
1,2,3,4,7,8-HxCDF	2.36	0.000599	0.00389	0.1	0.000389	0.1	0.000389
1,2,3,6,7,8-HxCDF	1.52	0.0042	0.0176	0.1	0.00176	0.1	0.00176
2,3,4,6,7,8-HxCDF	1.48	0.00354	0.0144	0.1	0.00144	0.1	0.00144
1,2,3,7,8,9-HxCDF	0	0	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	5.2	0.000157	0.00225	0.01	0.0000225	0.01	0.0000225
1,2,3,4,7,8,9-HpCDF	0	0	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	29.05	0.00000522	0.000417	0.0003	0.000000125	0.0001	4.17E-08
2,3,7,8-TCDD TEQ (pg/g)					**0.154**		**0.152**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Average Soil Concentration, Site-Wide)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.27	0.18	0.0243	1	0.0243	1	0.0243
1,2,3,7,8-PeCDD	1.27	0.291	0.185	1	0.185	1	0.185
1,2,3,4,7,8-HxCDD	0.69	0.209	0.0721	0.1	0.00721	0.05	0.00361
1,2,3,6,7,8-HxCDD	4.97	0.121	0.301	0.1	0.0301	0.01	0.00301
1,2,3,7,8,9-HxCDD	3.56	0.0472	0.084	0.1	0.0084	0.1	0.0084
1,2,3,4,6,7,8-HpCDD	251.5	0.0603	7.58	0.01	0.0758	<0.001	0
1,2,3,4,6,7,8,9-OCDD	4365	0.0333	72.7	0.0003	0.0218	0.0001	0.00727
2,3,7,8-TCDF	2.1	0.0566	0.0594	0.1	0.00594	1	0.0594
1,2,3,7,8-PeCDF	0	0.0307	0	0.03	0	0.1	0
2,3,4,7,8-PeCDF	2.03	0.653	0.663	0.3	0.199	1	0.663
1,2,3,4,7,8-HxCDF	2.36	0.335	0.395	0.1	0.0395	0.1	0.0395
1,2,3,6,7,8-HxCDF	1.52	0.413	0.314	0.1	0.0314	0.1	0.0314
2,3,4,6,7,8-HxCDF	1.48	0.425	0.315	0.1	0.0315	0.1	0.0315
1,2,3,7,8,9-HxCDF	0	0.0588	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	5.2	0.0616	0.16	0.01	0.0016	0.01	0.0016
1,2,3,4,7,8,9-HpCDF	0	0.102	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	29.05	0.0499	0.725	0.0003	0.000218	0.0001	0.0000725
2,3,7,8-TCDD TEQ (pg/g)					**0.662**		**1.06**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

2,3,7,8-TCDD TEQ HQ CALCULATIONS USING AVERAGE SOIL CONCENTRATIONS

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): American Robin

American Robin			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0773		BW
Soil ingestion proportion	0.02		Ps
Food ingestion Rate (kg/kgBW/d)	0.132		FIR
Proportion of diet, plants	0.41		Pp
Proportion of diet, soil inverts	0.59		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.09E-06	Soil	5.52E-09
2,3,7,8-TCDD TEQ	1.43E-08	Plants	7.73E-10
2,3,7,8-TCDD TEQ	8.35E-07	Soil invertebrates	6.51E-08
		Daily Intake	2.14E-08
		HQ	0.00765

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): Mallard Duck

Mallard Duck			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	1.134		BW
Soil ingestion proportion	0.033		Ps
Food ingestion Rate (kg/kgBW/d)	0.05		FIR
Proportion of diet, plants	0.5		Pp
Proportion of diet, benthic inverts	0.5		Pbi
Area use factor	0.0099		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.09E-06	Soil	3.45E-09
2,3,7,8-TCDD TEQ	1.43E-08	Plants	3.57E-10
2,3,7,8-TCDD TEQ	5.03E-09	Benthic Invertebrates	1.26E-10
		Daily Intake	1.17E-11
		HQ	0.00000417

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): Spotted Sandpiper

Spotted Sandpiper			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0425		BW
Soil ingestion proportion	0.17		Ps
Food ingestion Rate (kg/kgBW/d)	0.196		FIR
Proportion of diet, benthic inverts	1		Pbi
Area use factor	0.5		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.09E-06	Soil	6.96E-08
2,3,7,8-TCDD TEQ	5.03E-09	Benthic Invertebrates	9.86E-10
		Daily Intake	1.06E-08
		HQ	0.00378

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): Snowy Egret

Snowy Egret			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.371		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.116		FIR
Proportion of diet, crabs	0.1		Pc
Proportion of diet, fish	0.9		Pf
Area use factor	0.0082		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.09E-06	Soil	1.21E-09
2,3,7,8-TCDD TEQ	5.03E-09	Crabs	5.83E-11
2,3,7,8-TCDD TEQ	1.00E-08	Fish	1.04E-09
		Daily Intake	5.68E-12
		HQ	0.00000203

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): Great Blue Heron

Great Blue Heron			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.229		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.103		FIR
Proportion of diet, crabs	0.1		Pc
Proportion of diet, fish	0.9		Pf
Area use factor	0.0071		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.09E-06	Soil	1.08E-09
2,3,7,8-TCDD TEQ	5.03E-09	Crabs	5.18E-11
2,3,7,8-TCDD TEQ	1.00E-08	Fish	9.27E-10
		Daily Intake	4.39E-12
		HQ	0.00000157

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): American Bald Eagle

American Bald Eagle			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.6		BW
Soil ingestion proportion	0		Ps
Food ingestion Rate (kg/kgBW/d)	0.09		FIR
Proportion of diet, mammals	0.068		Pm
Proportion of diet, birds	0.165		Pb
Proportion of diet, fish	0.767		Pf
Area use factor	0.000032		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	1.06E-06	Mammals	6.49E-09
2,3,7,8-TCDD TEQ	1.52E-07	Birds	2.26E-09
2,3,7,8-TCDD TEQ	1.00E-08	Fish	6.90E-10
		Daily Intake	9.06E-14
		HQ	0.0000000324

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): Swamp Rabbit

Swamp Rabbit			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.118		BW
Soil ingestion proportion	0.063		Ps
Food ingestion Rate (kg/kgBW/d)	0.13		FIR
Proportion of diet, plants	1		Pp
Area use factor	0.51		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.21E-06	Soil	1.81E-08
2,3,7,8-TCDD TEQ	1.54E-08	Plants	2.00E-09
		Daily Intake	3.08E-09
		HQ	0.000854

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): Least Shrew

Least Shrew			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.017		BW
Soil ingestion proportion	0.13		Ps
Food ingestion Rate (kg/kgBW/d)	0.096		FIR
Proportion of diet, soil inverts	1		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.21E-06	Soil	2.76E-08
2,3,7,8-TCDD TEQ	9.01E-07	Soil invertebrates	8.65E-08
		Daily Intake	3.42E-08
		HQ	0.00951

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): Red Fox

Red Fox			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.53		BW
Soil ingestion proportion	0.028		Ps
Food ingestion Rate (kg/kgBW/d)	0.16		FIR
Proportion of diet, plants	0.07		Pp
Proportion of diet, soil inverts	0.03		Pi
Proportion of diet, mammals	0.9		Pm
Area use factor	0.0017		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.21E-06	Soil	9.90E-09
2,3,7,8-TCDD TEQ	1.54E-08	Plants	1.72E-10
2,3,7,8-TCDD TEQ	9.01E-07	Soil invertebrates	4.32E-09
2,3,7,8-TCDD TEQ	6.62E-07	Mammals	9.53E-08
		Daily Intake	5.59E-11
		HQ	0.0000155

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): Site-Wide (0-4'): American Mink

American Mink			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	1		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.137		FIR
Proportion of diet, mammals	0.22		Pm
Proportion of diet, benthic inverts	0.64		Pbi
Proportion of diet, fish	0.14		Pf
Area use factor	0.019		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.21E-06	Soil	1.51E-09
2,3,7,8-TCDD TEQ	6.62E-07	Mammals	2.00E-08
2,3,7,8-TCDD TEQ	2.61E-09	Benthic Invertebrates	2.29E-10
2,3,7,8-TCDD TEQ	5.54E-09	Fish	1.06E-10
		Daily Intake	1.25E-10
		HQ	0.0000346

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

ATTACHMENT 2 ON SITE INCLUDING REMEDIATION AREAS

COPEC concentrations used for estimating potential risk (HQs) in the BERA for Hero Lands Property in soil samples (On Site).

Constituent	Units	95% UCL Concentration	Maximum Concentration	Average Concentration
Arsenic	mg/kg dry	9.03	27.8	8.19
Barium	mg/kg dry	2385	9320	1469
Cadmium	mg/kg dry	0.623	1.79	0.505
Lead	mg/kg dry	83.1	508	43.0
Mercury	mg/kg dry	0.0971	0.148	0.0619
Zinc	mg/kg dry	111	464	95.6
2,3,7,8-TCDD TEQ (bird)	pg/g dry	NA	12.9	8.3
2,3,7,8-TCDD TEQ (mammal)	pg/g dry	NA	9.42	5.9

Summary Results (HQs) from BERA for the Hero Lands Property Using 95% UCL Concentrations as the Exposure Concentrations (On Site).

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0236	0.0000495	0.0153	0.0000153	0.0000118	0.0000000428
Barium	0.00875	0.00000814	0.0027	0.0000312	0.000024	0.00000235
Cadmium	0.0804	0.0000378	0.00773	0.0000531	0.0000409	0.000000125
Lead	0.349	0.000399	0.101	0.0000967	0.0000744	0.0000016
Mercury	0.00131	0.00000167	0.000422	0.00000889	0.0000068	0.00000361
Zinc	0.136	0.000337	0.116	0.000171	0.000132	0.00000023

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.00658	0.0563	0.00000841	0.000558
Barium	0.0000404	0.00115	0.00000193	0.0000107
Cadmium	0.00947	0.18	0.0000379	0.000332
Lead	0.0139	0.136	0.000153	0.000904
Mercury	0.000517	0.00469	0.000000924	0.0000355
Zinc	0.0109	0.136	0.0000982	0.00193

Summary Results (HQs) from BERA for the Hero Lands Property Using Maximum Concentrations as the Exposure Concentrations (On Site).

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0726	0.000152	0.0470	0.0000473	0.0000363	0.000000131
Barium	0.0342	0.0000318	0.0105	0.000122	0.0000938	0.00000919
Cadmium	0.230	0.000109	0.0222	0.000153	0.000117	0.000000358
Lead	2.13	0.00244	0.620	0.000592	0.000454	0.00000976
Mercury	0.00200	0.00000254	0.000642	0.0000135	0.0000104	0.00000548
Zinc	0.569	0.00141	0.485	0.000715	0.000550	0.000000960

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.0203	0.174	0.0000259	0.00171
Barium	0.000157	0.00450	0.00000756	0.0000417
Cadmium	0.0271	0.515	0.000109	0.000954
Lead	0.0850	0.834	0.000933	0.00552
Mercury	0.000786	0.00716	0.00000141	0.0000541
Zinc	0.0456	0.571	0.000412	0.00808

COPEC: 2,3,7,8-TCDD TEQ	
Species	HQ
Avian Receptors	
American Robin	0.0138
Mallard Duck	0.00000742
Spotted Sandpiper	0.00670
Snowy Egret	0.00000361
Great Blue Heron	0.00000277
American Bald Eagle	0.0000000474
Mammalian Receptors	
Swamp Rabbit	0.00102
Least Shrew	0.0116
Red Fox	0.0000175
American Mink	0.0000386

Summary Results (HQs) from BERA for the Hero Lands Property Using Average Concentrations as the Exposure Concentrations (On Site).

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0214	0.0000448	0.0138	0.000014	0.0000107	0.0000000386
Barium	0.00538	0.00000502	0.00166	0.0000192	0.0000148	0.00000145
Cadmium	0.0651	0.0000307	0.00627	0.0000430	0.0000332	0.000000101
Lead	0.181	0.000207	0.0525	0.0000500	0.0000385	0.000000827
Mercury	0.000837	0.00000106	0.000269	0.00000564	0.00000434	0.00000230
Zinc	0.117	0.00029	0.0999	0.000148	0.000113	0.000000198

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.00597	0.0511	0.00000763	0.000504
Barium	0.0000248	0.000707	0.00000119	0.00000657
Cadmium	0.00768	0.146	0.0000307	0.000269
Lead	0.00718	0.0706	0.0000791	0.000468
Mercury	0.000329	0.00300	0.000000589	0.0000227
Zinc	0.00939	0.117	0.0000846	0.00166

COPEC: 2,3,7,8-TCDD TEQ	
Species	HQ
Avian Receptors	
American Robin	0.00885
Mallard Duck	0.00000474
Spotted Sandpiper	0.00428
Snowy Egret	0.00000242
Great Blue Heron	0.0000019
American Bald Eagle	0.0000000350
Mammalian Receptors	
Swamp Rabbit	0.000652
Least Shrew	0.00727
Red Fox	0.0000137
American Mink	0.0000308

HAZARD QUOTIENT CALCULATIONS - METALS – 95% UCL CONCENTRATIONS

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): American Robin

American Robin		
Parameter	**Value**	**Symbol**
Body weight (kg)	0.0773	BW
Soil ingestion proportion	0.02	Ps
Food ingestion Rate (kg/kgBW/d)	0.132	FIR
Proportion of diet, plants	0.41	Pp
Proportion of diet, soil inverts	0.59	Pi
Area use factor	1	AUF
Time (temporal) factor	0.3	TF

Calculations based on 95% UCL values

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	9.03	2.24	0.01	0.0375	0.224	0.000238	0.0183	0.158	0.0236
Barium	2385	600	0.0002	0.0046	0.091	0.00126	0.594	16.9	0.00875
Cadmium	0.623	1.47	0.036	0.586	7.708	0.0000592	0.0198	0.374	0.0804
Lead	83.1	1.63	0.01	0.0389	0.266	0.00219	0.175	1.72	0.349
Mercury	0.0971	3.25	0.00031	0.27	1.693	7.95E-08	0.00142	0.0128	0.00131
Zinc	111	66.1	0.1	0.366	3.201	0.0293	2.2	27.7	0.136

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): Mallard Duck

Mallard Duck			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	1.134	BW	
Soil ingestion proportion	0.033	Ps	
Food ingestion Rate (kg/kgBW/d)	0.05	FIR	
Proportion of diet, plants	0.5	Pp	
Proportion of diet, benthic inverts	0.5	Pbi	
Area use factor	0.0099	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	9.03	2.24	0.01	0.0375	0.127	0.000149	0.00847	0.0287	0.0000495
Barium	2385	600	0.0002	0.0046	0.023	0.000787	0.274	1.37	0.00000814
Cadmium	0.623	1.47	0.036	0.586	0.614	0.000037	0.00913	0.00956	0.0000378
Lead	83.1	1.63	0.01	0.0389	0.066	0.00137	0.0808	0.137	0.000399
Mercury	0.0971	3.25	0.00031	0.27	0.48	4.97E-08	0.000655	0.00117	0.00000167
Zinc	111	66.1	0.1	0.366	2.33	0.0183	1.02	6.47	0.000337

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0425	BW	
Soil ingestion proportion	0.17	Ps	
Food ingestion Rate (kg/kgBW/d)	0.196	FIR	
Proportion of diet, benthic inverts	1	Pbi	
Area use factor	0.5	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	9.03	2.24	0.01	0.127	0.00301	0.225	0.0153
Barium	2385	600	0.0002	0.023	0.0159	10.8	0.0027
Cadmium	0.623	1.47	0.036	0.614	0.000747	0.075	0.00773
Lead	83.1	1.63	0.01	0.066	0.0277	1.07	0.101
Mercury	0.0971	3.25	0.00031	0.48	0.000001	0.00914	0.000422
Zinc	111	66.1	0.1	2.33	0.37	50.7	0.116

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): Snowy Egret

Snowy Egret			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.371	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.116	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0082	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	9.03	2.24	0.01	0.127	0.00065	0.0000524	0.0133	0.000613	0.0000153
Barium	2385	600	0.0002	0.023	0.028	0.000277	0.636	6.97	0.0000312
Cadmium	0.623	1.47	0.036	0.614	0.42	0.000013	0.00444	0.0273	0.0000531
Lead	83.1	1.63	0.01	0.066	0.0000018	0.000482	0.0636	0.0000156	0.0000967
Mercury	0.0971	3.25	0.00031	0.48	1.1	1.75E-08	0.000541	0.0112	0.00000889
Zinc	111	66.1	0.1	2.33	0.138	0.00644	3	1.6	0.000171

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	9.03	2.24	0.01	0.127	0.00065	0.0000465	0.0118	0.000544	0.0000118
Barium	2385	600	0.0002	0.023	0.028	0.000246	0.565	6.19	0.000024
Cadmium	0.623	1.47	0.036	0.614	0.42	0.0000116	0.00394	0.0243	0.0000409
Lead	83.1	1.63	0.01	0.066	0.0000018	0.000428	0.0565	0.0000139	0.0000744
Mercury	0.0971	3.25	0.00031	0.48	1.1	1.55E-08	0.00048	0.0099	0.0000068
Zinc	111	66.1	0.1	2.33	0.138	0.00572	2.66	1.42	0.000132

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): American Bald Eagle

American Bald Eagle		
Parameter	**Value**	**Symbol**
Body weight (kg)	4.6	BW
Soil ingestion proportion	0	Ps
Food ingestion Rate (kg/kgBW/d)	0.09	FIR
Proportion of diet, mammals	0.068	Pm
Proportion of diet, birds	0.165	Pb
Proportion of diet, fish	0.767	Pf
Area use factor	0.000032	AUF
Time (temporal) factor	0.3	TF

Calculations based on 95% UCL values

			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	9.03	2.24	-	0.0025	0.075	0.00065	-	0.000138	0.0101	0.000405	0.0000000456
Barium	2385	20.8	-	0.0566	0.00001	0.028	-	0.826	0.000354	4.61	0.00000251
Cadmium	0.623	1.47	-	0.3333	0.113	0.42	-	0.00127	0.00105	0.0181	0.000000133
Lead	83.1	1.63	-	0.1054	0.191	0.0000018	-	0.0536	0.236	0.0000103	0.00000171
Mercury	0.0971	0.019	-	0.0534	0.148	1.1	-	0.0000317	0.000213	0.00737	0.00000385
Zinc	111	66.1	-	0.7717	0.0645	0.138	-	0.524	0.106	1.06	0.000000245

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on 95% UCL values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	2.118	BW					
Soil ingestion proportion	0.063	Ps					
Food ingestion Rate (kg/kgBW/d)	0.13	FIR					
Proportion of diet, plants	1	Pp					
Area use factor	0.51	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	9.03	1.04	0.01	0.0375	0.00074	0.044	0.00658
Barium	2385	5433	0.0002	0.0046	0.00391	1.43	0.0000404
Cadmium	0.623	0.77	0.036	0.586	0.000184	0.0475	0.00947
Lead	83.1	4.7	0.01	0.0389	0.00681	0.42	0.0139
Mercury	0.0971	1.01	0.00031	0.27	2.47E-07	0.00341	0.000517
Zinc	111	75.4	0.1	0.366	0.0909	5.28	0.0109

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): Least Shrew

Least Shrew			Calculations based on 95% UCL values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.017	BW	
Soil ingestion proportion	0.13	Ps	
Food ingestion Rate (kg/kgBW/d)	0.096	FIR	
Proportion of diet, soil inverts	1	Pi	
Area use factor	1	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	9.03	1.04	0.01	0.224	0.00113	0.194	0.0563
Barium	2385	5433	0.0002	0.091	0.00595	20.8	0.00115
Cadmium	0.623	0.77	0.036	7.708	0.00028	0.461	0.18
Lead	83.1	4.7	0.01	0.266	0.0104	2.12	0.136
Mercury	0.0971	1.01	0.00031	1.693	3.76E-07	0.0158	0.00469
Zinc	111	75.4	0.1	3.201	0.139	34.1	0.136

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): Red Fox

Red Fox		
Parameter	**Value**	**Symbol**
Body weight (kg)	4.53	BW
Soil ingestion proportion	0.028	Ps
Food ingestion Rate (kg/kgBW/d)	0.16	FIR
Proportion of diet, plants	0.07	Pp
Proportion of diet, soil inverts	0.03	Pi
Proportion of diet, mammals	0.9	Pm
Area use factor	0.0017	AUF
Time (temporal) factor	0.3	TF

Calculations based on 95% UCL values

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	9.03	1.04	0.01	0.0375	0.224	0.0025	0.000405	0.00379	0.00971	0.00325	0.00000841
Barium	2385	5433	0.0002	0.0046	0.091	0.0566	0.00214	0.123	1.04	19.4	0.00000193
Cadmium	0.623	0.77	0.036	0.586	7.708	0.3333	0.0001	0.00409	0.0231	0.0299	0.0000379
Lead	83.1	4.7	0.01	0.0389	0.266	0.1054	0.00372	0.0362	0.106	1.26	0.000153
Mercury	0.0971	1.01	0.00031	0.27	1.693	0.0534	1.35E-07	0.000294	0.000789	0.000747	0.000000924
Zinc	111	75.4	0.1	0.366	3.201	0.7717	0.0497	0.455	1.71	12.3	0.0000982

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (95% UCL Conc.): On Site (0-4'): American Mink

American Mink			Calculations based on 95% UCL values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**95% UCL Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	9.03	1.04	0.01	0.0025	0.127	0.00065	0.0000619	0.00068	0.101	0.000113	0.000558
Barium	2385	5433	0.0002	0.0566	0.023	0.028	0.000327	4.07	4.81	1.28	0.0000107
Cadmium	0.623	0.77	0.036	0.3333	0.614	0.42	0.0000154	0.00626	0.0335	0.00502	0.000332
Lead	83.1	4.7	0.01	0.1054	0.066	0.0000018	0.000569	0.264	0.481	2.87E-06	0.000904
Mercury	0.0971	1.01	0.00031	0.0534	0.48	1.1	2.06E-08	0.000156	0.00409	0.00205	0.0000355
Zinc	111	75.4	0.1	0.7717	2.33	0.138	0.0076	2.58	22.7	0.294	0.00193

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT CALCULATIONS - METALS - MAXIMUM CONCENTRATIONS

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): American Robin

American Robin			Calculations based on maximum values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	0.0773	BW							
Soil ingestion proportion	0.02	Ps							
Food ingestion Rate (kg/kgBW/d)	0.132	FIR							
Proportion of diet, plants	0.41	Pp							
Proportion of diet, soil inverts	0.59	Pi							
Area use factor	1	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	27.8	2.24	0.01	0.0375	0.224	0.000734	0.0564	0.485	0.0726
Barium	9320	600	0.0002	0.0046	0.091	0.00492	2.32	66.1	0.0342
Cadmium	1.79	1.47	0.036	0.586	7.708	0.00017	0.0568	1.07	0.23
Lead	508	1.63	0.01	0.0389	0.266	0.0134	1.07	10.5	2.13
Mercury	0.148	3.25	0.00031	0.27	1.693	1.21E-07	0.00216	0.0195	0.002
Zinc	464	66.1	0.1	0.366	3.201	0.122	9.19	116	0.569

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): Mallard Duck

Mallard Duck			Calculations based on maximum values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	1.134	BW							
Soil ingestion proportion	0.033	Ps							
Food ingestion Rate (kg/kgBW/d)	0.05	FIR							
Proportion of diet, plants	0.5	Pp							
Proportion of diet, benthic inverts	0.5	Pbi							
Area use factor	0.0099	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	27.8	2.24	0.01	0.0375	0.127	0.000459	0.0261	0.0883	0.000152
Barium	9320	600	0.0002	0.0046	0.023	0.00308	1.07	5.36	0.0000318
Cadmium	1.79	1.47	0.036	0.586	0.614	0.000106	0.0262	0.0275	0.000109
Lead	508	1.63	0.01	0.0389	0.066	0.00838	0.494	0.838	0.00244
Mercury	0.148	3.25	0.00031	0.27	0.48	7.57E-08	0.000999	0.00178	0.00000254
Zinc	464	66.1	0.1	0.366	2.33	0.0766	4.25	27	0.00141

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0425	BW	
Soil ingestion proportion	0.17	Ps	
Food ingestion Rate (kg/kgBW/d)	0.196	FIR	
Proportion of diet, benthic inverts	1	Pbi	
Area use factor	0.5	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	27.8	2.24	0.01	0.127	0.00926	0.692	0.047
Barium	9320	600	0.0002	0.023	0.0621	42	0.0105
Cadmium	1.79	1.47	0.036	0.614	0.00215	0.215	0.0222
Lead	508	1.63	0.01	0.066	0.169	6.57	0.62
Mercury	0.148	3.25	0.00031	0.48	0.00000153	0.0139	0.000642
Zinc	464	66.1	0.1	2.33	1.55	212	0.485

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): Snowy Egret

Snowy Egret			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.371	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.116	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0082	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	27.8	2.24	0.01	0.127	0.00065	0.000161	0.041	0.00189	0.0000473
Barium	9320	600	0.0002	0.023	0.028	0.00108	2.49	27.2	0.000122
Cadmium	1.79	1.47	0.036	0.614	0.42	0.0000374	0.0127	0.0785	0.000153
Lead	508	1.63	0.01	0.066	0.0000018	0.00295	0.389	0.0000955	0.000592
Mercury	0.148	3.25	0.00031	0.48	1.1	2.66E-08	0.000824	0.017	0.0000135
Zinc	464	66.1	0.1	2.33	0.138	0.0269	12.5	6.68	0.000715

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	27.8	2.24	0.01	0.127	0.00065	0.000143	0.0364	0.00168	0.0000363
Barium	9320	600	0.0002	0.023	0.028	0.00096	2.21	24.2	0.0000938
Cadmium	1.79	1.47	0.036	0.614	0.42	0.0000332	0.0113	0.0697	0.000117
Lead	508	1.63	0.01	0.066	0.0000018	0.00262	0.345	0.0000848	0.000454
Mercury	0.148	3.25	0.00031	0.48	1.1	2.36E-08	0.000732	0.0151	0.0000104
Zinc	464	66.1	0.1	2.33	0.138	0.0239	11.1	5.94	0.00055

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): American Bald Eagle

American Bald Eagle			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.6	BW	
Soil ingestion proportion	0	Ps	
Food ingestion Rate (kg/kgBW/d)	0.09	FIR	
Proportion of diet, mammals	0.068	Pm	
Proportion of diet, birds	0.165	Pb	
Proportion of diet, fish	0.767	Pf	
Area use factor	0.000032	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	27.8	2.24	-	0.0025	0.075	0.00065	-	0.000425	0.031	0.00125	0.00000014
Barium	9320	20.8	-	0.0566	0.00001	0.028	-	3.23	0.00138	18	0.0000098
Cadmium	1.79	1.47	-	0.3333	0.113	0.42	-	0.00365	0.003	0.0519	0.000000382
Lead	508	1.63	-	0.1054	0.191	0.0000018	-	0.328	1.44	0.0000631	0.0000104
Mercury	0.148	0.019	-	0.0534	0.148	1.1	-	0.0000484	0.000325	0.0112	0.00000585
Zinc	464	66.1	-	0.7717	0.0645	0.138	-	2.19	0.444	4.42	0.00000102

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.118	BW	
Soil ingestion proportion	0.063	Ps	
Food ingestion Rate (kg/kgBW/d)	0.13	FIR	
Proportion of diet, plants	1	Pp	
Area use factor	0.51	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	27.8	1.04	0.01	0.0375	0.00228	0.136	0.0203
Barium	9320	5433	0.0002	0.0046	0.0153	5.57	0.000157
Cadmium	1.79	0.77	0.036	0.586	0.000528	0.136	0.0271
Lead	508	4.7	0.01	0.0389	0.0416	2.57	0.085
Mercury	0.148	1.01	0.00031	0.27	3.76E-07	0.00519	0.000786
Zinc	464	75.4	0.1	0.366	0.38	22.1	0.0456

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): Least Shrew

Least Shrew			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.017	BW	
Soil ingestion proportion	0.13	Ps	
Food ingestion Rate (kg/kgBW/d)	0.096	FIR	
Proportion of diet, soil inverts	1	Pi	
Area use factor	1	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	27.8	1.04	0.01	0.224	0.00347	0.598	0.174
Barium	9320	5433	0.0002	0.091	0.0233	81.4	0.0045
Cadmium	1.79	0.77	0.036	7.708	0.000804	1.32	0.515
Lead	508	4.7	0.01	0.266	0.0634	13	0.834
Mercury	0.148	1.01	0.00031	1.693	5.73E-07	0.0241	0.00716
Zinc	464	75.4	0.1	3.201	0.579	143	0.571

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): Red Fox

Red Fox			Calculations based on maximum values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	4.53	BW									
Soil ingestion proportion	0.028	Ps									
Food ingestion Rate (kg/kgBW/d)	0.16	FIR									
Proportion of diet, plants	0.07	Pp									
Proportion of diet, soil inverts	0.03	Pi									
Proportion of diet, mammals	0.9	Pm									
Area use factor	0.0017	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	27.8	1.04	0.01	0.0375	0.224	0.0025	0.00125	0.0117	0.0299	0.01	0.0000259
Barium	9320	5433	0.0002	0.0046	0.091	0.0566	0.00835	0.48	4.07	76	0.00000756
Cadmium	1.79	0.77	0.036	0.586	7.708	0.3333	0.000289	0.0117	0.0662	0.0859	0.000109
Lead	508	4.7	0.01	0.0389	0.266	0.1054	0.0228	0.221	0.649	7.71	0.000933
Mercury	0.148	1.01	0.00031	0.27	1.693	0.0534	2.06E-07	0.000448	0.0012	0.00114	0.00000141
Zinc	464	75.4	0.1	0.366	3.201	0.7717	0.208	1.9	7.13	51.6	0.000412

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): On Site (0-4'): American Mink

American Mink			Calculations based on maximum values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	27.8	1.04	0.01	0.0025	0.127	0.00065	0.00019	0.00209	0.31	0.000347	0.00171
Barium	9320	5433	0.0002	0.0566	0.023	0.028	0.00128	15.9	18.8	5.01	0.0000417
Cadmium	1.79	0.77	0.036	0.3333	0.614	0.42	0.0000441	0.018	0.0964	0.0144	0.000954
Lead	508	4.7	0.01	0.1054	0.066	0.0000018	0.00348	1.61	2.94	0.0000175	0.00552
Mercury	0.148	1.01	0.00031	0.0534	0.48	1.1	3.14E-08	0.000238	0.00623	0.00312	0.0000541
Zinc	464	75.4	0.1	0.7717	2.33	0.138	0.0318	10.8	94.8	1.23	0.00808

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT CALCULATIONS - METALS - AVERAGE CONCENTRATIONS

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): American Robin

American Robin			Calculations based on average values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	0.0773	BW							
Soil ingestion proportion	0.02	Ps							
Food ingestion Rate (kg/kgBW/d)	0.132	FIR							
Proportion of diet, plants	0.41	Pp							
Proportion of diet, soil inverts	0.59	Pi							
Area use factor	1	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	8.19	2.24	0.01	0.0375	0.224	0.000216	0.0166	0.143	0.0214
Barium	1469	600	0.0002	0.0046	0.091	0.000776	0.366	10.4	0.00538
Cadmium	0.505	1.47	0.036	0.586	7.708	0.000048	0.016	0.303	0.0651
Lead	43	1.63	0.01	0.0389	0.266	0.00114	0.0905	0.891	0.181
Mercury	0.0619	3.25	0.00031	0.27	1.693	5.07E-08	0.000905	0.00816	0.000837
Zinc	95.6	66.1	0.1	0.366	3.201	0.0252	1.89	23.8	0.117

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): Mallard Duck

Mallard Duck			Calculations based on average values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	1.134	BW							
Soil ingestion proportion	0.033	Ps							
Food ingestion Rate (kg/kgBW/d)	0.05	FIR							
Proportion of diet, plants	0.5	Pp							
Proportion of diet, benthic inverts	0.5	Pbi							
Area use factor	0.0099	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	8.19	2.24	0.01	0.0375	0.127	0.000135	0.00768	0.026	0.0000448
Barium	1469	600	0.0002	0.0046	0.023	0.000485	0.169	0.845	0.00000502
Cadmium	0.505	1.47	0.036	0.586	0.614	0.00003	0.0074	0.00775	0.0000307
Lead	43	1.63	0.01	0.0389	0.066	0.00071	0.0418	0.071	0.000207
Mercury	0.0619	3.25	0.00031	0.27	0.48	3.17E-08	0.000418	0.000743	0.00000106
Zinc	95.6	66.1	0.1	0.366	2.33	0.0158	0.875	5.57	0.00029

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	0.0425	BW					
Soil ingestion proportion	0.17	Ps					
Food ingestion Rate (kg/kgBW/d)	0.196	FIR					
Proportion of diet, benthic inverts	1	Pbi					
Area use factor	0.5	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	8.19	2.24	0.01	0.127	0.00273	0.204	0.0138
Barium	1469	600	0.0002	0.023	0.00979	6.62	0.00166
Cadmium	0.505	1.47	0.036	0.614	0.000606	0.0608	0.00627
Lead	43	1.63	0.01	0.066	0.0143	0.556	0.0525
Mercury	0.0619	3.25	0.00031	0.48	6.39E-07	0.00582	0.000269
Zinc	95.6	66.1	0.1	2.33	0.319	43.7	0.0999

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): Snowy Egret

Snowy Egret			Calculations based on average values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	0.371	BW							
Soil ingestion proportion	0.005	Ps							
Food ingestion Rate (kg/kgBW/d)	0.116	FIR							
Proportion of diet, benthic inverts	0.1	Pbi							
Proportion of diet, fish	0.9	Pf							
Area use factor	0.0082	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	8.19	2.24	0.01	0.127	0.00065	0.0000475	0.0121	0.000556	0.000014
Barium	1469	600	0.0002	0.023	0.028	0.00017	0.392	4.29	0.0000192
Cadmium	0.505	1.47	0.036	0.614	0.42	0.0000105	0.0036	0.0221	0.000043
Lead	43	1.63	0.01	0.066	0.0000018	0.000249	0.0329	8.08E-06	0.00005
Mercury	0.0619	3.25	0.00031	0.48	1.1	1.11E-08	0.000345	0.00711	0.00000564
Zinc	95.6	66.1	0.1	2.33	0.138	0.00554	2.58	1.38	0.000148

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	8.19	2.24	0.01	0.127	0.00065	0.0000422	0.0107	0.000493	0.0000107
Barium	1469	600	0.0002	0.023	0.028	0.000151	0.348	3.81	0.0000148
Cadmium	0.505	1.47	0.036	0.614	0.42	0.00000936	0.00319	0.0197	0.0000332
Lead	43	1.63	0.01	0.066	0.0000018	0.000221	0.0292	7.17E-06	0.0000385
Mercury	0.0619	3.25	0.00031	0.48	1.1	9.88E-09	0.000306	0.00631	0.00000434
Zinc	95.6	66.1	0.1	2.33	0.138	0.00492	2.29	1.22	0.000113

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): American Bald Eagle

American Bald Eagle			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.6	BW	
Soil ingestion proportion	0	Ps	
Food ingestion Rate (kg/kgBW/d)	0.09	FIR	
Proportion of diet, mammals	0.068	Pm	
Proportion of diet, birds	0.165	Pb	
Proportion of diet, fish	0.767	Pf	
Area use factor	0.000032	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	8.19	2.24	-	0.0025	0.075	0.00065	-	0.000125	0.00912	0.000367	0.0000000412
Barium	1469	20.8	-	0.0566	0.00001	0.028	-	0.509	0.000218	2.84	0.00000155
Cadmium	0.505	1.47	-	0.3333	0.113	0.42	-	0.00103	0.000847	0.0146	0.000000108
Lead	43	1.63	-	0.1054	0.191	0.0000018	-	0.0277	0.122	5.34E-06	0.000000882
Mercury	0.0619	0.019	-	0.0534	0.148	1.1	-	0.0000202	0.000136	0.0047	0.00000245
Zinc	95.6	66.1	-	0.7717	0.0645	0.138	-	0.452	0.0916	0.911	0.000000211

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	2.118	BW					
Soil ingestion proportion	0.063	Ps					
Food ingestion Rate (kg/kgBW/d)	0.13	FIR					
Proportion of diet, plants	1	Pp					
Area use factor	0.51	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	8.19	1.04	0.01	0.0375	0.000671	0.0399	0.00597
Barium	1469	5433	0.0002	0.0046	0.00241	0.878	0.0000248
Cadmium	0.505	0.77	0.036	0.586	0.000149	0.0385	0.00768
Lead	43	4.7	0.01	0.0389	0.00352	0.217	0.00718
Mercury	0.0619	1.01	0.00031	0.27	0.000000157	0.00217	0.000329
Zinc	95.6	75.4	0.1	0.366	0.0783	4.55	0.00939

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): Least Shrew

Least Shrew			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	0.017	BW					
Soil ingestion proportion	0.13	Ps					
Food ingestion Rate (kg/kgBW/d)	0.096	FIR					
Proportion of diet, soil inverts	1	Pi					
Area use factor	1	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	8.19	1.04	0.01	0.224	0.00102	0.176	0.0511
Barium	1469	5433	0.0002	0.091	0.00367	12.8	0.000707
Cadmium	0.505	0.77	0.036	7.708	0.000227	0.374	0.146
Lead	43	4.7	0.01	0.266	0.00537	1.1	0.0706
Mercury	0.0619	1.01	0.00031	1.693	2.39E-07	0.0101	0.003
Zinc	95.6	75.4	0.1	3.201	0.119	29.4	0.117

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): Red Fox

Red Fox			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.53	BW	
Soil ingestion proportion	0.028	Ps	
Food ingestion Rate (kg/kgBW/d)	0.16	FIR	
Proportion of diet, plants	0.07	Pp	
Proportion of diet, soil inverts	0.03	Pi	
Proportion of diet, mammals	0.9	Pm	
Area use factor	0.0017	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	8.19	1.04	0.01	0.0375	0.224	0.0025	0.000367	0.00344	0.00881	0.00295	0.00000763
Barium	1469	5433	0.0002	0.0046	0.091	0.0566	0.00132	0.0757	0.642	12	0.00000119
Cadmium	0.505	0.77	0.036	0.586	7.708	0.3333	0.0000814	0.00331	0.0187	0.0242	0.0000307
Lead	43	4.7	0.01	0.0389	0.266	0.1054	0.00193	0.0187	0.0549	0.653	0.0000791
Mercury	0.0619	1.01	0.00031	0.27	1.693	0.0534	8.6E-08	0.000187	0.000503	0.000476	0.000000589
Zinc	95.6	75.4	0.1	0.366	3.201	0.7717	0.0428	0.392	1.47	10.6	0.0000846

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): On Site (0-4'): American Mink

American Mink			Calculations based on average values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	8.19	1.04	0.01	0.0025	0.127	0.00065	0.0000561	0.000617	0.0912	0.000102	0.000504
Barium	1469	5433	0.0002	0.0566	0.023	0.028	0.000201	2.51	2.96	0.789	0.00000657
Cadmium	0.505	0.77	0.036	0.3333	0.614	0.42	0.0000125	0.00507	0.0272	0.00407	0.000269
Lead	43	4.7	0.01	0.1054	0.066	0.0000018	0.000295	0.137	0.249	1.48E-06	0.000468
Mercury	0.0619	1.01	0.00031	0.0534	0.48	1.1	1.31E-08	0.0000996	0.00261	0.00131	0.0000227
Zinc	95.6	75.4	0.1	0.7717	2.33	0.138	0.00655	2.22	19.5	0.253	0.00166

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT INPUT FACTORS AND CALCULATIONS - DIOXINS/FURANS

SOIL 2,3,7,8-TCDD TEQ CALCULATIONS

Calculation of 2,3,7,8-TCDD TEQ for On Site Soil 0-4': Bird

		Reported Data								Calculated Toxicity Equivalent Concentration Predicted for Birds						
Location ID		BC-16R	BC-16R	BC-16R	BC-16R	SB-4R	SB-4R	Calculated		BC-16R	BC-16R	BC-16R	BC-16R	SB-4R	SB-4R	Calculated
Depth Interval		0-2'	0-2'	2-4'	2-4'	0-2'	0-2'	Average	WHO	0-2'	0-2'	2-4'	2-4'	0-2'	0-2'	Average Toxic
Sample Date		6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	Congener	1998	6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	Equivalent
Sampler		ICON	ERM	ICON	ERM	ICON	ERM	Concentration	TEF	ICON	ERM	ICON	ERM	ICON	ERM	Concentration
Reported Parameter	*Area*	On Site	On Site	On Site	On Site	On Site	On Site	0-4' On Site	Bird	On Site	On Site	On Site	On Site	On Site	On Site	Predicted for Bird
2,3,7,8-TCDD	pg/g-dry	0.404	<0.775	0.549	<0.705	0.484	<0.761	0.24	1	0.404	0	0.549	0	0.484	0	0.24
1,2,3,7,8-PeCDD	pg/g-dry	1.05	<1.02	1.2	1.34	0.866 K	1.82	0.9	1	1.05	0	1.2	1.34	0	1.82	0.9
1,2,3,4,7,8-HxCDD	pg/g-dry	<0.283	1.7	<0.431	1.38	<0.141	<0.827	0.51	0.05	0	0.085	0	0.069	0	0	0.0255
1,2,3,6,7,8-HxCDD	pg/g-dry	3.37	5.08	6.14	3.79	1.16	1.72	3.54	0.01	0.0337	0.0508	0.0614	0.0379	0.0116	0.0172	0.0354
1,2,3,7,8,9-HxCDD	pg/g-dry	3.2	3.56	4.09	3.03	1.37	1.66	2.82	0.1	0.32	0.356	0.409	0.303	0.137	0.166	0.282
1,2,3,4,6,7,8-HpCDD	pg/g-dry	136	253	343	160	16.1	22	155.02	<0.001	0	0	0	0	0	0	0
1,2,3,4,6,7,8,9-OCDD	pg/g-dry	1980	3930	5860	2870	481	511	2605.33	0.0001	0.198	0.393	0.586	0.287	0.0481	0.0511	0.261
2,3,7,8-TCDF	pg/g-dry	1.95	3.43, **3.59**	2.12	**2.08**, 2.67	4.47	**5.74**, 6.01 K	3.33	1	1.95	3.59	2.12	2.08	4.47	5.74	3.33
1,2,3,7,8-PeCDF	pg/g-dry	1.87	2.7 K	1.56 K	1.58 K	2.9	4.95	1.62	0.1	0.187	0	0	0	0.29	0.495	0.162
2,3,4,7,8-PeCDF	pg/g-dry	1.92	2.01	2.16	1.9	2.86	3.82	2.45	1	1.92	2.01	2.16	1.9	2.86	3.82	2.45
1,2,3,4,7,8-HxCDF	pg/g-dry	2.1	3.01	2.68	2.03	3.13	5.19 K	2.16	0.1	0.21	0.301	0.268	0.203	0.313	0	0.216
1,2,3,6,7,8-HxCDF	pg/g-dry	1.75	1.8 K	1.61	1.43	2.29	4.01	1.85	0.1	0.175	0	0.161	0.143	0.229	0.401	0.185
2,3,4,6,7,8-HxCDF	pg/g-dry	1.2 K	1.87 K	1.59	1.36	1.4	2.3	1.11	0.1	0	0	0.159	0.136	0.14	0.23	0.111
1,2,3,7,8,9-HxCDF	pg/g-dry	0.488	<0.948	<0.762	<0.745	<0.469	<0.925	0.08	0.1	0.0488	0	0	0	0	0	0.008
1,2,3,4,6,7,8-HpCDF	pg/g-dry	10.3	17.4	12 K	10.4	5.43 K	11.1	8.2	0.01	0.103	0.174	0	0.104	0	0.111	0.082
1,2,3,4,7,8,9-HpCDF	pg/g-dry	0.731 K	1.43	<4.56	1.02 K	<1.88	1.25 K	0.24	0.01	0	0.0143	0	0	0	0	0.0024
1,2,3,4,6,7,8,9-OCDF	pg/g-dry	16.4	30.8	38.9	19.2	3.36 K	7.4	18.78	0.0001	0.00164	0.00308	0.00389	0.00192	0	0.00074	0.00188
							Calculated 2,3,7,8-TCDD TEQ (bird)			6.60	6.98	7.68	6.60	8.98	12.9	8.29

Notes:

WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

K-flagged values were reported by the laboratory as estimated maximum probable concentrations (EMPC).

Non-detect and K-flagged values were assumed a value of 0 for average and TEQ calculations.

For ERM samples, the laboratory reported two 2,3,7,8-TCDF results: one from the original analysis run and one from subsequent dual column confirmation. Bolded 2,3,7,8-TCDF values were used in average and TEQ calculations, and were reported from the original analysis run, except for sample SB-4R 0-2'. 2,3,7,8-TCDF in the original run for sample SB-4R was a K-flagged result. Therefore the non-flagged result from the dual column confirmation run was used to represent 2,3,7,8-TCDF concentration in sample SB-4R 0-2'.

Calculation of 2,3,7,8-TCDD TEQ for On Site Soil 0-4': Mammal

		Reported Data								Calculated Toxicity Equivalent Concentration Predicted for Mammals						
Location ID		BC-16R	BC-16R	BC-16R	BC-16R	SB-4R	SB-4R	Calculated		BC-16R	BC-16R	BC-16R	BC-16R	SB-4R	SB-4R	Calculated
Depth Interval		0-2'	0-2'	2-4'	2-4'	0-2'	0-2'	Average		0-2'	0-2'	2-4'	2-4'	0-2'	0-2'	Average Toxic
Sample Date		6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	Congener	WHO	6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	6/24/2019	Equivalent
Sampler		ICON	ERM	ICON	ERM	ICON	ERM	Concentration	2005 TEF	ICON	ERM	ICON	ERM	ICON	ERM	Concentration
Reported Parameter	*Area*	On Site	On Site	On Site	On Site	On Site	On Site	0-4' On Site	Mammal	On Site	On Site	On Site	On Site	On Site	On Site	Predicted for Mammal
2,3,7,8-TCDD	pg/g-dry	0.404	<0.775	0.549	<0.705	0.484	<0.761	0.24	1	0.404	0	0.549	0	0.484	0	0.24
1,2,3,7,8-PeCDD	pg/g-dry	1.05	<1.02	1.2	1.34	0.866 K	1.82	0.9	1	1.05	0	1.2	1.34	0	1.82	0.9
1,2,3,4,7,8-HxCDD	pg/g-dry	<0.283	1.7	<0.431	1.38	<0.141	<0.827	0.51	0.1	0	0.17	0	0.138	0	0	0.051
1,2,3,6,7,8-HxCDD	pg/g-dry	3.37	5.08	6.14	3.79	1.16	1.72	3.54	0.1	0.337	0.508	0.614	0.379	0.116	0.172	0.354
1,2,3,7,8,9-HxCDD	pg/g-dry	3.2	3.56	4.09	3.03	1.37	1.66	2.82	0.1	0.32	0.356	0.409	0.303	0.137	0.166	0.282
1,2,3,4,6,7,8-HpCDD	pg/g-dry	136	253	343	160	16.1	22	155.02	0.01	1.36	2.53	3.43	1.6	0.161	0.22	1.55
1,2,3,4,6,7,8,9-OCDD	pg/g-dry	1980	3930	5860	2870	481	511	2605.33	0.0003	0.594	1.179	1.758	0.861	0.1443	0.1533	0.782
2,3,7,8-TCDF	pg/g-dry	1.95	3.43, **3.59**	2.12	**2.08**, 2.67	4.47	**5.74**, 6.01 K	3.33	0.1	0.195	0.359	0.212	0.208	0.447	0.574	0.333
1,2,3,7,8-PeCDF	pg/g-dry	1.87	2.7 K	1.56 K	1.58 K	2.9	4.95	1.62	0.03	0.0561	0	0	0	0.087	0.1485	0.0486
2,3,4,7,8-PeCDF	pg/g-dry	1.92	2.01	2.16	1.9	2.86	3.82	2.45	0.3	0.576	0.603	0.648	0.57	0.858	1.146	0.735
1,2,3,4,7,8-HxCDF	pg/g-dry	2.1	3.01	2.68	2.03	3.13	5.19 K	2.16	0.1	0.21	0.301	0.268	0.203	0.313	0	0.216
1,2,3,6,7,8-HxCDF	pg/g-dry	1.75	1.8 K	1.61	1.43	2.29	4.01	1.85	0.1	0.175	0	0.161	0.143	0.229	0.401	0.185
2,3,4,6,7,8-HxCDF	pg/g-dry	1.2 K	1.87 K	1.59	1.36	1.4	2.3	1.11	0.1	0	0	0.159	0.136	0.14	0.23	0.111
1,2,3,7,8,9-HxCDF	pg/g-dry	0.488	<0.948	<0.762	<0.745	<0.469	<0.925	0.08	0.1	0.0488	0	0	0	0	0	0.008
1,2,3,4,6,7,8-HpCDF	pg/g-dry	10.3	17.4	12 K	10.4	5.43 K	11.1	8.2	0.01	0.103	0.174	0	0.104	0	0.111	0.082
1,2,3,4,7,8,9-HpCDF	pg/g-dry	0.731 K	1.43	<4.56	1.02 K	<1.88	1.25 K	0.24	0.01	0	0.0143	0	0	0	0	0.0024
1,2,3,4,6,7,8,9-OCDF	pg/g-dry	16.4	30.8	38.9	19.2	3.36 K	7.4	18.78	0.0003	0.00492	0.00924	0.01167	0.00576	0	0.00222	0.00563
								Calculated 2,3,7,8-TCDD TEQ (mammal)		5.43	6.20	9.42	5.99	3.12	5.1	5.89

Notes:

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

K-flagged values were reported by the laboratory as estimated maximum probable concentrations (EMPC).

Non-detect and K-flagged values were assumed a value of 0 for average and TEQ calculations.

For ERM samples, the laboratory reported two 2,3,7,8-TCDF results: one from the original analysis run and one from subsequent dual column confirmation. Bolded 2,3,7,8-TCDF values were used in average and TEQ calculations, and were reported from the original analysis run, except for sample SB-4R 0-2'. 2,3,7,8-TCDF in the original run for sample SB-4R was a K-flagged result. Therefore the non-flagged result from the dual column confirmation run was used to represent 2,3,7,8-TCDF concentration in sample SB-4R 0-2'.

DIET 2,3,7,8-TCDD TEQ CALCULATIONS USING MAXIMUM SOIL CONCENTRATIONS

Summary of 2,3,7,8-TCDD TEQ Concentration by Food Item and Taxa Based on Maximum Soil Concentration (On Site)

	Bird		Mammal	
	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ
Diet Item	pg/g	mg/kg	pg/g	mg/kg
Soil	3.69	0.00000369	2.64	0.00000264
Plants	0.0258	0.0000000258	0.0188	0.0000000188
Soil invertebrates	1.51	0.00000151	1.10	0.00000110
Mammals	1.83	0.00000183	0.734	0.00000073
Birds	0.0942	0.0000000942	0.256	0.000000256
Benthic Invertebrates	0.0103	0.0000000103	0.00344	0.00000000344
Fish	0.0177	0.0000000177	0.00819	0.00000000819

Note:
Concentrations based on Dioxins/Furans reported for maximum on site 0-4' soil (BC-16R 2-4' for mammal and SB-4R 0-2' for bird).

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Maximum Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Mean Relative Bioavailability	Available Concentration in Soil	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	SB-4R 0-2'		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFbird
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	<0.761	2	0	1	0
1,2,3,7,8-PeCDD	1.82	31.7	0.577	1	0.577
1,2,3,4,7,8-HxCDD	<0.827	23.6	0	0.05	0
1,2,3,6,7,8-HxCDD	1.72	21.1	0.363	0.01	0.00363
1,2,3,7,8,9-HxCDD	1.66	19.7	0.327	0.1	0.0327
1,2,3,4,6,7,8-HpCDD	22	24.3	5.35	<0.001	0
1,2,3,4,6,7,8,9-OCDD	511	39.8	203	0.0001	0.0203
2,3,7,8-TCDF	5.74, 6.01 K	24.1	1.38	1	1.38
1,2,3,7,8-PeCDF	4.95	22.8	1.13	0.1	0.113
2,3,4,7,8-PeCDF	3.82	34.4	1.31	1	1.31
1,2,3,4,7,8-HxCDF	5.19 K	40.9	0	0.1	0
1,2,3,6,7,8-HxCDF	4.01	31.5	1.26	0.1	0.126
2,3,4,6,7,8-HxCDF	2.3	39.4	0.906	0.1	0.0906
1,2,3,7,8,9-HxCDF	<0.925	28.6	0	0.1	0
1,2,3,4,6,7,8-HpCDF	11.1	28.5	3.16	0.01	0.0316
1,2,3,4,7,8,9-HpCDF	1.25 K	28	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	7.4	42.2	3.12	0.0001	0.000312

2,3,7,8-TCDD TEQ (pg/g)	**3.69**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
SB-4R 0-2' contains the maximum 2,3,7,8-TCDD TEQ (bird) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Maximum Soil Concentration, On Site, Bird Receptor)

Receptor	Maximum 2,3,7,8-TCDD TEQ 0-4' On Site SB-4R 0-2' (pg/g)	Sample ID	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Bird	12.9	SB-4R 0-2'	0.002	0.0258	0.117	1.51

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
SB-4R 0-2' contains the maximum 2,3,7,8-TCDD TEQ (bird) concentration in 0-4' on site soil.
TEQ for bird uses WHO 1998 TEF-bird applied to site concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Maximum Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	SB-4R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	<0.761	0.0114	0	1	0
1,2,3,7,8-PeCDD	1.82	0.00126	0.00172	1	0.00172
1,2,3,4,7,8-HxCDD	<0.827	0.000265	0	0.05	0
1,2,3,6,7,8-HxCDD	1.72	0.00026	0.000335	0.01	0.00000335
1,2,3,7,8,9-HxCDD	1.66	0.0000759	0.0000945	0.1	0.00000945
1,2,3,4,6,7,8-HpCDD	22	0.000317	0.00523	<0.001	0
1,2,3,4,6,7,8,9-OCDD	511	0.000223	0.0855	0.0001	0.00000855
2,3,7,8-TCDF	5.74, 6.01 K	0.00289	0.0124	1	0.0124
1,2,3,7,8-PeCDF	4.95	0.000224	0.000832	0.1	0.0000832
2,3,4,7,8-PeCDF	3.82	0.00116	0.00332	1	0.00332
1,2,3,4,7,8-HxCDF	5.19 K	0.000147	0	0.1	0
1,2,3,6,7,8-HxCDF	4.01	0.000415	0.00125	0.1	0.000125
2,3,4,6,7,8-HxCDF	2.3	0.000107	0.000185	0.1	0.0000185
1,2,3,7,8,9-HxCDF	<0.925	0.0000251	0	0.1	0
1,2,3,4,6,7,8-HpCDF	11.1	0.000239	0.00199	0.01	0.0000199
1,2,3,4,7,8,9-HpCDF	1.25 K	0.000064	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	7.4	0.000208	0.00115	0.0001	0.000000115

2,3,7,8-TCDD TEQ (pg/g)	**0.0177**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
SB-4R 0-2' contains the maximum 2,3,7,8-TCDD TEQ (bird) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Maximum Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	SB-4R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	<0.761	0.00389	0	1	0
1,2,3,7,8-PeCDD	1.82	0.000778	0.000708	1	0.000708
1,2,3,4,7,8-HxCDD	<0.827	0.0000917	0	0.05	0
1,2,3,6,7,8-HxCDD	1.72	0.000109	0.0000937	0.01	0.000000937
1,2,3,7,8,9-HxCDD	1.66	0.0000792	0.0000657	0.1	0.00000657
1,2,3,4,6,7,8-HpCDD	22	0.000436	0.0048	<0.001	0
1,2,3,4,6,7,8,9-OCDD	511	0.000363	0.0927	0.0001	0.00000927
2,3,7,8-TCDF	5.74, 6.01 K	0.00235	0.00674	1	0.00674
1,2,3,7,8-PeCDF	4.95	0.000901	0.00223	0.1	0.000223
2,3,4,7,8-PeCDF	3.82	0.0013	0.00248	1	0.00248
1,2,3,4,7,8-HxCDF	5.19 K	0.000559	0	0.1	0
1,2,3,6,7,8-HxCDF	4.01	0.000365	0.000732	0.1	0.0000732
2,3,4,6,7,8-HxCDF	2.3	0.000208	0.000239	0.1	0.0000239
1,2,3,7,8,9-HxCDF	<0.925	0.0000468	0	0.1	0
1,2,3,4,6,7,8-HpCDF	11.1	0.000447	0.00248	0.01	0.0000248
1,2,3,4,7,8,9-HpCDF	1.25 K	0.0000604	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	7.4	0.00025	0.000925	0.0001	0.0000000925

2,3,7,8-TCDD TEQ (pg/g)	**0.0103**

Fraction Organic Carbon: 4%

Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
SB-4R 0-2' contains the maximum 2,3,7,8-TCDD TEQ (bird) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Maximum Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	SB-4R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	<0.761	0.128	0	1	0
1,2,3,7,8-PeCDD	1.82	0.00196	0.00981	1	0.00981
1,2,3,4,7,8-HxCDD	<0.827	0.0233	0	0.05	0
1,2,3,6,7,8-HxCDD	1.72	0.0192	0.0908	0.01	0.000908
1,2,3,7,8,9-HxCDD	1.66	0.00738	0.0337	0.1	0.00337
1,2,3,4,6,7,8-HpCDD	22	0.000262	0.0159	<0.001	0
1,2,3,4,6,7,8,9-OCDD	511	0.000033	0.0464	0.0001	0.00000464
2,3,7,8-TCDF	5.74, 6.01 K	0.00148	0.0234	1	0.0234
1,2,3,7,8-PeCDF	4.95	0.00073	0.00994	0.1	0.000994
2,3,4,7,8-PeCDF	3.82	0.00465	0.0488	1	0.0488
1,2,3,4,7,8-HxCDF	5.19 K	0.000599	0	0.1	0
1,2,3,6,7,8-HxCDF	4.01	0.0042	0.0463	0.1	0.00463
2,3,4,6,7,8-HxCDF	2.3	0.00354	0.0224	0.1	0.00224
1,2,3,7,8,9-HxCDF	<0.925	0	0	0.1	0
1,2,3,4,6,7,8-HpCDF	11.1	0.000157	0.00479	0.01	0.0000479
1,2,3,4,7,8,9-HpCDF	1.25 K	0	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	7.4	0.00000522	0.000106	0.0001	0.0000000106

2,3,7,8-TCDD TEQ (pg/g)	**0.0942**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
SB-4R 0-2' contains the maximum 2,3,7,8-TCDD TEQ (bird) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Maximum Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	SB-4R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	<0.761	0.18	0	1	0
1,2,3,7,8-PeCDD	1.82	0.291	0.265	1	0.265
1,2,3,4,7,8-HxCDD	<0.827	0.209	0	0.05	0
1,2,3,6,7,8-HxCDD	1.72	0.121	0.104	0.01	0.00104
1,2,3,7,8,9-HxCDD	1.66	0.0472	0.0392	0.1	0.00392
1,2,3,4,6,7,8-HpCDD	22	0.0603	0.663	<0.001	0
1,2,3,4,6,7,8,9-OCDD	511	0.0333	8.51	0.0001	0.000851
2,3,7,8-TCDF	5.74, 6.01 K	0.0566	0.162	1	0.162
1,2,3,7,8-PeCDF	4.95	0.0307	0.076	0.1	0.0076
2,3,4,7,8-PeCDF	3.82	0.653	1.25	1	1.25
1,2,3,4,7,8-HxCDF	5.19 K	0.335	0	0.1	0
1,2,3,6,7,8-HxCDF	4.01	0.413	0.828	0.1	0.0828
2,3,4,6,7,8-HxCDF	2.3	0.425	0.489	0.1	0.0489
1,2,3,7,8,9-HxCDF	<0.925	0.0588	0	0.1	0
1,2,3,4,6,7,8-HpCDF	11.1	0.0616	0.342	0.01	0.00342
1,2,3,4,7,8,9-HpCDF	1.25 K	0.102	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	7.4	0.0499	0.185	0.0001	0.0000185

2,3,7,8-TCDD TEQ (pg/g)	**1.83**

Fraction Organic Carbon: 4%

Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
SB-4R 0-2' contains the maximum 2,3,7,8-TCDD TEQ (bird) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Maximum Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Mean Relative Bioavailability	Available Concentration in Soil	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFmammal
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	2	0.011	1	0.011
1,2,3,7,8-PeCDD	1.2	31.7	0.38	1	0.38
1,2,3,4,7,8-HxCDD	<0.431	23.6	0	0.1	0
1,2,3,6,7,8-HxCDD	6.14	21.1	1.3	0.1	0.13
1,2,3,7,8,9-HxCDD	4.09	19.7	0.806	0.1	0.0806
1,2,3,4,6,7,8-HpCDD	343	24.3	83.3	0.01	0.833
1,2,3,4,6,7,8,9-OCDD	5860	39.8	2330	0.0003	0.699
2,3,7,8-TCDF	2.12	24.1	0.511	0.1	0.0511
1,2,3,7,8-PeCDF	1.56 K	22.8	0	0.03	0
2,3,4,7,8-PeCDF	2.16	34.4	0.743	0.3	0.223
1,2,3,4,7,8-HxCDF	2.68	40.9	1.1	0.1	0.11
1,2,3,6,7,8-HxCDF	1.61	31.5	0.507	0.1	0.0507
2,3,4,6,7,8-HxCDF	1.59	39.4	0.626	0.1	0.0626
1,2,3,7,8,9-HxCDF	<0.762	28.6	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	28.5	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	28	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	42.2	16.4	0.0003	0.00492

2,3,7,8-TCDD TEQ (pg/g)	**2.64**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ (mammal) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Maximum Soil Concentration, On Site, Mammal Receptor)

Receptor	Maximum 2,3,7,8-TCDD TEQ 0-4' On Site BC-16R 2-4' (pg/g)	Sample ID	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Mammal	9.42	BC-16R 2-4'	0.002	0.0188	0.117	1.10

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ (mammal) concentration in 0-4' on site soil.
TEQ for mammal uses WHO 2005 TEF-mammal applied to site concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Maximum Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.0114	0.00469	1	0.00469
1,2,3,7,8-PeCDD	1.2	0.00126	0.00113	1	0.00113
1,2,3,4,7,8-HxCDD	<0.431	0.000265	0	0.1	0
1,2,3,6,7,8-HxCDD	6.14	0.00026	0.0012	0.1	0.00012
1,2,3,7,8,9-HxCDD	4.09	0.0000759	0.000233	0.1	0.0000233
1,2,3,4,6,7,8-HpCDD	343	0.000317	0.0815	0.01	0.000815
1,2,3,4,6,7,8,9-OCDD	5860	0.000223	0.98	0.0003	0.000294
2,3,7,8-TCDF	2.12	0.00289	0.0046	0.1	0.00046
1,2,3,7,8-PeCDF	1.56 K	0.000224	0	0.03	0
2,3,4,7,8-PeCDF	2.16	0.00116	0.00188	0.3	0.000564
1,2,3,4,7,8-HxCDF	2.68	0.000147	0.000295	0.1	0.0000295
1,2,3,6,7,8-HxCDF	1.61	0.000415	0.000501	0.1	0.0000501
2,3,4,6,7,8-HxCDF	1.59	0.000107	0.000128	0.1	0.0000128
1,2,3,7,8,9-HxCDF	<0.762	0.0000251	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.000239	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0.000064	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.000208	0.00607	0.0003	0.00000182

2,3,7,8-TCDD TEQ (pg/g)	**0.00819**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ (mammal) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Maximum Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.00389	0.00107	1	0.00107
1,2,3,7,8-PeCDD	1.2	0.000778	0.000467	1	0.000467
1,2,3,4,7,8-HxCDD	<0.431	0.0000917	0	0.1	0
1,2,3,6,7,8-HxCDD	6.14	0.000109	0.000335	0.1	0.0000335
1,2,3,7,8,9-HxCDD	4.09	0.0000792	0.000162	0.1	0.0000162
1,2,3,4,6,7,8-HpCDD	343	0.000436	0.0748	0.01	0.000748
1,2,3,4,6,7,8,9-OCDD	5860	0.000363	1.06	0.0003	0.000318
2,3,7,8-TCDF	2.12	0.00235	0.00249	0.1	0.000249
1,2,3,7,8-PeCDF	1.56 K	0.000901	0	0.03	0
2,3,4,7,8-PeCDF	2.16	0.0013	0.0014	0.3	0.00042
1,2,3,4,7,8-HxCDF	2.68	0.000559	0.000749	0.1	0.0000749
1,2,3,6,7,8-HxCDF	1.61	0.000365	0.000294	0.1	0.0000294
2,3,4,6,7,8-HxCDF	1.59	0.000208	0.000165	0.1	0.0000165
1,2,3,7,8,9-HxCDF	<0.762	0.0000468	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.000447	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0.0000604	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.00025	0.00486	0.0003	0.00000146

2,3,7,8-TCDD TEQ (pg/g)	**0.00344**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ (mammal) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Maximum Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.128	0.193	1	0.193
1,2,3,7,8-PeCDD	1.2	0.00196	0.00647	1	0.00647
1,2,3,4,7,8-HxCDD	<0.431	0.0233	0	0.1	0
1,2,3,6,7,8-HxCDD	6.14	0.0192	0.324	0.1	0.0324
1,2,3,7,8,9-HxCDD	4.09	0.00738	0.083	0.1	0.0083
1,2,3,4,6,7,8-HpCDD	343	0.000262	0.247	0.01	0.00247
1,2,3,4,6,7,8,9-OCDD	5860	0.000033	0.532	0.0003	0.00016
2,3,7,8-TCDF	2.12	0.00148	0.00863	0.1	0.000863
1,2,3,7,8-PeCDF	1.56 K	0.00073	0	0.03	0
2,3,4,7,8-PeCDF	2.16	0.00465	0.0276	0.3	0.00828
1,2,3,4,7,8-HxCDF	2.68	0.000599	0.00441	0.1	0.000441
1,2,3,6,7,8-HxCDF	1.61	0.0042	0.0186	0.1	0.00186
2,3,4,6,7,8-HxCDF	1.59	0.00354	0.0155	0.1	0.00155
1,2,3,7,8,9-HxCDF	<0.762	0	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.000157	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.00000522	0.000558	0.0003	0.000000167

2,3,7,8-TCDD TEQ (pg/g)	**0.256**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ (mammal) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Maximum Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' On Site	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	BC-16R 2-4'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.549	0.18	0.0494	1	0.0494
1,2,3,7,8-PeCDD	1.2	0.291	0.175	1	0.175
1,2,3,4,7,8-HxCDD	<0.431	0.209	0	0.1	0
1,2,3,6,7,8-HxCDD	6.14	0.121	0.371	0.1	0.0371
1,2,3,7,8,9-HxCDD	4.09	0.0472	0.0965	0.1	0.00965
1,2,3,4,6,7,8-HpCDD	343	0.0603	10.3	0.01	0.103
1,2,3,4,6,7,8,9-OCDD	5860	0.0333	97.6	0.0003	0.0293
2,3,7,8-TCDF	2.12	0.0566	0.06	0.1	0.006
1,2,3,7,8-PeCDF	1.56 K	0.0307	0	0.03	0
2,3,4,7,8-PeCDF	2.16	0.653	0.705	0.3	0.212
1,2,3,4,7,8-HxCDF	2.68	0.335	0.449	0.1	0.0449
1,2,3,6,7,8-HxCDF	1.61	0.413	0.332	0.1	0.0332
2,3,4,6,7,8-HxCDF	1.59	0.425	0.338	0.1	0.0338
1,2,3,7,8,9-HxCDF	<0.762	0.0588	0	0.1	0
1,2,3,4,6,7,8-HpCDF	12 K	0.0616	0	0.01	0
1,2,3,4,7,8,9-HpCDF	<4.56	0.102	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	38.9	0.0499	0.971	0.0003	0.000291

2,3,7,8-TCDD TEQ (pg/g)	**0.734**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-16R 2-4' contains the maximum 2,3,7,8-TCDD TEQ (mammal) concentration in 0-4' on site soil.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

2,3,7,8-TCDD TEQ HQ CALCULATIONS USING MAXIMUM SOIL CONCENTRATIONS

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): American Robin

American Robin			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0773		BW
Soil ingestion proportion	0.02		Ps
Food ingestion Rate (kg/kgBW/d)	0.132		FIR
Proportion of diet, plants	0.41		Pp
Proportion of diet, soil inverts	0.59		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.69E-06	Soil	9.74E-09
2,3,7,8-TCDD TEQ	2.58E-08	Plants	1.40E-09
2,3,7,8-TCDD TEQ	1.51E-06	Soil invertebrates	1.18E-07
		Daily Intake	3.87E-08
		HQ	0.0138

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): Mallard Duck

Mallard Duck			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	1.134		BW
Soil ingestion proportion	0.033		Ps
Food ingestion Rate (kg/kgBW/d)	0.05		FIR
Proportion of diet, plants	0.5		Pp
Proportion of diet, benthic inverts	0.5		Pbi
Area use factor	0.0099		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.69E-06	Soil	6.09E-09
2,3,7,8-TCDD TEQ	2.58E-08	Plants	6.45E-10
2,3,7,8-TCDD TEQ	1.03E-08	Benthic Invertebrates	2.58E-10
		Daily Intake	2.08E-11
		HQ	0.00000742

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): Spotted Sandpiper

Spotted Sandpiper			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0425		BW
Soil ingestion proportion	0.17		Ps
Food ingestion Rate (kg/kgBW/d)	0.196		FIR
Proportion of diet, benthic inverts	1		Pbi
Area use factor	0.5		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.69E-06	Soil	1.23E-07
2,3,7,8-TCDD TEQ	1.03E-08	Benthic Invertebrates	2.02E-09
		Daily Intake	1.88E-08
		HQ	0.00670

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): Snowy Egret

Snowy Egret			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.371		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.116		FIR
Proportion of diet, benthic inverts	0.1		Pbi
Proportion of diet, fish	0.9		Pf
Area use factor	0.0082		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.69E-06	Soil	2.14E-09
2,3,7,8-TCDD TEQ	1.03E-08	Benthic Invertebrates	1.19E-10
2,3,7,8-TCDD TEQ	1.77E-08	Fish	1.85E-09
		Daily Intake	1.01E-11
		HQ	0.00000361

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): Great Blue Heron

Great Blue Heron			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.229		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.103		FIR
Proportion of diet, benthic inverts	0.1		Pbi
Proportion of diet, fish	0.9		Pf
Area use factor	0.0071		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.69E-06	Soil	1.90E-09
2,3,7,8-TCDD TEQ	1.03E-08	Benthic Invertebrates	1.06E-10
2,3,7,8-TCDD TEQ	1.77E-08	Fish	1.64E-09
		Daily Intake	7.77E-12
		HQ	0.00000277

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): American Bald Eagle

American Bald Eagle			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.6		BW
Soil ingestion proportion	0		Ps
Food ingestion Rate (kg/kgBW/d)	0.09		FIR
Proportion of diet, mammals	0.068		Pm
Proportion of diet, birds	0.165		Pb
Proportion of diet, fish	0.767		Pf
Area use factor	0.000032		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.69E-06	Soil	-
2,3,7,8-TCDD TEQ	1.83E-06	Mammals	1.12E-08
2,3,7,8-TCDD TEQ	9.42E-08	Birds	1.40E-09
2,3,7,8-TCDD TEQ	1.77E-08	Fish	1.22E-09
		Daily Intake	1.33E-13
		HQ	0.0000000474

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): Swamp Rabbit

Swamp Rabbit			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.118		BW
Soil ingestion proportion	0.063		Ps
Food ingestion Rate (kg/kgBW/d)	0.13		FIR
Proportion of diet, plants	1		Pp
Area use factor	0.51		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	2.16E-08
2,3,7,8-TCDD TEQ	1.88E-08	Plants	2.45E-09
		Daily Intake	3.68E-09
		HQ	0.00102

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): Least Shrew

Least Shrew			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.017		BW
Soil ingestion proportion	0.13		Ps
Food ingestion Rate (kg/kgBW/d)	0.096		FIR
Proportion of diet, soil inverts	1		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	3.29E-08
2,3,7,8-TCDD TEQ	1.10E-06	Soil invertebrates	1.06E-07
		Daily Intake	4.17E-08
		HQ	0.0116

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai} \;]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): Red Fox

Red Fox			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.53		BW
Soil ingestion proportion	0.028		Ps
Food ingestion Rate (kg/kgBW/d)	0.16		FIR
Proportion of diet, plants	0.07		Pp
Proportion of diet, soil inverts	0.03		Pi
Proportion of diet, mammals	0.9		Pm
Area use factor	0.0017		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	1.18E-08
2,3,7,8-TCDD TEQ	1.88E-08	Plants	2.11E-10
2,3,7,8-TCDD TEQ	1.10E-06	Soil invertebrates	5.29E-09
2,3,7,8-TCDD TEQ	7.34E-07	Mammals	1.06E-07
		Daily Intake	6.29E-11
		HQ	0.0000175

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): On Site (0-4'): American Mink

American Mink			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	1		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.137		FIR
Proportion of diet, mammals	0.22		Pm
Proportion of diet, benthic inverts	0.64		Pbi
Proportion of diet, fish	0.14		Pf
Area use factor	0.019		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.64E-06	Soil	1.81E-09
2,3,7,8-TCDD TEQ	7.34E-07	Mammals	2.21E-08
2,3,7,8-TCDD TEQ	3.44E-09	Benthic Invertebrates	3.02E-10
2,3,7,8-TCDD TEQ	8.19E-09	Fish	1.57E-10
		Daily Intake	1.39E-10
		HQ	0.0000386

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration on site, BC-16R 2-4' for mammal and SB-4R 0-2' for bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

DIET 2,3,7,8-TCDD TEQ CALCULATIONS USING AVERAGE SOIL CONCENTRATIONS

Summary of 2,3,7,8-TCDD TEQ Concentration by Food Item and Taxa Based on Average Soil Concentration (On Site)

	Bird		Mammal	
	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ
Diet Item	pg/g	mg/kg	pg/g	mg/kg
Soil	2.36	0.00000236	1.68	0.00000168
Plants	0.0166	0.0000000166	0.0118	0.0000000118
Soil invertebrates	0.970	0.00000097	0.689	0.00000069
Mammals	1.17	0.00000117	0.597	0.00000060
Birds	0.147	0.0000001470	0.133	0.000000133
Benthic Invertebrates	0.00658	0.0000000066	0.00234	0.00000000234
Fish	0.0125	0.0000000125	0.00497	0.00000000497

Note:
Diet 2,3,7,8-TCDD TEQ concentrations are calculated using average soil 2,3,7,8-TCDD TEQ or congener concentrations for 0-4' on site samples.

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Average Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Mean Relative Bioavailability	Available Concentration in Soil	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFbird
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	2	0.0048	1	0.0048
1,2,3,7,8-PeCDD	0.9	31.7	0.285	1	0.285
1,2,3,4,7,8-HxCDD	0.51	23.6	0.12	0.05	0.006
1,2,3,6,7,8-HxCDD	3.54	21.1	0.747	0.01	0.00747
1,2,3,7,8,9-HxCDD	2.82	19.7	0.556	0.1	0.0556
1,2,3,4,6,7,8-HpCDD	155.02	24.3	37.7	<0.001	0
1,2,3,4,6,7,8,9-OCDD	2605.33	39.8	1040	0.0001	0.104
2,3,7,8-TCDF	3.33	24.1	0.803	1	0.803
1,2,3,7,8-PeCDF	1.62	22.8	0.369	0.1	0.0369
2,3,4,7,8-PeCDF	2.45	34.4	0.843	1	0.843
1,2,3,4,7,8-HxCDF	2.16	40.9	0.883	0.1	0.0883
1,2,3,6,7,8-HxCDF	1.85	31.5	0.583	0.1	0.0583
2,3,4,6,7,8-HxCDF	1.11	39.4	0.437	0.1	0.0437
1,2,3,7,8,9-HxCDF	0.08	28.6	0.0229	0.1	0.00229
1,2,3,4,6,7,8-HpCDF	8.2	28.5	2.34	0.01	0.0234
1,2,3,4,7,8,9-HpCDF	0.24	28	0.0672	0.01	0.000672
1,2,3,4,6,7,8,9-OCDF	18.78	42.2	7.93	0.0001	0.000793

2,3,7,8-TCDD TEQ (pg/g)	**2.36**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.

WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Average Soil Concentration, On Site, Bird Receptor)

Receptor	Average 2,3,7,8-TCDD TEQ 0-4' On Site All Samples (pg/g)	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Bird	8.29	0.002	0.01658	0.117	0.970

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
Average 2,3,7,8-TCDD TEQ concentrations were calculated by multiplying the congener average concentration for 0-4' on site soil by the TEF.
TEQ for bird uses WHO 1998 TEF-bird applied to site average concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Average Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.0114	0.00205	1	0.00205
1,2,3,7,8-PeCDD	0.9	0.00126	0.000851	1	0.000851
1,2,3,4,7,8-HxCDD	0.51	0.000265	0.000101	0.05	0.00000505
1,2,3,6,7,8-HxCDD	3.54	0.00026	0.00069	0.01	0.0000069
1,2,3,7,8,9-HxCDD	2.82	0.0000759	0.000161	0.1	0.0000161
1,2,3,4,6,7,8-HpCDD	155.02	0.000317	0.0369	<0.001	0
1,2,3,4,6,7,8,9-OCDD	2605.33	0.000223	0.436	0.0001	0.0000436
2,3,7,8-TCDF	3.33	0.00289	0.00722	1	0.00722
1,2,3,7,8-PeCDF	1.62	0.000224	0.000272	0.1	0.0000272
2,3,4,7,8-PeCDF	2.45	0.00116	0.00213	1	0.00213
1,2,3,4,7,8-HxCDF	2.16	0.000147	0.000238	0.1	0.0000238
1,2,3,6,7,8-HxCDF	1.85	0.000415	0.000576	0.1	0.0000576
2,3,4,6,7,8-HxCDF	1.11	0.000107	0.0000891	0.1	0.00000891
1,2,3,7,8,9-HxCDF	0.08	0.0000251	0.00000151	0.1	0.000000151
1,2,3,4,6,7,8-HpCDF	8.2	0.000239	0.00147	0.01	0.0000147
1,2,3,4,7,8,9-HpCDF	0.24	0.000064	0.0000115	0.01	0.000000115
1,2,3,4,6,7,8,9-OCDF	18.78	0.000208	0.00293	0.0001	0.000000293

2,3,7,8-TCDD TEQ (pg/g)	**0.0125**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Average Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.00389	0.000467	1	0.000467
1,2,3,7,8-PeCDD	0.9	0.000778	0.00035	1	0.00035
1,2,3,4,7,8-HxCDD	0.51	0.0000917	0.0000234	0.05	0.00000117
1,2,3,6,7,8-HxCDD	3.54	0.000109	0.000193	0.01	0.00000193
1,2,3,7,8,9-HxCDD	2.82	0.0000792	0.000112	0.1	0.0000112
1,2,3,4,6,7,8-HpCDD	155.02	0.000436	0.0338	<0.001	0
1,2,3,4,6,7,8,9-OCDD	2605.33	0.000363	0.473	0.0001	0.0000473
2,3,7,8-TCDF	3.33	0.00235	0.00391	1	0.00391
1,2,3,7,8-PeCDF	1.62	0.000901	0.00073	0.1	0.000073
2,3,4,7,8-PeCDF	2.45	0.0013	0.00159	1	0.00159
1,2,3,4,7,8-HxCDF	2.16	0.000559	0.000604	0.1	0.0000604
1,2,3,6,7,8-HxCDF	1.85	0.000365	0.000338	0.1	0.0000338
2,3,4,6,7,8-HxCDF	1.11	0.000208	0.000115	0.1	0.0000115
1,2,3,7,8,9-HxCDF	0.08	0.0000468	0.00000187	0.1	0.000000187
1,2,3,4,6,7,8-HpCDF	8.2	0.000447	0.00183	0.01	0.0000183
1,2,3,4,7,8,9-HpCDF	0.24	0.0000604	0.00000725	0.01	7.25E-08
1,2,3,4,6,7,8,9-OCDF	18.78	0.00025	0.00235	0.0001	0.000000235

2,3,7,8-TCDD TEQ (pg/g)	**0.00658**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Average Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.128	0.0845	1	0.0845
1,2,3,7,8-PeCDD	0.9	0.00196	0.00485	1	0.00485
1,2,3,4,7,8-HxCDD	0.51	0.0233	0.0327	0.05	0.00164
1,2,3,6,7,8-HxCDD	3.54	0.0192	0.187	0.01	0.00187
1,2,3,7,8,9-HxCDD	2.82	0.00738	0.0572	0.1	0.00572
1,2,3,4,6,7,8-HpCDD	155.02	0.000262	0.112	<0.001	0
1,2,3,4,6,7,8,9-OCDD	2605.33	0.000033	0.236	0.0001	0.0000236
2,3,7,8-TCDF	3.33	0.00148	0.0136	1	0.0136
1,2,3,7,8-PeCDF	1.62	0.00073	0.00325	0.1	0.000325
2,3,4,7,8-PeCDF	2.45	0.00465	0.0313	1	0.0313
1,2,3,4,7,8-HxCDF	2.16	0.000599	0.00356	0.1	0.000356
1,2,3,6,7,8-HxCDF	1.85	0.0042	0.0214	0.1	0.00214
2,3,4,6,7,8-HxCDF	1.11	0.00354	0.0108	0.1	0.00108
1,2,3,7,8,9-HxCDF	0.08	0	0	0.1	0
1,2,3,4,6,7,8-HpCDF	8.2	0.000157	0.00354	0.01	0.0000354
1,2,3,4,7,8,9-HpCDF	0.24	0	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	18.78	0.00000522	0.00027	0.0001	0.000000027

2,3,7,8-TCDD TEQ (pg/g)	**0.147**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Average Soil Concentration, On Site, Bird Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.18	0.0216	1	0.0216
1,2,3,7,8-PeCDD	0.9	0.291	0.131	1	0.131
1,2,3,4,7,8-HxCDD	0.51	0.209	0.0533	0.05	0.00267
1,2,3,6,7,8-HxCDD	3.54	0.121	0.214	0.01	0.00214
1,2,3,7,8,9-HxCDD	2.82	0.0472	0.0666	0.1	0.00666
1,2,3,4,6,7,8-HpCDD	155.02	0.0603	4.67	<0.001	0
1,2,3,4,6,7,8,9-OCDD	2605.33	0.0333	43.4	0.0001	0.00434
2,3,7,8-TCDF	3.33	0.0566	0.0942	1	0.0942
1,2,3,7,8-PeCDF	1.62	0.0307	0.0249	0.1	0.00249
2,3,4,7,8-PeCDF	2.45	0.653	0.8	1	0.8
1,2,3,4,7,8-HxCDF	2.16	0.335	0.362	0.1	0.0362
1,2,3,6,7,8-HxCDF	1.85	0.413	0.382	0.1	0.0382
2,3,4,6,7,8-HxCDF	1.11	0.425	0.236	0.1	0.0236
1,2,3,7,8,9-HxCDF	0.08	0.0588	0.00235	0.1	0.000235
1,2,3,4,6,7,8-HpCDF	8.2	0.0616	0.253	0.01	0.00253
1,2,3,4,7,8,9-HpCDF	0.24	0.102	0.0122	0.01	0.000122
1,2,3,4,6,7,8,9-OCDF	18.78	0.0499	0.469	0.0001	0.0000469

2,3,7,8-TCDD TEQ (pg/g)	**1.17**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Average Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Mean Relative Bioavailability	Available Concentration in Soil	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	All Samples		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFmammal
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	2	0.0048	1	0.0048
1,2,3,7,8-PeCDD	0.9	31.7	0.285	1	0.285
1,2,3,4,7,8-HxCDD	0.51	23.6	0.12	0.1	0.012
1,2,3,6,7,8-HxCDD	3.54	21.1	0.747	0.1	0.0747
1,2,3,7,8,9-HxCDD	2.82	19.7	0.556	0.1	0.0556
1,2,3,4,6,7,8-HpCDD	155.02	24.3	37.7	0.01	0.377
1,2,3,4,6,7,8,9-OCDD	2605.33	39.8	1040	0.0003	0.312
2,3,7,8-TCDF	3.33	24.1	0.803	0.1	0.0803
1,2,3,7,8-PeCDF	1.62	22.8	0.369	0.03	0.0111
2,3,4,7,8-PeCDF	2.45	34.4	0.843	0.3	0.253
1,2,3,4,7,8-HxCDF	2.16	40.9	0.883	0.1	0.0883
1,2,3,6,7,8-HxCDF	1.85	31.5	0.583	0.1	0.0583
2,3,4,6,7,8-HxCDF	1.11	39.4	0.437	0.1	0.0437
1,2,3,7,8,9-HxCDF	0.08	28.6	0.0229	0.1	0.00229
1,2,3,4,6,7,8-HpCDF	8.2	28.5	2.34	0.01	0.0234
1,2,3,4,7,8,9-HpCDF	0.24	28	0.0672	0.01	0.000672
1,2,3,4,6,7,8,9-OCDF	18.78	42.2	7.93	0.0003	0.00238

2,3,7,8-TCDD TEQ (pg/g)	**1.68**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Average Soil Concentration, On Site, Mammal Receptor)

Receptor	Average 2,3,7,8-TCDD TEQ 0-4' On Site All Samples (pg/g)	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Mammal	5.89	0.002	0.0118	0.117	0.689

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
Average 2,3,7,8-TCDD TEQ concentrations were calculated by multiplying the congener average concentration for 0-4' on site soil by the TEF.
TEQ for mammal uses WHO 2005 TEF-mammal applied to site average concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Average Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.0114	0.00205	1	0.00205
1,2,3,7,8-PeCDD	0.9	0.00126	0.000851	1	0.000851
1,2,3,4,7,8-HxCDD	0.51	0.000265	0.000101	0.1	0.0000101
1,2,3,6,7,8-HxCDD	3.54	0.00026	0.00069	0.1	0.000069
1,2,3,7,8,9-HxCDD	2.82	0.0000759	0.000161	0.1	0.0000161
1,2,3,4,6,7,8-HpCDD	155.02	0.000317	0.0369	0.01	0.000369
1,2,3,4,6,7,8,9-OCDD	2605.33	0.000223	0.436	0.0003	0.000131
2,3,7,8-TCDF	3.33	0.00289	0.00722	0.1	0.000722
1,2,3,7,8-PeCDF	1.62	0.000224	0.000272	0.03	0.00000816
2,3,4,7,8-PeCDF	2.45	0.00116	0.00213	0.3	0.000639
1,2,3,4,7,8-HxCDF	2.16	0.000147	0.000238	0.1	0.0000238
1,2,3,6,7,8-HxCDF	1.85	0.000415	0.000576	0.1	0.0000576
2,3,4,6,7,8-HxCDF	1.11	0.000107	0.0000891	0.1	0.00000891
1,2,3,7,8,9-HxCDF	0.08	0.0000251	0.00000151	0.1	0.000000151
1,2,3,4,6,7,8-HpCDF	8.2	0.000239	0.00147	0.01	0.0000147
1,2,3,4,7,8,9-HpCDF	0.24	0.000064	0.0000115	0.01	0.000000115
1,2,3,4,6,7,8,9-OCDF	18.78	0.000208	0.00293	0.0003	0.000000879

2,3,7,8-TCDD TEQ (pg/g)	**0.00497**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Average Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.00389	0.000467	1	0.000467
1,2,3,7,8-PeCDD	0.9	0.000778	0.00035	1	0.00035
1,2,3,4,7,8-HxCDD	0.51	0.0000917	0.0000234	0.1	0.00000234
1,2,3,6,7,8-HxCDD	3.54	0.000109	0.000193	0.1	0.0000193
1,2,3,7,8,9-HxCDD	2.82	0.0000792	0.000112	0.1	0.0000112
1,2,3,4,6,7,8-HpCDD	155.02	0.000436	0.0338	0.01	0.000338
1,2,3,4,6,7,8,9-OCDD	2605.33	0.000363	0.473	0.0003	0.000142
2,3,7,8-TCDF	3.33	0.00235	0.00391	0.1	0.000391
1,2,3,7,8-PeCDF	1.62	0.000901	0.00073	0.03	0.0000219
2,3,4,7,8-PeCDF	2.45	0.0013	0.00159	0.3	0.000477
1,2,3,4,7,8-HxCDF	2.16	0.000559	0.000604	0.1	0.0000604
1,2,3,6,7,8-HxCDF	1.85	0.000365	0.000338	0.1	0.0000338
2,3,4,6,7,8-HxCDF	1.11	0.000208	0.000115	0.1	0.0000115
1,2,3,7,8,9-HxCDF	0.08	0.0000468	0.00000187	0.1	0.000000187
1,2,3,4,6,7,8-HpCDF	8.2	0.000447	0.00183	0.01	0.0000183
1,2,3,4,7,8,9-HpCDF	0.24	0.0000604	0.00000725	0.01	0.0000000725
1,2,3,4,6,7,8,9-OCDF	18.78	0.00025	0.00235	0.0003	0.000000705

2,3,7,8-TCDD TEQ (pg/g)	**0.00234**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Average Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.128	0.0845	1	0.0845
1,2,3,7,8-PeCDD	0.9	0.00196	0.00485	1	0.00485
1,2,3,4,7,8-HxCDD	0.51	0.0233	0.0327	0.1	0.00327
1,2,3,6,7,8-HxCDD	3.54	0.0192	0.187	0.1	0.0187
1,2,3,7,8,9-HxCDD	2.82	0.00738	0.0572	0.1	0.00572
1,2,3,4,6,7,8-HpCDD	155.02	0.000262	0.112	0.01	0.00112
1,2,3,4,6,7,8,9-OCDD	2605.33	0.000033	0.236	0.0003	0.0000708
2,3,7,8-TCDF	3.33	0.00148	0.0136	0.1	0.00136
1,2,3,7,8-PeCDF	1.62	0.00073	0.00325	0.03	0.0000975
2,3,4,7,8-PeCDF	2.45	0.00465	0.0313	0.3	0.00939
1,2,3,4,7,8-HxCDF	2.16	0.000599	0.00356	0.1	0.000356
1,2,3,6,7,8-HxCDF	1.85	0.0042	0.0214	0.1	0.00214
2,3,4,6,7,8-HxCDF	1.11	0.00354	0.0108	0.1	0.00108
1,2,3,7,8,9-HxCDF	0.08	0	0	0.1	0
1,2,3,4,6,7,8-HpCDF	8.2	0.000157	0.00354	0.01	0.0000354
1,2,3,4,7,8,9-HpCDF	0.24	0	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	18.78	0.00000522	0.00027	0.0003	0.000000081

2,3,7,8-TCDD TEQ (pg/g)	**0.133**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Average Soil Concentration, On Site, Mammal Receptor)

Dioxin/Furan Congener	Average Soil Concentration 0-4' On Site	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.24	0.18	0.0216	1	0.0216
1,2,3,7,8-PeCDD	0.9	0.291	0.131	1	0.131
1,2,3,4,7,8-HxCDD	0.51	0.209	0.0533	0.1	0.00533
1,2,3,6,7,8-HxCDD	3.54	0.121	0.214	0.1	0.0214
1,2,3,7,8,9-HxCDD	2.82	0.0472	0.0666	0.1	0.00666
1,2,3,4,6,7,8-HpCDD	155.02	0.0603	4.67	0.01	0.0467
1,2,3,4,6,7,8,9-OCDD	2605.33	0.0333	43.4	0.0003	0.013
2,3,7,8-TCDF	3.33	0.0566	0.0942	0.1	0.00942
1,2,3,7,8-PeCDF	1.62	0.0307	0.0249	0.03	0.000747
2,3,4,7,8-PeCDF	2.45	0.653	0.8	0.3	0.24
1,2,3,4,7,8-HxCDF	2.16	0.335	0.362	0.1	0.0362
1,2,3,6,7,8-HxCDF	1.85	0.413	0.382	0.1	0.0382
2,3,4,6,7,8-HxCDF	1.11	0.425	0.236	0.1	0.0236
1,2,3,7,8,9-HxCDF	0.08	0.0588	0.00235	0.1	0.000235
1,2,3,4,6,7,8-HpCDF	8.2	0.0616	0.253	0.01	0.00253
1,2,3,4,7,8,9-HpCDF	0.24	0.102	0.0122	0.01	0.000122
1,2,3,4,6,7,8,9-OCDF	18.78	0.0499	0.469	0.0003	0.000141

2,3,7,8-TCDD TEQ (pg/g)	**0.597**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' on site soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

2,3,7,8-TCDD TEQ HQ CALCULATIONS USING AVERAGE SOIL CONCENTRATIONS

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): American Robin

American Robin			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0773		BW
Soil ingestion proportion	0.02		Ps
Food ingestion Rate (kg/kgBW/d)	0.132		FIR
Proportion of diet, plants	0.41		Pp
Proportion of diet, soil inverts	0.59		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.36E-06	Soil	6.23E-09
2,3,7,8-TCDD TEQ	1.66E-08	Plants	8.97E-10
2,3,7,8-TCDD TEQ	9.70E-07	Soil invertebrates	7.55E-08
		Daily Intake	2.48E-08
		HQ	0.0089

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): Mallard Duck

Mallard Duck			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	1.134		BW
Soil ingestion proportion	0.033		Ps
Food ingestion Rate (kg/kgBW/d)	0.05		FIR
Proportion of diet, plants	0.5		Pp
Proportion of diet, benthic inverts	0.5		Pbi
Area use factor	0.0099		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.36E-06	Soil	3.89E-09
2,3,7,8-TCDD TEQ	1.66E-08	Plants	4.15E-10
2,3,7,8-TCDD TEQ	6.58E-09	Benthic Invertebrates	1.65E-10
		Daily Intake	1.33E-11
		HQ	0.00000474

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): Spotted Sandpiper

Spotted Sandpiper			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0425		BW
Soil ingestion proportion	0.17		Ps
Food ingestion Rate (kg/kgBW/d)	0.196		FIR
Proportion of diet, benthic inverts	1		Pbi
Area use factor	0.5		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.36E-06	Soil	7.86E-08
2,3,7,8-TCDD TEQ	6.58E-09	Benthic Invertebrates	1.29E-09
		Daily Intake	1.20E-08
		HQ	0.00428

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): Snowy Egret

Snowy Egret			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.371		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.116		FIR
Proportion of diet, crabs	0.1		Pc
Proportion of diet, fish	0.9		Pf
Area use factor	0.0082		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.36E-06	Soil	1.37E-09
2,3,7,8-TCDD TEQ	6.58E-09	Crabs	7.63E-11
2,3,7,8-TCDD TEQ	1.25E-08	Fish	1.31E-09
		Daily Intake	6.78E-12
		HQ	0.00000242

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): Great Blue Heron

Great Blue Heron			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.229		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.103		FIR
Proportion of diet, crabs	0.1		Pc
Proportion of diet, fish	0.9		Pf
Area use factor	0.0071		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	2.36E-06	Soil	1.22E-09
2,3,7,8-TCDD TEQ	6.58E-09	Crabs	6.78E-11
2,3,7,8-TCDD TEQ	1.25E-08	Fish	1.16E-09
		Daily Intake	5.21E-12
		HQ	0.000002

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): American Bald Eagle

American Bald Eagle			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.6		BW
Soil ingestion proportion	0		Ps
Food ingestion Rate (kg/kgBW/d)	0.09		FIR
Proportion of diet, mammals	0.068		Pm
Proportion of diet, birds	0.165		Pb
Proportion of diet, fish	0.767		Pf
Area use factor	0.000032		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	1.17E-06	Mammals	7.16E-09
2,3,7,8-TCDD TEQ	1.47E-07	Birds	2.18E-09
2,3,7,8-TCDD TEQ	1.25E-08	Fish	8.63E-10
		Daily Intake	9.79E-14
		HQ	0.0000000350

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): Swamp Rabbit

Swamp Rabbit			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.118		BW
Soil ingestion proportion	0.063		Ps
Food ingestion Rate (kg/kgBW/d)	0.13		FIR
Proportion of diet, plants	1		Pp
Area use factor	0.51		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	1.68E-06	Soil	1.38E-08
2,3,7,8-TCDD TEQ	1.18E-08	Plants	1.53E-09
		Daily Intake	2.35E-09
		HQ	0.00065

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): Least Shrew

Least Shrew			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.017		BW
Soil ingestion proportion	0.13		Ps
Food ingestion Rate (kg/kgBW/d)	0.096		FIR
Proportion of diet, soil inverts	1		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	1.68E-06	Soil	2.10E-08
2,3,7,8-TCDD TEQ	6.89E-07	Soil invertebrates	6.62E-08
		Daily Intake	2.62E-08
		HQ	0.0073

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): Red Fox

Red Fox			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.53		BW
Soil ingestion proportion	0.028		Ps
Food ingestion Rate (kg/kgBW/d)	0.16		FIR
Proportion of diet, plants	0.07		Pp
Proportion of diet, soil inverts	0.03		Pi
Proportion of diet, mammals	0.9		Pm
Area use factor	0.0017		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	1.68E-06	Soil	7.53E-09
2,3,7,8-TCDD TEQ	1.18E-08	Plants	1.32E-10
2,3,7,8-TCDD TEQ	6.89E-07	Soil invertebrates	3.31E-09
2,3,7,8-TCDD TEQ	5.97E-07	Mammals	8.60E-08
		Daily Intake	4.95E-11
		HQ	0.0000137

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): On Site (0-4'): American Mink

American Mink			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	1		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.137		FIR
Proportion of diet, mammals	0.22		Pm
Proportion of diet, benthic inverts	0.64		Pbi
Proportion of diet, fish	0.14		Pf
Area use factor	0.019		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	1.68E-06	Soil	1.15E-09
2,3,7,8-TCDD TEQ	5.97E-07	Mammals	1.80E-08
2,3,7,8-TCDD TEQ	2.34E-09	Benthic Invertebrates	2.05E-10
2,3,7,8-TCDD TEQ	4.97E-09	Fish	9.53E-11
		Daily Intake	1.11E-10
		HQ	0.0000308

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations on site.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

ATTACHMENT 3 BC-8 AREA

COPEC concentrations used for estimating potential risk (HQs) in the BERA for Hero Lands Property in soil samples (BC-8 Area).

Constituent	Units	Maximum Concentration	Average Concentration
Arsenic	mg/kg dry	7.79	4.18
Barium	mg/kg dry	524	223
Cadmium	mg/kg dry	0.916	0.427
Lead	mg/kg dry	69.9	20.9
Mercury	mg/kg dry	0.162	0.0788
Zinc	mg/kg dry	144	53.7
2,3,7,8-TCDD TEQ (bird)	pg/g dry	30.5	29.6
2,3,7,8-TCDD TEQ (mammal)	pg/g dry	14.2	11.7

Summary Results (HQs) from BERA for the Hero Lands Property Using Maximum Concentrations as the Exposure Concentrations (BC-8 Area).

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0204	0.0000426	0.0132	0.0000133	0.0000102	0.0000000392
Barium	0.00192	0.00000179	0.000591	0.00000685	0.00000527	0.00000055
Cadmium	0.118	0.0000557	0.0113	0.0000782	0.0000601	0.000000196
Lead	0.294	0.000336	0.085	0.0000814	0.0000626	0.00000143
Mercury	0.00219	0.00000277	0.000702	0.0000148	0.0000113	0.00000642
Zinc	0.176	0.000437	0.15	0.000222	0.000171	0.000000318

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.00568	0.0487	0.00000726	0.000479
Barium	0.00000884	0.00025	0.000000425	0.00000234
Cadmium	0.0139	0.264	0.0000557	0.000488
Lead	0.0117	0.114	0.000128	0.000761
Mercury	0.000862	0.00781	0.00000155	0.0000593
Zinc	0.0141	0.177	0.000128	0.00251

COPEC: 2,3,7,8-TCDD TEQ	
Species	HQ
Avian Receptors	
American Robin	0.0326
Mallard Duck	0.0000175
Spotted Sandpiper	0.01579
Snowy Egret	0.00000890
Great Blue Heron	0.00000685
American Bald Eagle	0.000000129
Mammalian Receptors	
Swamp Rabbit	0.00146
Least Shrew	0.0176
Red Fox	0.0000478
American Mink	0.000109

Summary Results (HQs) from BERA for the Hero Lands Property Using Average Concentrations as the Exposure Concentrations (BC-8 Area).

COPEC	Avian Receptor Species					
	American Robin	Mallard Duck	Spotted Sandpiper	Snowy Egret	Great Blue Heron	American Bald Eagle
Arsenic	0.0109	0.0000229	0.00706	0.0000071	0.00000546	0.0000000211
Barium	0.000818	0.000000761	0.000253	0.00000292	0.00000224	0.000000235
Cadmium	0.055	0.0000259	0.0053	0.0000364	0.000028	0.0000000914
Lead	0.0879	0.0001	0.0255	0.0000243	0.0000187	0.000000429
Mercury	0.00107	0.00000135	0.000342	0.00000718	0.00000552	0.00000312
Zinc	0.0657	0.000163	0.056	0.0000829	0.0000638	0.000000119

COPEC	Mammalian Receptor Species			
	Swamp Rabbit	Least Shrew	Red Fox	American Mink
Arsenic	0.00305	0.0261	0.00000389	0.000257
Barium	0.00000376	0.000108	0.000000181	0.000000997
Cadmium	0.00648	0.123	0.0000259	0.000228
Lead	0.00351	0.0343	0.0000384	0.000227
Mercury	0.00042	0.00380	0.000000749	0.0000288
Zinc	0.00528	0.0659	0.0000476	0.000937

COPEC: 2,3,7,8-TCDD TEQ	
Species	HQ
Avian Receptors	
American Robin	0.0317
Mallard Duck	0.0000170
Spotted Sandpiper	0.0153
Snowy Egret	0.00000887
Great Blue Heron	0.00000682
American Bald Eagle	0.000000133
Mammalian Receptors	
Swamp Rabbit	0.00131
Least Shrew	0.0145
Red Fox	0.0000422
American Mink	0.0000969

HAZARD QUOTIENT CALCULATIONS - METALS - MAXIMUM CONCENTRATIONS

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): American Robin

American Robin			Calculations based on maximum values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	0.0773	BW							
Soil ingestion proportion	0.02	Ps							
Food ingestion Rate (kg/kgBW/d)	0.132	FIR							
Proportion of diet, plants	0.41	Pp							
Proportion of diet, soil inverts	0.59	Pi							
Area use factor	1	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	7.79	2.24	0.01	0.0375	0.224	0.000206	0.0158	0.136	0.0204
Barium	524	600	0.0002	0.0046	0.091	0.000277	0.13	3.71	0.00192
Cadmium	0.916	1.47	0.036	0.586	7.708	0.0000871	0.0291	0.55	0.118
Lead	69.9	1.63	0.01	0.0389	0.266	0.00185	0.147	1.45	0.294
Mercury	0.162	3.25	0.00031	0.27	1.693	0.000000133	0.00237	0.0214	0.00219
Zinc	144	66.1	0.1	0.366	3.201	0.038	2.85	35.9	0.176

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): Mallard Duck

Mallard Duck			
Parameter	**Value**	**Symbol**	**Calculations based on maximum values**
Body weight (kg)	1.134	BW	
Soil ingestion proportion	0.033	Ps	
Food ingestion Rate (kg/kgBW/d)	0.05	FIR	
Proportion of diet, plants	0.5	Pp	
Proportion of diet, benthic inverts	0.5	Pbi	
Area use factor	0.0099	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	7.79	2.24	0.01	0.0375	0.127	0.000129	0.0073	0.0247	0.0000426
Barium	524	600	0.0002	0.0046	0.023	0.000173	0.0603	0.301	0.00000179
Cadmium	0.916	1.47	0.036	0.586	0.614	0.0000544	0.0134	0.0141	0.0000557
Lead	69.9	1.63	0.01	0.0389	0.066	0.00115	0.068	0.115	0.000336
Mercury	0.162	3.25	0.00031	0.27	0.48	0.0000000829	0.00109	0.00194	0.00000277
Zinc	144	66.1	0.1	0.366	2.33	0.0238	1.32	8.39	0.000437

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0425	BW	
Soil ingestion proportion	0.17	Ps	
Food ingestion Rate (kg/kgBW/d)	0.196	FIR	
Proportion of diet, benthic inverts	1	Pbi	
Area use factor	0.5	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	7.79	2.24	0.01	0.127	0.0026	0.194	0.0132
Barium	524	600	0.0002	0.023	0.00349	2.36	0.000591
Cadmium	0.916	1.47	0.036	0.614	0.0011	0.11	0.0113
Lead	69.9	1.63	0.01	0.066	0.0233	0.904	0.0853
Mercury	0.162	3.25	0.00031	0.48	0.00000167	0.0152	0.000702
Zinc	144	66.1	0.1	2.33	0.48	65.8	0.15

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): Snowy Egret

Snowy Egret			Calculations based on maximum values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	0.371	BW							
Soil ingestion proportion	0.005	Ps							
Food ingestion Rate (kg/kgBW/d)	0.116	FIR							
Proportion of diet, benthic inverts	0.1	Pbi							
Proportion of diet, fish	0.9	Pf							
Area use factor	0.0082	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	7.79	2.24	0.01	0.127	0.00065	0.0000452	0.0115	0.000529	0.0000133
Barium	524	600	0.0002	0.023	0.028	0.0000608	0.14	1.53	0.00000685
Cadmium	0.916	1.47	0.036	0.614	0.42	0.0000191	0.00652	0.0402	0.0000782
Lead	69.9	1.63	0.01	0.066	0.0000018	0.000405	0.0535	0.0000131	0.0000814
Mercury	0.162	3.25	0.00031	0.48	1.1	0.0000000291	0.000902	0.0186	0.0000148
Zinc	144	66.1	0.1	2.33	0.138	0.00835	3.89	2.07	0.000222

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	7.79	2.24	0.01	0.127	0.00065	0.0000401	0.0102	0.000469	0.0000102
Barium	524	600	0.0002	0.023	0.028	0.000054	0.124	1.36	0.00000527
Cadmium	0.916	1.47	0.036	0.614	0.42	0.000017	0.00579	0.0357	0.0000601
Lead	69.9	1.63	0.01	0.066	0.0000018	0.00036	0.0475	0.0000117	0.0000626
Mercury	0.162	3.25	0.00031	0.48	1.1	0.0000000259	0.000801	0.0165	0.0000113
Zinc	144	66.1	0.1	2.33	0.138	0.00742	3.46	1.84	0.000171

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): American Bald Eagle

American Bald Eagle			Calculations based on maximum values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.6	BW	
Soil ingestion proportion	0	Ps	
Food ingestion Rate (kg/kgBW/d)	0.09	FIR	
Proportion of diet, mammals	0.068	Pm	
Proportion of diet, birds	0.165	Pb	
Proportion of diet, fish	0.767	Pf	
Area use factor	0.000032	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	7.79	2.24	-	0.0025	0.075	0.00065	-	0.000119	0.00868	0.00035	3.92E-08
Barium	524	20.8	-	0.0566	0.00001	0.028	-	0.182	0.0000778	1.01	0.00000055
Cadmium	0.916	1.47	-	0.3333	0.113	0.42	-	0.00187	0.00154	0.0266	0.000000196
Lead	69.9	1.63	-	0.1054	0.191	0.0000018	-	0.0451	0.198	0.00000869	0.00000143
Mercury	0.162	0.019	-	0.0534	0.148	1.1	-	0.0000529	0.000356	0.0123	0.00000642
Zinc	144	66.1	-	0.7717	0.0645	0.138	-	0.68	0.138	1.37	0.000000318

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on maximum values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	2.118	BW					
Soil ingestion proportion	0.063	Ps					
Food ingestion Rate (kg/kgBW/d)	0.13	FIR					
Proportion of diet, plants	1	Pp					
Area use factor	0.51	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	7.79	1.04	0.01	0.0375	0.000638	0.038	0.00568
Barium	524	5433	0.0002	0.0046	0.000858	0.313	0.00000884
Cadmium	0.916	0.77	0.036	0.586	0.00027	0.0698	0.0139
Lead	69.9	4.7	0.01	0.0389	0.00572	0.353	0.0117
Mercury	0.162	1.01	0.00031	0.27	0.000000411	0.00569	0.000862
Zinc	144	75.4	0.1	0.366	0.118	6.85	0.0141

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): Least Shrew

Least Shrew			Calculations based on maximum values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	0.017	BW					
Soil ingestion proportion	0.13	Ps					
Food ingestion Rate (kg/kgBW/d)	0.096	FIR					
Proportion of diet, soil inverts	1	Pi					
Area use factor	1	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	7.79	1.04	0.01	0.224	0.000972	0.168	0.0487
Barium	524	5433	0.0002	0.091	0.00131	4.58	0.000253
Cadmium	0.916	0.77	0.036	7.708	0.000412	0.678	0.264
Lead	69.9	4.7	0.01	0.266	0.00872	1.78	0.114
Mercury	0.162	1.01	0.00031	1.693	0.000000627	0.0263	0.00781
Zinc	144	75.4	0.1	3.201	0.18	44.3	0.177

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): Red Fox

Red Fox			Calculations based on maximum values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	4.53	BW									
Soil ingestion proportion	0.028	Ps									
Food ingestion Rate (kg/kgBW/d)	0.16	FIR									
Proportion of diet, plants	0.07	Pp									
Proportion of diet, soil inverts	0.03	Pi									
Proportion of diet, mammals	0.9	Pm									
Area use factor	0.0017	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	7.79	1.04	0.01	0.0375	0.224	0.0025	0.000349	0.00327	0.00838	0.0028	0.00000726
Barium	524	5433	0.0002	0.0046	0.091	0.0566	0.00047	0.027	0.229	4.27	0.000000425
Cadmium	0.916	0.77	0.036	0.586	7.708	0.3333	0.000148	0.00601	0.0339	0.044	0.0000557
Lead	69.9	4.7	0.01	0.0389	0.266	0.1054	0.00313	0.0305	0.0892	1.06	0.000128
Mercury	0.162	1.01	0.00031	0.27	1.693	0.0534	0.000000225	0.00049	0.00132	0.00125	0.00000155
Zinc	144	75.4	0.1	0.366	3.201	0.7717	0.0645	0.59	2.21	16	0.000128

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Max. Conc.): BC-8 Area (0-4'): American Mink

American Mink			Calculations based on maximum values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Maximum Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	7.79	1.04	0.01	0.0025	0.127	0.00065	0.0000534	0.000587	0.0867	0.0000971	0.000479
Barium	524	5433	0.0002	0.0566	0.023	0.028	0.0000718	0.894	1.06	0.281	0.00000234
Cadmium	0.916	0.77	0.036	0.3333	0.614	0.42	0.0000226	0.0092	0.0493	0.00738	0.000488
Lead	69.9	4.7	0.01	0.1054	0.066	0.0000018	0.000479	0.222	0.405	0.00000241	0.000761
Mercury	0.162	1.01	0.00031	0.0534	0.48	1.1	0.0000000344	0.000261	0.00682	0.00342	0.0000593
Zinc	144	75.4	0.1	0.7717	2.33	0.138	0.00986	3.35	29.4	0.381	0.00251

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT CALCULATIONS - METALS - AVERAGE CONCENTRATIONS

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): American Robin

American Robin			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0773	BW	
Soil ingestion proportion	0.02	Ps	
Food ingestion Rate (kg/kgBW/d)	0.132	FIR	
Proportion of diet, plants	0.41	Pp	
Proportion of diet, soil inverts	0.59	Pi	
Area use factor	1	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**HQ**
Arsenic	4.18	2.24	0.01	0.0375	0.224	0.00011	0.00848	0.0729	0.0109
Barium	223	600	0.0002	0.0046	0.091	0.000118	0.0555	1.58	0.000818
Cadmium	0.427	1.47	0.036	0.586	7.708	0.0000406	0.0135	0.256	0.055
Lead	20.9	1.63	0.01	0.0389	0.266	0.000552	0.044	0.433	0.0879
Mercury	0.0788	3.25	0.00031	0.27	1.693	0.0000000645	0.00115	0.0104	0.00107
Zinc	53.7	66.1	0.1	0.366	3.201	0.0142	1.06	13.4	0.0657

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): Mallard Duck

Mallard Duck			Calculations based on average values						
Parameter	**Value**	**Symbol**							
Body weight (kg)	1.134	BW							
Soil ingestion proportion	0.033	Ps							
Food ingestion Rate (kg/kgBW/d)	0.05	FIR							
Proportion of diet, plants	0.5	Pp							
Proportion of diet, benthic inverts	0.5	Pbi							
Area use factor	0.0099	AUF							
Time (temporal) factor	0.3	TF							
			Absorbed Fraction (AF)			**Absorbed Concentration from Medium and Biota**			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF benthic inverts**	**Soil/ Sediment**	**Plants**	**Benthic Inverts**	**HQ**
Arsenic	4.18	2.24	0.01	0.0375	0.127	0.000069	0.00392	0.0133	0.0000229
Barium	223	600	0.0002	0.0046	0.023	0.0000736	0.0256	0.128	0.000000761
Cadmium	0.427	1.47	0.036	0.586	0.614	0.0000254	0.00626	0.00655	0.0000259
Lead	20.9	1.63	0.01	0.0389	0.066	0.000345	0.0203	0.0345	0.0001
Mercury	0.0788	3.25	0.00031	0.27	0.48	0.0000000403	0.000532	0.000946	0.00000135
Zinc	53.7	66.1	0.1	0.366	2.33	0.00886	0.491	3.13	0.000163

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): Spotted Sandpiper

Spotted Sandpiper			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.0425	BW	
Soil ingestion proportion	0.17	Ps	
Food ingestion Rate (kg/kgBW/d)	0.196	FIR	
Proportion of diet, benthic inverts	1	Pbi	
Area use factor	0.5	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)		Absorbed Concentration from Medium and Biota		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**Soil/ Sediment**	**Benthic Inverts**	**HQ**
Arsenic	4.18	2.24	0.01	0.127	0.00139	0.104	0.00706
Barium	223	600	0.0002	0.023	0.00149	1.01	0.000253
Cadmium	0.427	1.47	0.036	0.614	0.000512	0.0514	0.0053
Lead	20.9	1.63	0.01	0.066	0.00696	0.27	0.0255
Mercury	0.0788	3.25	0.00031	0.48	0.000000814	0.00741	0.000342
Zinc	53.7	66.1	0.1	2.33	0.179	24.5	0.056

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): Snowy Egret

Snowy Egret			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	0.371	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.116	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0082	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	4.18	2.24	0.01	0.127	0.00065	0.0000242	0.00616	0.000284	0.0000071
Barium	223	600	0.0002	0.023	0.028	0.0000259	0.0595	0.652	0.00000292
Cadmium	0.427	1.47	0.036	0.614	0.42	0.00000892	0.00304	0.0187	0.0000364
Lead	20.9	1.63	0.01	0.066	0.0000018	0.000121	0.016	0.00000393	0.0000243
Mercury	0.0788	3.25	0.00031	0.48	1.1	0.0000000142	0.000439	0.00905	0.00000718
Zinc	53.7	66.1	0.1	2.33	0.138	0.00311	1.45	0.774	0.0000829

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): Great Blue Heron

Great Blue Heron			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	2.229	BW	
Soil ingestion proportion	0.005	Ps	
Food ingestion Rate (kg/kgBW/d)	0.103	FIR	
Proportion of diet, benthic inverts	0.1	Pbi	
Proportion of diet, fish	0.9	Pf	
Area use factor	0.0071	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)			Absorbed Concentration from Medium and Biota			
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	4.18	2.24	0.01	0.127	0.00065	0.0000215	0.00547	0.000252	0.00000546
Barium	223	600	0.0002	0.023	0.028	0.000023	0.0528	0.579	0.00000224
Cadmium	0.427	1.47	0.036	0.614	0.42	0.00000792	0.0027	0.0166	0.000028
Lead	20.9	1.63	0.01	0.066	0.0000018	0.000108	0.0142	0.00000349	0.0000187
Mercury	0.0788	3.25	0.00031	0.48	1.1	0.0000000126	0.00039	0.00804	0.00000552
Zinc	53.7	66.1	0.1	2.33	0.138	0.00277	1.29	0.687	0.0000638

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): American Bald Eagle

American Bald Eagle			Calculations based on average values
Parameter	**Value**	**Symbol**	
Body weight (kg)	4.6	BW	
Soil ingestion proportion	0	Ps	
Food ingestion Rate (kg/kgBW/d)	0.09	FIR	
Proportion of diet, mammals	0.068	Pm	
Proportion of diet, birds	0.165	Pb	
Proportion of diet, fish	0.767	Pf	
Area use factor	0.000032	AUF	
Time (temporal) factor	0.3	TF	

			Absorbed Fraction (AF)				Absorbed Concentration from Medium and Biota				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF birds**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Birds**	**Fish**	**HQ**
Arsenic	4.18	2.24	-	0.0025	0.075	0.00065	-	0.000064	0.00466	0.000188	0.0000000211
Barium	223	20.8	-	0.0566	0.00001	0.028	-	0.0772	0.0000331	0.431	0.000000235
Cadmium	0.427	1.47	-	0.3333	0.113	0.42	-	0.000871	0.000717	0.0124	0.0000000914
Lead	20.9	1.63	-	0.1054	0.191	0.0000018	-	0.0135	0.0593	0.0000026	0.000000429
Mercury	0.0788	0.019	-	0.0534	0.148	1.1	-	0.0000258	0.000173	0.00598	0.00000312
Zinc	53.7	66.1	-	0.7717	0.0645	0.138	-	0.254	0.0514	0.512	0.000000119

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): Swamp Rabbit

Swamp Rabbit			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	2.118	BW					
Soil ingestion proportion	0.063	Ps					
Food ingestion Rate (kg/kgBW/d)	0.13	FIR					
Proportion of diet, plants	1	Pp					
Area use factor	0.51	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**Soil/ Sediment**	**Plants**	**HQ**
Arsenic	4.18	1.04	0.01	0.0375	0.000342	0.0204	0.00305
Barium	223	5433	0.0002	0.0046	0.000365	0.133	0.00000376
Cadmium	0.427	0.77	0.036	0.586	0.000126	0.0325	0.00648
Lead	20.9	4.7	0.01	0.0389	0.00171	0.106	0.00351
Mercury	0.0788	1.01	0.00031	0.27	0.0000002	0.00277	0.00042
Zinc	53.7	75.4	0.1	0.366	0.044	2.56	0.00528

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): Least Shrew

Least Shrew			Calculations based on average values				
Parameter	**Value**	**Symbol**					
Body weight (kg)	0.017	BW					
Soil ingestion proportion	0.13	Ps					
Food ingestion Rate (kg/kgBW/d)	0.096	FIR					
Proportion of diet, soil inverts	1	Pi					
Area use factor	1	AUF					
Time (temporal) factor	0.3	TF					
			Absorbed Fraction (AF)		**Absorbed Concentration from Medium and Biota**		
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF soil inverts**	**Soil/ Sediment**	**Soil Inverts**	**HQ**
Arsenic	4.18	1.04	0.01	0.224	0.000522	0.0899	0.0261
Barium	223	5433	0.0002	0.091	0.000557	1.95	0.000108
Cadmium	0.427	0.77	0.036	7.708	0.000192	0.316	0.123
Lead	20.9	4.7	0.01	0.266	0.00261	0.534	0.0343
Mercury	0.0788	1.01	0.00031	1.693	0.000000305	0.0128	0.0038
Zinc	53.7	75.4	0.1	3.201	0.067	16.5	0.0659

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): Red Fox

Red Fox											
Parameter	**Value**	**Symbol**	**Calculations based on average values**								
Body weight (kg)	4.53	BW									
Soil ingestion proportion	0.028	Ps									
Food ingestion Rate (kg/kgBW/d)	0.16	FIR									
Proportion of diet, plants	0.07	Pp									
Proportion of diet, soil inverts	0.03	Pi									
Proportion of diet, mammals	0.9	Pm									
Area use factor	0.0017	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF plants**	**BCF soil inverts**	**BCF mammals**	**Soil/ Sediment**	**Plants**	**Soil Inverts**	**Mammals**	**HQ**
Arsenic	4.18	1.04	0.01	0.0375	0.224	0.0025	0.000187	0.00176	0.00449	0.0015	0.00000389
Barium	223	5433	0.0002	0.0046	0.091	0.0566	0.0002	0.0115	0.0974	1.82	0.000000181
Cadmium	0.427	0.77	0.036	0.586	7.708	0.3333	0.0000689	0.0028	0.0158	0.0205	0.0000259
Lead	20.9	4.7	0.01	0.0389	0.266	0.1054	0.000936	0.00911	0.0267	0.317	0.0000384
Mercury	0.0788	1.01	0.00031	0.27	1.693	0.0534	0.000000109	0.000238	0.00064	0.000606	0.000000749
Zinc	53.7	75.4	0.1	0.366	3.201	0.7717	0.0241	0.22	0.825	5.97	0.0000476

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil/Sediment HQ Calculations (Avg. Conc.): BC-8 Area (0-4'): American Mink

American Mink			Calculations based on average values								
Parameter	**Value**	**Symbol**									
Body weight (kg)	1	BW									
Soil ingestion proportion	0.005	Ps									
Food ingestion Rate (kg/kgBW/d)	0.137	FIR									
Proportion of diet, mammals	0.22	Pm									
Proportion of diet, benthic inverts	0.64	Pbi									
Proportion of diet, fish	0.14	Pf									
Area use factor	0.019	AUF									
Time (temporal) factor	0.3	TF									
			Absorbed Fraction (AF)				**Absorbed Concentration from Medium and Biota**				
COPEC	**Average Soil/Sediment Concentration (0-4')**	**TRV**	**Soil bio-factor**	**BCF mammals**	**BCF benthic inverts**	**BCF fish**	**Soil/ Sediment**	**Mammals**	**Benthic Inverts**	**Fish**	**HQ**
Arsenic	4.18	1.04	0.01	0.0025	0.127	0.00065	0.0000286	0.000315	0.0465	0.0000521	0.000257
Barium	223	5433	0.0002	0.0566	0.023	0.028	0.0000306	0.38	0.45	0.12	0.000000997
Cadmium	0.427	0.77	0.036	0.3333	0.614	0.42	0.0000105	0.00429	0.023	0.00344	0.000228
Lead	20.9	4.7	0.01	0.1054	0.066	0.0000018	0.000143	0.0664	0.121	7.22E-07	0.000227
Mercury	0.0788	1.01	0.00031	0.0534	0.48	1.1	0.0000000167	0.000127	0.00332	0.00166	0.0000288
Zinc	53.7	75.4	0.1	0.7717	2.33	0.138	0.00368	1.25	11	0.142	0.000937

Notes:
- Not Applicable. NA: Not Available
Soil/sediment concentrations are in mg/kg dry weight.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (fo
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

HAZARD QUOTIENT INPUT FACTORS AND CALCULATIONS - DIOXINS/FURANS

SOIL 2,3,7,8-TCDD TEQ CALCULATIONS

Calculation of 2,3,7,8-TCDD TEQ for BC-8 Area Soil 0-4': Bird

		Reported Data		Calculated Average Congener Concentration (BC-8 Area, 0-4')	WHO 1998 TEF Bird	Calculated Toxicity Equivalent Concentration Predicted for Birds		Calculated Average Toxic Equivalent Concentration Predicted for Bird (BC-8 Area, 0-4')
Location ID		BC-8R	BC-8R			BC-8R	BC-8R	
Depth Interval		0-2'	2-4'			0-2'	2-4'	
Sample Date		6/24/2019	6/24/2019			6/24/2019	6/24/2019	
Sampler		ERM	ERM			ERM	ERM	
Reported Parameter	*Area*	Off Site	Off Site			Off Site	Off Site	
2,3,7,8-TCDD	pg/g-dry	0.884	1.17	1.03	1	0.884	1.17	1.03
1,2,3,7,8-PeCDD	pg/g-dry	4.1	4.22 K	2.05	1	4.1	0	2.05
1,2,3,4,7,8-HxCDD	pg/g-dry	2.51	1.78 K	1.26	0.05	0.1255	0	0.0630
1,2,3,6,7,8-HxCDD	pg/g-dry	5.55	2.9	4.23	0.01	0.0555	0.029	0.0423
1,2,3,7,8,9-HxCDD	pg/g-dry	4.93	2.84 K	2.47	0.1	0.493	0	0.247
1,2,3,4,6,7,8-HpCDD	pg/g-dry	52.9	26.5	39.7	<0.001	0	0	0
1,2,3,4,6,7,8,9-OCDD	pg/g-dry	867	393	630	0.0001	0.0867	0.0393	0.0630
2,3,7,8-TCDF	pg/g-dry	10.6, **12.2**	**13.1**, 17.3	12.7	1	12.2	13.1	12.7
1,2,3,7,8-PeCDF	pg/g-dry	10.3	10.5	10.4	0.1	1.03	1.05	1.04
2,3,4,7,8-PeCDF	pg/g-dry	8.56	10.6	9.58	1	8.56	10.6	9.58
1,2,3,4,7,8-HxCDF	pg/g-dry	14	9.48	11.7	0.1	1.4	0.948	1.17
1,2,3,6,7,8-HxCDF	pg/g-dry	8.05	8.59	8.32	0.1	0.805	0.859	0.832
2,3,4,6,7,8-HxCDF	pg/g-dry	4.9	5.98	5.44	0.1	0.49	0.598	0.544
1,2,3,7,8,9-HxCDF	pg/g-dry	0.982K	<2.32	0	0.1	0	0	0
1,2,3,4,6,7,8-HpCDF	pg/g-dry	28.4	21.5	25.0	0.01	0.284	0.215	0.250
1,2,3,4,7,8,9-HpCDF	pg/g-dry	2.01	<2.15	1.01	0.01	0.0201	0	0.0101
1,2,3,4,6,7,8,9-OCDF	pg/g-dry	20.4	10.4	15.4	0.0001	0.00204	0.00104	0.00154
				Calculated 2,3,7,8-TCDD TEQ (bird)		30.5	28.6	29.6

Notes:
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
K-flagged values were reported by the laboratory as estimated maximum probable concentrations (EMPC).
Non-detect and K-flagged values were assumed a value of 0 for average and TEQ calculations.
For ERM samples, the laboratory reported two 2,3,7,8-TCDF results: one from the original analysis run and one from subsequent dual column confirmation. Bolded 2,3,7,8-TCDF values were used in average and TEQ calculations, and were reported from the original analysis run, except for sample SB-4R 0-2'. 2,3,7,8-TCDF in the original run for sample SB-4R was a K-flagged result. Therefore the non-flagged result from the dual column confirmation run was used to represent 2,3,7,8-TCDF concentration in sample SB-4R 0-2'.

Calculation of 2,3,7,8-TCDD TEQ for BC-8 Area Soil 0-4': Mammal

		Reported Data		Calculated Average Congener Concentration (BC-8 Area, 0-4')	WHO 2005 TEF Mammal	Calculated Toxicity Equivalent Concentration Predicted for Mammals		Calculated Average Toxic Equivalent Concentration Predicted for Mammal (BC-8 Area, 0-4')
Location ID		BC-8R	BC-8R			BC-8R	BC-8R	
Depth Interval		0-2'	2-4'			0-2'	2-4'	
Sample Date		6/24/2019	6/24/2019			6/24/2019	6/24/2019	
Sampler		ERM	ERM			ERM	ERM	
Reported Parameter	*Area*	Off Site	Off Site			Off Site	Off Site	
2,3,7,8-TCDD	pg/g-dry	0.884	1.17	1.03	1	0.884	1.17	1.03
1,2,3,7,8-PeCDD	pg/g-dry	4.1	4.22 K	2.05	1	4.1	0	2.05
1,2,3,4,7,8-HxCDD	pg/g-dry	2.51	1.78 K	1.26	0.1	0.251	0	0.126
1,2,3,6,7,8-HxCDD	pg/g-dry	5.55	2.9	4.23	0.1	0.555	0.29	0.423
1,2,3,7,8,9-HxCDD	pg/g-dry	4.93	2.84 K	2.47	0.1	0.493	0	0.247
1,2,3,4,6,7,8-HpCDD	pg/g-dry	52.9	26.5	39.7	0.01	0.529	0.265	0.40
1,2,3,4,6,7,8,9-OCDD	pg/g-dry	867	393	630	0.0003	0.2601	0.1179	0.189
2,3,7,8-TCDF	pg/g-dry	10.6, **12.2**	**13.1**, 17.3	12.7	0.1	1.22	1.31	1.265
1,2,3,7,8-PeCDF	pg/g-dry	10.3	10.5	10.4	0.03	0.309	0.315	0.312
2,3,4,7,8-PeCDF	pg/g-dry	8.56	10.6	9.58	0.3	2.568	3.18	2.874
1,2,3,4,7,8-HxCDF	pg/g-dry	14	9.48	11.7	0.1	1.4	0.948	1.174
1,2,3,6,7,8-HxCDF	pg/g-dry	8.05	8.59	8.32	0.1	0.805	0.859	0.832
2,3,4,6,7,8-HxCDF	pg/g-dry	4.9	5.98	5.44	0.1	0.49	0.598	0.544
1,2,3,7,8,9-HxCDF	pg/g-dry	0.982K	<2.32	0	0.1	0	0	0
1,2,3,4,6,7,8-HpCDF	pg/g-dry	28.4	21.5	25.0	0.01	0.284	0.215	0.2495
1,2,3,4,7,8,9-HpCDF	pg/g-dry	2.01	<2.15	1.01	0.01	0.0201	0	0.0101
1,2,3,4,6,7,8,9-OCDF	pg/g-dry	20.4	10.4	15.4	0.0003	0.00612	0.00312	0.00462
				Calculated 2,3,7,8-TCDD TEQ (mammal)		14.2	9.27	11.7

Notes:

WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.
K-flagged values were reported by the laboratory as estimated maximum probable concentrations (EMPC).
Non-detect and K-flagged values were assumed a value of 0 for average and TEQ calculations.

For ERM samples, the laboratory reported two 2,3,7,8-TCDF results: one from the original analysis run and one from subsequent dual column confirmation. Bolded 2,3,7,8-TCDF values were used in average and TEQ calculations, and were reported from the original analysis run, except for sample SB-4R 0-2'. 2,3,7,8-TCDF in the original run for sample SB-4R was a K-flagged result. Therefore the non-flagged result from the dual column confirmation run was used to represent 2,3,7,8-TCDF concentration in sample SB-4R 0-2'.

DIET 2,3,7,8-TCDD TEQ CALCULATIONS USING MAXIMUM SOIL CONCENTRATIONS

Summary of 2,3,7,8-TCDD TEQ Concentration by Food Item and Taxa Based on Maximum Soil Concentration (BC-8 Area)

	Bird		Mammal	
	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ
Diet Item	pg/g	mg/kg	pg/g	mg/kg
Soil	8.71	0.00000871	4.18	0.00000418
Plants	0.061	0.0000000610	0.0284	0.0000000284
Soil invertebrates	3.57	0.00000357	1.66	0.00000166
Mammals	4.37	0.00000437	2.160	0.00000216
Birds	0.531	0.0000005310	0.444	0.000000444
Benthic Invertebrates	0.0243	0.0000000243	0.00743	0.00000000743
Fish	0.046	0.0000000460	0.0172	0.0000000172

Note:
Concentrations based on Dioxins/Furans reported for maximum 0-4' soil in BC-8 Area (BC-8R 0-2' for mammal and bird).

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Maximum Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' BC-8 Area	Mean Relative Bioavailability	Available Concentration in Soil	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-8R 0-2'		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFmammal		Bioavailable Soil Conc x TEFbird
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.884	2	0.0177	1	0.0177	1	0.0177
1,2,3,7,8-PeCDD	4.1	31.7	1.3	1	1.3	1	1.3
1,2,3,4,7,8-HxCDD	2.51	23.6	0.592	0.1	0.0592	0.05	0.0296
1,2,3,6,7,8-HxCDD	5.55	21.1	1.17	0.1	0.117	0.01	0.0117
1,2,3,7,8,9-HxCDD	4.93	19.7	0.971	0.1	0.0971	0.1	0.0971
1,2,3,4,6,7,8-HpCDD	52.9	24.3	12.9	0.01	0.129	<0.001	0
1,2,3,4,6,7,8,9-OCDD	867	39.8	345	0.0003	0.104	0.0001	0.0345
2,3,7,8-TCDF	10.6, **12.2**	24.1	2.94	0.1	0.294	1	2.94
1,2,3,7,8-PeCDF	10.3	22.8	2.35	0.03	0.0705	0.1	0.235
2,3,4,7,8-PeCDF	8.56	34.4	2.94	0.3	0.882	1	2.94
1,2,3,4,7,8-HxCDF	14	40.9	5.73	0.1	0.573	0.1	0.573
1,2,3,6,7,8-HxCDF	8.05	31.5	2.54	0.1	0.254	0.1	0.254
2,3,4,6,7,8-HxCDF	4.9	39.4	1.93	0.1	0.193	0.1	0.193
1,2,3,7,8,9-HxCDF	0.982K	28.6	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	28.4	28.5	8.09	0.01	0.0809	0.01	0.0809
1,2,3,4,7,8,9-HpCDF	2.01	28	0.563	0.01	0.00563	0.01	0.00563
1,2,3,4,6,7,8,9-OCDF	20.4	42.2	8.61	0.0003	0.00258	0.0001	0.000861
2,3,7,8-TCDD TEQ (pg/g)					**4.18**		**8.71**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
BC-8R 0-2' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' BC-8 Area soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Maximum Soil Concentration, BC-8 Area)

Receptor	Maximum 2,3,7,8-TCDD TEQ 0-4' On Site BC-16R 2-4' (pg/g)	Sample ID	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Bird	30.5	BC-8R 0-2'	0.002	0.0610	0.117	3.569
Mammal	14.2	BC-8R 0-2'	0.002	0.0284	0.117	1.66

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
BC-8R 0-2' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' BC-8 Area soil.
TEQ for bird uses WHO 1998 TEF-bird applied to site concentration.
TEQ for mammal uses WHO 2005 TEF-mammal applied to site concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Maximum Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' BC-8 Area	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-8R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.884	0.0114	0.00756	1	0.00756	1	0.00756
1,2,3,7,8-PeCDD	4.1	0.00126	0.00387	1	0.00387	1	0.00387
1,2,3,4,7,8-HxCDD	2.51	0.000265	0.000499	0.1	0.0000499	0.05	0.000025
1,2,3,6,7,8-HxCDD	5.55	0.00026	0.00108	0.1	0.000108	0.01	0.0000108
1,2,3,7,8,9-HxCDD	4.93	0.0000759	0.000281	0.1	0.0000281	0.1	0.0000281
1,2,3,4,6,7,8-HpCDD	52.9	0.000317	0.0126	0.01	0.000126	<0.001	0
1,2,3,4,6,7,8,9-OCDD	867	0.000223	0.145	0.0003	0.0000435	0.0001	0.0000145
2,3,7,8-TCDF	10.6, **12.2**	0.00289	0.0264	0.1	0.00264	1	0.0264
1,2,3,7,8-PeCDF	10.3	0.000224	0.00173	0.03	0.0000519	0.1	0.000173
2,3,4,7,8-PeCDF	8.56	0.00116	0.00745	0.3	0.00224	1	0.00745
1,2,3,4,7,8-HxCDF	14	0.000147	0.00154	0.1	0.000154	0.1	0.000154
1,2,3,6,7,8-HxCDF	8.05	0.000415	0.00251	0.1	0.000251	0.1	0.000251
2,3,4,6,7,8-HxCDF	4.9	0.000107	0.000393	0.1	0.0000393	0.1	0.0000393
1,2,3,7,8,9-HxCDF	0.982K	0.0000251	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	28.4	0.000239	0.00509	0.01	0.0000509	0.01	0.0000509
1,2,3,4,7,8,9-HpCDF	2.01	0.000064	0.0000965	0.01	0.000000965	0.01	0.000000965
1,2,3,4,6,7,8,9-OCDF	20.4	0.000208	0.00318	0.0003	0.000000954	0.0001	0.000000318

2,3,7,8-TCDD TEQ (pg/g)	**0.0172**	**0.046**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-8R 0-2' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' BC-8 Area soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Maximum Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' BC-8 Area	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-8R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.884	0.00389	0.00172	1	0.00172	1	0.00172
1,2,3,7,8-PeCDD	4.1	0.000778	0.00159	1	0.00159	1	0.00159
1,2,3,4,7,8-HxCDD	2.51	0.0000917	0.000115	0.1	0.0000115	0.05	0.00000575
1,2,3,6,7,8-HxCDD	5.55	0.000109	0.000302	0.1	0.0000302	0.01	0.00000302
1,2,3,7,8,9-HxCDD	4.93	0.0000792	0.000195	0.1	0.0000195	0.1	0.0000195
1,2,3,4,6,7,8-HpCDD	52.9	0.000436	0.0115	0.01	0.000115	<0.001	0
1,2,3,4,6,7,8,9-OCDD	867	0.000363	0.157	0.0003	0.0000471	0.0001	0.0000157
2,3,7,8-TCDF	10.6, **12.2**	0.00235	0.0143	0.1	0.00143	1	0.0143
1,2,3,7,8-PeCDF	10.3	0.000901	0.00464	0.03	0.000139	0.1	0.000464
2,3,4,7,8-PeCDF	8.56	0.0013	0.00556	0.3	0.00167	1	0.00556
1,2,3,4,7,8-HxCDF	14	0.000559	0.00391	0.1	0.000391	0.1	0.000391
1,2,3,6,7,8-HxCDF	8.05	0.000365	0.00147	0.1	0.000147	0.1	0.000147
2,3,4,6,7,8-HxCDF	4.9	0.000208	0.00051	0.1	0.000051	0.1	0.000051
1,2,3,7,8,9-HxCDF	0.982K	0.0000468	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	28.4	0.000447	0.00635	0.01	0.0000635	0.01	0.0000635
1,2,3,4,7,8,9-HpCDF	2.01	0.0000604	0.0000607	0.01	0.000000607	0.01	0.000000607
1,2,3,4,6,7,8,9-OCDF	20.4	0.00025	0.00255	0.0003	0.000000765	0.0001	0.0000002550

2,3,7,8-TCDD TEQ (pg/g)					**0.00743**		**0.0243**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-8R 0-2' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' BC-8 Area soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Maximum Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' BC-8 Area	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-8R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.884	0.128	0.311	1	0.311	1	0.311
1,2,3,7,8-PeCDD	4.1	0.00196	0.0221	1	0.0221	1	0.0221
1,2,3,4,7,8-HxCDD	2.51	0.0233	0.161	0.1	0.0161	0.05	0.00805
1,2,3,6,7,8-HxCDD	5.55	0.0192	0.293	0.1	0.0293	0.01	0.00293
1,2,3,7,8,9-HxCDD	4.93	0.00738	0.1	0.1	0.01	0.1	0.01
1,2,3,4,6,7,8-HpCDD	52.9	0.000262	0.0381	0.01	0.000381	<0.001	0
1,2,3,4,6,7,8,9-OCDD	867	0.000033	0.0787	0.0003	0.0000236	0.0001	0.00000787
2,3,7,8-TCDF	10.6, **12.2**	0.00148	0.0497	0.1	0.00497	1	0.0497
1,2,3,7,8-PeCDF	10.3	0.00073	0.0207	0.03	0.000621	0.1	0.00207
2,3,4,7,8-PeCDF	8.56	0.00465	0.109	0.3	0.0327	1	0.109
1,2,3,4,7,8-HxCDF	14	0.000599	0.0231	0.1	0.00231	0.1	0.00231
1,2,3,6,7,8-HxCDF	8.05	0.0042	0.093	0.1	0.0093	0.1	0.0093
2,3,4,6,7,8-HxCDF	4.9	0.00354	0.0477	0.1	0.00477	0.1	0.00477
1,2,3,7,8,9-HxCDF	0.982K	0	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	28.4	0.000157	0.0123	0.01	0.000123	0.01	0.000123
1,2,3,4,7,8,9-HpCDF	2.01	0	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	20.4	0.00000522	0.000293	0.0003	8.79E-08	0.0001	0.0000000293
2,3,7,8-TCDD TEQ (pg/g)					**0.444**		**0.531**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-8R 0-2' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' BC-8 Area soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Maximum Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Reported Maximum Soil Concentration 0-4' BC-8 Area	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	BC-8R 0-2'		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	0.884	0.18	0.0796	1	0.0796	1	0.0796
1,2,3,7,8-PeCDD	4.1	0.291	0.597	1	0.597	1	0.597
1,2,3,4,7,8-HxCDD	2.51	0.209	0.262	0.1	0.0262	0.05	0.0131
1,2,3,6,7,8-HxCDD	5.55	0.121	0.336	0.1	0.0336	0.01	0.00336
1,2,3,7,8,9-HxCDD	4.93	0.0472	0.116	0.1	0.0116	0.1	0.0116
1,2,3,4,6,7,8-HpCDD	52.9	0.0603	1.59	0.01	0.0159	<0.001	0
1,2,3,4,6,7,8,9-OCDD	867	0.0333	14.4	0.0003	0.00432	0.0001	0.00144
2,3,7,8-TCDF	10.6, **12.2**	0.0566	0.345	0.1	0.0345	1	0.345
1,2,3,7,8-PeCDF	10.3	0.0307	0.158	0.03	0.00474	0.1	0.0158
2,3,4,7,8-PeCDF	8.56	0.653	2.79	0.3	0.837	1	2.79
1,2,3,4,7,8-HxCDF	14	0.335	2.35	0.1	0.235	0.1	0.235
1,2,3,6,7,8-HxCDF	8.05	0.413	1.66	0.1	0.166	0.1	0.166
2,3,4,6,7,8-HxCDF	4.9	0.425	1.04	0.1	0.104	0.1	0.104
1,2,3,7,8,9-HxCDF	0.982K	0.0588	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	28.4	0.0616	0.875	0.01	0.00875	0.01	0.00875
1,2,3,4,7,8,9-HpCDF	2.01	0.102	0.103	0.01	0.00103	0.01	0.00103
1,2,3,4,6,7,8,9-OCDF	20.4	0.0499	0.509	0.0003	0.000153	0.0001	0.0000509
2,3,7,8-TCDD TEQ (pg/g)					**2.160**		**4.37**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
BC-8R 0-2' contains the maximum 2,3,7,8-TCDD TEQ concentration (bird and mammal) in 0-4' BC-8 Area soil.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

2,3,7,8-TCDD TEQ HQ CALCULATIONS USING MAXIMUM SOIL CONCENTRATIONS

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): American Robin

American Robin			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0773		BW
Soil ingestion proportion	0.02		Ps
Food ingestion Rate (kg/kgBW/d)	0.132		FIR
Proportion of diet, plants	0.41		Pp
Proportion of diet, soil inverts	0.59		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.71E-06	Soil	2.30E-08
2,3,7,8-TCDD TEQ	6.10E-08	Plants	3.30E-09
2,3,7,8-TCDD TEQ	3.57E-06	Soil invertebrates	2.78E-07
		Daily Intake	9.13E-08
		HQ	0.0326

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): Mallard Duck

Mallard Duck			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	1.134		BW
Soil ingestion proportion	0.033		Ps
Food ingestion Rate (kg/kgBW/d)	0.05		FIR
Proportion of diet, plants	0.5		Pp
Proportion of diet, benthic inverts	0.5		Pbi
Area use factor	0.0099		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.71E-06	Soil	1.44E-08
2,3,7,8-TCDD TEQ	6.10E-08	Plants	1.53E-09
2,3,7,8-TCDD TEQ	2.43E-08	Benthic Invertebrates	6.08E-10
		Daily Intake	4.91E-11
		HQ	0.0000175

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): Spotted Sandpiper

Spotted Sandpiper			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0425		BW
Soil ingestion proportion	0.17		Ps
Food ingestion Rate (kg/kgBW/d)	0.196		FIR
Proportion of diet, benthic inverts	1		Pbi
Area use factor	0.5		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.71E-06	Soil	2.90E-07
2,3,7,8-TCDD TEQ	2.43E-08	Benthic Invertebrates	4.76E-09
		Daily Intake	4.42E-08
		HQ	0.0158

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): Snowy Egret

Snowy Egret			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.371		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.116		FIR
Proportion of diet, benthic inverts	0.1		Pbi
Proportion of diet, fish	0.9		Pf
Area use factor	0.0082		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.71E-06	Soil	5.05E-09
2,3,7,8-TCDD TEQ	2.43E-08	Benthic Invertebrates	2.82E-10
2,3,7,8-TCDD TEQ	4.60E-08	Fish	4.80E-09
		Daily Intake	2.49E-11
		HQ	0.00000890

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): Great Blue Heron

Great Blue Heron			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.229		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.103		FIR
Proportion of diet, benthic inverts	0.1		Pbi
Proportion of diet, fish	0.9		Pf
Area use factor	0.0071		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.71E-06	Soil	4.49E-09
2,3,7,8-TCDD TEQ	2.43E-08	Benthic Invertebrates	2.50E-10
2,3,7,8-TCDD TEQ	4.60E-08	Fish	4.26E-09
		Daily Intake	1.92E-11
		HQ	0.00000685

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): American Bald Eagle

American Bald Eagle			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.6		BW
Soil ingestion proportion	0		Ps
Food ingestion Rate (kg/kgBW/d)	0.09		FIR
Proportion of diet, mammals	0.068		Pm
Proportion of diet, birds	0.165		Pb
Proportion of diet, fish	0.767		Pf
Area use factor	0.000032		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.71E-06	Soil	-
2,3,7,8-TCDD TEQ	4.37E-06	Mammals	2.67E-08
2,3,7,8-TCDD TEQ	5.31E-07	Birds	7.89E-09
2,3,7,8-TCDD TEQ	4.60E-08	Fish	3.18E-09
		Daily Intake	3.63E-13
		HQ	0.000000129

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): Swamp Rabbit

Swamp Rabbit			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.118		BW
Soil ingestion proportion	0.063		Ps
Food ingestion Rate (kg/kgBW/d)	0.13		FIR
Proportion of diet, plants	1		Pp
Area use factor	0.51		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	4.18E-06	Soil	3.42E-08
2,3,7,8-TCDD TEQ	2.00E-09	Plants	2.60E-10
		Daily Intake	5.27E-09
		HQ	0.00146

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): Least Shrew

Least Shrew			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.017		BW
Soil ingestion proportion	0.13		Ps
Food ingestion Rate (kg/kgBW/d)	0.096		FIR
Proportion of diet, soil inverts	1		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	4.18E-06	Soil	5.22E-08
2,3,7,8-TCDD TEQ	1.66E-06	Soil invertebrates	1.59E-07
		Daily Intake	6.34E-08
		HQ	0.0176

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): Red Fox

Red Fox			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.53		BW
Soil ingestion proportion	0.028		Ps
Food ingestion Rate (kg/kgBW/d)	0.16		FIR
Proportion of diet, plants	0.07		Pp
Proportion of diet, soil inverts	0.03		Pi
Proportion of diet, mammals	0.9		Pm
Area use factor	0.0017		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	4.18E-06	Soil	1.87E-08
2,3,7,8-TCDD TEQ	2.00E-09	Plants	2.24E-11
2,3,7,8-TCDD TEQ	1.66E-06	Soil invertebrates	7.97E-09
2,3,7,8-TCDD TEQ	2.16E-06	Mammals	3.11E-07
		Daily Intake	1.72E-10
		HQ	0.0000478

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Max. Conc.): BC-8 Area (0-4'): American Mink

American Mink			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	1		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.137		FIR
Proportion of diet, mammals	0.22		Pm
Proportion of diet, benthic inverts	0.64		Pbi
Proportion of diet, fish	0.14		Pf
Area use factor	0.019		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	4.18E-06	Soil	2.86E-09
2,3,7,8-TCDD TEQ	2.16E-06	Mammals	6.51E-08
2,3,7,8-TCDD TEQ	7.43E-09	Benthic Invertebrates	6.51E-10
2,3,7,8-TCDD TEQ	1.72E-08	Fish	3.30E-10
		Daily Intake	3.93E-10
		HQ	0.000109

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on maximum soil 0-4' concentration in BC-8 Area, BC-8R 0-2' for mammal and bird.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

DIET 2,3,7,8-TCDD TEQ CALCULATIONS USING AVERAGE SOIL CONCENTRATIONS

Summary of 2,3,7,8-TCDD TEQ Concentration by Food Item and Taxa Based on Average Soil Concentration (BC-8 Area)

	Bird		Mammal	
	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ	2,3,7,8-TCDD TEQ
Diet Item	pg/g	mg/kg	pg/g	mg/kg
Soil	8.4	0.0000084	3.41	0.00000341
Plants	0.0592	0.0000000592	0.0234	0.0000000234
Soil invertebrates	3.463	0.00000346	1.369	0.00000137
Mammals	4.40	0.0000044	1.920	0.00000192
Birds	0.579	0.0000005790	0.469	0.000000469
Benthic Invertebrates	0.025	0.0000000250	0.00705	0.00000000705
Fish	0.0473	0.0000000473	0.0168	0.00000001680

Note:
Diet 2,3,7,8-TCDD TEQ concentrations are calculated using average soil 2,3,7,8-TCDD TEQ or congener concentrations for 0-4' on site samples.

Calculation of 2,3,7,8-TCDD TEQ in Soil (Diet) (Average Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Average Soil Concentration 0-4' BC-8 Area	Mean Relative Bioavailability	Available Concentration in Soil	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF		Bioavailable Soil Conc x TEFmammal		Bioavailable Soil Conc x TEFbird
	(pg/g)	(%)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	1.03	2	0.0206	1	0.0206	1	0.0206
1,2,3,7,8-PeCDD	2.05	31.7	0.65	1	0.65	1	0.65
1,2,3,4,7,8-HxCDD	1.26	23.6	0.297	0.1	0.0297	0.05	0.0149
1,2,3,6,7,8-HxCDD	4.23	21.1	0.893	0.1	0.0893	0.01	0.00893
1,2,3,7,8,9-HxCDD	2.47	19.7	0.487	0.1	0.0487	0.1	0.0487
1,2,3,4,6,7,8-HpCDD	39.7	24.3	9.65	0.01	0.0965	<0.001	0
1,2,3,4,6,7,8,9-OCDD	630	39.8	251	0.0003	0.0753	0.0001	0.0251
2,3,7,8-TCDF	12.7	24.1	3.06	0.1	0.306	1	3.06
1,2,3,7,8-PeCDF	10.4	22.8	2.37	0.03	0.0711	0.1	0.237
2,3,4,7,8-PeCDF	9.58	34.4	3.3	0.3	0.99	1	3.3
1,2,3,4,7,8-HxCDF	11.7	40.9	4.79	0.1	0.479	0.1	0.479
1,2,3,6,7,8-HxCDF	8.32	31.5	2.62	0.1	0.262	0.1	0.262
2,3,4,6,7,8-HxCDF	5.44	39.4	2.14	0.1	0.214	0.1	0.214
1,2,3,7,8,9-HxCDF	0	28.6	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	25.0	28.5	7.13	0.01	0.0713	0.01	0.0713
1,2,3,4,7,8,9-HpCDF	1.01	28	0.283	0.01	0.00283	0.01	0.00283
1,2,3,4,6,7,8,9-OCDF	15.4	42.2	6.5	0.0003	0.00195	0.0001	0.00065
2,3,7,8-TCDD TEQ (pg/g)					**3.41**		**8.4**

Notes:
TEC = Soil Concentration x Soil Bioavailability x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' BC-8 Area soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Plant and Soil Invertebrates (Average Soil Concentration, BC-8 Area)

Receptor	Average 2,3,7,8-TCDD TEQ 0-4' On Site All Samples (pg/g)	Soil-to-Plant BCF	2,3,7,8-TCDD TEQ Concentration in Plant	Soil-to-Earthworm BCF	2,3,7,8-TCDD TEQ Concentration in Soil Invertebrates
Bird	29.6	0.002	0.0592	0.117	3.463
Mammal	11.7	0.002	0.0234	0.117	1.369

Notes:
2,3,7,8-TCDD TEQ Concentation in Plants = Soil Concentration x Soil-to-Plant BCF.
2,3,7,8-TCDD TEQ Concentation in Soil Invertebrates = Soil Concentration x Soil-to-Earthworm BCF.
Average 2,3,7,8-TCDD TEQ concentrations were calculated by multiplying the congener average concentration for 0-4' BC-8 Area soil by the TEF.
TEQ for bird uses WHO 1998 TEF-bird applied to site average concentration.
TEQ for mammal uses WHO 2005 TEF-mammal applied to site average concentration.
Soil-to-plant BCF is the geometric mean of reported median plant BCFs.
Soil-to-earthworm BCF is the geometric mean of reported median earthworm BCFs.
Reference:

Tazelaar, D., Fredricks , T., Seston , R., Coefield , S., Bradley ,P., Roark , S., Kay , D., Newsted , J., Giesy , J., Bursian , S., Zwiernik, M. 2013. Multiple lines of evidence risk assessment of american robins exposed to polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-dioxins (PCDDS) in the Tittabawassee River. Environmental Toxicology and Chemistry / Volume 32, Issue 6.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Fish (Average Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Average Soil Concentration 0-4' BC-8 Area	Soil/Sediment-to-Fish BCF	Concentration in Food Item (Fish)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	1.03	0.0114	0.00881	1	0.00881	1	0.00881
1,2,3,7,8-PeCDD	2.05	0.00126	0.00194	1	0.00194	1	0.00194
1,2,3,4,7,8-HxCDD	1.26	0.000265	0.00025	0.1	0.000025	0.05	0.0000125
1,2,3,6,7,8-HxCDD	4.23	0.00026	0.000825	0.1	0.0000825	0.01	0.00000825
1,2,3,7,8,9-HxCDD	2.47	0.0000759	0.000141	0.1	0.0000141	0.1	0.0000141
1,2,3,4,6,7,8-HpCDD	39.7	0.000317	0.00944	0.01	0.0000944	<0.001	0
1,2,3,4,6,7,8,9-OCDD	630	0.000223	0.105	0.0003	0.0000315	0.0001	0.0000105
2,3,7,8-TCDF	12.7	0.00289	0.0275	0.1	0.00275	1	0.0275
1,2,3,7,8-PeCDF	10.4	0.000224	0.00175	0.03	0.0000525	0.1	0.000175
2,3,4,7,8-PeCDF	9.58	0.00116	0.00833	0.3	0.0025	1	0.00833
1,2,3,4,7,8-HxCDF	11.7	0.000147	0.00129	0.1	0.000129	0.1	0.000129
1,2,3,6,7,8-HxCDF	8.32	0.000415	0.00259	0.1	0.000259	0.1	0.000259
2,3,4,6,7,8-HxCDF	5.44	0.000107	0.000437	0.1	0.0000437	0.1	0.0000437
1,2,3,7,8,9-HxCDF	0	0.0000251	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	25.0	0.000239	0.00448	0.01	0.0000448	0.01	0.0000448
1,2,3,4,7,8,9-HpCDF	1.01	0.000064	0.0000485	0.01	0.000000485	0.01	0.000000485
1,2,3,4,6,7,8,9-OCDF	15.4	0.000208	0.0024	0.0003	0.00000072	0.0001	0.00000024
2,3,7,8-TCDD TEQ (pg/g)					**0.0168**		**0.0473**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 3%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' BC-8 Area soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Benthic Invertebrate (Average Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Average Soil Concentration 0-4' BC-8 Area	Soil/Sediment-to-Benthic Invertebrate BCF	Concentration in Food Item (Benthic Invertebrate)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	1.03	0.00389	0.002	1	0.002	1	0.002
1,2,3,7,8-PeCDD	2.05	0.000778	0.000797	1	0.000797	1	0.000797
1,2,3,4,7,8-HxCDD	1.26	0.0000917	0.0000578	0.1	0.00000578	0.05	0.00000289
1,2,3,6,7,8-HxCDD	4.23	0.000109	0.000231	0.1	0.0000231	0.01	0.00000231
1,2,3,7,8,9-HxCDD	2.47	0.0000792	0.0000978	0.1	0.00000978	0.1	0.00000978
1,2,3,4,6,7,8-HpCDD	39.7	0.000436	0.00865	0.01	0.0000865	<0.001	0
1,2,3,4,6,7,8,9-OCDD	630	0.000363	0.114	0.0003	0.0000342	0.0001	0.0000114
2,3,7,8-TCDF	12.7	0.00235	0.0149	0.1	0.00149	1	0.0149
1,2,3,7,8-PeCDF	10.4	0.000901	0.00469	0.03	0.000141	0.1	0.000469
2,3,4,7,8-PeCDF	9.58	0.0013	0.00623	0.3	0.00187	1	0.00623
1,2,3,4,7,8-HxCDF	11.7	0.000559	0.00327	0.1	0.000327	0.1	0.000327
1,2,3,6,7,8-HxCDF	8.32	0.000365	0.00152	0.1	0.000152	0.1	0.000152
2,3,4,6,7,8-HxCDF	5.44	0.000208	0.000566	0.1	0.0000566	0.1	0.0000566
1,2,3,7,8,9-HxCDF	0	0.0000468	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	25.0	0.000447	0.00559	0.01	0.0000559	0.01	0.0000559
1,2,3,4,7,8,9-HpCDF	1.01	0.0000604	0.0000305	0.01	0.000000305	0.01	0.000000305
1,2,3,4,6,7,8,9-OCDF	15.4	0.00025	0.00193	0.0003	0.000000579	0.0001	0.000000193

2,3,7,8-TCDD TEQ (pg/g)					**0.00705**		**0.025**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' BC-8 Area soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Bird (Average Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Average Soil Concentration 0-4' BC-8 Area	Soil-to-Bird BCF	Concentration in Food Item (Bird)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	1.03	0.128	0.363	1	0.363	1	0.363
1,2,3,7,8-PeCDD	2.05	0.00196	0.011	1	0.011	1	0.011
1,2,3,4,7,8-HxCDD	1.26	0.0233	0.0807	0.1	0.00807	0.05	0.00404
1,2,3,6,7,8-HxCDD	4.23	0.0192	0.223	0.1	0.0223	0.01	0.00223
1,2,3,7,8,9-HxCDD	2.47	0.00738	0.0501	0.1	0.00501	0.1	0.00501
1,2,3,4,6,7,8-HpCDD	39.7	0.000262	0.0286	0.01	0.000286	<0.001	0
1,2,3,4,6,7,8,9-OCDD	630	0.000033	0.0572	0.0003	0.0000172	0.0001	0.00000572
2,3,7,8-TCDF	12.7	0.00148	0.0517	0.1	0.00517	1	0.0517
1,2,3,7,8-PeCDF	10.4	0.00073	0.0209	0.03	0.000627	0.1	0.00209
2,3,4,7,8-PeCDF	9.58	0.00465	0.123	0.3	0.0369	1	0.123
1,2,3,4,7,8-HxCDF	11.7	0.000599	0.0193	0.1	0.00193	0.1	0.00193
1,2,3,6,7,8-HxCDF	8.32	0.0042	0.0961	0.1	0.00961	0.1	0.00961
2,3,4,6,7,8-HxCDF	5.44	0.00354	0.053	0.1	0.0053	0.1	0.0053
1,2,3,7,8,9-HxCDF	0	0	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	25.0	0.000157	0.0108	0.01	0.000108	0.01	0.000108
1,2,3,4,7,8,9-HpCDF	1.01	0	0	0.01	0	0.01	0
1,2,3,4,6,7,8,9-OCDF	15.4	0.00000522	0.000221	0.0003	6.63E-08	0.0001	2.21E-08
2,3,7,8-TCDD TEQ (pg/g)					**0.469**		**0.579**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 11%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' BC-8 Area soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

Calculation of 2,3,7,8-TCDD TEQ in Food Item: Mammal (Average Soil Concentration, BC-8 Area)

Dioxin/Furan Congener	Average Soil Concentration 0-4' BC-8 Area	Soil-to-Mammal BCF	Concentration in Food Item (Mammal)	WHO 2005 TEF-mammal	2,3,7,8-TCDD Equivalent Conc in Mammal Receptor	WHO 1998 TEF-bird	2,3,7,8-TCDD Equivalent Conc in Bird Receptor
	All Samples		(Soil Conc/foc) x BCF x lipid		Conc Food x TEFmammal		Conc Food x TEFbird
	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)	(unitless)	(pg/g)
2,3,7,8-TCDD	1.03	0.18	0.0927	1	0.0927	1	0.0927
1,2,3,7,8-PeCDD	2.05	0.291	0.298	1	0.298	1	0.298
1,2,3,4,7,8-HxCDD	1.26	0.209	0.132	0.1	0.0132	0.05	0.0066
1,2,3,6,7,8-HxCDD	4.23	0.121	0.256	0.1	0.0256	0.01	0.00256
1,2,3,7,8,9-HxCDD	2.47	0.0472	0.0583	0.1	0.00583	0.1	0.00583
1,2,3,4,6,7,8-HpCDD	39.7	0.0603	1.2	0.01	0.012	<0.001	0
1,2,3,4,6,7,8,9-OCDD	630	0.0333	10.5	0.0003	0.00315	0.0001	0.00105
2,3,7,8-TCDF	12.7	0.0566	0.359	0.1	0.0359	1	0.359
1,2,3,7,8-PeCDF	10.4	0.0307	0.16	0.03	0.0048	0.1	0.016
2,3,4,7,8-PeCDF	9.58	0.653	3.13	0.3	0.939	1	3.13
1,2,3,4,7,8-HxCDF	11.7	0.335	1.96	0.1	0.196	0.1	0.196
1,2,3,6,7,8-HxCDF	8.32	0.413	1.72	0.1	0.172	0.1	0.172
2,3,4,6,7,8-HxCDF	5.44	0.425	1.16	0.1	0.116	0.1	0.116
1,2,3,7,8,9-HxCDF	0	0.0588	0	0.1	0	0.1	0
1,2,3,4,6,7,8-HpCDF	25.0	0.0616	0.77	0.01	0.0077	0.01	0.0077
1,2,3,4,7,8,9-HpCDF	1.01	0.102	0.0515	0.01	0.000515	0.01	0.000515
1,2,3,4,6,7,8,9-OCDF	15.4	0.0499	0.384	0.0003	0.000115	0.0001	0.0000384
2,3,7,8-TCDD TEQ (pg/g)					**1.920**		**4.40**

Fraction Organic Carbon: 4% Fraction Lipid in Food Item: 2%

Notes:
TEC = (Soil Concentration ÷ Fraction Organic Carbon) x BCF Food Item x Fraction Lipid Food Item x TEF Receptor
Dioxin/Furan congener concentrations in soil were averaged using 0-4' BC-8 Area soil samples.
ND and K-flagged EMPC results are assumed to be 0.
WHO TEF Birds Source: Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.
WHO TEF Mammals Source: Van den Berg, M; Birnbaum, LS; Denison, M, DeVito, M, Farland, W, Feeley, M; Fiedler, H; Hakansson, H; Hanberg, A; Haws, L; Rose, M; Safe, S; Schrenk, D; Tohyama, C; Tritscher, A; Tuomisto, J; Tysklind, M; Walker, N; Peterson, RE. (2006) The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicol Sci 93:223-241.

2,3,7,8-TCDD TEQ HQ CALCULATIONS USING AVERAGE SOIL CONCENTRATIONS

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): American Robin

American Robin			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0773		BW
Soil ingestion proportion	0.02		Ps
Food ingestion Rate (kg/kgBW/d)	0.132		FIR
Proportion of diet, plants	0.41		Pp
Proportion of diet, soil inverts	0.59		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.40E-06	Soil	2.22E-08
2,3,7,8-TCDD TEQ	5.92E-08	Plants	3.20E-09
2,3,7,8-TCDD TEQ	3.46E-06	Soil invertebrates	2.70E-07
		Daily Intake	8.86E-08
		HQ	0.0317

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): Mallard Duck

Mallard Duck			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	1.134		BW
Soil ingestion proportion	0.033		Ps
Food ingestion Rate (kg/kgBW/d)	0.05		FIR
Proportion of diet, plants	0.5		Pp
Proportion of diet, benthic inverts	0.5		Pbi
Area use factor	0.0099		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.40E-06	Soil	1.39E-08
2,3,7,8-TCDD TEQ	5.92E-08	Plants	1.48E-09
2,3,7,8-TCDD TEQ	2.50E-08	Benthic Invertebrates	6.25E-10
		Daily Intake	4.75E-11
		HQ	0.0000170

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): Spotted Sandpiper

Spotted Sandpiper			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.0425		BW
Soil ingestion proportion	0.17		Ps
Food ingestion Rate (kg/kgBW/d)	0.196		FIR
Proportion of diet, benthic inverts	1		Pbi
Area use factor	0.5		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.40E-06	Soil	2.80E-07
2,3,7,8-TCDD TEQ	2.50E-08	Benthic Invertebrates	4.90E-09
		Daily Intake	4.27E-08
		HQ	0.0153

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): Snowy Egret

Snowy Egret			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.371		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.116		FIR
Proportion of diet, crabs	0.1		Pc
Proportion of diet, fish	0.9		Pf
Area use factor	0.0082		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.40E-06	Soil	4.87E-09
2,3,7,8-TCDD TEQ	2.50E-08	Crabs	2.90E-10
2,3,7,8-TCDD TEQ	4.73E-08	Fish	4.94E-09
		Daily Intake	2.48E-11
		HQ	0.00000887

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a	=	Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a	=	Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N	=	Number of different biota types in diet (food types)
B i	=	Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i	=	Proportion of biota type (i) in diet
FIR	=	Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai	=	Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as	=	Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a	=	The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps	=	Soil ingestion as a proportion of diet
AUF	=	Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): Great Blue Heron

Great Blue Heron			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.229		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.103		FIR
Proportion of diet, crabs	0.1		Pc
Proportion of diet, fish	0.9		Pf
Area use factor	0.0071		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	8.40E-06	Soil	4.33E-09
2,3,7,8-TCDD TEQ	2.50E-08	Crabs	2.58E-10
2,3,7,8-TCDD TEQ	4.73E-08	Fish	4.38E-09
		Daily Intake	1.91E-11
		HQ	0.00000682

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): American Bald Eagle

American Bald Eagle			
Taxa: Bird			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.6		BW
Soil ingestion proportion	0		Ps
Food ingestion Rate (kg/kgBW/d)	0.09		FIR
Proportion of diet, mammals	0.068		Pm
Proportion of diet, birds	0.165		Pb
Proportion of diet, fish	0.767		Pf
Area use factor	0.000032		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000028		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	4.40E-06	Mammals	2.69E-08
2,3,7,8-TCDD TEQ	5.79E-07	Birds	8.60E-09
2,3,7,8-TCDD TEQ	4.73E-08	Fish	3.27E-09
		Daily Intake	3.72E-13
		HQ	0.000000133

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): Swamp Rabbit

Swamp Rabbit			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	2.118		BW
Soil ingestion proportion	0.063		Ps
Food ingestion Rate (kg/kgBW/d)	0.13		FIR
Proportion of diet, plants	1		Pp
Area use factor	0.51		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.41E-06	Soil	2.79E-08
2,3,7,8-TCDD TEQ	2.34E-08	Plants	3.04E-09
		Daily Intake	4.73E-09
		HQ	0.00131

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): Least Shrew

Least Shrew			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	0.017		BW
Soil ingestion proportion	0.13		Ps
Food ingestion Rate (kg/kgBW/d)	0.096		FIR
Proportion of diet, soil inverts	1		Pi
Area use factor	1		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.41E-06	Soil	4.26E-08
2,3,7,8-TCDD TEQ	1.37E-06	Soil invertebrates	1.31E-07
		Daily Intake	5.21E-08
		HQ	0.0145

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): Red Fox

Red Fox			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	4.53		BW
Soil ingestion proportion	0.028		Ps
Food ingestion Rate (kg/kgBW/d)	0.16		FIR
Proportion of diet, plants	0.07		Pp
Proportion of diet, soil inverts	0.03		Pi
Proportion of diet, mammals	0.9		Pm
Area use factor	0.0017		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.41E-06	Soil	1.53E-08
2,3,7,8-TCDD TEQ	2.34E-08	Plants	2.62E-10
2,3,7,8-TCDD TEQ	1.37E-06	Soil invertebrates	6.57E-09
2,3,7,8-TCDD TEQ	1.92E-06	Mammals	2.76E-07
		Daily Intake	1.52E-10
		HQ	0.0000422

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

Soil HQ Calculations for 2,3,7,8-TCDD TEQ (Avg. Conc.): BC-8 Area (0-4'): American Mink

American Mink			
Taxa: Mammal			
Parameter	**Value**		**Symbol**
Body weight (kg)	1		BW
Soil ingestion proportion	0.005		Ps
Food ingestion Rate (kg/kgBW/d)	0.137		FIR
Proportion of diet, mammals	0.22		Pm
Proportion of diet, benthic inverts	0.64		Pbi
Proportion of diet, fish	0.14		Pf
Area use factor	0.019		AUF
Time (temporal) factor	0.3		TF
Toxicity Reference Value	0.0000036		TRV
COPEC	**Diet Item Concentration (mg/kg)**	**Diet Item**	**Absorbed Concentration (mg/kg BW/day)**
2,3,7,8-TCDD TEQ	3.41E-06	Soil	2.34E-09
2,3,7,8-TCDD TEQ	1.92E-06	Mammals	5.79E-08
2,3,7,8-TCDD TEQ	7.05E-09	Benthic Invertebrates	6.18E-10
2,3,7,8-TCDD TEQ	1.68E-08	Fish	3.22E-10
		Daily Intake	3.49E-10
		HQ	0.0000969

Notes:
- Not Applicable. NA: Not Available
Diet item concentration was calculated based on average soil 0-4' concentrations in BC-8 Area.

$$\frac{\left([Soil_a \; x \; P_s \; x \; FIR \; x \; AF_{as}] + [\sum_i^N B_i \; x \; P_i \; x \; FIR \; x \; AF_{ai}]\right) x \; AUF}{TRV} = HQ$$

Where:

HQ a = Hazard Quotient for analyte a (COPEC a) (unitless)
Soil a = Concentration of analyte a (COPEC a) in soil (mg/kg dry weight)
N = Number of different biota types in diet (food types)
B i = Analyte a (COPEC a) in biota type (i) (mg/kg dry weight)
P i = Proportion of biota type (i) in diet
FIR = Food ingestion rate (kg food [dry weight]/kg BW [wet weight]/day); BW = body weight
AF ai = Absorbed fraction of analyte a (COPEC a) from biota type (i)
AF as = Absorbed fraction of analyte a (COPEC a) from soil (s)
TRV a = The estimated no adverse effect dose (mg/kg BW/day) for the surrogate species
Ps = Soil ingestion as a proportion of diet
AUF = Area use factor ([home range factor] and [temporal factor, TF])

ERM has over 160 offices across the following countries and territories worldwide

Argentina
Australia
Belgium
Brazil
Canada
Chile
China
Colombia
France
Germany
Guyana
Hong Kong
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Kenya
Malaysia
Mexico
Mozambique
Myanmar
The Netherlands
New Zealand
Norway
Panama
Peru
Poland
Portugal
Puerto Rico
Romania
Russia
Singapore
South Africa
South Korea
Spain
Sweden
Switzerland
Taiwan
Tanzania
Thailand
UK
US
Vietnam

ERM's Baton Rouge Office

Two United Plaza, 8550 United Plaza
Baton Rouge, Louisiana 70809

T: 225-292-3001
F: 225-292-3011

www.erm.com

The business of sustainability

ERM